Water Resource Planning Systems

SUB-SERIES NO. WQP 1

Resource Directed Management of Water Quality

August 2006

water & forestry

Department:
Water Affairs & Forestry
REPUBLIC OF SOUTH AFRICA

Water Resource Planning Systems Series

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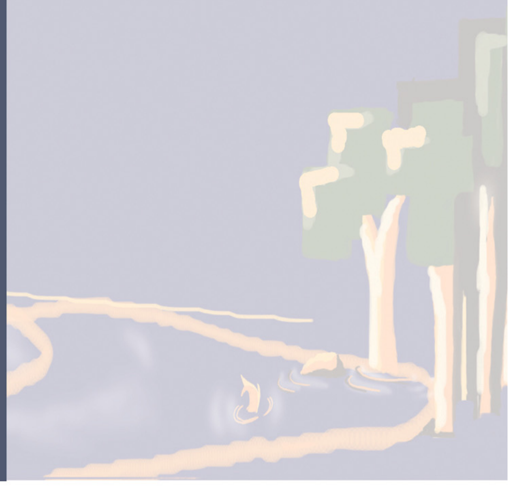
Water Resource Planning Systems Series

SUB-SERIES NO. WQP 1.7.6

Resource Directed Management of Water Quality

Introduction

August 2006



water & forestry

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Resource Directed Management of Water Quality

Introduction

water & forestry

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Bold type indicates this report.

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FOREWORD

The Constitution of the Republic of South Africa (1996) ushered in an era aiming at the promotion of sustainability, where social, ecological and developmental issues are considered to be equally important. The South African National Water Policy (1997) and the National Water Act (1998) were promulgated with the specific purpose to ensure that the nations' water resources are protected, used, developed, conserved, managed and controlled in an equitable, efficient and sustainable manner.

To support these objectives, a number of changes were required in the national approaches to water (resource) management. One of the most substantial changes was stipulating the Reserve, the highest priority water use in the Act, and the only water allocation that is protected in law. The Reserve comprises two components: the Basic Human Needs Reserve and the Ecological Reserve. The Basic Human Needs Reserve refers to the quantity and quality of water that is required to meet basic human needs, typically 25 ℓ per person per day, within 200 m of the source. While, the Ecological Reserve refers to that quantity and quality of water that is needed to protect aquatic ecosystems in order to secure ecologically sustainable development and use of the relevant water resource.

Various methods used to determine the quantity of water available for use have been developed and are generally available. The challenge was to develop appropriate methods to determine the levels of stress in water resources and then to identify, from a water quality perspective, what proportion (if any) of the water resource could still be allocated for use by the other recognised water users, *i.e.* domestic, industrial, agriculture and recreation. These need to be implemented in a carefully integrated and structured manner to ensure efficiency, sustainability and equity. This challenge is complex due to the nature of water resource management, the need to integrate water quantity and quality, and the need to make decisions in a multi-criteria environment.

The series of documents and instruments dealing with RDMWQ have been developed to assist in making water resource management water quality-friendly. In other words, to operasionalise the management of water quality from a resource perspective. This is achieved through the interpretation of policy principles from a resource directed water quality perspective, and determining the allocatable water quality component of a specific water resource. The series of RDMWQ documents and instruments form part of the iterative decision-making framework for making the policy operational through water quality resource allocation.

The RDMWQ documents and instruments consist of a RDMWQ Policy and Strategy (including summaries), a RDMWQ institutional arrangements guideline, a suite of management instruments and additional supporting documents. The management instruments facilitate the implementation of the RDMWQ policy, with a catchment visioning guideline, procedures to determine resource water quality objectives and the allocatable resource, a guideline for determining stress levels, a guideline for converting objectives to end-of-pipe discharge standards, and a monitoring and auditing guideline. Much of the above is consolidated into a dedicated decision support system.

It is intended that these RDMWQ documents and instruments will promote integration of water quality and quantity aspects within Water Resource Management. These tools should also support the principles of equity, efficiency and sustainability, while providing a robust, but predictable framework that balances protection with water use and development on a sustainable basis.

Ms Barbara Schreiner

Deputy Director-General: Policy and Regulation
Department of Water Affairs and Forestry Date:

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ACRONYMS

DWAF	Department of Water Affairs & Forestry	RQOs	Resource Quality Objectives
IWRM	Integrated Water Resource Management	RWQOs	Resource Water Quality Objectives
NWA (36:1998)	National Water Act	SDC	Source Directed Controls
RDMs	Resource Directed Measures	WQM	Water Quality Management
RDMWQ	Resource Directed Management of Water Quality	WRC	Water Research Commission

I N T R O D U C T I O N

1. Purpose

The Water Resource Planning System Series (Sub-series No. WQP 1) provides policy, strategy and management instruments to facilitate the management of water quality from a resource perspective.

This introduction provides (a) the background to the particular sub-series, (b) an overview of the general context in which resource directed management of water quality is practiced, and (c) an overview of the content of the sub-series itself.

2. Background

The promulgation of the National Water Act, 1998 (Act No. 36 of 1998), various other acts, policies and White Papers (e.g. White Paper on a National Water Policy for South Africa, 1994) gave a new direction to water resources management and, more specifically, the management of water quality in South Africa.

The primary purpose of the National Water Act (NWA (36: 1998)) is to ensure that the nations' water resources are protected, used, developed, conserved, managed and controlled in an equitable, efficient and sustainable manner. This necessitates an integrated source-, resource- and remediation-focused approach to water quality management (WQM).

Limited policy guidance was available on resource related management of water quality. Furthermore, it was unclear how resource management should guide source management relating to water quality. Assessments to date were generally done on an *ad hoc* basis with little uniformity.

A number of mechanisms to facilitate management of water resources were introduced with the promulgation of the NWA (36: 1998), such as resource directed measures (RDMs). The current priority of the Department is to implement both source and resource directed management approaches in an integrated and structured manner. Sub-series WQP. 1 focuses specifically on the water quality aspect of the water resource.

2.1 The National Water Act

In terms of the NWA (36:1998), the following are prominent management functions of the Department:

- Protection of the nation's water resources by ensuring sufficient water quantity of appropriate water quality to satisfy the basic human needs and ecological Reserve, as well as the needs of the other recognised water users (*sustainability*);
- Management and control of the nation's water resources to ensure the sustainable utilisation of water resources in the long term (*efficiency)*; and
- Equitable allocation of available water to different water users (*equity*).

The fundamental principle guiding the NWA (36:1998) of South Africa is that water is a national resource, owned by the people of South Africa. National Government has overall responsibility for, and authority over, the management thereof. This includes utilisation of all aspects of the resource.

3. Contextual Overview

Some of the text used in this introductory chapter has been sourced from the following project documents; these documents are also available as Appendices to the RDMWQ sub-series:

- Department of Water Affairs and Forestry, 2004. Water Resource Planning Systems Series, Sub-Series No. WQP 1.7.3, Resource Directed Management of Water Quality: Project Document: Philosophy of Sustainable Development. Version 2. Pretoria. (Appendix A)
- Department of Water Affairs and Forestry, 2004. Water Resource Planning Systems, Sub-Series No. WQP 1.4.1, Resource Directed Management of Water Quality: Project Document: Conceptual Review for water use licence applications from a RDWQM perspective. Version 2. Pretoria. (Appendix B)
- Department of Water Affairs and Forestry, 2004. Water Resource Planning Systems, Sub-Series No. WQP 1.7.5, Resource Directed Management of Water Quality: Project Document: Guidelines for Setting Licence Conditions for Resource Directed Management of Water Quality. Version 2. Pretoria. (Appendix C)

3.2 Sustainable development

3.2.1 History

The 1960's witnessed a widespread recognition of the impact of expanding global environmental crises due to industrialisation and this fuelled a growing realisation that, if we continued on the current development trajectory, we would exceed most of the earth's ecological limits. At the 1972 Stockholm UN Conference on Human Environment, it was recognised that the environment-development conflict would have to be resolved in a mutually beneficial manner. The idea of sustainable development evolved out of the debates around environment and development as a means to promote development whilst still ensuring environmental protection.

A widely accepted definition of sustainable development has been provided by the World Commission on Environment and Development (1987), which describes it as "development that meets the need of current generations without compromising the ability of future generations to meet their own needs and aspirations".

The expression and concept of sustainable development originated from a realisation that the earth's natural resource base can pose ecological limits to development. Therefore, it is important to realise that the concept of sustainable development originates from the ecological school of thought. Similarly, it must be recognised that the term sustainable development is often used outside of the context in which it originated, and expressions such as economic and social sustainability are also used.

The Constitution of the Republic of South Africa (Act No. 108 of 1996) clearly states that reasonable legislative and other measures should be used to "secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development" (Section 24 (b) (iii)).

