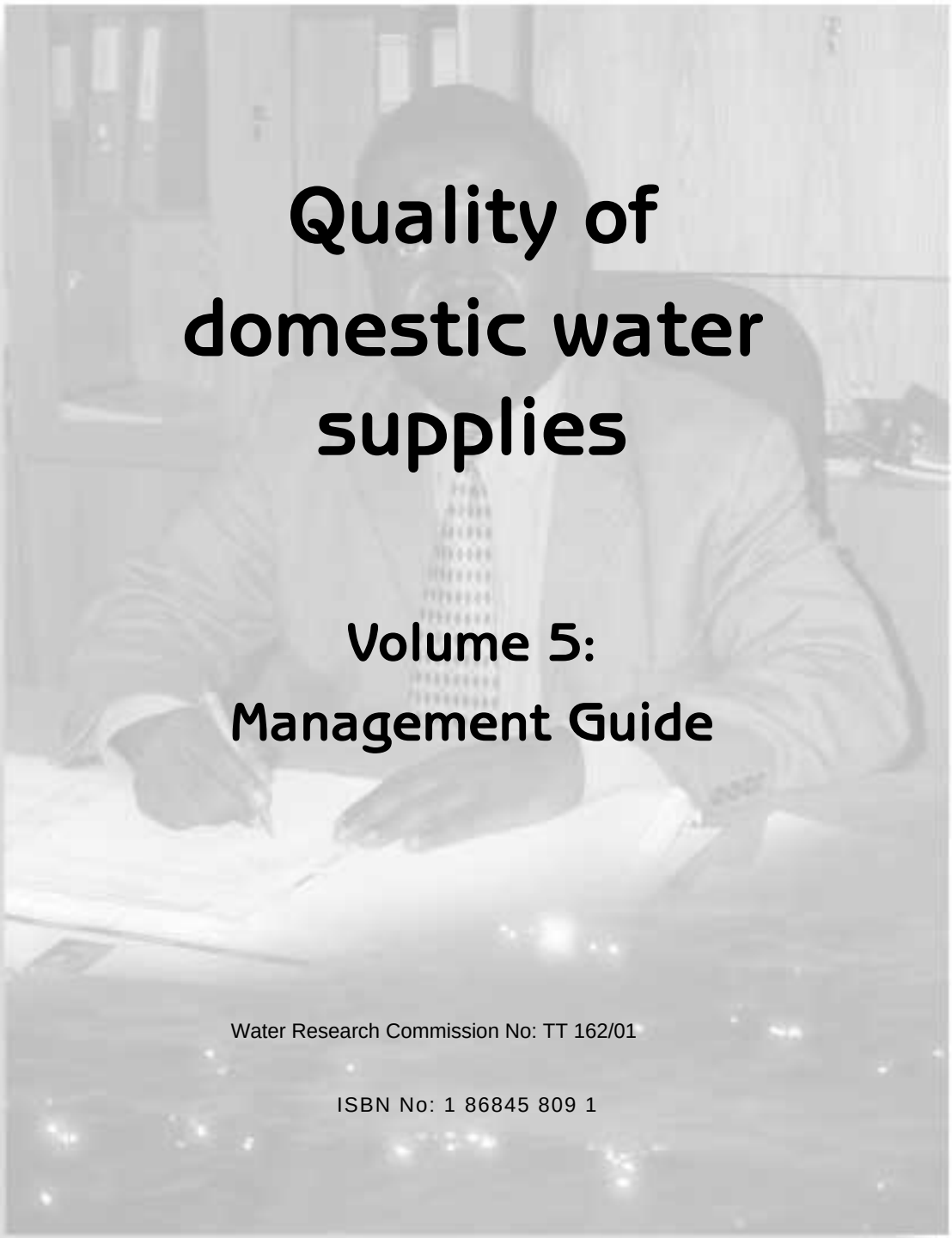
Quality of Domestic Water Supplies

Volume 5: Management Guide

The Department of Water Affairs and Forestry

The Department of Health

Water Research Commission



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Volume 5: Management Guide

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OTHER REPORTS IN THIS SERIES

This Guide forms part of a series, which is intended to provide water supply agencies, water resource managers, workers in health related fields, as well as communities throughout South Africa with guidance on domestic water quality with regard to:

- planning a new domestic water supply scheme,
- implementation of a domestic water supply scheme, and
- actions that can or should be taken if something goes wrong at selected points in the domestic water supply scheme.

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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FOREWORD

This Management Guide, the final volume (No 5) in the series "Quality of Domestic Water Supplies" completes the series on easy-to-read, capacity-building and training documents. The series addresses the five key elements of ensuring a safe domestic water supply, viz. Vol 1-*Assessment Guide*; Vol 2 - *Sampling guide* ; Vol 3 - *Analysis Guide*; Vol 4 - *Treatment Guide*, and now the fifth volume, Management guide. The completion of this series represents a milestone in the drive to make the somewhat esoteric science of water quality understandable by those not versed in the depths of water quality science.

The demand for and success of the first volumes in the series, showed a definite need by a broad spectrum of users for linking and interpretive guides which explain the basic principles underlying the concept of a safe drinking water supply. The successful completion of this series of interpretive guides has been made possible by consultative team efforts involving a great number of role players and organisations. Key to the successful production of the series has been the co-operative interplay between the Water Research Commission, the Department of Water Affairs and Forestry and the Department of Health, which guiding triangle of leaders brought in the co-operation and assistance of many other experts.

Particular attention has been placed on making the guide user friendly and yet of use both to the layman in the field and to the salted manager as a quick consultative reference, which serves to link the many disciplines that water quality and quantity management interface with.

We hope that this guide will serve as the crowning capstone on a series of water quality texts that have already proved invaluable in capacitating the upcoming generation.

Mr Ronnie Kasrils
Minister of Water Affairs & Forestry

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TABLE OF CONTENTS

PURPOSE OF THE GUIDE

What is the purpose of the Management Guide?

The Management Guide is the fifth in a series on the Quality of Domestic Water Supplies. This Guide should be used in conjunction with the other Guides. It will refer especially to the Assessment Guide (Volume 1) and the Treatment Guide (Volume 4).

The purpose of this Guide is to provide guidance on domestic water quality with regard to:

- **Planning of a new domestic water supply scheme** (suitability of a source for domestic water supply)

Sometimes perfectly good water resources are discarded because some water quality variable does not comply with the ideal or blue class. Groundwater in the western parts of the country tends to be hard (high in calcium carbonate). Although this water poses some problems when used for bathing and laundry purposes, the water can still be safely utilised for drinking purposes.

- **Operation and management of a domestic water supply scheme** (risk of contamination at selected points in the domestic water supply scheme)

It is important to consider the total water supply route when considering the safe supply of domestic water. An example is the collection of water at a standpipe with a container and the potential areas of contamination during transport and storage of this container.

- **Actions that can or should be taken if something goes wrong at selected points in the domestic water supply system** (emergencies)

During flood and drought conditions less strict quality rules may apply for domestic water supply. Water in the yellow and red classes can be used, though only for short intermittent periods.

- **Identification of the responsible authority at selected points within the water supply scheme.**

The Guide is picture (diagram) driven, ensuring that the reader/user is at all times aware of the applicability of a specific section to his/her situation. The diagrams further ensure that cross-referencing between sections is easier and user friendly.

Who should use this Guide?

The Management Guide is intended for use by:

- Water resource managers
- Members of water committees and/or local authorities responsible for water supply
- Environmental health officers who have to assess water quality for domestic use
- The householder (user of domestic water)
- Water supply agencies
- Educators and students

STRUCTURE OF THE GUIDE

This Guide is divided into seven parts each with a number of subsections.

Part 1

Provides general information on the concepts of domestic water supply.

Part 2

Describes the institutional responsibilities - who does what?

Part 3

Provides definitions for the terms and concepts used in the guide and four basic water supply routes are highlighted.

Part 4

Forms the basis of the Guide. A description is given of the overall domestic water supply route, what can go wrong, the possible consequences and what to do at each strategic point in the supply route to solve the problem.

Part 5

Guides the user through a decision-making process on whether a water source can be used for domestic purposes and the potential costs involved.

Part 6

Provides general information on management concepts.

Part 7

Describes briefly the need for capacity building, and what initiatives are to be taken by government to capacitate all spheres of society involved in domestic water supply.

PART 1

General information on the concepts of domestic water supply

YOU ARE HERE

Part 1

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Introduction

In South Africa, city dwellers generally receive a constant supply of high quality treated water. However, many communities in rural areas receive partially treated water, or use untreated water taken directly from rivers, streams, springs, or boreholes. Similarly, sanitation infrastructure is generally more advanced in urban areas than in rural areas. A primary goal of the South African government is to ensure that all citizens have access to a safe water supply and to sanitation services.

This 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 information they need to assess the following:

- whether a source would be suitable for domestic water supply;
- how to prevent contamination at selected points in the domestic water supply system; and
- if something goes wrong at a specific point in the domestic water supply system in terms of water quality; what can be or should be done, especially during emergencies (floods and droughts).

Thus, the aim of the Guide is essentially to provide the information and tools needed to ensure domestic water supply schemes deliver a sustained safe supply of water.

What is the water cycle?

Water in nature is continually moving, even though in some cases it may move very slowly over millions of years, trapped in rocks deep below the earth's surface. Not only is water continually moving, it is also changing its state between a liquid, a gas and a solid. This continual movement and changing of water is known as the water cycle and is illustrated in **Figure 1**.

The fresh water we use for drinking, washing and for preparing food comes from rainwater, surface water sources (such as rivers or dams), or groundwater sources (such as boreholes and springs). It is important to realise that all the water described in the water cycle is not suitable or available for domestic purposes because of practical and economical constraints, for example sea water can be treated but this is not always economically viable and the water in clouds can not be practically exploited.

Landuse activities such as industry, mining, residential, agriculture all could impact negatively on the water within the water cycle (rainwater as well as surface and groundwater). These landuse activities will impact on the water quality and quantity if the activities are not properly managed, which will in turn affect the domestic water user.

What is domestic water use?

Domestic water is used for a number of purposes in and around the home. These are:

- drinking
- food preparation

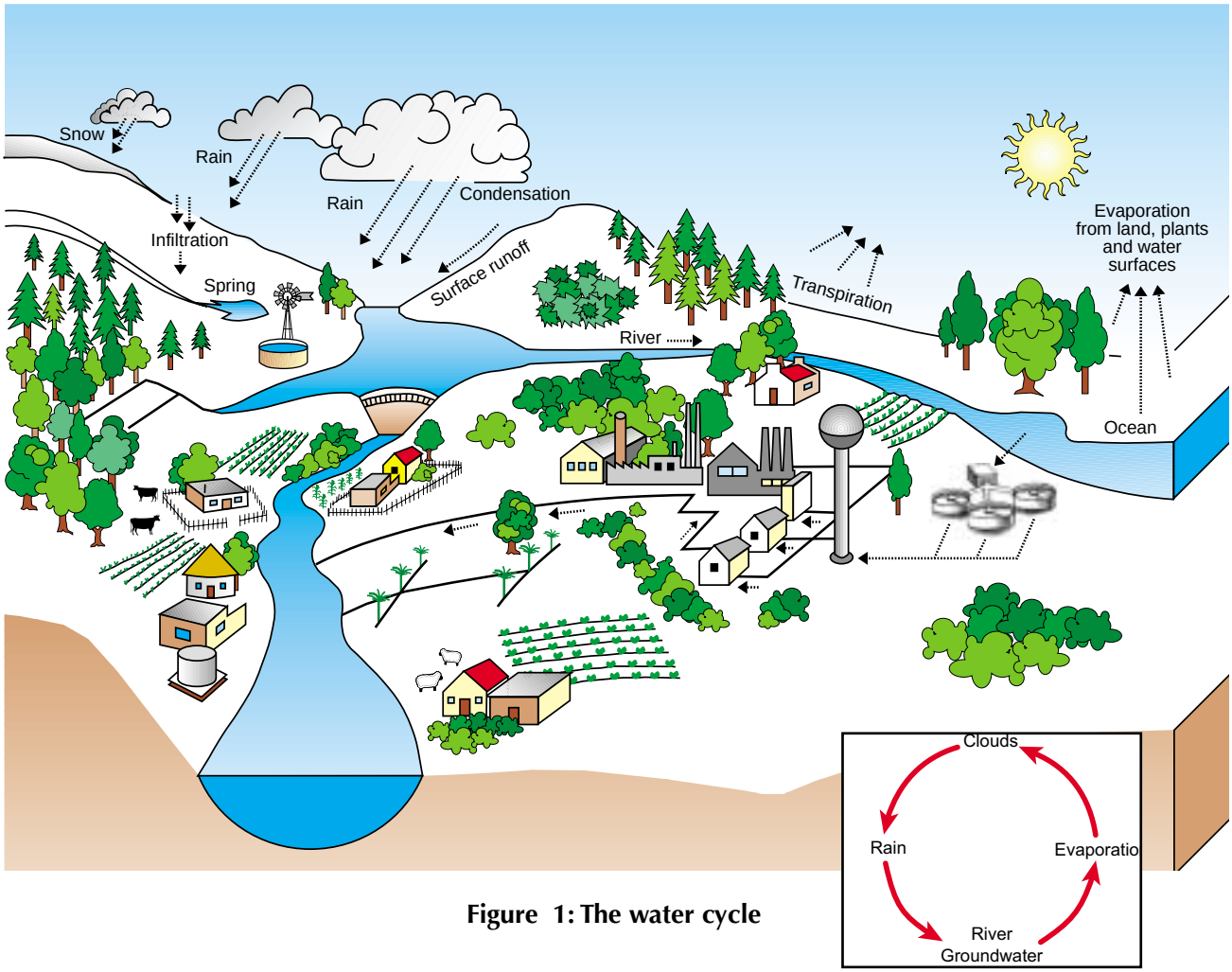


Figure 1: The water cycle

- washing clothes
- bathing
- sewage removal
- water a vegetable patch, and beautifying the surroundings (gardening).

In the *Assessment Guide*, Volume 1, the health and aesthetic requirements of the first four bullets are considered.

What are water services?

Water services are defined in the Water Services Act, 108 of 1997 as water supply services and sanitation services, sometimes referred to as "taps and toilets". Water supply services are defined as the services necessary for the reliable supply of sufficient quantity and quality of water to households, including informal households, to support life and personal hygiene (basic water supply). Sanitation services include all the actions necessary to remove human excreta and domestic wastewater from households.

Basic water supply is defined as:

- **Quantity** - 25 litres per person per day. This is considered to be the minimum required for direct consumption, for the preparation of food and for personal hygiene. It is not considered

to be adequate for a full, healthy and productive life, which is why it is considered as a minimum.

- **Cartage** - The maximum distance that a person should have to cart water to their dwelling is 200 m. In steep terrain this distance may have to be reduced to take account of the extra effort required to cart water up steep slopes.

- **Availability** - The flow rate of water from the outlet should not be less than 10 litres a minute and the water should be available on a regular, daily basis.

- **Assurance of supply** - The supply should provide water security for the community. Two factors are important here:

  - Firstly, schemes for domestic water supply should ensure the availability of untreated or "raw" water for 98% of the time. This means that the service should not fail (failure means less water, not no water at all) due to drought more than one year in fifty, on average.
  - Second, the operation and maintenance of the system must be effective. The aim should be to have no more than one week's interruption in supply per year. This interruption is spread over a full year period and not a whole week at once.

- **Quality** - Once the minimum quantity of water is available, its health-related quality is as important in achieving the goal of a water supply adequate for health. The quality of water provided as a basic service should be in accordance with currently accepted minimum standards with respect to health related chemical and microbial contaminants. It should also be acceptable to consumers in terms of its potability (taste, odour and appearance).

The water quality guidelines in the *Assessment Guide* (Volume 1 of this series) give a description of the water quality requirements of the domestic water user.

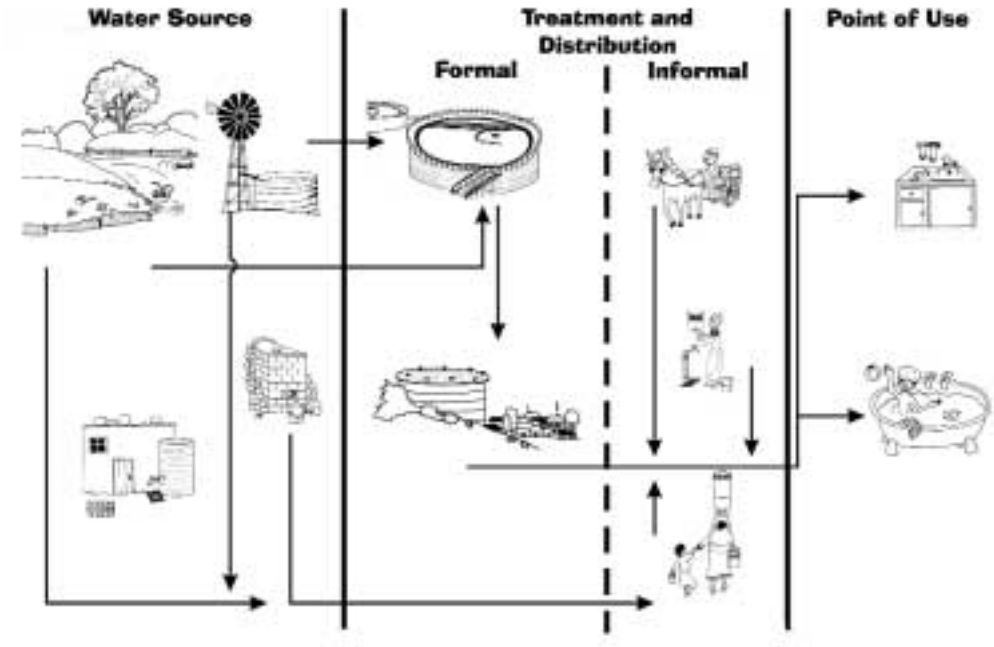
Where does domestic water come from?

A constant supply of clean drinking water is essential to every community. People in large cities frequently drink water that comes from surface water sources, such as dams and rivers. These sources are sometimes close to the community or in cases such as towns in Gauteng, most of the water is transferred from other catchments where the need for water is not so high such as the Lesotho Highlands Scheme. When thinking about where drinking water is coming from, it is important to not only think of the dam or river from where domestic water is abstracted, but also about the entire catchment. (A catchment is a defined area of land from which rainfall will drain via watercourses (rivers) to a defined point, or points e.g. a dam or confluence with the next river). Different landuse activities within the catchment could potentially impact negatively on the drinking water source.

In rural areas, people are more likely to use water for domestic purposes from groundwater (obtained from a borehole, hand pump or a spring). This water comes from aquifers (natural reservoirs under the earth's surface) that may be a small aquifer or stretch across two or more catchments. Therefore, activities far away from the actual abstraction point may affect the quality of the groundwater.

What are the links in a domestic water supply route?

A domestic water supply route refers to the actions needed to take water from the source into the home. This route includes the source (dam, river, borehole or rainwater tank) and all stops the water makes before the householder uses the water for domestic purposes. **Figure 2** indicates all the potential routes that can be followed to supply water for domestic purposes.



Based on **Figure 2**, four basic water supply routes have been identified and these routes are discussed further in **Part 3.**

What is domestic water quality?

The term water quality is used to describe the microbiological, physical and chemical properties of water that determine its fitness for use. Many of these properties are controlled or influenced by substances, which are either dissolved or suspended in the water.

In nature, water rarely occurs in its pure form and it normally contains a variety of substances. People generally have their own feeling for what "good" or "bad" quality water is, without giving it much thought. If water looks clean, and the taste and smell are not unpleasant, then people usually think it is good. If water does not look clean, or it has an unpleasant taste or smell, people think it is bad quality.

- Water that is murky, or has a colour or an unpleasant taste or smell, is not necessarily unsafe to drink; e.g. groundwater in some parts of the country tastes salty and has a sulphurous smell, but can be used for domestic purposes without a health risk.
- Whereas, clear water, without any smell is not always safe to drink as it may contain dissolved substances or disease-causing organisms that are harmful to health. This means that good quality water sources are sometimes rejected while bad quality sources are accepted.

The use of tea as a hot-beverage is an ancient practice, which originated in China. The brewing of Chinese Green Tea, introduced by Buddhist monks, serves to ensure safe water quality in two ways:

- The boiling of the water to brew the tea, disinfects the water and so prevents the transmission of waterborne infectious diseases
- Green tea is very bitter, and a bitter flavour effectively masks other unacceptable tastes in the water.

What is water pollution?

Water pollution occurs when water is rendered less fit for use as a result of human activities. Water pollution occurs where waste generated by human activity enters the water environment (surface water and groundwater). Human activities that typically cause problems for domestic water quality are:

- intensive irrigation
- mining activities
- industries
- dense human settlements - particularly if these settlements have poor sanitation facilities. Wastes from dense settlements are associated with four waste streams:
  - sewage waste;
  - gray or sullage water;
  - stormwater, and;
  - solid waste.

These waste streams increase with the implementation of a formal supply of domestic water. Poor operation, maintenance and use of services are the biggest cause of water quality problems.

Figure 3 shows schematically a catchment with landuse activities that could impact on the abstraction point of water for domestic purposes.

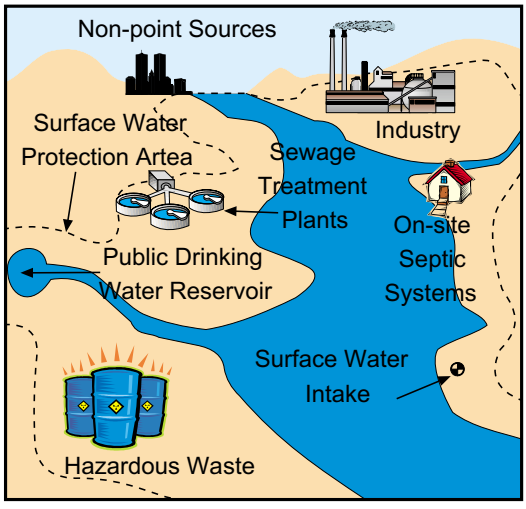


Figure 3: Land-use activities in a catchment

Why is it important to protect your water source from pollution?

Many communities in South Africa are suffering from the effects of poor quality river and undergroundwater. Those most affected are the people who live in crowded settlements, with poor water supply, sanitation and waste removal services.

Many of these people are poor and depend on untreated water from nearby streams, rivers, and springs or from boreholes. They drink it, use it for cooking, washing of clothes, bathing and fishing and children swim in it.

But what happens when this water becomes polluted? Instead of providing the basic foundation for life to develop and grow, it causes health problems and even death in many cases, especially children. Most of the common diseases in these communities, such as stomach problems, diarrhoea, cholera or typhoid, come from poor sanitation and dirty water.

Heavily polluted rivers are unsightly and affect the quality of life of residents. Polluted surface and groundwater can no longer provide fresh water, food or income. When this happens, the long-term life of the community and the health of the environment are endangered. It must also be remembered that, since human development tends to concentrate around water resources, people living downstream are affected by what happens further up the river. It is thus in the interest of communities living along the river to protect its quality so that they can continue to use the water to support ongoing development.

In addition, the more polluted the water, the more expensive it is to treat the water to the required quality in treatment plants.

Figure 4 illustrates the resultant effects of poor operation and management of wastewater treatment facilities (sewage). The pollution of surface and groundwater has a direct negative impact on the health of a community due to the pollution of their environment. These negative impacts spark the initiation of the pollution spiral of low payment and inadequate service with the eventual total failure of the delicate balance between nature and man.

How can you protect your water source from pollution?

The sources of our domestic water supply are subject to a number of threats, including growing population, chemical use, agricultural activities, solid waste facilities, stormwater from residential areas, etc. These threats make protecting our domestic water sources important.

To make the prevention of water pollution a success, everyone needs to be involved.

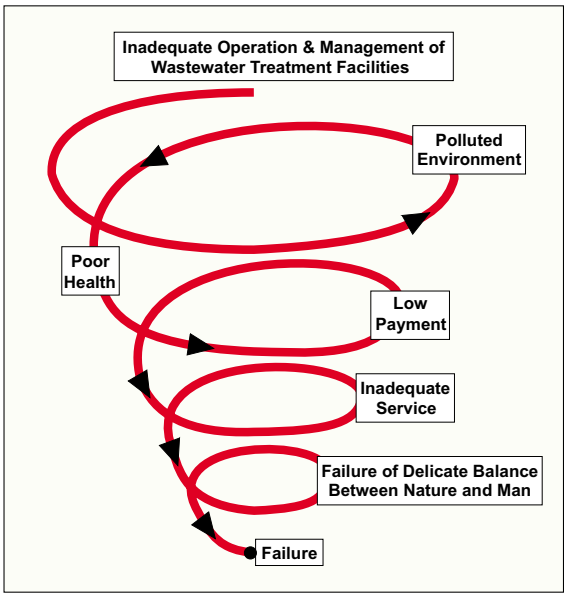


Figure 4: Disaster spiral

National Government must provide a framework (policy) and legislation for protecting our water sources. On a provincial and local level management measures and actions must be developed for giving effect to the national water quality management framework and legislation. Business owners, industry, mines, farmers, interest groups, and the general public must also take part in ensuring that domestic water sources are protected.

It is more effective and economical to prevent contamination of drinking water supplies than to pay for treatment, or to clean up an already-polluted source. South Africa's three tiered government structure (described in **Part 2**) ensures that the total water cycle is protected, from the source to the user. But it is important to realise that the protection of water sources is not only the Government's responsibility, the users or general public should make the protection of water sources their priority as well.

As mentioned earlier, numerous landuse activities could potentially impact on water sources if these are not properly controlled and managed, but even with proper control and management the continuous growth in population exerts ever increasing pressure on natural resources and at some stage the carrying or assimilative capacity of the natural system will be exceeded. It is therefore important that everyone attempts to protect the country's water sources to safeguard this scarce resource for future generations.

The protection of water sources begins at home. The way you dispose of products you use at home can contribute to the contamination of your community's water sources. It is well know that products such as motor oil, pesticides, leftover paints, mothballs, weedkillers, and household cleaners contain material that can be harmful to water sources. Anything you pour down a drain or flush down your toilet will enter your septic tank system or your community's sewer system. Using this method to dispose of products that contain harmful substances can affect your septic tank systems ability to treat human wastes. Once in the ground, these substances can eventually contaminate the groundwater. In addition, wastewater treatment works are not designed to treat many of these substances, thus they can eventually be discharged into bodies of surface water and cause contamination.

Domestic solid waste disposal facilities are also not designed to handle hazardous materials. As rainwater leaches through the disposal facility, the water can become contaminated by these products and eventually carry them into the ground and surface water systems.

Water conservation, using water sparingly and wisely, fixing leaks, also contributes to ensuring that the scarce water resources are able to support communities for longer periods of time. Therefore, by just ensuring that you dispose of normal household wastes properly and by using water wisely, you can contribute to the conservation of the country's water sources.

How will you know that your water resource is polluted?

The quality of the water can only be determined by means of chemical and microbiological analyses. Depending on the source a monitoring program will have to be implemented as detailed in Volume 1 Section B1. Representative samples will have to be taken at predetermined sites at the required frequency. This information will establish the typical water quality of a specific source.

The monitoring program will also have to include samples for water in the treatment facility as well as at strategic points within the distribution network.

Regular processing of the data in the database with statistical methods will give the service provider or the user an indication of the water quality status of the source, in the treatment facility as well as the distribution network.

From the water quality status assessment the water source can be classified as described in Volume 1. Each variable of concern can therefore be classified in terms of its potential negative impact on the domestic user. Based on the classification of the substances, a decision on a specific action (do nothing, intervene immediately or long term action) could be taken.

Decisions on the suitability of water for domestic use is largely determined by the health related drinking class of the water. It is therefore important to assess whether the substance causing the problem has any health effect. The classification system described below can then be used to guide the decision-making process.

The classification system is described in detail in Volume 1, Section C1. The classification system describes the effects of increasing concentrations of each of the substances considered important for domestic use. The system uses a simple colour and number code ranging from ideal to totally unacceptable water quality (See Table 1).

- Water falling in the **Blue** or **Green** class can be used without reservation and should be considered safe for all users.
- Water falling in the **Yellow** class can generally be regarded as safe, but sensitive users should be identified and warned that there may in some situations be a need to take their own precautions.
- Water falling in the **Red** class may be used for short-term emergency supply (7 days) only, where other sources are not available
- When water falls into the **Purple** class the public should be warned not to use the water, or to use emergency treatment where possible.

It is important to remember that if only one substance falls in the red class then the whole source is classified as a Class 3 source and may only be used after treatment.

Water falling in the Red or Purple class should be re-sampled immediately to confirm the classification. It should also be remembered that water falling into the Red or Purple class for "drinking health" may still be suitable for the other domestic uses. In these cases an alternate supply, for example water tankers, can be used for drinking water until the problem has been solved, while the normal supply is used for other purposes.

If water supplies frequently fall into the Red or Purple class, it is recommended that water quality experts be consulted for more detailed advice on treatment.

CLASS/COLOUR	DESCRIPTION	EFFECTS
Class 0 - Blue	Ideal water quality	**Drinking Health**: No effects, suitable for many generations. **Drinking Aesthetic**: Water is pleasing. **Food preparation:** No effects. **Bathing:** No effects. **Laundry:** No effects.
Class 1 - Green	Good water quality	**Drinking Health:** Suitable for lifetime use. Rare instances of sub-clinical effects. **Drinking Aesthetic:** Some aesthetic effects may be apparent. **Food preparation:** Suitable for lifetime use. **Bathing:** Minor effects on bathing or on bathroom fixtures. **Laundry:** Minor effects on laundry or on fixtures.
Class 2 - Yellow	Marginal water quality	**Drinking Health:** May be used without health effects by the majority of individuals of all ages, but may cause effects in some individuals in sensitive groups. Some effects possible after lifetime use. **Drinking Aesthetic:** Poor taste and appearance are noticeable. **Food preparation:** May be used without health or aesthetic effects by the majority of individuals. **Bathing:** Slight effects on bathing or on bathroom fixtures. **Laundry:** Slight effects on laundry or on fixtures.
Class 3 - Red	Poor water quality	**Drinking Health:** Poses a risk of chronic health effects, especially in babies, children and the elderly. **Drinking Aesthetic:** Bad taste and appearance may lead to rejection of the water. **Food preparation:** Poses a risk of chronic health effects, especially in children and the elderly. **Bathing:** Significant effects on bathing or on bathroom fixtures. **Laundry:** Significant effects on laundry or on fixtures.
Class 4 - Purple	Unacceptable water quality	**Drinking Health:** Severe acute health effects, even with short-term use. **Drinking Aesthetic:** Taste and appearance may lead to rejection of the water. **Food preparation:** Severe acute health effects, even with short-term use. **Bathing:** Serious effects on bathing or on bathroom fixtures. **Laundry:** Serious effects on laundry or on fixtures.

Table 1: Structure of the classification system describing the effects of the different classes of water on the various domestic uses of water

Why does it cost money to get water into our homes?

Water is a natural resource - considered by many to be a "gift from God" - which should be available to all free of charge. However the cost of domestic water supply results from the need to abstract it from a source (river, dam or borehole), to clean or purify the water to reduce the risk of negative health impacts on the water user and bring (transport) it to where it is required or used.

There are limited public funds available for water supply and sanitation and the policy of Government is to use these as far as possible to achieve the goal of ensuring that all South Africans have access to at least basic levels of service. The approach for allocating cost to water is based on three levels.

- **The first level of water cost is** for the use of water, without purification, directly from a river, dam or borehole. This cost is to be paid for by National Government for ensuring that water is available and can be used to the benefit of all. This means that water is available for everybody, and not used by only a few large users.
- **The second level of water cost is** for water supplied in bulk, often by Water Boards. Bulk water refers to the storage of water in large dams and the distribution of this water with large pumps and pipes to large reservoirs.
- **The third level of water cost is** for the purification and further distribution of water to households, normally by the Local Authority.

The cost of water for the first level water consists of functions to be performed by the Department of Water Affairs and Forestry and/or water management institutions. The functions can be:

- planning and implementation of catchment management strategies
- endorsing laws and regulations concerning the use of water, including the discharge of waste
- monitoring and assessment of water resource availability, quality and use
- planning, design, development, operation, maintenance and improvement of Government water schemes.