Accordingly, for the purposes of this sub-series, the context in which the term sustainable development is used is an ecological one; thus, we are referring to development that is ecologically sustainable.

3.2.2 Current Understanding

Sustainable development requires ongoing interaction between the ecological resource, the economic system and the social system (WCED, 1987, Mebratu, 1998). The economic system exists within and because of the social system, while the social system and human existence is only possible within the ecosphere (the ecological system). This conceptual "nesting" of systems represents the reality of how systems function (Figure 1).

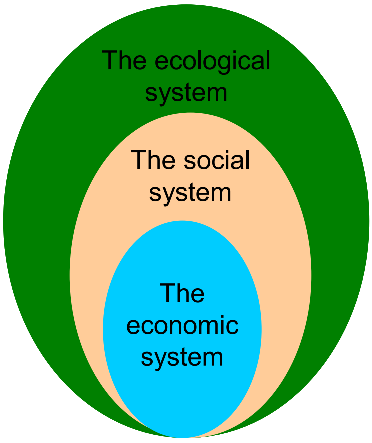

Figure 1: The cosmic interdependence model (adapted from Mebratu, 1998).

Modern society has tended to disaggregate these three systems in order to simplify the inherent complexity of these systems and also to attempt to understand and manage the world around us. Typically, this nested system has been separated into three separate components (namely three spheres).

However, most previous attempts to manage one system in isolation of the others have led to social injustice, unfair trade and economic imbalances, environmental degradation, and ineffective governance. The concept of sustainable development embodies integrating these three systems, whereby there is a central area of overlap encircled by good governance (Figure 2).

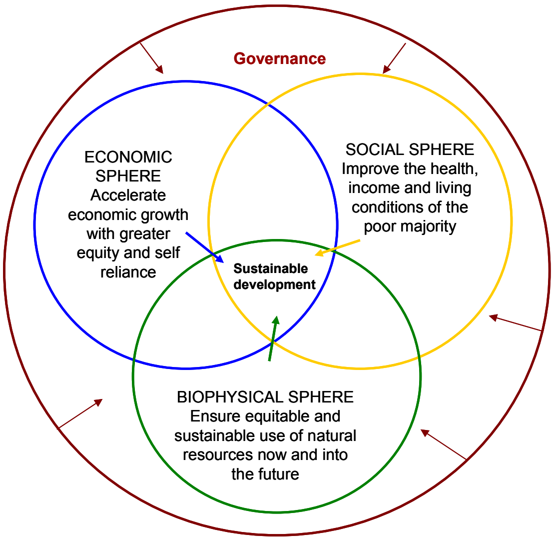

Figure 2: The trifocal approach of sustainability (adapted from MMSD, 2002).

It is perhaps most useful to think about sustainability as the direction we need to move in, in order to achieve an acceptable balance between the three spheres. Sustainability is about the actions we take and the decisions we make to realise sustainable development. Sustainable development can only be achieved through recognising that all three spheres interact and must be addressed together in a holistic manner.

This process is ordered, sustained and grown by good governance. It is both a process of development and a series of stages along a development trajectory (Figure 2).

3.2.3 Approaches

Human-centred approach

In the early days of industrialisation, a *human-centred approach* dominated much of the world's thinking in the early half of the 20th century, with humans being seen as the most important species on earth. According to this attitude to natural resources:

- Humans are apart from, and in charge of, the rest of nature;
- The earth has an unlimited supply of resources to which we can gain access through science and technology;
- All economic growth is good and the potential for economic growth is unlimited;
- A healthy environment depends on a healthy economy; and
- Human success is dependent on how well we can control nature to our benefit.

This highly consumptive approach led to the global crises which, in turn, prompted the concept of sustainable development.

Ecocentric approach

In adopting the principles of sustainable development, it was recognized that a new approach was needed to guide human attitudes towards natural resources. This new approach, described as an *ecocentric view*, saw humans as working with and within nature. According to this approach:

- Nature exists for all of Earth's species and humans are not apart from or in charge of the rest of nature;
- Earth's resources are limited, should not be wasted, and should be used in a sustainable way for us and all species;
- Some forms of economic growth are beneficial but some are harmful;
- A healthy economy depends on a healthy environment; and
- Our success depends on learning to co-operate with one another and the rest of nature (Tyler Miller, 1994).

Stewardship approach

In South Africa, natural resource management is underpinned by the recognition that humans have a duty of care for maintaining natural resources in a healthy state. This *stewardship approach* is eloquently captured in South African law through the Constitution of the Republic of South Africa (Act No. 108 of 1996), which sets out the right of every South African to have an environment that is "not harmful to their health or well-being; and to have the environment protected, for the benefit of present and future generations" (Republic of South Africa, 1996, section 24 (a)&(b)). This approach is also evident in the Department's appointment as the public trustee of the nation's water resources.

Multi-level considerations

In discussions about sustainable development and natural resource management, it is important to understand that there are different levels at which sustainability and natural resource management must be considered.

At a national level a strategy is necessary to ensure we have healthy, well-functioning natural resources that are able to meet both human and ecological needs. However, at lower levels it is sometimes necessary to find a balance between the various needs of water users and the needs of ecological systems. In this context, balancing may require a "trade-off". Costs and benefits include both positive and negative impacts on the biophysical environment as well as the costs to society and to the national economy, now and in the future.

3.2.4 Water resources

Sustainable development in respect of water resource management seeks to ensure that future generations will still be able to meet their own basic water needs, while promoting socio-economic development and improved quality of life for all in the current generation. This can only be done in a manner that uses water resources in general within the ability of the ecosystem to satisfy such needs, both now and in the future (DWAF, 2005a).

Society benefits immeasurably from water resources. In fact, survival of human society depends entirely on water, resources associated with water, and the goods and services they provide. These goods and services include for example: water supply; waste disposal; processing and dilution; natural products (e.g. fish, reeds, medicinal plants); biodiversity conservation; flood control; and places for rituals or spiritual needs.

Inevitably, there will be conflicting demands for water at the water management area and local levels. These include the conflicting needs for water for economic development, water to meet basic human needs and water to maintain ecosystems. The water resource manager must therefore at a local level manage the development of different types of capital. Water resource managers, however, need to understand how the management of their particular area contributes to the achievement of the national vision in the long-term.

The National Water Resource Strategy aims to find a balance between protection of water resources and social and economic development. The strategy states that “it is not possible for all resources throughout the country to be given a high level of protection without prejudicing social and economic development. Equally, it is not desirable for all resources to be classified at a uniformly low level so as to permit maximum use” (DWAF, 2004a). The net result must therefore ensure that a balance between the social, economic and ecological imperatives of the country is met without unsustainable compromises.

At national level, effective water resource management in South Africa requires an accepted national vision for our water resources. This vision seeks to ensure that water resources are sustained into the future to meet future needs while still improving the quality of life of present generations – a sustainability ethos is thus encouraged.

3.3 Managing water resources

To manage water resources, the national water policy (DWAF, 1997) and the NWA (36:1998) present two sets of complementary strategies that lawfully bind all water users. These are: Resource Directed Measures (RDMs) and Source Directed Controls (SDC) (DWAF, 2004b).

3.3.1 Resource Directed Measures

Resource Directed Measures (RDMs) focus on the quality of the water resource itself, regarding it as an ecosystem rather than a commodity. RDMs comprise the following components:

- ***Classification system***: The purpose is to provide a set of nationally consistent rules to guide decision making about water resources - what will be allowed to happen in our water resources and what will not be allowed to happen. The management class is a combination of the ecological requirements for the resource and the requirements of other water users within the catchment.

  As a precursor to the classification process, ***catchment visioning*** needs to be done. This is a process of articulating a collective statement of future aspiration of society’s relationship with the water resource – of the benefits derived from aquatic ecosystem goods and services and the costs associated with their use.

- ***The Reserve***: This is the quantity and quality of water required to satisfy the basic human needs, and to protect aquatic ecosystems, in order to secure ecologically sustainable development and use of the relevant water resource (Figure 3). The Reserve *is the only water right specified as inviolable in the law* (DWAF, 1997). Water for basic human needs has the highest allocation priority in the country.