The cost of water for the second and third level water is made up of three basic components:

- **Installation/building costs:** The money required for building the water scheme. These costs vary depending on the nature of the scheme. They may include the costs of:
  - storage facilities such as dams and reservoirs
  - water treatment plants
  - pump stations
  - main pipe lines
  - distribution/reticulation (moving the water from point A to point B)
  - borehole drilling and equipping, or
  - simple spring protection.
- **Operation and maintenance costs:** (the costs of keeping the services running). These include the costs of:

- maintenance and operating staff
- fuel or electricity for pumps
- replacement of broken pipes and fittings, and
- the costs of chemicals for treating the water.

- **Replacement costs:** (the money required replacing a pump or a pipeline when it reaches the end of its useful life).

A detailed description of the mechanisms for cost recovery can be found in **Part 5.**

PART 2

Institutional responsibilities - who does what?

Part 1

Provides general information on the concepts of domestic water supply.

Part 2

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YOU ARE HERE

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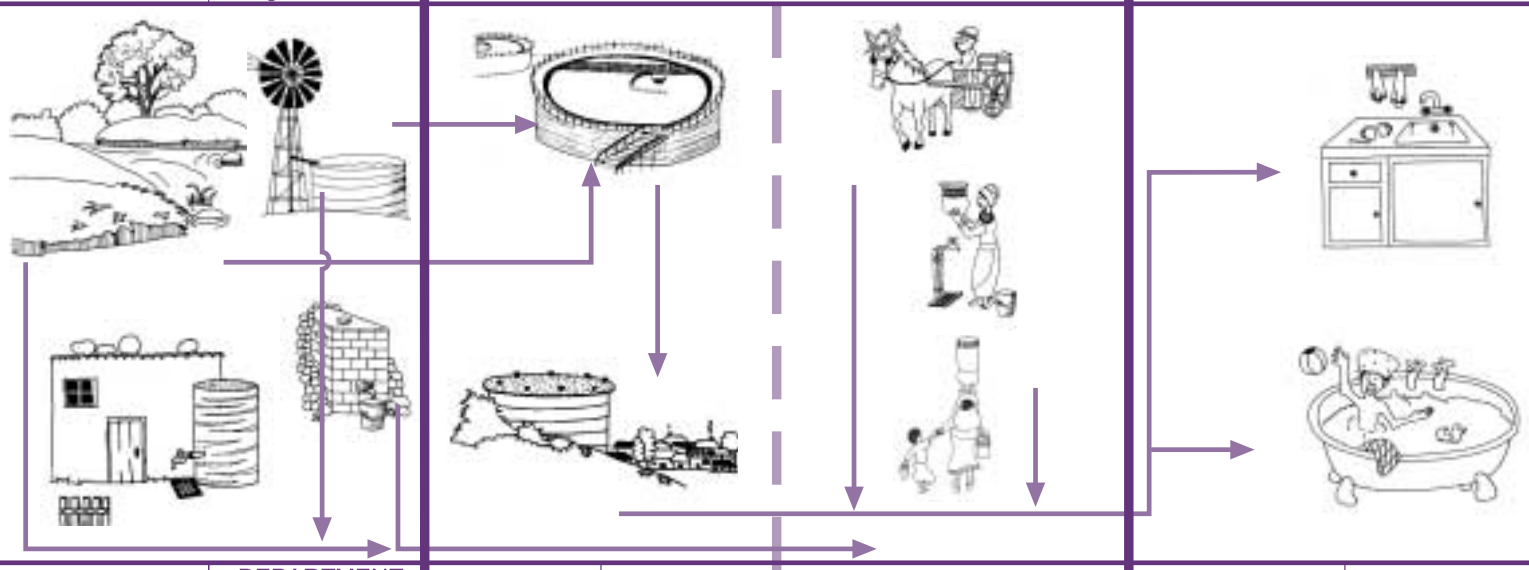
	WATER SOURCE		TREATMENT AND DISTRIBUTION		POINT OF USE
			FORMAL	INFORMAL	
ACT:	NATIONAL WATER ACT		WATER SERVICES ACT	HEALTH ACT	
ACTION:	WATER RESOURCE MANAGEMENT		WATER SUPPLY AND DISTRIBUTION	WATER USE	
LEVEL:	NATIONAL	REGIONAL	WSA	LOCAL	
INSTITUTION:	DWAF	CMA/DWAF Regional Office	LOCAL	DEPARTMENT OF HEALTH	
					
INSTITUTION:	HOUSEHOLDER	DEPARTMENT OF HEALTH	WSA	WSP	HOUSEHOLDER / DEPARTMENT OF HEALTH
LEVEL:	USER	LOCAL	LOCAL		USER / LOCAL
ACTION:	WATER USE		WATER RETICULATION		WATER USE
ACT:	HEALTH ACT		WATER SERVICES ACT		HEALTH ACT
	WATER SOURCE		FORMAL	INFORMAL	**POINT OF USE**
			TREATMENT AND DISTRIBUTION		

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Figure 5: Institutional responsibilities

Introduction

The roles and responsibilities of the different institutions and organisations involved in making sure clean water reaches the people, are sketched in this section. This section will give a broad picture of who is required to do what in terms of providing water services. Not every institution will be involved in all the water supply routes and some may do the work of others in certain areas. **Figure 5** depicts a generic overview of all potential domestic water supply routes, as well as the institution responsible for each sector.

What is the role of the Department of Water Affairs and Forestry?

The role of the Department of Water Affairs and Forestry (DWAF) in the water sector can be divided into two distinct areas:

- managing the nation's water resources in the public interest, which includes the protection, development, management, and control of use of raw water (surface and groundwater), and
- ensuring that all citizens have access to adequate water and sanitation services

Protection of water resources means:

- To maintain the quality of surface and groundwater so that it can be used in an ecologically sustainable way.
- To prevent degradation of the river or aquifer.
- To rehabilitate the river or aquifer.

Naturally occurring water can only effectively be managed within a river basin or catchment area. Since in many cases provincial and other political boundaries divide catchment basins, and because water is a strategic national resource, water resource management is defined as a national function in the Constitution.

DWAF plays a less direct role in the provision of water and sanitation services. The Department must ensure that the provisions of the Water Services Act (Act 108 of 1997) are implemented effectively and fairly across the land. This requires monitoring and guidance with setting up of institutions and how they work, assisting with capital infrastructure funding and with interpreting and distributing information.

The National Water Act (Act 36 of 1998) makes provision for DWAF to firstly establish Catchment Management Agencies (CMAs) and secondly delegate specific responsibilities to the CMAs. This ensures that the responsibility for the development, apportionment and management of water resources is delegated to a catchment level. Certain responsibilities that are currently DWAF responsibilities could therefore be CMA responsibilities in future.

Provincial Governments share the responsibility with DWAF for assuring service provision by Local Authorities, specifically through the promotion of effective local government.

It is of utmost importance that the closest co-operation be maintained between DWAF and Forestry and the Provinces given their joint interest in the development of the capacity of local government to provide water and sanitation services on an equitable and efficient basis.

To ensure effective formal communication and liaison between DWAF and the Provinces, Provincial Water Liaison Committees have been established. The functions of the Provincial Water Liaison Committees include liaison with the National Departments, as well as the identification of priorities and critical areas of need.

It is important to note that DWAF is the custodian of all water in South Africa, but certain areas in the country have naturally high concentrations of chemical and microbiological substances such as:

- The rivers that drain the dry interior regions carry water that may have a high Total Dissolved Solids (TDS) concentration mostly resulting from high sulphate and chloride concentrations. This means that the water is corrosive and has a distinctly salty taste.
- Fluoride concentrations in groundwater in some areas tend to be high, especially in the central and western parts of the country. High fluoride concentrations can damage the skeleton, causing a hardening of the bones, making them brittle.
- Some rivers will have high faecal and total coliform counts due to natural causes (e.g. bird colonies) from surrounding areas. These are indicators of the possible presence of disease-causing micro-organisms, which may give rise to gastro-intestinal diseases.

DWAF cannot be held responsible for these naturally occurring pollutants.

What is the role of the Department of Health? (DOH)

The Health Act, Act 63 of 1977, places the custodianship of the health of the citizens of South Africa in the hands of the Department of Health. As such the Department of Health is responsible for investigating and ameliorating any impact from the general living and working environment that may have a negative effect on human health.

The Department of Health, in collaboration with other relevant sectors, is responsible for the improvement of South Africa's environmental health status. It therefore endeavours to limit the health risks, which arise from the physical and social environment.

Environmental Health Officers are responsible to ensure that environmental health services are distributed at community level. Thus, based on community needs and risk assessments, environmental health service interventions including the promotion of clean water, adequate sanitation provision, and food safety are part of an environmental health officer's responsibilities. Furthermore, communities are empowered through the dissemination of environmental health and hygiene information.

What are Water Services Authorities (WSA) and what is their role?

A WSA regulates how water supply and sanitation services are provided and who provides them within its area of jurisdiction.

The Water Services Authority is the local government structure - usually Metropolitan Municipalities and / or Local Municipalities. Water services can only be obtained through a Water Services Authority and its contracted Water Services Providers.

The Municipal Structures Act (Act 117 of 1998), known as the "Structures Act" sets up the basis for the establishment of new municipalities in the "A" (Metropolitan Municipalities), "B" (Local Municipalities), and "C" (District Municipalities) categories.

Based on the criteria in Section 2 of the Municipal Structures Amendment Act, 2000 (Act 33 of 2000), category A, B and C municipalities can be described as follows:

- **Category A:** Metropolitan Councils, which exercise the full range of municipal powers and duties.
- **Category B:** Urban, urban-rural and rural municipalities with a geographical area of 3500km^2 and at least 20 000 people.
- **Category C:** District governments that consist of a number of urban, urban-rural and rural municipalities. District governments assume responsibility for integrated development plans for bulk infrastructure in non-metropolitan areas as well as providing assistance for the category B municipalities falling in its area of jurisdiction.

The Water Services Authority function is allocated to Category C municipalities. However, a Category B municipality can be authorised to perform the Water Services Authority function by the Minister of Provincial and Local Government under section 84(3) of this Act.

District Municipalities are responsible for the water services authority function (potable water systems according to the Water Services Act), but, if authorised, Local Municipalities should perform the water services authority function

The Municipal Systems Act, 2000 (Act 32 of 2000), Chapter 8 enacted the responsibilities of the local authorities with regard to service provision. Some of these responsibilities are listed below:

- prepare a water services development plan outlining how water services will be provided
- involve communities in drawing up the plan, and report on how it is being implemented
- carry out the functions of the Water Services provider itself, or make use of contractors
- create by-laws, and set tariff structures for payment.

What are Water Services Providers (WSP) and what is their role?

A WSP does the work of providing water services to customers.

The Water Services Authority can also be the Water Services Provider, or the Water Services Authority can contract a community-based organisation, a Water Board, a private company, an NGO or an adjoining local authority, to be the Water Services Provider. No Water Services

Provider, not even ordinary water vendors, may operate without permission from a Water Services Authority.

The tasks and duties of a Water Services Provider are to:

- operate the water services provision system
- handle customer relations
- collect revenue payments for water services,

Water from large rivers stored in dams, or water pumped up from the ground, is sometimes supplied in bulk quantity by another organisation to a Water Services Provider in an area. This bulk Water Service Provider may be a Water Board, NGO, private company, or local government.

What is the role of Householders?

Householders are the final users of water for domestic purposes. The householder can get domestic water from a Water Service Provider or directly from a water source such as rivers or boreholes.

The domestic water that is supplied by a Water Service Provider becomes the responsibility of the Householder at the point of delivery namely in the house, at the standpipe or from the vendor.

The domestic water that the Householder acquires directly from a water source such as a river, borehole or spring is the responsibility of that Householder.

The tasks and duties of householders are:

- identify their water services needs and jointly negotiate with their Water Services Provider so these needs can be met;
- pay agreed rates for water services provided;
- monitor their Water Services Provider and water services;
- support the Water Services Provider by reporting leaks and illegal connections;
- ensure that water used directly from a source be at least treated with bleach or boiled before it is used as drinking water; and
- ensure that the containers in which water is kept or transported are clean, and that open containers in which water is stored are kept covered.

PART 3

Water supply infrastructure

Part 1

Provides general information on the concepts of domestic water supply.

Part 2

Describes the institutional responsibilities - who does what?

Part 3

Provides definitions for the terms and concepts used in the guide and four basic water supply routes are highlighted.

YOU ARE HERE

Part 4

Forms the basis of the Guide. A description is given of the overall domestic water supply route, what can go wrong, the possible consequences and what to do at each strategic point in the supply route to solve the problem.

Part 5

Guides the user through a decision-making process on whether a water source can be used for domestic purposes and the potential costs involved.

Part 6

Provides general information on management concepts.

Part 7

Describes briefly the need for capacity building, and what initiatives are to be taken by government to capacitate all spheres of society involved in domestic water supply.

Water supply infrastructure

Water used for domestic purposes can be acquired via numerous water supply routes. Some of these routes are inherently more risky than other routes.

Water supplied for domestic purposes via a supply route that incorporates abstraction, treatment, and distribution as services, has a much lower risk for contamination than water supplied via a supply route that incorporates no service (user abstract and deliver water).

ABSTRACTION FROM WATER SOURCES

River/dam

Rivers and dams are surface water sources. Water in river systems is stored in dams to ensure that a constant supply of water is available even during dry months.

(The Department of Water Affairs and Forestry is the custodian of South Africa's water resources, and has the overall responsibility for the protection and use of water resources).

Borehole/handpump

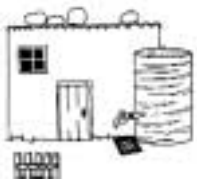
Groundwater is mainly abstracted by means of boreholes and handpumps. Smaller communities in rural areas generally use groundwater. One or two boreholes can service small communities. Larger communities need a wellfield to supply sufficient water.

(The management of the groundwater resource is the responsibility of the Department of Water Affairs and Forestry. It is important to note that the protection of the resource is everybody's responsibility).

Spring

Springs are not always a reliable source of water. Smaller communities harvest spring water as their only source of water.

(The overall responsibility for the management of springs (ground water) is that of the Department of Water Affairs and Forestry).



Rainwater harvesting

Rainwater harvesting means the accumulation of roof runoff water during the rainy season. Some areas in South Africa have saline groundwater as the only domestic water source.

(Rainwater thus accumulated and used for drinking purposes is the responsibility of the householder).

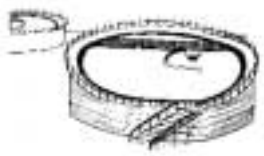
Water supply infrastructure concepts and definitions

In water supply there are four basic actions, relevant to water supply infrastructure, namely:

- abstraction from source,
- treatment (cleaning),
- distribution, and
- use.

In each of these there are various options and/or alternatives as explained below (the institutional responsibility is described in more detail in **Part 2):**

TREATMENT



Surface water and groundwater should in most cases be treated to make it fit for domestic use. The level of treatment required is related to the physical, chemical and bacteriological impurities in the water. The treatment of water can be done in several ways:

- Home treatment – This can be done in the home, using materials which are common in most households or which are readily available such as boiling of the water, household bleach for disinfection or straining water through a cloth.
- Basic treatment – This can be done by the community, using materials which are common in most communities, or which can be easily bought such as chlorine pills.
- Conventional treatment - This is done in a treatment plant constructed for this purpose. Conventional treatment includes: coagulation, flocculation, filtration, and disinfection. Conventional treatment requires trained people to run the plant.
- Advanced treatment - This requires specialised treatment such as activated carbon filtration, reverse osmosis and ion exchange. These technologies are not commonly used in conventional treatment plants.

(The Water Services Provider is responsible for ensuring that an acceptable water quality for domestic purposes is supplied).

DISTRIBUTION

Several systems are available to distribute water to users and include a wide spectrum of methods including:

Fetching water

The householder fetches water directly from a river, dam, borehole, etc. This is a high-risk method of using water for domestic purposes since the water from a river, dam or borehole has not been treated.

(The householder is solely responsible for this water supply method).

sy

House connection

This is a pipe system from a reservoir to each house. This can be a connection to the house or yard of a property.