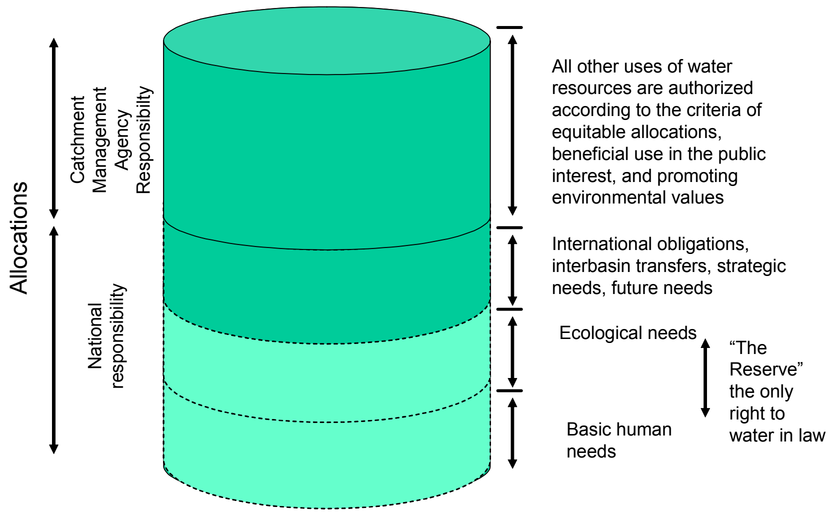

Figure 3: Conceptualisation of the Reserve (DWAF, 1999)

The *basic human needs Reserve*, includes water for drinking, food preparation and personal hygiene. The intention of the basic human needs Reserve is to secure the quality requirements for basic human needs with minimal treatment.

Apart from basic human needs, the only other right to water is the water quantity and quality required to protect aquatic ecosystems "…in order to secure ecologically sustainable development and use" of significant water resources (such as rivers, streams, wetlands, lakes, estuaries and groundwater) (DWAF, 2000). The intention of the *ecological Reserve* is to secure sufficient water of an appropriate quality to maintain aquatic ecosystems in such a form that they can continuously provide the desired set of socio-economic goods and services to society. The intention is not to protect ecosystems per se.

The objective of the Reserve is to serve the needs of the people who depend on ecosystem-based goods and services (Van Wyk et al., 2003).

- ***Resource Quality Objectives*** *(RQOs):* RQOs are "clear goals relating to the quality of the relevant water resources" set in accordance with the management class that has been selected for that resource, and may relate to water quality, water quantity, or the integrity of the aquatic ecosystems. They are objectives for controlling impacts on the water resource through regulatory measures such as licensing of water use. It is formally the Department's responsibility to comply with RQOs, not individual water users.

  Resource Water Quality Objectives (RWQOs) are the water quality component of the Resource Quality Objectives (RQOs). "The RWQOs outline both water user needs with respect to water quality, as well as their needs with respect to the disposal of water containing waste to the resource (DWAF, 2003).

The NWA (36:1998) ultimately aims that before a water use can be considered for licensing, it is necessary to determine and take into account the *class, Reserve and Resource Quality Objectives* (collectively referred to as Resource Directed Measures) for the relevant water resource unit(s) (NWA (36:1998) 17(1)(b)).

3.3.2 Source Directed Controls

Chapter 4 of the NWA (36:1998) contains provisions on *Source Directed Controls* (SDC). These deal with the regulation of water use. SDC focus on managing the quality and quantity of water **entering a water resource** with the primary purpose of ensuring that the objectives that have been set for the water resource (typically defined by the management class and RQOs) are achieved. SDC include regulatory mechanisms such as water quality standards for waste water, waste water discharges, pollution prevention, and waste minimisation technologies. Additionally, progressive implementation of self-regulation is encouraged. Economic incentive mechanisms are also implemented (DWAF 1997).

The authorisation of a water use (through a licence) is an important SDC. The purpose of a licence is to (a) ensure that water is used for the authorised purpose(s) only, and (b) enable the Department to achieve its water resource management objectives (such as RQOs), and hence contribute to sustainable development.

Individual licence conditions must also (a) be within the Department's ability to monitor, manage, and enforce, (b) not impose unreasonable demands on the licensee, and (c) have a purpose that is clear both to the licensee and to the Department.

3.3.3 Link between RDMs and SDC

Source directed controls (SDC) aim to control and minimise potential impacts on the water resource so that resource protection objectives (such as RQOs) are achieved. Licence conditions and monitoring as part of SDC, as well as RDMs, facilitates the auditing of the appropriateness of RDMs and SDC. This relationship is illustrated in Figure 3.

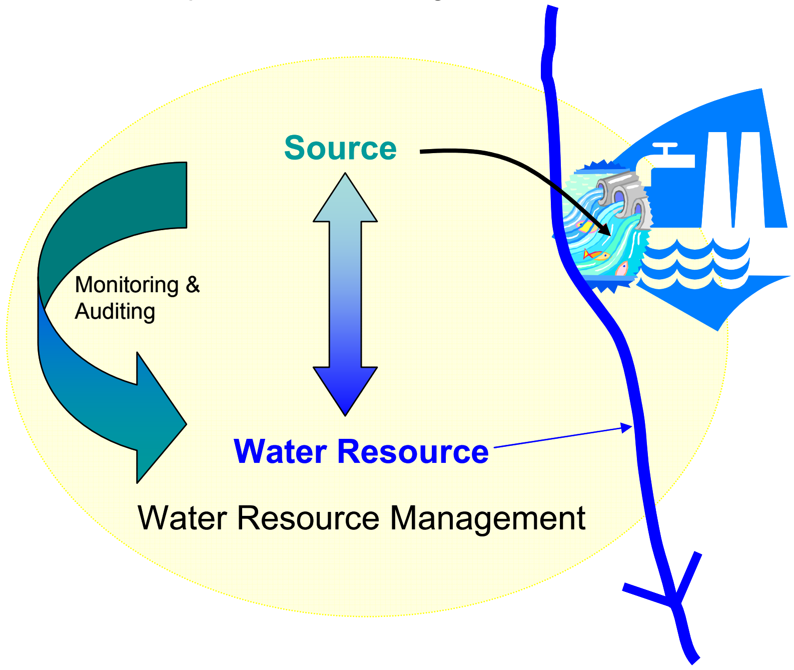

Figure 3: The relationship between RDMs and SDC.

In the context of water use licence conditions, resource directed measures (RDMs) - the resource management class (the desired future state) aligned with the catchment vision, and the Reserve and resource quality objectives (RQOs) - are relatively new concepts. This document addresses the issues around formulating appropriate licence conditions that will ensure that they are given effect specifically in the context of resource directed management of water quality.

Examples of licence conditions for RWQOs and other RDMs directed at the monitoring of the catchment vision, as are provided for consideration within the Appendix C in the RDMWQ sub-series.

4. Overview of Content: Water Resource Planning System Series (Sub-series No. WQP 1)

4.1 Focus and Objective

The RDMWQ sub-series focuses specifically on the *water quality aspect* of the *water resource* and provides guiding principles and methods on:

- Various facets of the resource-based management of water quality;
- Determining the water quality requirements of the resource; and
- Incorporation of these into decision making regarding source-directed water quality management.

The objective of the Series is to facilitate the integration of the source and resource directed management approaches in an uniform and structured manner.

4.2 RDMWQ Framework for making Resource Directed Management operational in licensing

The Sub series forms part of the iterative RDMWQ framework for making Resource Directed Management operational in licensing, provided as Figure 4 and consist of the following volumes:

Volume 1: RDMWQ Policy (Colour coded: Orange)

The RDMWQ policy consists of a summary policy (colour coded: **peach**) and the detailed policy (colour coded: **orange**).

The Policy documents pertain specifically to the management of the use and protection of the water quality component of inland water resources, including surface watercourses, groundwater, estuaries and wetlands. These documents also address how the "resource directed" management of water quality should influence the management of anthropogenic activities that modify the water quality in water resources.

A strong emphasis has therefore been given in the policy to the underlying principles of water resource management and the clear description of underlying principles allows concise yet powerfully comprehensive policy statements to be made. The principles are, in effect, 'the rules of the game'

Volume 2: RDMWQ Strategy (Colour coded: Green)

The objective of the Strategy is the implementation plan for the Policy. It addresses "who should do what by when", explicitly linking the Policy to management approaches and management instruments to facilitate its practical and pragmatic implementation. It is also the intention that, in some contexts, this strategy presents a first-level interpretation of the policy.

Volume 3: Institutional Arrangement for RDMWQ (Colour coded: Purple)

A number of additional challenges will be faced with the decentralisation of Departmental functions to CMAs in cooperation with other water sector institutions, particularly related to changing institutional structures and arrangements, and the shifting roles and responsibilities.

This report focuses on institutional and organisational issues, with the objective of clarifying roles and responsibilities. While the discussion is aligned with the specific areas of focus of the RDMWQ project, it has to engage the broader water quality (and in fact the water resources management) environment.

Volume 4: RDMWQ Management Instruments (Colour coded: Navy Blue)

The Management Instruments refer to the suite of management instruments that have been developed as part of the RDMWQ sub-series to assist the Regional Offices, proto-CMAs and in future CMAs to make the *water quality* component of Resource Directed Management operational in licences and to assist the Department with the evaluation and issuing of licences.

The management instruments to be developed were identified through a two-day workshop with representatives of the Regional Offices and the relevant directorates within the Department. Several officials and specialists were consulted throughout the development process of these instruments.