(A Water Services Provider is responsible for the maintenance of the pipe

Standpipe

The objective of the Department of Water Affairs and Forestry is to at least have water at 200 m interval standpipes available for domestic use.

(The Water Services Provider is responsible for the maintenance of this system. The householder is responsible for the container used to transport the water to the household).

Vendor

Vendor (central water distributor). A vendor can source water directly from a dam or a river), reservoir, standpipe or tanker for further distribution. The selling of bottled water is also a vendor activity.

(The control over vendors is limited and their only responsibility is towards their clients although the WSA should, i.t.o. the Water Services Act, have control over all vendors operating in their area of jurisdiction).

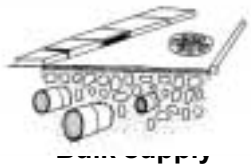
Tanker

A tanker is a mobile reservoir transporting water from a distant source for example a reservoir, dam, river, etc.

(The Water Services Provider is responsible to ensure that water delivered in this manner is safe for domestic purposes).

Reservoirs are required to allow temporary storage of the water. Water is used by communities during daylight hours with peak abstractions occur ring at about 5-8 a.m. and again at about 4-9 p.m. Sufficient storage is therefore required in the reservoir to balance inflow and outflow. Storage is also required to provide backup supply during times when delivery is i nterrupted due to pump failure and other breakdown.

(The Water Services Provider is responsible to ensure that the reservoirs **Reservoirs** are maintained).



Water is conveyed from the water source (e.g. river) to the bulk water reservoir by means of bulk water pipelines.

(These pipelines are the responsibility of either the Water Services Authority or the Water Services Provider).

USE

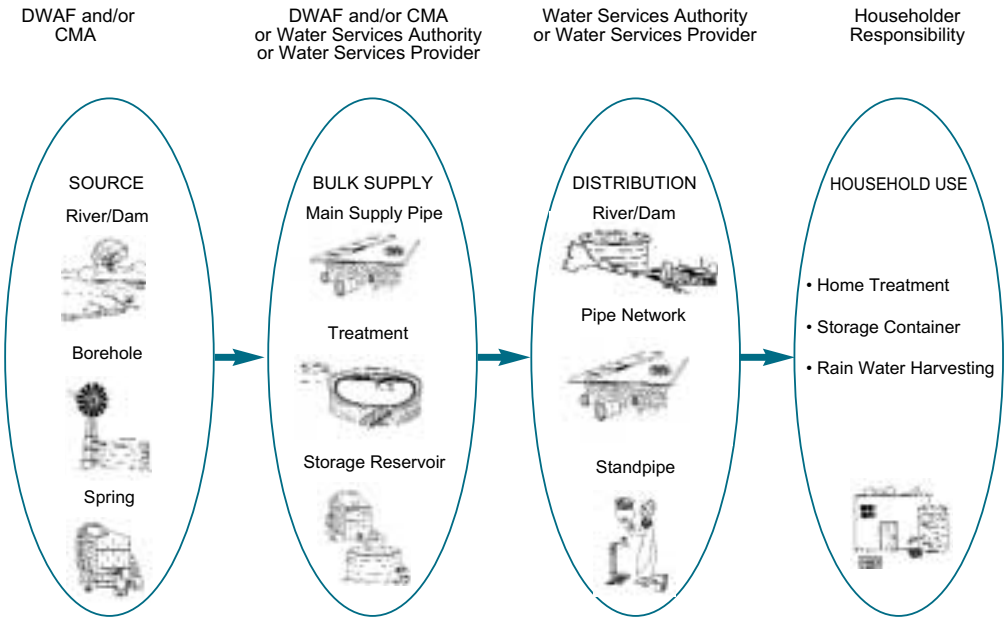
Water at the house can be used for drinking, food preparation, bathing, and washing.

(The protection of the quality of the water in the house is the responsibility of the householder).

Basic water supply delivery routes

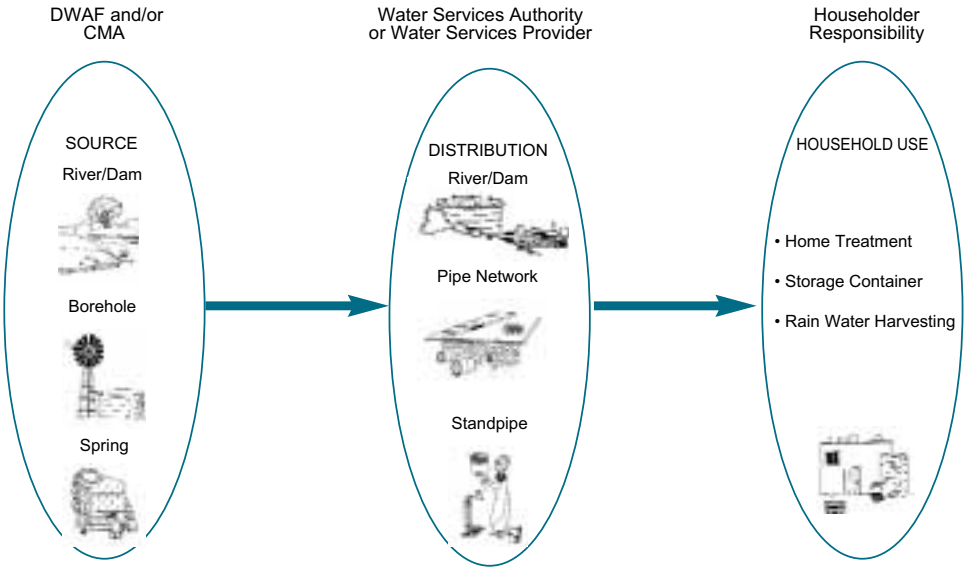
Four generic supply routes are shown below. The user of this Guide should be able to relate to a water supply route that describes his or her situation best.

Route 1 depicts a full service, which includes the **abstraction** of water for domestic purposes, the **treatment** of the water and finally the **distribution** of the treated water to the householder. This service ensures that the risk for contamination is very low but this service will also be the most expensive option.



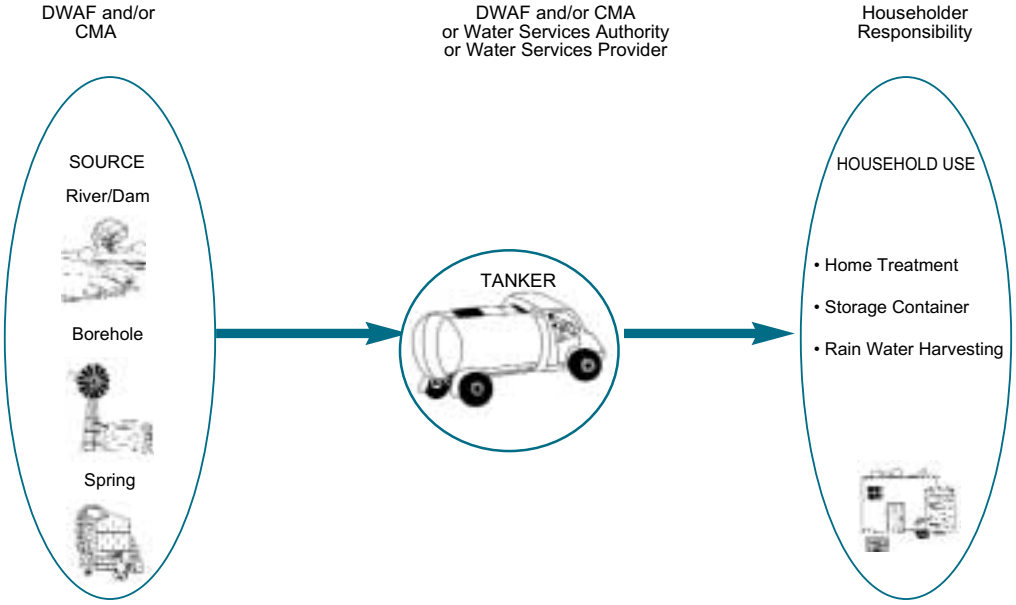
ROUTE 1: Abstraction, Treatment & Distribution (Full Service)

Route 2 depicts a partial service, which includes the abstraction of water for domestic purposes and the distribution of the untreated water to the householder, but where no provision is made for a treatment facility. This service would normally be applied in areas where the water source fall within the blue or green class and that the risk for potential contamination is low, such as protected springs and groundwater sources.



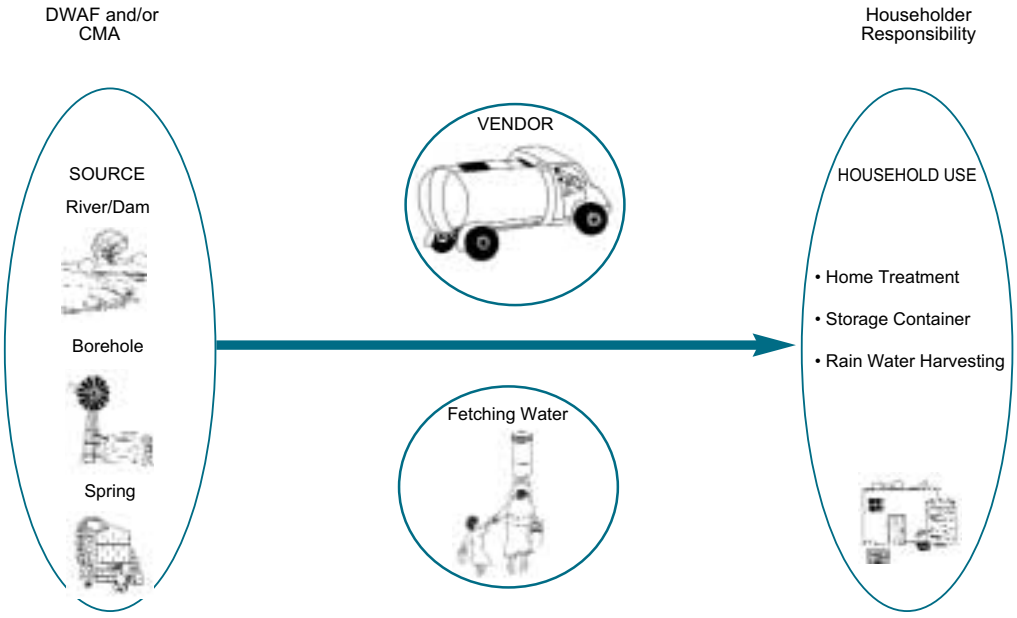
ROUTE 2: Abstraction & Distribution, no Treatment (Partial Service)

Route 3 depicts a low service, which includes the abstraction of water for domestic purposes and the delivery of the untreated water via tankers to the householder, no provision is made for a treatment facility or formal distribution system. This service has a higher potential for contamination because the water is not treated and the delivery method could result in contamination (e.g., tankers are not cleaned on a regular basis).



ROUTE 3: Abstraction & Delivery, no Treatment, no Distribution (Low Service)

Route 4 depicts a no service situation. The user abstracts and delivers his or her water for domestic purposes. This method of acquiring water is not acceptable and the user is exposed to a very high risk of contracting water borne diseases.



ROUTE 4: No Service, User Must Abstract and Deliver

PART 4

Something has gone wrong - what now?

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Introduction

In this section the focus will be on identifying what can go wrong, what is the possible effect, how will you know, and what can you do to rectify the situation. This is described for the four basic components of water supply, namely abstraction, treatment, distribution and use as shown graphically in **Figure 2** and described in **Part 3**.

Firstly, the section below describes typical water quality problems in different parts of South Africa. It is important for the user of this guide to understand what typical water quality problems to expect and what the sources of such water quality problems could be. Secondly, the second section groups substances together based on their frequency of testing and indication of pollution (general indicators of pollution).

Typical water quality problems in South Africa

The most important water quality problem in surface water in South Africa is most likely to be faecal pollution together with the associated disease-causing organisms. However, elevated salt concentrations (Total Dissolved Solids, sodium and chloride) are also common in many parts of the country. In groundwater the most common problems are high nitrate/nitrite and fluoride concentrations.

Problems in surface water

Most of the surface water in South Africa is of good quality and requires only clarification and disinfection. There are, however, a few notable exceptions:

- **Faecal pollution**
  High faecal and total coliform counts (used as indicator organism to indicate recent faecal pollution) occur in most surface water near dense human settlements.

- **Colour and stability (buffer capacity)**
  The rivers that drain the mountain catchments along the southern coastline of the Cape Province (e.g. the Berg River) have waters that are highly coloured due to organic acids. These waters have characteristically low TDS concentrations and a low pH. Colour removal requires precise chemical dosing, and together with the stabilisation of the water (specific chemical dosing to control pH), treatment is costly and not easy.

- **Salinity (Total Dissolved Salts (TDS) or Electrical Conductivity (EC), sodium, chloride and sulphate)**
  The rivers that drain the dry interior regions carry water that may have a high TDS concentration mostly resulting from high sulphate and chloride concentrations. This means that the water is corrosive and has a distinctly salty taste. Salt removal by means of reverse osmosis or ion exchange is expensive, and most communities accept the water after clarification and disinfection, Care should be taken in areas where the TDS, sulphate or chloride concentrations are in the Red or Purple classes.

  The rivers that drain the northern and eastern parts of South Africa generally carry good quality water, unless it has been contaminated due to human activity. A prime example of this is the Vaal River downstream of the Vaal Dam, which has a high TDS due to effluent from the

Witwatersrand area and from the gold mines. Treatment is expensive and the consumers normally accept the high salinity.

- **Eutrophication (high algal concentrations)**
  Some dams in South Africa have high algal concentrations. Water from these water bodies may have taste and odour problems. In many cases, authorities have implemented treatment options such as powdered activated carbon, or processes such as dissolved air flotation instead of the more conventional sedimentation in the clarification process. In some cases algae may produce toxins which are of concern to human health. Generally, however, the above processes also remove these toxins.

Problems in groundwater

The most common problems in groundwater are:

- **Salinity**
  Many groundwaters have high TDS concentrations, especially those in the drier regions of the country where the predominating geological formations are sedimentary rocks of marine origin. The Karoo shales are a prime example of this. Salinity can be removed only at high cost and by means of, for instance, reverse osmosis, electrodialysis or de-ionisation.

- **Fluoride**
  Fluoride concentrations in groundwater in some areas tend to be high, especially in the central and western parts of the country. In the coal-bearing regions of the country fluoride concentrations tend to be very high. Fluoride removal is expensive.

- **Sulphate and chloride**
  Water with high TDS concentrations tends to have high sulphate concentrations as well. Sulphate removal is expensive (desalination or ion exchange) and normally not considered viable.

- **Calcium and magnesium**
  The groundwater in the dolomitic areas and the northern parts of the country tends to be very hard. This usually has no health implications, except where concentrations are extremely high. It does, however, lead to clogging of pipes and scaling of the elements in hot water appliances. The cost of replacement and maintenance of these appliances may make it cheaper to treat the water. For small communities, or single households, water softening by means of ion exchange is recommended. For larger communities, chemical dosing, settling and filtration will be more economic.

  It is important to note that water softening by means of ion exchange will add sodium to the water. This could prove problematic if the sodium concentration is already high.

- **Iron and/or manganese**
  Iron and manganese commonly occur in high concentrations in groundwater. Treatment for both of these problems is generally cheap and easy, consisting of oxidation by means of aeration, or by adding chlorine.

Substances which are general indicators of water quality

Numerous substances can be found in water. However, only a few of these commonly occur in concentrations high enough to be of concern to domestic water users. The most important substances to measure are those that often occur in concentrations high enough to cause health, aesthetic or other problems.

The substances that are of main concern to the domestic user are presented in order of priority in the following tables.

GROUP A	
Group A substances are indicators of potential problems and should be frequently tested at all points in the water supply system, irrespective of the source of the water. (Free available (or residual) chlorine has to be measured only if the water has been treated with chlorine-based disinfectants).	
Electrical conductivity (total dissolved salts)	Conductivity is an indicator of total dissolved salts (TDS), and also establishes if the water is drinkable and capable of slaking thirst.
Faecal coliforms	This is an indicator of the possible presence of disease-causing organisms. It establishes if water is polluted with faecal matter.
pH value	This has a marked effect on the taste of the water and also indicates possible corrosion problems and potential copper, zinc and cadmium problems.
Turbidity	This affects the appearance, and thus the aesthetic acceptability, of the water. Turbidity is commonly high in surface waters.
Free available chlorine (Residual chlorine)	This is a measure of effectiveness of the disinfection of the water. Residual chlorine is the chlorine concentration remaining at least 30 minutes after disinfection. There should be residual chlorine in the water, but if the con centrations are to high it may impart an unpleasant taste and smell to the water.

GROUP B	
The presence / concentration of Group B substances should be determined before the water is supplied. The frequency of testing depends on the source and the treatment applied. Note that substances of concern due to pollution sources in the area, may have to be added to Group B.	
Nitrate & nitrite	These are common in groundwater (borehole) samples, particularly in areas of intensive agricultural activity, or where pit latrines are used. Severe toxic effects are possible in infants.
Fluoride	This is often elevated in groundwater in hot, arid areas. Can cause damage to the skeleton and the marking of teeth.
Sulphate	This is particularly common in mining areas. Causes diarrhoea, particularly in users not accustomed to drinking water with high sulphate concentrations.
Chloride	This is often elevated in hot, arid areas, and on the western and southern Cape coasts (particularly in groundwater). May cause nausea and vomiting at very high concentrations.
Arsenic	This may be present in groundwater, particularly in mining areas. Can lead to arsenic poisoning.
Total coliforms	This provides an additional indicator of disease-causing organisms, and the effectiveness of disinfection.

GROUP C	
Group C substances should be tested for at point of use only in areas of the country where soft water of a low pH value is used.	
Cadmium	This usually occurs along with zinc in acidic waters where it may have been dissolved from appliances.
Copper	This affects the colour of the water and can cause upset stomachs. Normally occurs only when copper piping is used to carry water with a low pH value.

GROUP D	
The presence of Group D substances should be determined at least when assessing the water for the first time. Thereafter, they can be included when there is reason to believe that their concentrations may have changed.	
Manganese	This is common reason for brown or black discolouration of fixtures and for stains in laundry. Can be common in bottom waters of dams, or in mining areas.
Zinc	This affects the taste of water. Usual cause is acidic water dissolving zinc from galvanised pipes or from appliances.
Iron	This affects the taste of the water and may also cause a reddish brown dis colouration. Can be common in bottom waters of dams, or in mining areas. Can cause growth of slimes of iron reducing bacteria that ultimately appear as black flecks in the water.
Potassium	This affects the taste of the water and is bitter at elevated concentrations.
Sodium	This affects the taste of water. Often elevated in hot, arid areas and on the western and southern Cape coasts (particularly in groundwater).
Calcium	This can cause scaling and can reduce the lathering of soap.
Magnesium	This affects the taste of water. It is bitter at high concentrations. Common in some areas it adds to the effect of calcium.
Hardness, Total	This is a combination of calcium and magnesium. It is associated with scaling and inhibition of soap lathering.

Possible problems in the water supply system

The section below describes potential high-risk areas for contamination and emergency situations that could arise at the four basic components of water supply, namely abstraction, treatment, distribution and use.

The Water Services Act defines an emergency situation as: *"Any situation declared as such in terms of a law and which is likely to cause injury or loss of life".*

Abstraction

Raw water can be abstracted from a river or dam, from a borehole and from a spring (groundwater). External conditions can effect the quality of these sources such as drought conditions, floods, pollution from different landuse activities, and over-exploitation.

River

What can go wrong?

Three factors can affect the quality of river water:

- drought or low flow conditions
- flood conditions
- pollution from landuse activities.

What is the possible effect?

The consequence of drinking bacteriologically contaminated water is typically an increased incidence of gastro-enteritis and water borne diseases such as cholera, typically with diarrhoea and fever. With chemical contaminants, depending on the dose and type of contaminant, negative health effects may occur either immediately or many years later.

How will you know?

It is very important to have a monitoring program in place for the total domestic water supply delivery route. Without water quality data the suitability of the water for domestic purposes cannot be assessed. For the implementation of a monitoring program, please refer to Volume 2: *Sampling Guide*.

The water, whether from the source, treatment plant, bulk supply or distribution network should be analysed for substances in Group A, B, D, (as described in Volume 1: *Assessment Guide*). For the interpretation of these results and to determine its fitness for use, Volume 1: *Assessment Guide* should also be used.

It is very expensive to analyse for all variables on a regular basis. Therefore, focus should be placed on indicator variables (such as electrical conductivity, which is an indication of the salt content of water).

For river sampling focus should be placed on general substances (Group A). Taste and odour will be prominent in the affected water.

During flood conditions the focus should be on bacteriological pollution.

If the source is suspected of being contaminated by industrial pollution then the focus should be placed on toxic substances (Group B & C).

What to do?

After the water has been analysed and assessed the following general guide can be used as a quick reference, but a thorough assessment by an expert should be done soonest:

- Water within the blue and green classes can be used without concern.
- Water within the yellow class must be used with caution.
- Water in the red class may only be used under emergency situations if no other source is available - only for short-term use.
- Water in the purple class may not be used at all.

Other options can also be considered when assessing the fitness for use of the water:

- Assess whether water from different sources can be mixed to achieve the required water quality.
- Make use of emergency treatment options or change the treatment process to cater for problem substances.
- If a pollution source can be identified address the problem at the source.
- Assess whether other sources are available for use such as groundwater sources and / or carting water with tankers from an uncontaminated source.

Dams/lakes

What can go wrong?

Four factors can effect the quality of water in dams or lakes:

- Drought or low flow conditions.
- Flood conditions.
- Pollution from landuse activities.
- Recreational activities such as boating on dams.

What is the possible effect?

Drought conditions will result in lower water levels in dams, which means that water has to be abstracted from the water close to or at the surface. This in turn may result in poorer water quality due to high algal concentrations. There may also be an increase in the salt concentration due to higher evaporation.

Floods will generally increase the risk of bacteriological (micro-organisms) contamination, and also increase the turbidity of the raw water, making the treatment and disinfection of the water difficult.

Pollution from industrial effluent discharges, sewage works discharges, agricultural activities and dense settlements could potentially affect the water quality of dams negatively. The water quality of dams can also be negatively affected by power boating which spill oils and fuels, albeit in small quantities per boat.

How will you know?

It is essential to have a monitoring programme in place to determine the water quality of the dam at the off-take point. The data should be assessed as described earlier, but dams with a high nutrient load (eutrophication) will show a greenish colour and definite taste and odour problems will be noticeable.

Flood conditions will increase the risk of bacteriological pollution and if the source is suspected of being contaminated by external sources the focus should be placed on toxic substances (Group B and C). Special analysis to determine lead and hydro-carbon contamination should be carried out if water is contaminated by oils and fuels.

What to do?

Once a dam has been contaminated it is difficult to rectify the situation. The only viable option is to adapt water treatment processes to overcome the problem.

Boreholes and springs

What can go wrong?

Three factors can effect the quality of water from boreholes and springs:

- Drought or low flow conditions.
- Pollution from landuse activities.
- Over-exploitation.

What is the possible effect?

Drought condition could potentially affect the water quality due to lower feed rates and higher mineralisation (concentration of salts in water).

External source can also impact on the water quality of boreholes and springs. Potential sources are septic tanks and french drains, solid waste disposal sites, industrial activities, feedlots, etc.

The over-exploitation of a groundwater source will result in a reduced yield. This could also draw polluted groundwater to the abstraction point because of the cone of depression created by the over abstraction.

How will you know?

For drought conditions focus should be placed on general substances (Group A)

- Analyse for substances in Groups A, B, D as described in Volume 1: *Assessment Guide*.
- Classify water to determine its fitness for use. For interpretation of results consult Volume 1: *Assessment Guide*.

For pollution conditions focus should be placed on toxic substances and bacteriological pollution (Group B & C)

- Analyse for substances in Group A, B, C, D as described in Volume 1: *Assessment Guide*.

- Classify water to determine its fitness for use. For interpretation of results consult Volume 1: *Assessment Guide*.

For over-exploitation conditions focus should be placed on:

- Classify water to determine its fitness for use. For interpretation of results use Volume 1.
- Deterioration in quality of water. Non compliance with SA Water Quality Guidelines.

What to do?

During drought conditions alternate sources for drinking and cooking should be considered after assessing the water quality. Treatment plant options should also be evaluated and considered for implementation.

External sources of contamination should be addressed at source. The water used for drinking and cooking purposes should be treated during the period of contamination or alternate sources should be considered.

If the source is over-exploited consideration should be given to the development of additional sources or allow enough time for the source to recover.

Treatment process

Home treatment

What can go wrong?

Use of a contaminated water source can occur either by

(a) direct use from a contaminated river, borehole or spring,

(b) secondary contamination of the supplied water during distribution or storage.

The type of contamination is most often microbiological. Other types of contamination can also occur such as by salts, metals or organic contaminants.

What is the possible effect?

The consequence of drinking bacteriologically contaminated water is typically an increased incidence of gastro-enteritis and water borne diseases, typically with diarrhoea and fever. With chemical contaminants, depending on the dose and type of contaminant, negative health effects may occur either immediately or many years later.

How will you know?

Evidence of contamination of the water may in some cases be obvious, such as a change in the appearance of the water, e.g. cloudy when you open the tap, but may in other cases only be inferred from an increase in the incidence of water borne disease in the consumers, or as an inference from the analysis of a water sample, where the medical staff suspect a water borne

disease from the symptoms of the patients. For assistance in the interpretation of a chemical analysis of the water, see **Volume 1** (*Assessment Guide*).

In some parts of the country the water may be milky when poured from the tap into a glass, especially during winter. This does not mean that the water is contaminated, it is merely tiny bubbles of air that appear when the pressure inside the distribution system is released when opening the tap. The water normally clears very quickly as the air bubbles escape from the water.

What to do?

Where the cause of the contamination is bacteriological (faecal pollution of the water), home treatment is easy, and one of the following home treatment options may be used:

- Boil the water continuously for at least 5 to 10 minutes. This is the most effective for making the water bacteriologically safe. Care should be taken to avoid burns and to keep the water out of reach of children until it has cooled.
- Disinfect the water by adding one teaspoon of domestic bleach in a bucket (20 litres) of water, mix well, and leave for 1 hour before use. Water with a high turbidity should be left for at least 2 hours before use, or the water should be filtered through a fine cloth prior to adding the bleach.
- The use of a suitable home treatment device, for example with a fine filter, which is capable of filtering out bacteria.
- Where possible use a safer and properly disinfected and treated water source.

Note that the usually available, low cost home treatment devices do not cater for contaminants such as salts and metals, and specialised equipment may be needed to treat the water if such contaminants are present at concentrations causing negative health effects.

Basic Treatment

What can go wrong?

The following are typical problems that may be encountered:

- Inadequate funds/resources, leading to a shortage of treatment chemicals.
- Shortage of trained operators.
- Power failure.
- Floods.
- Droughts.

What is the possible effect?

In the case of under-usage of treatment chemicals, there is an increased risk of bacteriological contamination in the treated water. Inability of the operator to properly operate the works may lead also to improperly disinfected water.

Power failure, with the inability to pump the water, leads to reduction in the water flow and quality.

Floods tend to cause a drastic change in the quality characteristics of the source water, and presents a challenge to the treatment operator to adapt the operating parameters so that water of good quality can still be supplied. With floods there tends to be a pulse coming through of improperly disinfected water. Floods may also on occasion mechanically damage the treatment works.

Droughts may lead to an increase in salts in the raw water, in the case of surface water supplies. A drought may also lead to the need to ration the supplied water due to inadequate volumes of available source water.

How will you know?

Reduction in quality of the supplied water may lead to consumer complaints about the aesthetic quality of the water, while reduction in quantity of water may manifest as reduced water pressure or periods of lack of water supply.

The deterioration in the quality of the water may also be established as the consequence of the analysis of the water (see Volume 1, *Assessment Guide* for the classification and interpretation of water quality in terms of fitness for domestic use.).

What to do?

- In the case of inadequate funding, initiate a process to acquire funds from other sources, such as provincial or national government.
- In the case of poorly trained operators, initiate a training programme for the operators to operate the specific water treatment works correctly.
- In the case of power failures, make use of an emergency power generator.
- In the case of floods, initiate modification of the treatment process to deal with the changed raw water conditions. In some cases (if sufficient water is stored in the distribution reservoirs) it may be possible to cease abstraction until the first "pulse" of flood water has passed. Note that water in the red class may only be used for short duration, and that the aim should be to comply at least with yellow class water.
- In the case of droughts, it may be necessary to supply emergency water supplies from an alternative source with tankers.

Conventional & Advanced Treatment

What can go wrong?

The following are possible problems, which may arise:

- Inadequate funds/resources
- Power failure
- Over-fluoridation
- Overdosing/underdosing of other chemicals such as chlorine
- Change in raw water quality, e.g., algal blooms
- Floods
- Drought.

What is the possible effect?

The effects of the above problems are for example, respectively, as follows:

- Shortage of chemicals or improper operation of the treatment works.
- Reduction in volume and quality.
- Over-fluoridation can cause brittle-bone disease and mottled teeth. Brittle bones break under mild stress.
- Overdosing of chlorine may result in elevated trihalomethane (THM) levels, with an increase in the risk of cancer in the long term. Underdosing of chlorine may result in inadequate disinfection of the water, with increased incidence of diarrhoeal diseases.
- Change in raw water quality results in deterioration of the quality of the supplied water.
- Floods may both change the quality of the available water, as well as cause possible physical damage to the treatment works.
- Drought may cause a deterioration (typically increased salinity) in the supplied water, as well as a reduction in the quantity of available water. Water abstracted from the bottom of a dam tends to be of poorer quality.

How will you know?

The signs that alert the manager to the above respective problems are as follows:

- Deterioration in the aesthetic and or bacteriological and chemical quality of the supplied water, as ascertained from an analysis and interpretation/ classification of the water (see *Assessment Guide*, Volume 1).
- The effects of a power failure are either an interruption in the water supply (no water in the case of water being pumped through the system) or a deterioration in the quality of the water if the water is gravity fed through the system.
- Discolouration of the teeth occurs where fluoride is ingested during the tooth formative years in concentrations in excess of the optimum health level. Please note that fluoride has no taste, colour or smell, and cannot be detected aesthetically even at toxic concentrations.
- In the event of over-dosing with chlorine the water will have a strong bleach-like smell and taste. In the event of under-dosing there will be no bleach smell or taste at all, and there is potentially an increased risk of diarrhoeal disease.
- During floods a deterioration in water quality will be noticed, particularly in the bacteriological quality. The increase in turbidity will cause blocked filters.
- During drought conditions, the salt content of the water will tend to increase. There may also be a deterioration in bacteriological quality due to, for example, leaking sewage pipes with less dilution in the water resource.

What to do?

The respective management measures for the above points are:

- Water within the yellow class can be used, but with caution. Should the water be in the red class, this may only be used in emergency situations if no other water supply is available (short-term use only). Initiate the process of acquiring adequate funding from other sources such as provincial and national government, and see that operators are properly trained to operate the specific treatment works concerned.

- During a power failure, make use of an emergency power generator, and implement basic emergency treatment options to comply with at least the red class water but preferably with the yellow class.
- In the case of over-fluoridation, stop fluoride addition immediately until the problem can be rectified, and warn the consumers. If the water is in the purple class then an alternative drinking water supply must be used. Most low cost conventional home treatment devices do not remove fluoride adequately. Good quality control is essential where fluoridation is practised, and hourly measurements of the fluoride concentration are a must. Care must be taken to prevent overdosing, as there is no antidote to fluoride poisoning. For the effective removal of fluoride advanced treatment methods are required, such as activated alumina or bone char to remove the fluoride. Home treatment with clay or calcium carbonate chips may ameliorate high concentrations. Home treatment kits using ion-exchange processes may also be used, but tend to become quickly saturated.
- In the case of overdosing with chlorine, a simple option, which may be exercised by the consumers, is to boil the water for a few minutes to drive off the excess chlorine. The same effect can be achieved by stirring the water vigorously or pouring it from one container to another a few times to aerate the water. If it is left standing long enough, the chlorine will also dissipate. In the case of under-dosing with chlorine, and bacteriological contamination is suspected, it would be wise for the consumer either to add some bleach to the water, or as a precaution to boil it for a few minutes to destroy micro-organisms.
- In the case of change in raw water quality, the action to take will depend on the nature of the change. The manager needs to obtain updated water quality analyses of the raw and final water to ascertain in what direction a possible modification of the treatment process may be required.
- In the case of flood events, there is usually a deterioration in microbiological water quality due partly to increase in turbidity, and the flocculation dosing may need to be adapted to obtain optimum flocculation, as well as more frequent backwashing of the filters. It may also be necessary to temporarily raise the chlorine dosing to achieve adequate disinfection of the water. Another option is to cease abstraction until the first "pulse" of flood water has passed. Where flood events have damaged the treatment works, the nature of the repair work and planning will of course depend on the nature and degree of the damage, which has occurred.
- In the case of droughts the change in raw water quality may require re-optimisation of the dosing chemical regimen, as well as planning for dealing with water shortages.