Volume 4.1: Guideline on Catchment Visioning for the Resource Directed Management of Water Quality (Colour coded: Blue)

One of the first step in the RDMWQ framework is the development of a catchment vision. Consequently, the first management instrument in the Management Instruments suite is a guideline for the generation of a catchment vision and goals to inform the water allocation process. This Instrument describes a practical process for developing a catchment vision and for disaggregating this vision into component management objectives through the hierarchical objectives approach.

Volume 4.2: Guideline for determining Resource Water Quality Objectives (RWQOs), Allocatable Water Quality and the Stress of the Water Resource (Colour Code: Light Blue)

The aim of this Guideline is to provide a practical, consistent approach to the determination of RWQOs, by integrating the results of the Catchment Vision, Resource Classification and Reserve,, with other user sector requirements, as well as an approach to operationalise these RWQOs when evaluating licence applications. The guideline further provides guidance on determining the level of stress within the water resource and the allocatable water quality. This Guideline is supported by the RWQOs Model and User Guide to streamline implementation.

Volume 4.3: Guideline for Monitoring & Auditing for resource directed management of water quality (Colour Code: Sky Blue)

This document provides guidelines for the monitoring that is required for resource directed management of water quality. It is one of many essential management tools required to implement the Strategy and ultimately the Policy. The guideline provides guidance on how to design a water quality monitoring programme, introduces a long-term monitoring vision for RDMWQ, and provides guidelines for managing performance monitoring.

Appendices to the RDMWQ Series

The following project documents are provided as Appendices to the Sub-series WQP. 1 for further information:

Appendix A: Resource Directed Management of Water Quality: Philosophy of Sustainable Development

Appendix B: Conceptual Review of water use licence applications in the context of the Resource Directed Management of Water Quality

Appendix C: Guidelines for Setting Licence Conditions for Resource Directed Management of Water Quality

Appendix D: ACWUA - Decision-making Support System for RDWQM

Appendix E: RDMWQ Glossary

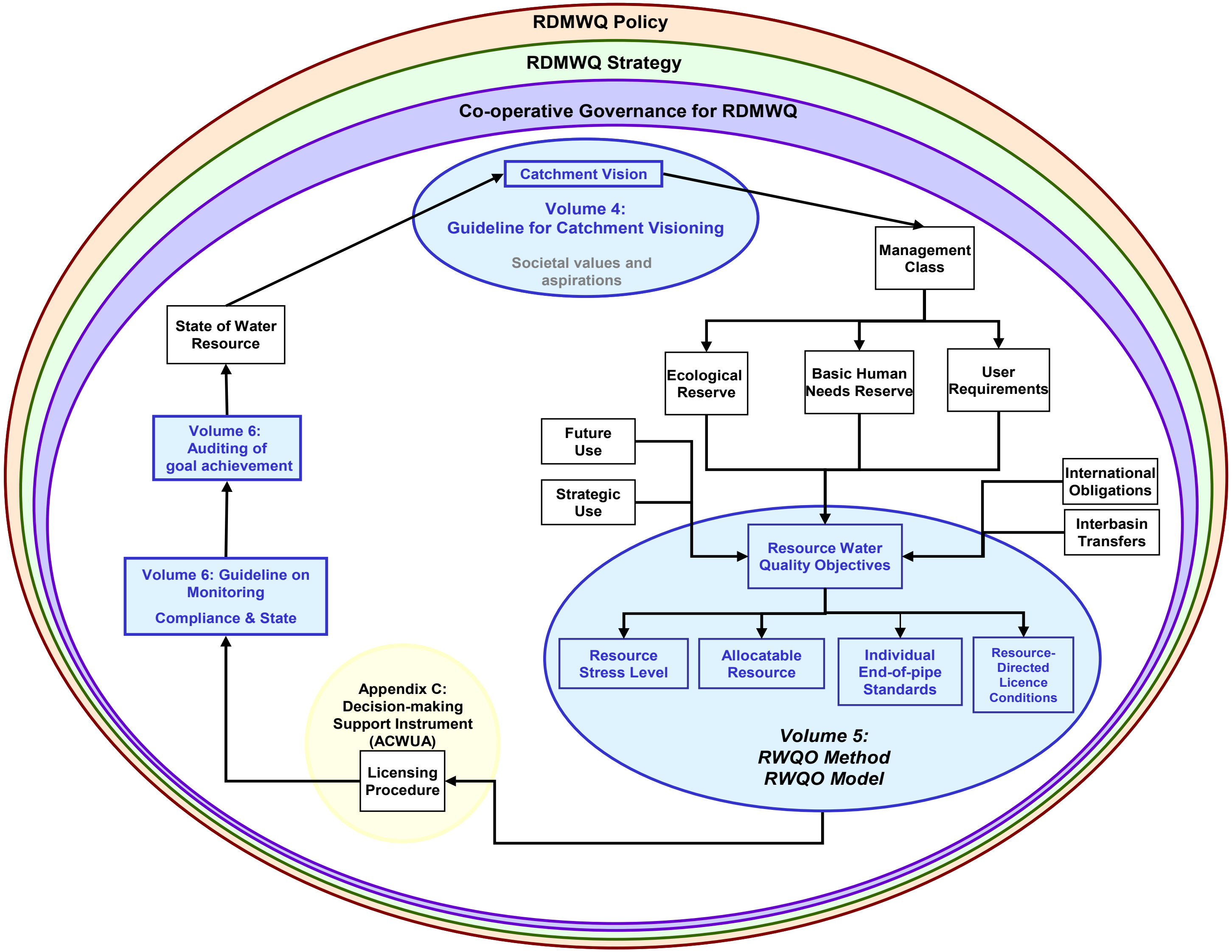

Figure 4: **RDMWQ Framework for making RDMs operational in licensing (adapted from DWAF, 2004c)**

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SUB-SERIES NO. WQP 1.4.1

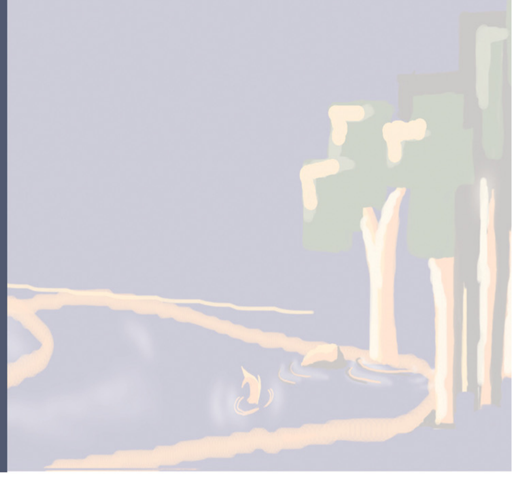
Resource Directed Management of Water Quality

Volume 1.1

Summary Policy

August 2006

Edition 1



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Reports as part of this project:

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1.3	Glossary of terminology often used in the Resource Directed Management of Water Quality
1.4	Volume 1: *Policy Document Series*
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Bold type indicates this report

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EXECUTIVE SUMMARY

"Making water resource management water quality friendly"

Scope

This document is a summary of a more complete supporting policy [DWAF, 2005] of the National Water Act (36:1998). It pertains specifically to management of the use and protection of the water quality component of inland water resources, including surface watercourses, groundwater, estuaries and wetlands.

Although the water quality component is addressed here explicitly, it must be managed holistically, within the general framework of "resource directed measures", with water quantity (flows) and the habitat and biota components that comprise the overall water resource quality.

This policy also addresses how this "resource directed" management of water quality should influence the management of anthropogenic activities that modify the water quality in water resources.

Vision and objectives

This policy envisions an equitable and sustainable balance between the use and protection of water quality in water resources to the benefit of all South Africans. To achieve this, the policy describes how water quality considerations should be integrated into water resource management. Detailed implementation requires the associated strategy and management instruments.

Sustainable development

The current political imperative for socio-economic development necessitates that the balance between the use of water resources and their protection gives preference to, from an overall national perspective, their sustained use for socio-economic development. However, strict protection will occur in some circumstances. The principles of sustainable development are used as a framework for understanding and managing this balance. "Equitable" is specifically taken to mean "just and fair in the sense of being based on laws and accepted principles".

Resource directed measures

Resource directed measures (the management class, Reserve and resource quality objectives) are seen as the primary framework for facilitating sustainable development and implementing this policy. The management class in particular must capture the most desirable balance between use and protection and be based on an appropriate degree of stakeholder engagement.

Adaptive management

The Department subscribes to a cyclical adaptive management approach often categorised as "plan, implement, check and review". The pragmatic though prudent use of lower confidence management instruments in the present interim transitional phase is also encouraged. However, this must be in the interests of facilitating appropriate socio-economic development.

Allocatable water quality

The Department recognises that water quality can be "used". The "allocatable water quality" will typically be quantified in terms of individual water quality attributes (*e.g.* as concentrations or loads). If there is no allocatable water quality, the water resource will be regarded as "stressed" in respect of that attribute.