Distribution

The distribution network includes storage reservoirs, a pipe network and standpipes. The network can be affected by having open reservoirs, silt build-up in reservoirs, sabotage, breaks and bursts of pipes, and infiltration/seepage from a contaminated source.

Reservoir

What can go wrong?

There are four general problems that can affect reservoirs, these are:

- Contamination of open reservoirs
- Silt build up in the reservoir
- Overly long retention times in large reservoirs
- Sabotage.

What is the possible effect?

- Common effects in open reservoirs are animals such as birds and rodents falling into the reservoir, and contaminating the water, or algal growth as a consequence of the exposure of the water to sunlight.
- Silt build-up in reservoirs can lead to an increase in the turbidity of the water, and an associated increase in bacteriological contamination of the water.
- Overly long retention times lead to:
  - Disappearance of the residual chlorine needed to keep the water disinfected.
  - An increase in bacteriological contamination.
  - An increase in algal growth and growth of slime bacteria.
  - Appearance of taste and smell problems.
- Sabotage can lead to loss of the water, as well as to contamination of the water supply.

How will you know?

- Physical inspection of the open reservoir may reveal the presence of dead animals or algal scums.
- Sampling at strategic points for substances in group A, B, C, and D as described in Volume 1: *Assessment Guide*, and classification of the water to determine the fitness for use. For interpretation of results, see Volume 1.
- Free chlorine sampling at strategic points, both in the distribution system and in the reservoir will show a decrease in the chlorine residual in the case of long retention times.
- Detection and evaluation of sabotage will need physical inspection as well as a full water quality analysis to reveal the possible presence of contaminants in the water.

What to do?

- In the case of open reservoirs, remove foreign objects and clean the reservoir regularly. Increase the chlorine dosage to reduce algal growth and bacteriological contamination.
- In the case of silt build-up in the reservoir, check and rectify the filters at the treatment works when a silt build-up is noticed. It may also be necessary to increase the chlorine dose to deal with increased bacteriological contamination.
- In the case of long retention times in a large reservoir there are a number of possible actions to take such as:
  - Implement a lower operational water level.
  - Change the frequency of filling, or replace the water regularly in the reservoir to eliminate long retention times.
  - Construct multiple compartments in the reservoir to ensure that there are no "dead pockets" in the reservoir with overly long retention times.
- Increase security when sabotage is suspected.

Network

What can go wrong?

Two common problems that can go wrong in the network are:

- Breaks and bursts of the pipes,
- Infiltration or seepage from a contaminated source, unless the water is under high pressure in the pipes.
- Contamination during repairs.

What is the possible effect?

- In the case of breaks and bursts, there is a loss of water, as well as the possibility of an increase in turbidity of the water.
- In the case of infiltration/seepage, a deterioration in water quality can be anticipated.
- During repair work to pipes, it is inevitable that some contamination of the pipeline occurs.

How will you know?

- Physical inspection will reveal a break or burst through an apparent water leak.
- In the case of possible infiltration and seepage, this may necessitate the conducting of regular sampling especially in industrial areas at strategic points to detect deterioration in water quality for indicator variables.
- In the case of deterioration in water quality it is advisable to do a full analysis to establish the fitness for use of the water (see Volume 1: *Assessment Guide*).
- After pipe repairs discoloured water may be noticeable for a short time until it has been purged from the pipeline.

What to do?

- Establish and rectify the leak immediately.
- Supply an interim source of water in the case of infiltration and contamination of the water source. Water in the yellow class can be used with caution, while water in the red class should only be used for a short period in emergency situations.
- After repairs the pipeline should be disinfected. Users should be warned as the disinfectant may result in taste and odour, as well as discolouration.

Standpipes

What can go wrong?

- Two common problems with standpipes are:
- Tap left open or leakage from a faulty washer.
- Rubbish dumped in area around standpipe, or faecal matter collecting from e.g. dogs.

What is the possible effect?

- Water lost.
- Contamination of water containers by splashing during filling of the containers if there is rubbish lying around the standpipe.

How will you know?

- Physical inspection of standpipes for leakages.
- Physical inspection of cleanliness of area around standpipe.

What to do?

- Repair faulty washers and educate consumers to close taps after use.
- Keep area around standpipes free of rubbish.

Point of use

Three point of use situations are discussed below, viz., rainwater harvesting/storage, boreholes and household containers.

Water can be used for various purposes at the house. This water can be contaminated through the incorrect storage of water, the use of contaminated storage facilities or the use of a contaminated source.

Rainwater harvesting/storage

What can go wrong?

Three common problems encountered are:

- Open storage tanks
- Dirty roofs
- Contamination from a septic tank or pit latrine
- Contamination from air pollution.

What is the possible effect?

- Open storage tanks can lead to suspended solids contamination, bacteriological pollution, and contamination of the water with mosquito larvae.
- Dirty roofs may lead to contamination with not only dust and suspended solids, but to contamination from old paint, rust products from iron roofs etc.
- In the case of leakages from septic tanks and pit latrines, there is a high risk of bacteriological contamination.
- Air pollution may cause the rainwater to contain pollutants.

How will you know?

- Physical inspection of open tanks revealing suspended solids or mosquito larvae presence.
- Off tastes and odours of the water in the case of dirty roofs.
- Diarrhoea in the case of bacteriological contamination.
- Health officer monitoring- classify water to determine fitness for use.
- Rainwater may also cause rust problems when atmospheric pollution is a problem.

What to do?

- Seal open storage tanks, and clean storage tanks regularly if possible.
- In the case of runoff from roofs bringing dirt with the first rainstorm, by-pass the first rainwater from the roofs. This should also be practiced where atmospheric pollution is a problem.
- In the case of bacteriological contamination, the water may be boiled or disinfected with bleach.
- In the case of other pollutants, the water may not be fit for use (as indicated by an analysis) and it may be advisable to use another and safer source of water.
- If water is in the purple class, it should not be used for drinking purposes, but only for flushing toilets, etc.

Boreholes

What can go wrong?

- Contamination from a septic tank or pit latrine
- Seepage from other sources (e.g. industrial)

What is the possible effect?

- In the case of contamination from a septic tank or pit latrine, there is an increased risk for diarrhoeal disease from bacteriological contamination of the water.
- In the case of seepage from other sources such as industries or petrol tanks, there may be other health and/or aesthetic effects consequent to contamination of the water.

How will you know?

- Bacteriological contamination leads to diarrhoeal disease as well as off tastes and odours.
- Physical inspection may reveal potential contamination from the close proximity of other sources of contaminants.
- Analysis of the water may need to be performed to ascertain the nature of any contaminants present.

What to do?

- Disinfect water by boiling or adding bleach in the case of bacteriological contamination.
- Use another safer source of water.
- Inform relevant authority for action, and use water only for washing and flushing toilets in the case of serious contamination where the water is in the red or purple class.

Household containers

What can go wrong?

- Contamination due to long standing and/or continuous use
- Prior contamination due to use of a container used previously for other purposes.

What is the possible effect?

- Increased risk of bacteriological contamination where containers are not washed regularly.
- In the case of use of other containers for transporting water, e.g. containers previously used for storing chemicals or pesticides, there is a serious risk of health effects from residues of the chemicals remaining in the container.

How will you know?

- Increased bacteriological contamination leads to taste and odour problems, as well as the possibility of diarrhoea.
- Physical inspections will reveal if the consumers are using chemical/pesticide containers for transporting water, with the potential for negative health effects.
- Monitoring of the water quality analytically may reveal the presence of unwanted contaminants.

What to do?

- Clean containers regularly, store in a clean ventilated area, and cover containers.

Remove and destroy chemical/pesticide containers, and replace with clean containers suitable for carrying and storing water.

A Quick Reference to Possible Problems in the Water Supply System

The tables are a quick reference and summarises what can go wrong, what the possible effect may be on the user of the water, how the user will know that the water is not suitable for domestic use and what action the user can take to rectify the emergency.

Abstraction

The abstraction section indicates all the possible raw water sources available to the domestic user for abstraction. Raw water can be sourced from a river or dam, from a borehole (groundwater) and from a spring (groundwater) and rainwater harvesting.

Drought conditions, floods, pollution from different landuse activities, and over-exploitation can affect these sources.

River

What can go wrong?	What is the possible effect?	How will you know?	What to do?
Drought (Low flow conditions)	Water quality will deteriorate.	It is very important to have a monitoring program in place for the total domestic water supply delivery route. Without water quality data the suitability of the water for domestic purposes cannot be assessed. For the implementation of a monitoring program, please refer to Volume 2: *Sampling Guide* The water, whether from the source, treatment plant, bulk supply or distribution network should be analysed for substances in Group A, B, D, (as described in Volume 1: *Assessment Guide*). For the interpretation of these results and to determine its fitness for use, Volume 1: *Assessment Guide* should alsobe used. It is very expensive to analyse for all variables on a regular basis. Therefore, focus should be placed on indicator variables (such as electrical conductivity, which is an indication of salt content of water).	Water rationing may be necessary in severe droughts. Chlorine dosingmay need to be increa-sed under flood conditions to ensure disinfection. With pollution, source control measures should be implemented. After the water has been analysed and assessed the following general guide can be used as a quick reference, but a thorough assessment by an expert should be done soonest: • Water within the blue and green classes can be used without concern. • Water within the yellow class must be used with caution. • Water in the red class may only be used for emergency situations if no other source is available - only for short-term use. • Water in the purple class may not be used at all.
Floods	Increased turbidity makes treatment and disinfection difficult.		
Pollution	Change in water quality due to: • Industrial effluent discharges • Sewage works discharges • Agricultural activities • Urbanisation .		

River (Continue)

What can go wrong?	What is the possible effect?	How will you know?	What to do?
		For river sampling focus should be placed on general substances (Group A) Taste and odour will be prominent of the affected water. During flood conditions the focus should be on bacteriological pollution If the source is suspected of being contaminated by industrial pollution then the focus should be placed on toxic substances (Group B & C)	Other options can also be considered when assessing the fitness for use of the water: • Assess whether different sources can be mixed to achieve the required water quality. • Make use of emergency treatment options or change the treatment prcess to cater for problemsubstanes. • If a pollution source can be identified address the problem at the source. • Assess whether other sources are available for use such as groundwater sources and or carting water with tan-kers from an uncontaminated source.

Dams/lakes

What can go wrong?	What is the possible effect?	How will you know?	What to do?
Drought (Low level conditions)	Lower off-takes have to be used: • Poorer water quality • Increased salts due to evaporation	It is very important to have a monitoring program in place for the total domestic water supply delivery route. Without water quality data the suitability of the water for domestic purposes cannot be assessed. For the implementation of a monitoring program, please refer to Volume 2: *Sampling Guide*. The water, whether from the source, treatment plant, bulk supply or	After the water has been analysed and assessed the following general guide can be used as a quick reference, but a thorough assessment by an expert should be done soonest: • Water within the blue and green classes can be used without concern • Water within the yellow class must be used with caution. • Water in the red class may only be
Floods	Change in water quality due to: • Increased risk from		

DamsLakes (Continued)

What can go wrong?	What is the possible effect?	How will you know?	What to do?
	micro-organisms • Increased turbidity making treatment and disinfection difficult.	distribution network should be analysed for substances in Group A, B, D (as described in Volume 1: *Assessment Guide*). For the interpretation of these results and to determine its fitness for use, Volume 1: *Assessment Guide* should also be used. It is very expensive to analyse for all variables on a regular basis. Therefore, focus should be placed on indicator variables (such as electrical conductivity, which is an indication of salt content of water). For dam/lake sampling, focus should be placed on general substances (Group A). During flood conditions the focus should be on bacteriological pollution. If the source is suspected of being contaminated by external pollution, then the focus should be placed on toxic substances (Group B & C). • Special analysis to determine lead and hydro-carbon contamination. • Specialist to assess and interpret data. Eutrophication: Green water in dam, taste and odour problems.	used for emergency situations if no other source is available - only for short-term use. • Water in the purple class may not be used at all. Other options can also be considered when assessing the fitness for use of the water: • Assess whether different sources be mixed to achieve the required water quality. • Make use of emergency treatment options or change the treatment process to cater for problem sub stances. • If a pollution source can be identified address the problem at the source. • Assess whether other sources are available for use such as groundwater sources and or carting water with tankers from an uncontaminated source. Once a dam has been contaminated it is difficult to rectify the situation. The only viable option is to adapt water treatment processes to overcome the problem.
Pollution can	Change in water quality due to: • Industrial effluent discharges • Sewage works discharges • Agricultural activities • Urbanisation		
Recreational activities	Change in water quality due to: • Oils and fuel from boats.		

Groundwater: Boreholes and springs

What can go wrong?	What is the possible effect?	How will you know?	What to do?
Drought	Change in water quality due to: • Lower feed rates and higher mineralisation (concentration of salts in the water)	**For drought conditions focus should be placed on general substances (Group A)** • Analyse for substances in Groups A, B, D as described in Volume 1: *Assessment Guide*. • Classify water to determine its fitness for use. For interpretation of results consult Volume 1: *Assessment Guide*.	Alternate source for drinking and cooking if change in water quality is too high. Install treatment plant for drinking water only.
Pollution	Change in water quality due to: • Septic tanks • VIP's • Solid waste sites • Industries, and • Feedlots, etc.	**For pollution conditions focus should be placed on toxic substances and bacteriological pollution (Group B & C)** • Analyse for substances in Group A, B, C, D as described in Volume 1: *Assessment Guide*. • Classify water to determine its fitness for use. For interpretation of results consult Volume 1: *Assessment Guide*.	For pollution conditions address source of contamination. Treat water until problem is solved or supply from alternative source.
Over-exploitation	Change in water quality due to: • Reduced yield and poorer quality	**For over-exploitation conditions focus should be placed on:** • Classify water to determine its fitness for use. For interpretation of results use Volume 1. • Deterioration in quality of water. Non compliance with SA Water Quality Guidelines.	If source is overexploited develop additional source or allow enough time for source to recover.

Treatment process

There are numerous treatment processes. These processes are described in detail in Volume 4: *Treatment Guide*. For the purposes of this Guide these processes were subdivided into: Home treatment, Basic treatment, Conventional treatment, and Advanced treatment.

The basic, conventional, and advanced treatment processes can be affected by the lack of funds/resources, shortage of chemicals, inability of operator to manage treatment works, power failures, fluctuations in raw water quality, floods and drought conditions.