The Department will facilitate equitable access to water quality in accordance with current national imperatives and the principles of sustainable development. Accordingly, the Department will give particular emphasis to redress and recognise the principle of acceptable prejudice when determining an equitable allocation. This will apply particularly when re-allocation of water, or water quality, requires curtailing existing lawful use (through, for example, compulsory licensing). Gender equity, and especially rural gender equity, will also receive priority.

Source directed controls

The control and management of sources of pollution must be guided by the National Environmental Management Act (108:1998) as well as the management classes set for potentially affected water resources.

The precautionary approach is always applicable and will be balanced against socio-economic necessities. Preventing pollution in the first place will always be encouraged while pursuing the best practicable environmental option. Should some water quality degradation be inevitable, waste minimisation will be encouraged. The precautionary approach will be applied to point sources of pollution by enforcing uniform national minimum requirements or standards. The degree to which they may be enforced or relaxed will depend on the degree of water quality stress.

Monitoring

Sound water quality monitoring is essential for adaptive management. This should include monitoring of (a) overall national water quality status and trends, (b) compliance with resource quality objectives, (c) compliance with water use licence conditions, including monitoring of the affected water resource, and (d) remediation efforts.

Useful monitoring variables include stressors (*e.g.* physico-chemical, radiological, microbial) and responses (*e.g.* eutrophication, invertebrates & fish, toxicity).

The expensive nature of monitoring necessitates monitoring designs and implementation strategies that (a) maximise demonstrably useful information while minimising costs, and (b) support well-defined objectives and informed decision-making.

Monitoring objectives, design and implementation must be reviewed at regular intervals not exceeding five years.

Review

All monitoring should inform the periodic review of policy objectives, the policy itself and the associated implementation strategy and instruments. The degree to which individual catchment visions are being realised through catchment management strategies and the degree to which these are influencing achievement of national goals should also be reviewed.

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ACRONYMS

DWAF	Department of Water Affairs and Forestry
NEMA	National Environmental Management Act
NWA (36:1998)	National Water Act
RDM	Resource Directed Measure
RWQOs	Resource Water Quality Objective

SECTION 1: SUMMARY POLICY ON THE RDMWQ

PHOTO: K MURRAY

1.1 Introduction

1.1.1 Need for policy

The National Water Act (NWA (36:1998)) is an enabling Act that provides for drafting of supporting policies, strategies and legislation. This policy is one such supporting policy relating specifically to the resource directed management of water quality. The following issues create a specific need for clear policy:

- Balancing the degree to which water, and water quality, is used (*e.g.* for socio-economic development) with the degree of protection of water resources as natural systems (for current and future generations) requires both political and scientific considerations.
- The nature of the imbalance between the demand and supply of water, and water quality, is such that equitable allocation of these resources is not possible without management intervention.
- Resource directed management of water quality requires certain specialist skills and decision-making is often complex and based on uncertain or incomplete data and information.
- Consistent nationwide application of legislation relating to management of water quality is essential.

1.1.2 Scope

This policy specifically focuses on measures to manage both the use and protection of the water quality component of inland water resources, including surface watercourses, groundwater, estuaries and wetlands. The specialised nature of water quality warrants addressing this component explicitly. However, the policy recognises that although water quality is the primary focus, it cannot, and should not, be managed in isolation. It is inextricably linked with water quantity (typically water flow) and the integrity of aquatic ecosystems, all collectively referred to in the NWA (36:1998) as the "resource quality".

This policy considers the management of water quality from the perspective of the water resource (making it "resource directed"). However, this perspective also influences the management of anthropogenic activities that modify the water quality in water resources, the so-called "source directed controls". The policy does not address source directed controls that do not relate directly to the water resource.

1.1.3 Broader alignment

This policy is about participatory management of the water quality component of water resources within the more general frameworks of integrated water quality management, integrated water resource management and, ultimately, integrated environmental management.

This policy also regards the overall strategies of continual improvement and adaptive management as essential frameworks for policy implementation. Specifically the "plan, implement, check and review" cycle provides a useful categorisation for activities relating to resource directed management of water quality (van Wyk *et al.*, 2002).

All aspects of this policy are aligned with, and give substance to, the principles described in the National Water Policy White Paper (DWAF, 1997a). The policy also supports the National Water Resource Strategy (DWAF, 2004), specifically providing more detail relating to the management of water quality.

1.2 Vision and Objectives

1.2.1 Integrating water quality

The vision of this policy is to ensure that the water quality in South African water resources enables an equitable and sustainable balance to be achieved between its use by society and its protection as a critical component of a natural system so that the quality of life of all South Africans is improved and sustained in the long term.

The specific management objective of this policy is to provide effective guidance on how water quality considerations should be integrated into water resource management in general, hence the slogan "making water resource management water quality friendly".

1.2.2 Implementation strategy and instruments

The policy is regarded as providing 'guidance' (implying generality) not 'guidelines' (implying specificity). It will be supplemented with a detailed implementation strategy and management instruments, all of which are necessary to give specificity to the policy. The instruments comprise practical guidelines and procedures for specific applications that make resource directed management of water quality more accessible to the target audience.

1.2.3 Target audience

The Department of Water Affairs and Forestry ("the Department") has primary responsibility for the implementation of this policy.

This policy is therefore intended to provide guidance to those responsible for either recommendations or decision-making relating to the above vision and management objective within:

- The Department, both at head office and in Regional Offices;
- Water Management Institutions, especially catchment management agencies;
- Other government departments with related functions;
- Specialist consultant organisations, and
- Other interested or affected organisations.

1.3 Underlying Philosophy

1.3.1 Sustainable development

The ethic of sustainable development is at the core of this policy. It specifically endeavours to ensure that future generations can meet their own needs while promoting socio-economic development and improved quality of life for all in the current generation. This should be done in a manner that uses water resources in general, and water quality in particular, within the ability of the ecosystems to satisfy such needs now and in the future.

1.3.2 Enabling principles

This policy explicitly addresses the balance that should be achieved between the following principles that enable sustainable development:

- *Protection of water resources*: This focuses specific efforts on maintaining and improving the integrity of water resources and of their water quality in particular, and thus regaining or sustaining their capacity to provide goods and services.
- *Optimal water use*: This extends the principle of beneficial use of the NWA (36:1998) to strive to promote socio-economic development and hence improved quality of life resulting from the use of water, and water quality in particular, in a manner that leads to the best alternative use in the public interest.
- *Equity between generations*: This promotes socio-economic enhancement that does not compromise the basic rights of future generations to (a) sufficient water of adequate quality, and (b) healthy ecosystems.
- *Current equitable access*: This strives to fairly and justly balance the priority needs of the nation with other socio-economic developmental needs of the current generation by basing decisions relating to access to these water resource goods and services on the following priority order: (a) the Reserve, (b) honouring international obligations, (c) national strategic uses, (d) strategic future growth in special circumstances, and (e) inter-basin water transfers, and then other uses.
- *Environmental integration*: This strives to holistically consider all important interactions with, and within, ecosystems and water quality in particular.
- *Good governance*. This strives to ensure that all stakeholders (a) manage their affairs with integrity and in a lawful manner, and (b) apply accepted principles and procedures.

Although acknowledging the inevitable difficulties, the Department will strive for an equitable balance between use and protection of water resources that is just (*i.e.* based on legislation) and fair (*i.e.* based on accepted principles).

1.3.3 Balancing the principles

The current political imperative for socio-economic development necessitates that the balance between the use of water resources and their protection gives preference to, from an overall national perspective, their use for socio-economic development, especially for poverty eradication and redress of past inequities. However, under no circumstances should water resources be exploited to the extent that they are "unacceptably degraded" and unable to provide adequate water quality on a sustainable basis.

It is acknowledged that the quality of life of all South Africans is inextricably linked, directly and indirectly, with maintaining the integrity of aquatic ecosystems since these provide many of the goods and services upon which society depends (particularly good quality water). Accordingly, strict protection of selected aquatic ecosystems will occur when this is considered necessary to sustain the biodiversity and general integrity of those ecosystems.

This philosophy will be implemented primarily through "resource directed measures". These measures relate to the management class, the Reserve and associated resource quality objectives. These will comprise some of the most important instruments that will ultimately enable improvement of quality of life through effective water resource management.

1.3.4 Interim transitional phase

The Department acknowledges the comprehensive nature of resource directed measures as mandated by the NWA (36:1998) and that achievement of full-scale implementation will be gradual and time-consuming. The current need for socio-economic development is also acknowledged. Accordingly, this policy is deliberately pragmatic about the interim transitional phase.

1.3.5 Adaptive management

The Department acknowledges that:

- There is a national service delivery imperative, and
- Management of water resources is complex and multi-disciplinary, and
- Water resources are (a) in a state of continuous change and (b) are subject to unpredictable changes, and
- Decisions need to be made in situations where there is frequently insufficient or uncertain data and information.

Consequently, the Department subscribes to adaptive management which strives for continual management improvement in a dynamic yet systematic manner by balancing robustness with a flexibility that allows for change when circumstances demand this.

In the spirit of such adaptive management, the Department will use pragmatic instruments and guidelines (typically associated with low confidence) as the basis for decision-making in the interim transitional phase. The objective is to avoid unnecessary delays in decision-making, particularly when in the interests of facilitating appropriate socio-economic development. These instruments will be progressively replaced by more accurate (and higher confidence) instruments when the demand arises. When using approximate methods of calculation as a basis for decision-making, the Department will openly acknowledge the known underlying assumptions and use independent sources of information or methods ("multiple lines of evidence) whenever this is feasible and cost-effective.

1.3.6 Allocatable water quality and stress

The Department recognises that, just as a quantity of water can be "used", so can water quality. For water to be regarded as "fit for use" for a number of different users in the same catchment, the water quality needs to satisfy the most demanding of those users. Typically this will be quantified in terms of individual water quality attributes. This is the basis for the concept of "allocatable water quality" which can be defined from two points of view.

First, it can be regarded as that water quality, if any, that remains allocatable (available) to uses other than the strategic national priority uses listed above (the Reserve, etc, see Section 1.3.2) and current lawful uses (all contributing to current equitable access) (see Figure 1). It can also be more formally regarded as the maximum worsening change in any water quality attribute away from its present value that maintains it within a pre-determined range reflecting the desired future state (typically defined by a resource quality objective).

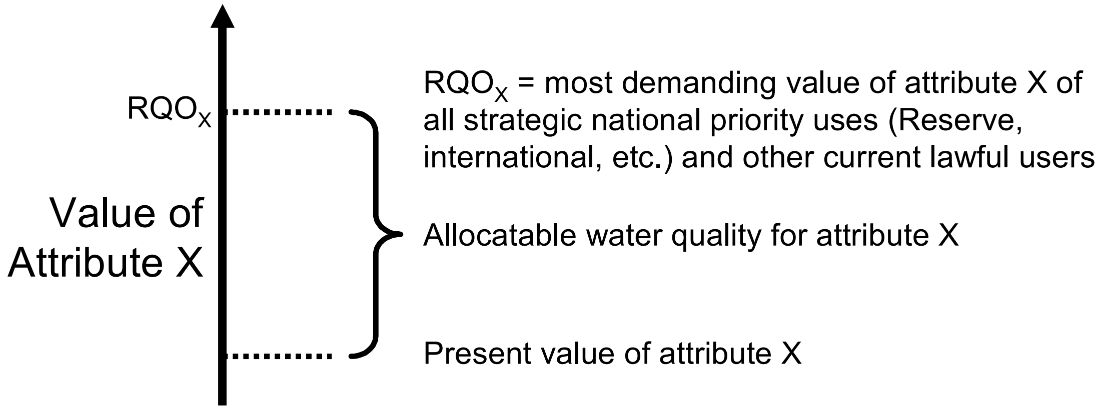

Figure 1.1: Simple conceptual illustration of allocatable water quality for an unstressed attribute.

It is also the Department's policy to continue to facilitate current equitable access to this remaining allocatable water quality in accordance with current national imperatives and the principles of sustainable development.

A water resource will be considered "stressed" in respect of a water quality attribute if, for that attribute, there is no allocatable water quality.

1.4 Strategic National Perspective

One objective of the Department is to improve the quality of life of all South Africans. On a broad national perspective, the Department recognises the interconnectedness of resource directed management of water quality, water resource management in general and the following particular challenges facing South African society:

- Climate change,
- HIV/AIDS,
- Poverty, and
- Past inequities.

Many other national imperatives are addressed in the policy either directly or indirectly (either through policy statements or policy principles). However, these four specific issues either affect water quality in water resources directly or can be addressed by effective management of such water quality.

The significant effects of climate change on evaporation rates, runoff, flow regimes, etc. will impact on the quality of water in South Africa's water resources. Impacts are also likely to be different in the various water management areas. Planning will take account of credible predictions relating to water quality to ensure that attainment of desired future states for water resources (reflected in their resource management classes) is feasible.

Besides the immeasurable human suffering caused by the HIV/AIDS pandemic, the Department also recognises that to perform its duties, it must take specific account of the many socio-economic effects of HIV/AIDS. These include demographic changes, increased inability to pay for services, increased risks to waterborne diseases in people with compromised immune systems and decreased productivity (Ashton and Ramasar, 2002). The Department recognises the need to work closely with the Department of Health in dealing with these issues in a spirit of co-operative governance.

The Department also recognises that poverty diminishes human dignity. Water is one of the most basic enabling elements of survival. The Department will therefore ensure sound application of the Reserve to address both basic human needs and the integrity of the ecosystems and aquifers that supply our water. The Department also recognises that water, and water quality in particular, is a critical enabling element for socio-economic enhancement. It will therefore give particular emphasis to water uses that demonstrably result in poverty eradication.

The Department recognises the enormously negative impacts that past discriminatory policies have had on all South Africans. It therefore commits itself to addressing these in an equitable manner that ensures sustainable development and use of our water resources. Although equality is a principle enshrined in the Constitution, redress will always be considered with due diligence. In particular, until general government policy dictates otherwise, redress may carry a greater relative weight than equality in those catchments in which previous water allocations made prior to the current NWA (36:1998) were discriminatory. The Department also commits itself to applying gender equity, with special emphasis on rural gender equity.

1.5 Catchment Management

1.5.1 Catchment assessment

Catchment assessment is the process of collating, processing and interpreting data and information about water-related conditions, issues and developments in a catchment for the ultimate purpose of providing a sound technical basis for catchment management strategies (DWAF, 2003). The catchment assessment should provide a statement on the present state of water quality, the degree of compliance with the vision and corrective actions that are needed to improve or maintain water quality.

The catchment assessment should be appropriately flexible in its scope, be pragmatically consistent with the degree of water quality stress and be carried out at an appropriate spatial scale. It must also address all necessary water quality issues, including those that relate to the Reserve and to current and future water uses and requirements.

1.5.2 Catchment visioning

Catchment visioning is the iterative process of evolving, over time, a more relevant and more detailed:

- Collective statement from all stakeholders of future aspirations regarding the relationship between the stakeholders, in particular their quality of life in its broadest sense, and the water resources in a catchment, and
- Strategy to move towards that vision, being either the catchment management strategy itself or one that directly supports it.

The Department regards catchment visioning as an important planning instrument for integrated water quality management. It is also an essential participatory management process for ensuring that use of the country's water resources is "in the public interest" (a specific mandate of the NWA (36:1998)). The Department will ensure that stakeholders have an understanding of the necessary concepts relating to resource directed management of water quality to enable their meaningful involvement.

The catchment vision should be progressively realised over time by applying adaptive management and prudent pragmatism within the catchment management strategy.

The products of the catchment visioning exercise should inform, and be quantified by, classification of the resources and the setting of the associated resource quality objectives.

In the interim transitional phase, and under special circumstances, the Department will permit catchment visioning at lower levels of confidence (referring to the level of confidence that can be placed in the appropriateness of the vision). The dangers of doing this will be explicitly acknowledged and carefully weighed against the advantages. For example, in catchments that are not water quality stressed (in respect of any variable of concern) the Department may permit catchment visioning with minimal levels of stakeholder engagement and less than ideal catchment assessment data in the interests of (a) cost-effectively initiating the longer-term progressive development and attainment of a vision, and (b) preparing for a process that is more inclusive.

Furthermore, in the interim transitional phase, while recognising that water quality problems are more acute in some areas than in others, and that cost-effective use of human and financial resources is essential, the catchment management strategy will focus initial implementation on those management units in which the need is most urgent.

1.5.3 Catchment management strategy

Acknowledging the strategic nature of water management areas, the Department will ensure that catchment management agencies progressively establish and implement catchment management strategies. These will give effect to the National Water Resource Strategy (DWAF, 2004) and give attention to water quality-related issues as described in this policy.

1.6 Resource Directed Measures

1.6.1 Confidence

The Department recognises the fundamental importance of (a) resource directed measure as a strategy contributing to sustainable development, and (b) establishing these resource directed measures with adequate confidence.

The Department recognises that there are many factors determining the required level of confidence. These include the immediate application of the outcome of the resource directed measure process, the degree of water quality stress and the severity of impacts of water uses on water quality - both at the present time and in the future.