Home treatment

What can go wrong?	What is the possible effect?	How will you know?	What to do?
Use of contaminated source: • Direct use from river, borehole or spring	• Risk for bacteriological contamination causing diarrhoea, fevers etc. • Negative health effects as a result of other contaminants.	• Negative health impacts. • Health Officer monitoring results – classify water to determine fitness for use as described in Volume 1: *Assessment Guide*.	• Boil water continuously for at least five to ten minutes, or • Add one teaspoon of domestic bleach in 20 litres (bucket) of water, mix well and leave for one hour before use. Water with a high turbidity should be left for at least two hours before use or the water should be filtered through a fine cloth prior to adding the bleach, or • The use of a home treatment device, or • Use a safer drinking water source.
• Inadequate boiling. • Inadequate use of chemicals such as bleach	Increased risk for bacteriological contamination.	• Negative health impacts. • Health Officer monitoring results – classify water to determine fitness for use as described in Volume 1: *Assessment Guide*.	• Boil water continuously for at least five to ten minutes, or • Add one teaspoon of domestic bleach in 20 litres (bucket) of water, mix well and leave for one hour before use. Water with a high tur bidity should be left for at least two hours before use or the water should be filtered through a fine

Home treatment (Continued)

What can go wrong?	What is the possible effect?	How will you know?	What to do?
			cloth prior to adding the bleach, or • The use of a home treatment device, or • Use a safer drinking water source.
Treatment option used does not cater for other contaminants such as salts and metals	High risk for other substances contamination – which may lead to health effects.	Negative health impacts. • Health Officer monitoring results – classify water to determine fitness for use as described in Volume 1: *Assessment Guide*.	• Boil water continuously for at least five to ten minutes, or • Add one teaspoon of domestic bleach in 20 litres (bucket) of water, mix well and leave for one hour before use. Water with a high turbidity should be left for at least two hours before use or the water should be filtered through a fine cloth prior to adding the bleach, or • The use of a home treatment device, or • Use a safer drinking water source

Basic treatment

What can go wrong?	What is the possible effect?	How will you know?	What to do?
Inadequate funds/ resources • Shortage of chemicals. • Inability of operator to manage treatment works.	• High risk for bacteriological contamination.	• Analyse for substances in Group A, B, D as described in Volume 1: *Assessment Guide*. • Classify water to determine its fitness for use. Use Volume 1: *Assessment Guide* to interpret results.	• Initiate a process to acquire funds from other sources such as provincial or national government. • Train operators to operate specific treatment works correctly.
Power failure	Reduction in water quality and flow.	• Analyse for substances in Group A, B, D as described in Volume 1: *Assessment Guide*.	

Basic treatment (Contibued)

What can go wrong?	What is the possible effect?	How will you know?	What to do?
		• Classify water to determine its fitness for use. Use Volume 1: *Assessment Guide* to interpret results.	• Make use of an emergency power generator.
Floods	Change in water quality due to: • Damaged treatment works.	• Analyse for substances in Group A, B, D as described in Volume 1: *Assessment Guide*. • Classify water to determine its fitness for use. Use Volume 1: *Assessment Guide* to interpret results.	• Basic emergency treatment options to comply with at least a red class water for short duration. • Water within the yellow class must be used with caution • Water in the red class may only be used for emergency situations if no other source is available – only for short-term use. • Make use of other sources supplied by water tankers.

Conventional and Advanced treatment

What can go wrong?	What is the possible effect?	How will you know?	What to do?
Inadequate funds/ resources	Shortage of chemicals Inability of operator to manage treatment works	• Analyse for substances in Group A, B, D as described in Volume 1: *Assessment Guide*. • Classify water to determine its fitness for use. Use Volume 1: *Assessment Guide* to interpret results.	Initiate process to acquire funds from other sources such as provincial or national government and train operators to be able to operate specific treatment works.
Power failure	Reduction in volume and quality	No water if water is pumped through system during a power failure and	During a power failure make use of an emergency power generator and

What can go wrong?	What is the possible effect?	How will you know?	What to do?
		deterioration in water quality if water is gravity fed through system.	implement basic emergency treatment options to comply to at least a red class water for short durations.
Over-fluoridation	Over-fluoridation causes brittle-bone disease. Fluoride fixes the calcium in the bone structure and, consequently, the bone becomes very hard. Brittle bones break easily under mild stress.	Discolouration of the teeth occurs where fluoride is ingested during the tooth formative years in concentrations in excess of optimum level for healthy tooth enamel. Please note that fluoride has no taste, colour or smell, and cannot be detected aesthetically, even at high concentrations.	Good quality control – hourly measurements are necessary when fluoridation is practiced. Care should be taken that overdosing does not occur. For the effective removal of fluoride, advanced treatment methods are required, such as activated alumina or bone char to absorb fluoride. Home treatment with clay or calcium carbonate chips may ameliorate high concentrations. Home treatment kits using ion exchange processes can be used.
Overdosing/under-dosing of other chemicals such as Chlorine	Carcinogenic (THM formation) Increasing risk of cancer with long-term use when chlorine dose is excessive.	Water tastes like bleach.	Optimise chlorine and treatment chemical dosing
Change in raw water quality	Deterioration in water quality – fluctuation in water quality	• Analyse for substances in Group A, B, D as described in Volume 1: *Assessment Guide*. • Classify water to determine its fitness for use. Use Volume 1: *Assessment Guide* to interpret results.	• Water within the yellow class could be used but with caution. • Water in the red class may only be used for emergency situations if no other source is available –only for short-term use. • Use other sources – groundwater sources and/or water tankers. • Mixing of water sources to achieve better water quality.

Conventional and Advanced treatment (Continued)

What can go wrong?	What is the possible effect?	How will you know?	What to do?
Floods	Change in water quality due to: • Damage to treatment works.	During floods a deterioration in water quality will be noticed. The increase in turbidity will cause blocked filters. Bacteriological quality may deteriorate.	• Water within the yellow class could be used but with caution. • Water in the red class may only be used for emergency situations if no other source is available — only for short-term use. • Use other sources – groundwater sources and/or water tankers. • Mixing of water sources to achieve better water quality.
Drought	• Stagnant water . abstraction • Use of poorer quality water from bottom of dam.	During drought conditions the salt content of the water will increase Leaking sewage pipes can create bacteriological problems during drought conditions.	• Water within the yellow class could be used but with caution. • Water in the red class may only be used for emergency situations if no other source is available — only for short-term use. • Use other sources – groundwater sources and/or water tankers. • Mixing of water sources to achieve better water quality.

The Distribution network includes storage reservoirs, a pipe network, and standpipes.

The network can be affected by having open reservoirs, silt build up in reservoirs, sabotage, breaks and bursts of pipes, and infiltration/ seepage from a contaminated source.

Reservoir

What can go wrong?	What is the possible effect?	How will you know?	What to do?
Open reservoirs	Change in water quality due to: • Contamination from birds etc. • Growth of Algae.	• Physical inspection. • Free chlorine sampling at strategic points • Sampling at strategic points to ensure right levels of free chlorine. • Free chlorine sampling in reservoir. • Sampling at strategic points for substances in Group A, B, C, D as described in Volume 1: *Assessment Guide*. • Classify water to determine its fitness for use. For interpretation of results use Volume 1.	• Remove foreign objects and clean reservoir regularly. • Increase chlorine dosage to reduce algal growth and bacteriological contamination.
Silt build up in reservoirs	Change in water quality due to: • Increase in turbidity. • Increase in bacteriological contamination.	• Sampling at strategic points for substances in Group A, B, C, D as described in Volume 1: *Assessment Guide*. • Classify water to determine its fitness for use. For interpretation of results use Volume 1. • Physical inspection. • Free chlorine sampling at strategic points	• Check and rectify filters at treatment works if a silt buildup is noticed in the reservoirs. • Increase chlorine dosage to reduce algal growth and bacteriological contamination

Reservoir (Continued)

What can go wrong?	What is the possible effect?	How will you know?	What to do?
Large reservoir – long retention time	Change in water quality due to: • No more free chlorine to disinfect water. • Increase in bacteriological contamination. • Increase in algal growth. • Taste and smell effects.	• Sampling at strategic points for substances in Group A, B, C, D as described in Volume 1: *Assessment Guide*. • Classify water to determine its fitness for use. For interpretation of results use Volume 1. • Free chlorine sampling at strategic points	• Increase chlorine dosage to reduce algal growth and bacteriological contamination. • Change the frequency of filling or replace the water regularly in the reservoir to eliminate long retention times. • Construct multiple compartments in reservoir to ensure that retention times are reduced.
Sabotage	• No water. • Contaminated water.	• Sampling at strategic points for substances in Group A, B, C, D as described in Volume 1: *Assessment Guide*. • Classify water to determine its fitness for use. For interpretation of results use Volume 1. • Physical inspection.	• Increase security when sabotage is suspected. • Water within the yellow class could be used but with caution. • Water in the red class may only be used for emergency situations if no other source is available – only for short-term use.

Network

What can go wrong?	What is the possible effect?	How will you know?	What to do?
Breaks and bursts	• Increase in turbidity • Loss of water	• Physical inspection. • Sampling at strategic points to establish fitness for use.	Water within the yellow class could be used but with caution. • Water in the red class may only be used for emergency situations if no other source is available –– only for short-term use.
Infiltration / seepage from contaminated source	Deterioration in water quality	• Regular sampling at strategic points for indicator variables at high-risk areas, e.g. Industrial sites.	• Establish and rectify problem immediately. • Supply an interim source of water.

Water can be used for various purposes at the house. This water can be contaminated through the incorrect storage of water, the use of contaminated storage facilities or the use of a contaminated source.

Rainwater harvesting / storage

What can go wrong?	What is the possible effect?	How will you know?	What to do?
Open storage tanks	Change in water quality due to: • Bacteriological pollution. • Suspended solids contamination.	• Taste, odours, diarrhoea. • Physical inspections. • Health Officer monitoring - classify water to determine fitness for use.	• Clean storage tanks regularly. • Seal storage tanks.
Dirty roofs / contamination from septic tank / pit latrine	High risk for other variable contamination - which may lead to health effects.	• Taste, odours, diarrhoea. • Physical inspections. • Health Officer monitoring - classify water to determine fitness for use.	• By-pass first rainwater runoff from roofs. • Use another safer source of water • Use water only for washing, flushing toilets, etc.

Boreholes

What can go wrong?	What is the possible effect?	How will you know?	What to do?
Contamination from septic tank / pit latrine.	Increased risk for bacteriological contamination - diarrhoea, fevers.	• Taste, odours, diarrhoea. • Health Officer monitoring - classify water to determine fitness for use.	• Use another safer source of water. • Use water only for washing, flushing toilets, etc. • Inform relevant authority for action.
Seepage from other sources.	Negative health effects as a result of other contaminants.	• Taste, odours, diarrhoea. • Health Officer monitoring - classify water to determine fitness for use.	• Another safer source of water. • Use water only for washing, flushing toilets, etc. • Inform relevant authority for action.

Boreholes

What can go wrong?	What is the possible effect?	How will you know?	What to do?
Contamination due to long standing and/or continuous use.	Increased risk for bacteriological contamination - diarrhoea, fevers.	• Taste, odours, diarrhoea. • Physical inspections. • Health Officer monitoring - classify water to determine fitness for use.	• Clean containers regularly. • Store in clean ventilated area. • Cover containers

PART 5

Decision-making hierarchy

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Describes the institutional responsibilities - who does what?

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Provides definitions for the terms and concepts used in the guide and four basic water supply routes are highlighted.

Part 4

Forms the basis of the Guide. A description is given of the overall domestic water supply route, what can go wrong, the possible consequences and what to do at each strategic point in the supply route to solve the problem.

Part 5

Guides the user through a decision-making process on whether a water source can be used for domestic purposes and the potential costs involved.

YOU ARE HERE

Part 6

Provides general information on management concepts.

Part 7

Describes briefly the need for capacity building, and what initiatives are to be taken by government to capacitate all spheres of society involved in domestic water supply.

Decision-making hierarchy

What is a decision-making hierarchy? (A process to determine if water can be used for domestic purposes)

A decision-making hierarchy is a chronological process that is followed to determine the "best" option to implement. A decision-making hierarchy is used to guide the decision-maker to make a decision acknowledging the contributions of other affected parties and the risks involved.

For the purposes of this document a decision-making hierarchy is used to determine the usability of a particular water resource with regard to its water quality. The decision-making hierarchy depicted in **Figure 6** only considers the water quality aspects and the resultant costs of producing a specific water quality.

Water quality is not the only aspect, which needs consideration when deciding on the usability and cost implications of supplying water from a specific source. Other factors that need consideration are:

- type and number of consumers,
- user water requirement per user,
- level of service required,
- water source quality and yield,
- water supply infrastructure, and operation, maintenance and management of water supply system.

The assessment process is shown in **Figure 6** and may be summarised as follows:

- Decision making on the suitability of water for domestic use is largely determined by the health related drinking class of the water. It is therefore important to assess whether the substance causing the problem has any health effect. The following can then be used to guide decision-making:

  - Water falling in the Blue or Green class can be used without reservation and should be considered safe for all users.
  - Water falling in the Yellow class can generally be regarded as safe, but sensitive users should be identified and warned to take their own precautions (e.g. for infants).
  - Water falling in the Red class may be used for short-term emergency supply (7 days) only, where other sources are not available
  - When water falls into the Purple class the public should be warned not to use the water, or to use emergency home treatment where possible.

- From the water quality status assessment the water source can be classified as described in the *Assessment Guide,* Volume 1. Each variable of concern can therefore be classified in terms of

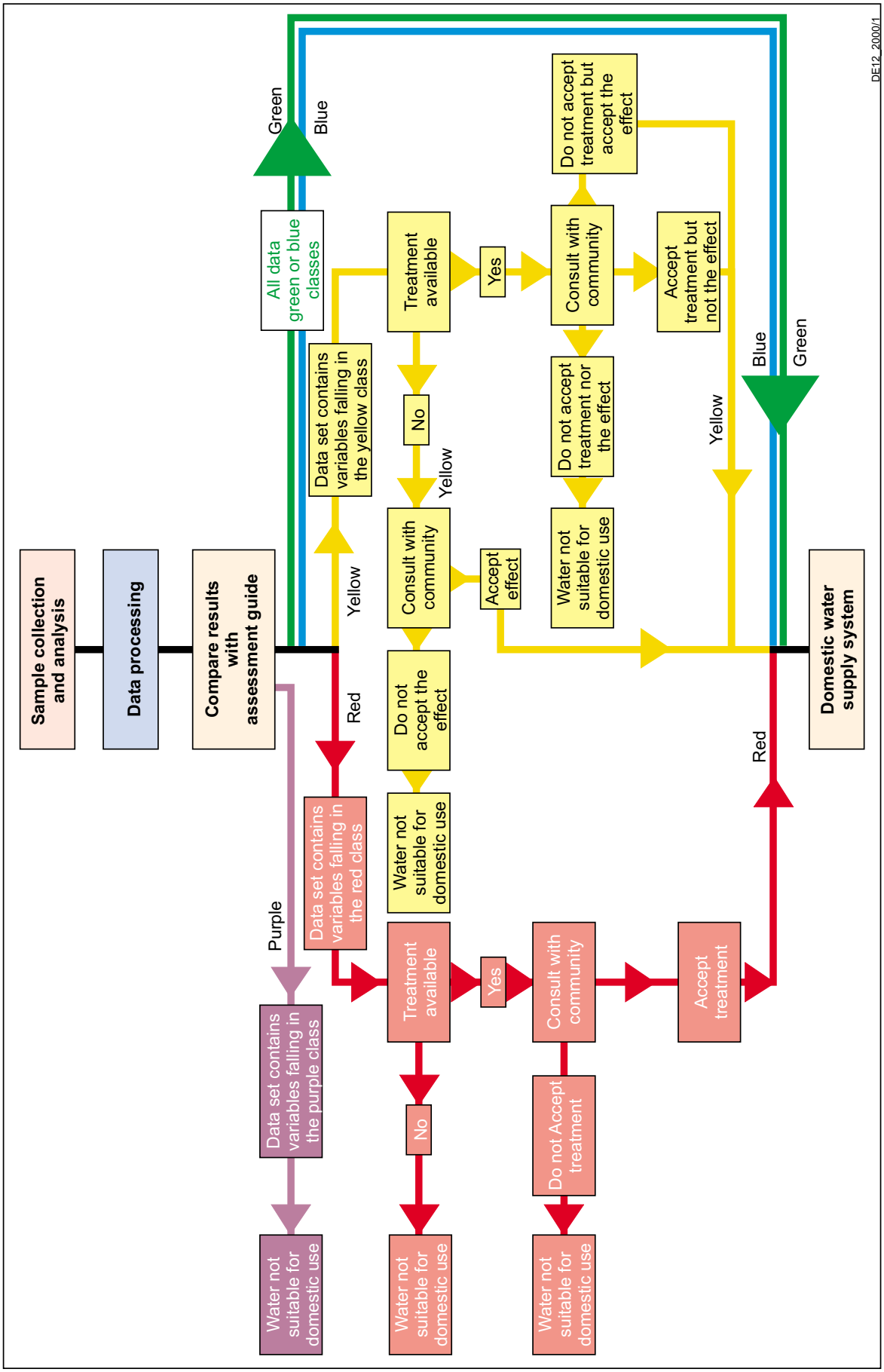


FIGURE 6

Decision-making Hierarchy in Terms of Water Quality for Domestic Use

its potential negative impact on the domestic user. Based on the classification of the substances, specific action (do nothing, intervene immediately or long term action) should be taken.