The Department will be permitted to establish resource directed measures at different levels of confidence, particularly during the interim transitional phase, with appropriate levels of caution. For example, if:

- A sense of urgency exists, or
- A culture of involvement in stakeholder engagement processes in the catchment is either lacking or is such that considerable preparatory groundwork is necessary,

These may be considered as reasons for adopting an initial approach of lower confidence. However, under all circumstances of resource directed measures being established at levels of confidence that are compromised for any of the above reasons, it is the Department's policy to explicitly acknowledge, and manage accordingly, the likely higher associated risks.

1.6.2 Resource management class

The resource management class must capture the most desirable long-term balance between protection of water resources, optimal water use, equity between generations and current equitable access (including honouring international obligations). This balance will be achieved for individual water resources through a resource classification system that applies the principle of environmental integration and takes cognisance of the catchment vision. However, an overall appropriate national balance of (a) strict protection of some resources on the one hand, with (b) use (and possible degradation) of other resources on the other, will be necessary.

Special consideration will be given to resources that are vulnerable, sensitive or scarce and in an unimpacted or near-unimpacted state. Groundwater will be regarded as vulnerable by default unless it can be shown otherwise.

The sustained achievement of the resource management class is regarded as an essential requirement for (a) progressive achievement of the catchment vision, and (b) facilitating sustainable development.

Once a management class has been established, the Department may in future consider a more protective or more lenient management class to either enable stricter control or promote much-needed socio-economic development. This may be driven, for example, by a fundamental inability to implement the catchment management strategy and hence achieve the catchment vision. However, this will typically require considerable justification, possibly a re-consideration of the vision and careful attention to due process.

1.6.3 Resource quality objectives and Reserve

The Department recognises that, in setting resource quality objectives for a chosen management unit of a water resource, a technical process of integration of water quality, water quantity and ecosystem integrity, is necessary, the results of which will further inform the stakeholder engagement process. These objectives can include a wide variety of characteristics of the resource, some of which can refer explicitly to water quality. Until the classification system has been prescribed, provision is made by the NWA (36:1998) for determination of a preliminary class, a preliminary Reserve and preliminary resource quality objectives. These preliminary measures can be determined at different levels of confidence.

Once resource quality objectives have been published in the *Gazette*, or preliminary resource quality objectives determined, they must be given effect. To do so, the Department or water management institutions (such as catchment management agencies) may also set narrative or quantitative "resource water quality objectives" (either in-stream or in-aquifer). These may be set at a greater spatial resolution (*i.e.* closer together) and/or temporal resolution (*i.e.* more frequently monitored) than the resource quality objectives (preliminary or otherwise) to which they may be linked. The purpose of these will be to provide greater detail upon which to base management of water quality aimed at achieving and sustaining compliance with resource quality objectives.

In the interim transitional phase, the Department will use low confidence standard approaches and instruments to determine a preliminary classification of water resources nationwide based on water quality. This will be used to identify potential priority water resources exhibiting water quality stress. Preliminary resource quality objectives relating to water quality and resource water quality objectives will then be set for these priority resources using more accurate (higher confidence) approaches. This will provide initial impetus to the implementation of resource directed management of water quality in accordance with the intentions of the NWA (36:1998).

The Department recognises that some impacts on water quality, particularly those relating to conservative water quality variables, can have increasingly cumulative effects towards the most downstream reaches of surface water resources. Accordingly, the setting of resource quality objectives or resource water quality objectives for a particular catchment must take cognisance of that catchment's water quality issues (current and future) and those of upstream, and particularly downstream catchments as well as those linked through inter-basin transfers. All water quality-related objectives in such catchments must be mutually compatible.

1.7 Source Directed Controls

1.7.1 Resource perspective

Recognising that the exact nature of source directed controls depends on the management objectives that are set for local water resources, it is within the scope of this policy to give guidance on source directed controls from this perspective. However, it is also noted that the nature of source directed controls is significantly determined by the National Environmental Management Act (NEMA (107:1998)).

1.7.2 Precautionary approach

The precautionary approach entails ensuring that conservative decisions or actions are implemented, which minimise the risk of unpredictable ecological impacts that may threaten sustainability when there is uncertainty regarding the likelihood of such impacts.

The Department will balance the ecological necessity of this approach with the water quality requirements, and associated socio-economic necessities, of current and proposed water uses. This will be particularly important in the interim transitional phase and in the absence of resource quality objectives for the potentially impacted water resource. The precautionary approach applies at many levels, including pollution prevention, waste minimisation and the differentiated approach.

1.7.3 Pollution prevention

Irrespective of the amount of allocatable water quality, the Department will strongly encourage water users to prevent pollution whenever possible (*e.g.* by striving for a "zero effluent" state for water users producing effluents) by pursuing the best practicable environmental option. This is the option that provides the most benefit or causes the least damage to the environment as a whole, at a cost acceptable to society, in the long-term as well as in the short-term (NEMA (107:1998)).

Pollution prevention is aimed specifically at controlling the handling and discharge or disposal of hazardous substances. Toxicity, persistence and capacity for bioaccumulation or endocrine disruption present major threats to the receiving water environment. Where these are involved, the differentiated approach below does not apply because of the difficulties associated with determining appropriate resource water quality objectives for these pollutants.

1.7.4 Waste minimisation

The Department acknowledges that some degradation of water quality in water resources is inevitable, and is sometimes necessary, for socio-economic development. Irrespective of the amount of allocatable water quality, cost-effective waste minimisation and water conservation will be encouraged at all times. For point sources such as waste discharges, the precautionary approach will also be applied by enforcing uniform national minimum requirements or standards by default, should they exist.

When non-point pollution sources are persistently responsible for unacceptable water quality degradation, the Department will approach the responsible authority, examine the causes of the problem, and identify appropriate interventions to address the problem.

1.7.5 Differentiated approach

In catchments with no water quality stress, even if considerable allocatable water quality exists, the Department will apply the precautionary approach by enforcing, particularly in respect of point waste discharges, uniform national minimum requirements or standards by default, should they exist. However, these may be relaxed in special and equitable circumstances although the management class will have to be maintained.

In catchments with water quality stress, it is policy to (a) consider stricter requirements, and/or (b) strictly regulate or prohibit unsustainable practices in order to comply with resource quality objectives and achieve the management class.

To protect water resources at a cost acceptable to society, the Department will generally be guided by the level of protection afforded by the resource management class (informed by catchment visioning) and associated resource quality objectives. This will apply to both point and non-point sources of pollution.

In the absence of resource quality objectives (preliminary or otherwise), the Department will enforce uniform national minimum requirements or standards, should they exist, in respect of point waste discharges. If the potentially impacted resource is vulnerable or sensitive to water quality degradation, the Department may act as though the water resource is water quality stressed, applying the precautionary approach as just described.

1.7.6 Remediation

Remediation (also referred to as rehabilitation) is regarded here as direct intervention in (a) degraded land, to minimise contamination risk to a water resource, or (b) a degraded water resource, to maintain or improve water quality in the water resource.

In order to promote both optimal water use and protection of water resources, the Department will:

- Facilitate remediation of water resources, and sources of pollution (*e.g.* degraded land), especially in catchments with existing water quality stress, where this is considered necessary, practical and equitable, and
- Apply the polluter pays principle.

The Department recognises that remediation can be extremely expensive and sometimes impractical, for example in the case of some aquifers. The Department regards this as strong motivation for avoiding the need for remediation in the first place, by applying pollution prevention, waste minimisation and the differentiated approach with the emphasis stated above.

1.7.7 Water allocation

Whether referring to water quantity or water quality, the Department recognises the fundamental role that current equitable access (*i.e.* in the present generation) will play in poverty eradication. Accordingly, in its quest to appropriately balance the enabling principles of sustainable development, the Department will give particular emphasis to redress and recognise the principle of acceptable prejudice when determining an equitable allocation. This will apply particularly when re-allocation of water, or water quality, requires curtailing existing lawful use (through, for example, compulsory licensing).

Effective stakeholder engagement will be strongly encouraged and supported to ensure that all water allocation is in the public interest. In this process, socio-economic enhancement, and in particular the enabling principle designed to empower stakeholders to participate in decision-making processes, will be emphasised. Water conservation and gender equity will also receive high priority.

If the resource contains some allocatable water quality, an applicant will typically not be allocated all that is available. An appropriate fraction will be allocated that takes account of all the considerations in Section 27 of the NWA (36:1998), as well as:

- The approximate nature of, or confidence in, the determination of the allocatable water quality, and
- Unforeseen circumstances.

Because optimal water use issues in the context of water allocation go beyond the mandate of the Department, the Department will apply good governance and especially co-operative governance across the spectrum of stakeholder organisations.

1.7.8 Water use

The Department will strive to attain and maintain the designated resource management class of each water resource by, at least:

- Limiting water quality allocations to the available allocatable water quality, *i.e.* complying with resource quality objectives relating to water quality, and
- Adhering appropriately to uniform minimum requirements or standards, and
- Not permitting continual deterioration of water quality that will result in an unacceptable trend that may potentially decrease its present management class.