If a water supply frequently falls into the Red or Purple class, it is recommended that water quality experts be consulted for more detailed advice on treatment.

Water blending is often an option overlooked when evaluating the suitability of a source for domestic purposes. Water with different water qualities can be blended to achieve an acceptable quality for domestic purposes.

What are the cost implications of treating water to a desired water quality?

Estimating water treatment costs for water quality are described in detail in the **Costing Model Handbook, How To Estimate Costs For Community Water Supply Projects, 1999**, developed by the Department of Water Affairs and Forestry.

Treatment costs are mainly dependant on:

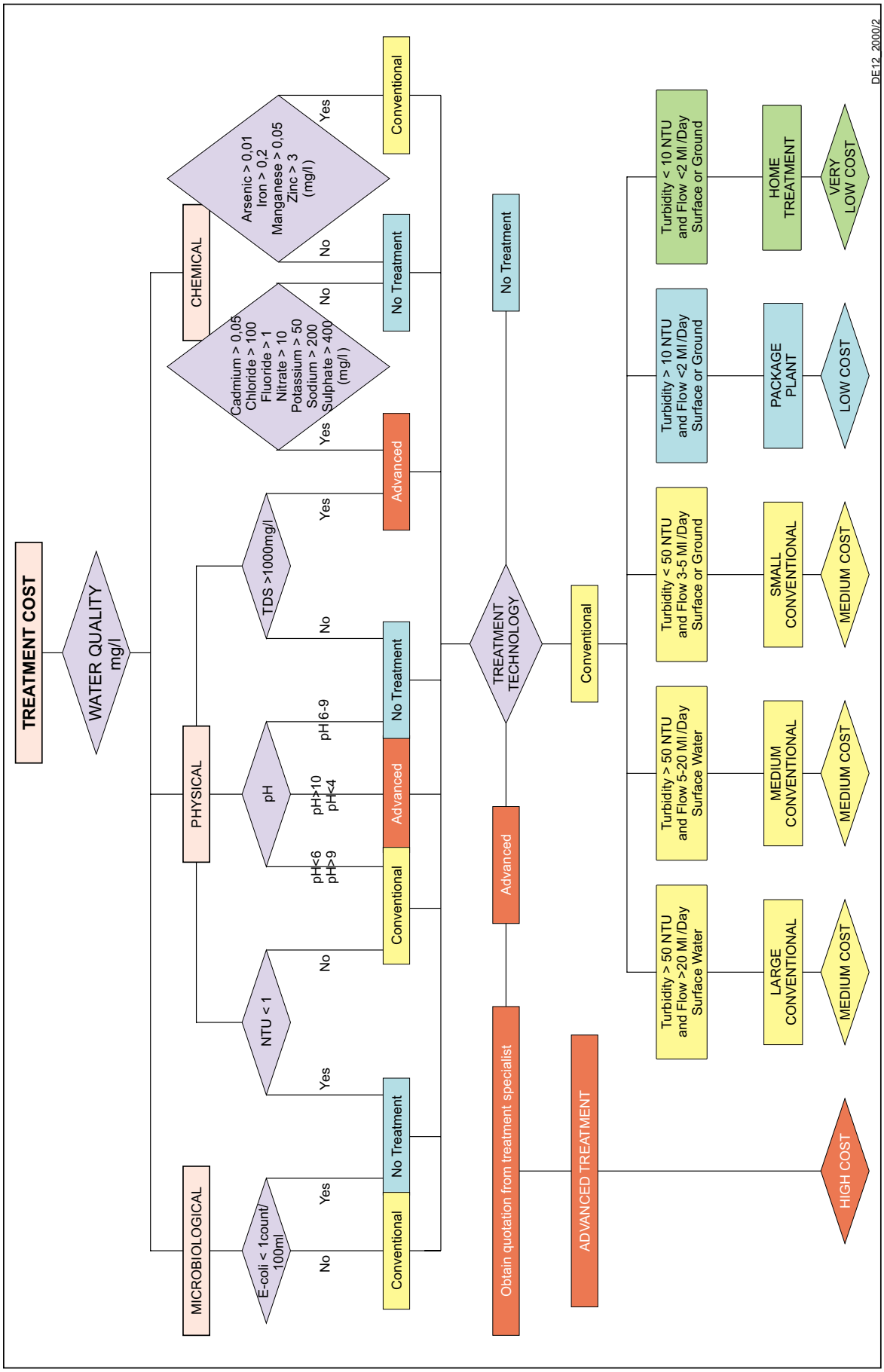
- the **volume** of water that has to be treated
- the **quality** of the water, and
- the **location** of the water.

The water variables that affect treatment are categorized into bacteriological constituents, physical constituents and chemical constituents.

A step-by-step procedure to determine the treatability of water for domestic purposes is described in the "*Assessment Guide*", Volume 1.

Water can be treated to remove any substance which may make it unsuitable for domestic use, but certain substances may be more difficult to remove than others, which can result in more expensive treatment options. However, some substances can be removed from water using chemicals, materials or processes that are both cheap and readily available in most communities. (For example, the use of bleach or boiling to disinfect water). **Figure 7** indicates the treatment processes required for different water qualities and the estimated cost of treating that water to comply with domestic water quality requirements. The costs indicated is generic and the only purpose is to indicate a cost relative to each treatment process.

For detailed descriptions of the different treatment options, please refer to the "*Treatment Guide*", Volume 4.



Treatment Cost Decision-making Hierarchy (After Costing Model Handbook: How to Estimate Costs for Community Water Supply Projects)

FIGURE 7

What other costs are associated with the supply of water for domestic purposes?

Costs associated with **protecting the raw water source:**

DWAF and/or CMA incur costs in protecting and managing the resource. It costs money to:

- evaluate and issue licences
- monitor water resource quality against the water resource objective
- detect and prosecute unlawful use
- promote water conservation and demand management
- remove alien vegetation.

These costs are recovered by DWAF and / or CMA from the users in the form of a **water resource management charge.**

Costs associated with **raw water supply:**

DWAF incurs costs to develop, finance, operate and maintain the raw water abstraction and storage schemes. It costs money to:

- develop (construct) the inter-basin transfer schemes, dams, and other infrastructure required to store and supply the raw water from the source
- repay the loans (and interest) required to finance the construction
- operate these works, including electricity and labour
- maintain theses works.

DWAF charges a **water resource development and use of water works charge** to cover these costs. This charge is added to the **Water Resource Management Charge** and the total costs are passed on to the bulk water services provider as a **Raw Water Tariff**.

Costs associated with **bulk water treatment and bulk potable distribution:**

The bulk water service provider incurs costs to abstract, treat and distribute bulk potable water. It costs money to:

- purchase the raw water from DWAF
- develop (construct) the abstraction works, bulk water treatment plant, the bulk reservoirs, pump stations and pipelines required to abstract and purify the raw water and distribute the potable bulk water to the municipality reservoirs
- repay the loans (and interest) required to finance the construction

- operate these works, including chemicals, electricity, and labour
- maintain these works.

These costs are recovered from the water services authority or water services provider by the bulk water services provider in the form of a **bulk potable water tariff**, which includes the **raw water tariff**.

Costs associated with **municipal water supply infrastructure**:

The water service authority incurs costs to reticulate water to the consumers. It costs money to:

- purchase the bulk water potable water from the bulk water service provider
- develop (construct) the municipal water supply infrastructure comprising the municipal reservoirs, pump stations, and pipelines used to reticulate the water to the consumer
- repay the loans (and interest) required to finance the construction
- operate these works, including electricity and labour
- maintain these works
- to read the meters and bill the customers.

These costs are recovered from the consumer by the water services authority in the form of a **municipal water tariff**, which includes the **bulk water tariff**.

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YOU ARE HERE

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MANAGEMENT CONCEPTS

Introduction

Management in all spheres of life is important. Even an everyday aspect such as going to work needs to be managed, which includes:

- The planning, organisation (e.g. who baths first),
- objectives (e.g. when should everybody be finished eating),
- controlling (e.g. the person controlling the sequence of bathing), and
- monitoring (e.g. a person monitoring the performance to make sure everybody is dressed properly and on time) in terms of the objectives of the process of going to work.

The field of management is complex and cannot be dealt with adequately in a guideline of this nature. There are, however, books on the topic such as:

Wade Miller Associates. 1993. "Meeting the management, organisational and staffing challenges of the 1990's". American Waterworks Association (AWWA) Research Foundation.

What is management and operation?

Management relates to the activities needed to organise the overall functioning of an organisation. These actions are a continuous cycle (**Figure 8**) with the main objective to improve functioning of the organisation over time.

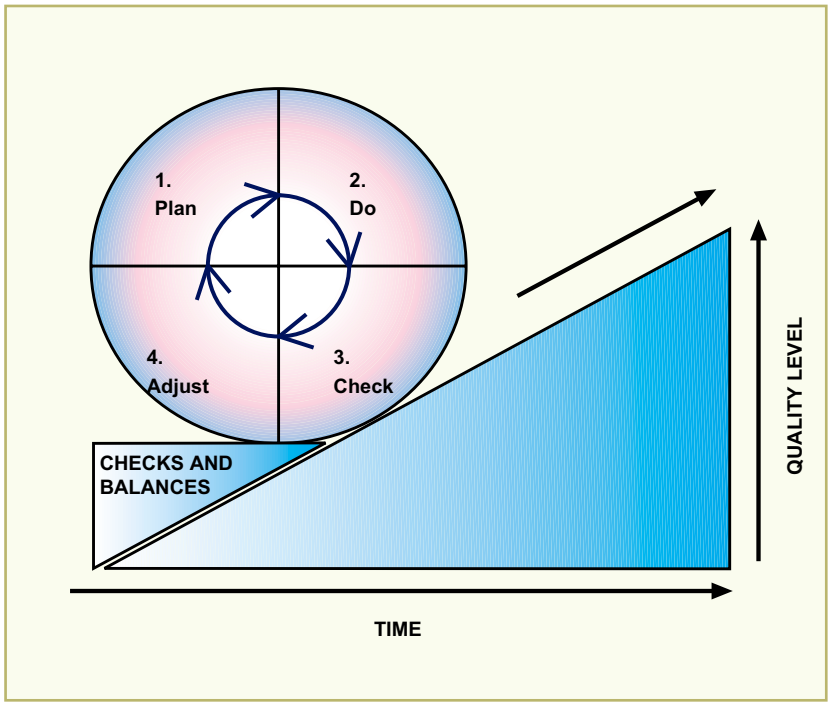

Figure 8: Management cycle

The actions can be summarised as:

- Planning - plan your activity.
- Doing - carry out the activity.
- Checking - check whether you have achieved what you have set out to do.
- Adjusting - adjust your plan if you did not achieve what you set out to do, or to improve on previous achievements.

Operation on the other hand covers the day to day activities required to run an organisation.

What other aspects of management are important?

- **Strategic management** - Strategic management implies the anticipation of changes and making the adjustments needed to deal with these changes pro-actively.
- **Business planning** - Business planning is about documenting your activities in ensuring that your goals are met.
- **Monitoring** - Monitoring is about setting goals and evaluating the performance in terms of these goals.
- **Reporting** - Reporting is the full account of actions and reactions.

If a sufficient quantity of water is delivered to all customers, with a quality which meets potable water standards, and at a reasonable price, the system can be said to be running efficiently. Conversely, if there is insufficient water provided to meet demand, if the quality is poor or if the price is too high, the system is not performing properly. For more detail refer to:

Palmer Development Group, 1998. "Introduction to organisational arrangements for water service providers". Water Research Commission.

Why is quality control important?

The key to effective service delivery is quality control through the use of a systematic approach to planning, controlling, measuring and improving an organisations' performance. There are a number of formal systems available to organisations for implementing a quality control system, such as ISO 9001.

A quality control system generally consists of the following key elements:

- Quality policy - the development of a statement of your organisation's commitment to the delivery of safe and reliable drinking water.
- Adequate resources - funds, man-power and materials.
- Responsibilities and Authorities - establish roles and responsibilities for quality control and provide adequate resources.
- Training, awareness and competence - ensure that your employees are trained and capable of carrying out their respective responsibilities.

- System documentation - maintain information on your quality control and related documents
- Process controls - identify, plan and manage your operations and activities in line with your policy, objectives and targets.
- Document control - ensure effective management of procedures and other system documents.
- Emergency preparedness and response - identify potential emergencies and develop procedures for preventing and responding to them.
- Monitoring and measurement - monitor key activities and track performance. Conduct periodic assessments and compliance with legal requirements.
- Nonconformance and corrective and preventative actions - identify and correct problems and prevent their recurrence.
- Records - maintain and manage records of quality control performance.
- System audits - periodically verify that your quality control system is operating as intended.
- Management review - periodically review your quality control system with continual improvement in mind.

Implementing a quality control system has a number of potential benefits:

- Producing a better quality product (drinking water complying to customers needs)
- Increased efficiency/reduced costs
- It will enhance employee morale
- Enhance image with public, regulators, etc
- Employee awareness of responsibilities

However, an effective quality control system does not just happen. A quality control systems needs ongoing and visible management support and employee involvement.

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YOU ARE HERE

Training and Capacity building

The enormous backlog of basic water and sanitation services to local communities will not be reduced unless the communities themselves are empowered to undertake their own development. This is not possible if they do not have the skills required which they can only acquire through training and experience.

Although training is not cheap, the costs of project failure are far greater. Because of the long lead times in establishing training resources and in training suitable trainers, it is imperative that the issue receives a high and early priority.

There is a need to develop new courses to train people as general development practitioners ("Jack of all Trades") with an understanding of both the social dynamics of development as well as specific technical skills.

Training and capacity building is not only required at community level. Skilled personnel are needed across a broad spectrum. The training categories include:

- general community awareness on water and sanitation, and related issues, including providing information packs and teaching aids to schools,
- training of Local Authorities and Local Water Committees in the principles of democratic governance and public office, a basic understanding of water and public health, administrative skills and necessary technical skills,
- training of community support personnel. Creative solutions are required to produce a cadre of development support workers who are equipped with a balanced set of both community organisation skills and appropriate technical skills,
- training of specialised water care technicians (plant operators etc.), and
- training of professional and managerial staff.

The established National Community Water and Sanitation Training Institute at the University of the North with the support of the Water Research Commission will build a national centre of expertise and research to address such issues as adult training and education methodology, assessment of the impact of education and training programmes, community training requirements, and training content. The Institute is also a centre for the training of trainers and will seek to co-operate with other universities, particularly those, which have historically been disadvantaged, to develop a network of training centres around the country. The Institute will also seek to work closely with the existing initiatives in other sectors of adult education and will seek contacts and interchange with similar training institutions is southern Africa and elsewhere.

REFERENCES

DWAF (1999). Costing Model Handbook: How to estimate costs for community water supply projects. Department of Water Affairs and Forestry.

DWAF (2001). Water and sanitation business. The roles and responsibilities of Local government and related institutions. Department of Water Affairs and Forestry.

DWAF (Poster). Providing water services: Institutional arrangements. Department of Water Affairs and Forestry, Chief Directorate: Water Services.

DWAF, DOH, WRC (1998). Quality of domestic water supplies, Volume 1: Assessment Guide. Water Research Commission, Department of Water Affairs and Forestry and Department of Health.

EPA QA/G-4 (1994) Guidance for the data quality objectives process. United States Environmental Protection Agency: Quality Assurance Management Staff.

European Commission (1998). Guidelines for water resources development co-operation. Towards sustainable water resources management: A strategic approach. European Commission, Directorate-General for Development, Directorate-General for External Relations and North-South Co-operation.

Palmer Development Group (1993). Overview of institutional and financial arrangements in water supply and sanitation. Water Research Commission.

Palmer Development Group (1998). Management Guidelines for water services institutions (urban). Water Research Commission.

Palmer Development Group (1998). Water supply services model manual. Water Research Commission.

Schutte CF (1998). Water Quality Management Advanced Course II. Policies, Procedures and Legislation for Water Quality Management. Chapter 3: General Management Concepts in Water Quality Management. University of Pretoria.

Schutte CF (1998). Water Quality Management Advanced Course II. Policies, Procedures and Legislation for Water Quality Management. Chapter 11: Water Treatment Plant Management: General Aspects. University of Pretoria.