Within the constraints of the allocatable water quality of the resource and the catchment management strategy, and until general government policy dictates otherwise, the Department's policy is to respond positively to water uses involving allocations that, specifically in respect of persons that were subject to past discriminatory practices:

- Actively redress previous discrimination, or
- Empower and uplift such persons by provision of a quality of water that demonstrably improves their quality of life.

1.8 Monitoring

Acknowledging the Department's mandate in terms of Chapter 14 of the NWA (36:1998) to create national monitoring systems for water resources, the Department will ensure that monitoring of water quality:

- Contributes meaningfully to the Department's efforts to facilitate sustainable development,
- Is explicitly linked to resource directed measures,
- Reflects the ecologically interdependent nature of water resources, including the dependence on water quantity, whenever appropriate, and
- Becomes an essential enabling component of effective integrated water quality management of South African water resources.

1.8.1 Monitoring variables

To achieve the above objectives, the Department recognises the following as providing useful data and information on water quality:

Stressor monitoring:
- Physico-chemical monitoring (typically inorganic variables but also organic and inorganic toxicants),
- Radiological monitoring,
- Microbial monitoring (*e.g.* faecal microorganisms).

Response monitoring:
- Eutrophication monitoring,
- Biomonitoring (*e.g.* invertebrates and fish),
- Toxicity monitoring.

Furthermore, the Department recognises the importance of monitoring to some degree:
- The pressures on water quality (*e.g.* the nature of the water uses that impact on water quality),
- The social and economic impacts of water quality, and
- Decisive responses of society and government to these impacts, and
- Management performance.

In the interim transitional phase, monitoring efforts will focus primarily on stressor and response monitoring that reflects the status and trends of water quality in water resources. The monitoring of pressures, impacts and societal responses is a longer-term objective. But because such information can be very useful, it will be included in the transitional phase when necessary, simple and cost-effective.

1.8.2 Management principles

The Department acknowledges the expensive nature of both the initial design and ultimate implementation of any water quality monitoring programme and therefore commits itself to the principles of sound financial management, adaptive management and co-operative governance to ensure the monitoring remains focussed, cost-effective and sustainable. It will be ensured that:

- Each monitoring programme has well-defined objectives,
- Each monitoring design provides the maximum amount of demonstrably useful information at minimum cost,
- Data assessments and reports support informed decision-making, in particular related to (a) water quality guidelines that may be used, and (b) uncertainties associated with observations,
- No duplication of effort occurs at any stage of implementation, and
- Partnerships will be created with appropriate stakeholders who will share costs and benefits.

1.8.3 Monitoring review

In the spirit of adaptive management, the Department will review, at regular intervals:

- The relevance of each programme's monitoring objectives, and
- The effectiveness with which they have been achieved.

On this basis the programme's objectives, design or implementation strategy will be updated if necessary. Review intervals can be programme-specific but will not exceed five years.

1.8.4 National status and trends

The Department will establish national status and trends monitoring programmes that measure, assess and report on the current status and appropriate temporal trends of selected groups of water quality indicators in South African water resources. This will be done in a soundly scientific manner that will support strategic management decisions in the context of sustainable fitness for use of those water resources and the integrity of aquatic ecosystems.

The Department recognises the following strategic responsibilities that specifically motivate the need for monitoring programmes with a broad national perspective:

- Monitoring the overall national effectiveness of water quality management policies and strategies,
- Honouring international obligations and participation in appropriate global initiatives,
- Keeping abreast of international trends in emerging problems, and
- In the current interim transitional phase, the creation of monitoring capacity upon which further region-specific capacity creation can be based, for example as catchment management agencies become operational.

1.8.5 Performance

Acknowledging the importance of ensuring that water uses are such that resource management classes are attained and maintained, the Department will establish performance monitoring programmes that measure, assess and report on the degree of compliance with resource quality objectives.

Recognising the legal status of resource quality objectives, the Department will ensure that the overall process of resource quality objective compliance monitoring is scientific, and all individual procedures are adequately defensible by being applied consistently and objectively.

The degree to which compliance with resource quality objectives, or movement towards such compliance, is being achieved will intimately feed back into and drive the catchment management strategy.

1.8.6 Compliance

Although compliance monitoring relating directly to 'end-of-pipe' monitoring is largely outside the scope of this policy, the Department acknowledges the importance of such source directed controls. However, the Department will ensure that water quality monitoring in affected resources is included in water use authorisations when appropriate. These will be closely aligned with resource quality objectives relating to water quality and source management objectives.

Such monitoring provides an important information base for subsequent well-focussed corrective actions in cases where non-compliance is evident.

1.8.7 Remediation

The Department will measure, assess and report on the effects of local water quality remediation efforts in order to provide data and information on the effectiveness of those efforts. The Department will approach such monitoring in three possible ways, in order of decreasing priority:

- Incorporation into resource quality objective performance monitoring programmes.
- Incorporation into national status and trends monitoring programmes, if appropriate to a national perspective and consistent with the designs of those programmes.
- Design and implementation of temporary site-specific monitoring programmes tailored solely to provide data and information on the effectiveness of the remediation efforts.

1.8.8 Management performance

The Department will apply good governance and place special emphasis on the enabling principles of accountability and transparency. Accordingly, the Department will implement appropriate in-house monitoring of management performance. This is to ensure that deficiencies in management actions within the Department are identified and corrected as soon as possible.

The Department will also ensure that staff members are provided with adequate training and general institutional support to ensure that appropriate capacity is created to allow water resource managers to confidently take full responsibility for their actions.

1.9 Review

The Department will periodically review the current relevance of the following:

- The original objectives of this policy, and
- The policy itself, and
- The appropriateness of the strategy and associated management instruments to implement the policy and achieve its objectives.

Any indication that creates cause for concern that any of the above is no longer relevant, should result in either (a) an appropriate change to the policy or strategy through effective stakeholder engagement, and/or (b) an improvement in confidence associated with management instruments.

The Department will also periodically examine:

- The degree to which individual catchment visions have been realised through implementation of their catchment management strategies, and
- The degree to which implementation of all catchment management strategies has influenced the achievement of national goals.

Changes to catchment visions, or associated catchment management strategies, through effective stakeholder engagement, are encouraged to ensure that these remain relevant and focussed.

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Anthony Turton	Gibb-Sera Chair in IWRM (CSIR)
Ashwin Seetal	DWAF: Water Allocation
Barbara Schreiner	DWAF: Policy and Regulation Branch
Barbara Weston	DWAF: Resource Directed Measures
Bettie Conradie	DWAF: Northern Cape Regional Office
Bill Rowlston	DWAF: Policy and Strategy Coordination
Carin Bosman	DWAF: Resource Protection and Waste
Chris Moseki	DWAF: Water Resource Planning Systems
Cornelius Ruiters	DWAF: Water Use
Danie Smit	Department of Environmental Affairs & Tourism
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Dirk Roux	CSIR: NRE
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Gys Hoon	DWAF: Free State Regional Office
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Hugh Dixon-Paver	DWAF: KwaZulu Natal Regional Office
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Marlese Nel	DWAF: Information Programmes
Martin van Veelen	BKS
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Nicky Naidoo	Nemai Consulting
Niel van Wyk	DWAF: National Water Resources Planning
Obet Baloyi	DWAF: Water Abstraction and Instream Use
Peter van Niekerk	DWAF: Integrated Water Resources Planning
Petrus Venter	DWAF: North West Regional Office
Piet Pretorius	DWAF: Water Abstraction and Instream Use
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Priya Moodley	DWAF: Water Resource Planning Systems
Retha Stassen	DWAF Project Co-ordinator
Riana Munnik	DWAF: Gauteng Regional Office
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Sebastian Jooste	DWAF: Resource Quality Services
Simon Moganetsi	DWAF: Water Abstraction and Instream Use
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EXECUTIVE SUMMARY

"Making water resource management water quality friendly"

Scope

This policy is a supporting policy of the National Water Act (36:1998). It pertains specifically to management of the use and protection of the water quality component of inland water resources, including surface watercourses, groundwater, estuaries and wetlands.

Although the water quality component is addressed here explicitly, it must be managed holistically, within the general framework of "resource directed measures", with water quantity (flows) and the habitat and biota components that comprise the overall water resource quality.

This policy also addresses how this "resource directed" management of water quality should influence the management of anthropogenic activities that modify the water quality in water resources.

Vision and objectives

This policy envisions an equitable and sustainable balance between the use and protection of water quality in water resources to the benefit of all South Africans. To achieve this, the policy describes how water quality considerations should be integrated into water resource management. Detailed implementation requires the associated strategy and management instruments.

Sustainable development

The current political imperative for socio-economic development necessitates that the balance between the use of water resources and their protection gives preference to, from an overall national perspective, their sustained use for socio-economic development. However, strict protection will occur in some circumstances. The principles of sustainable development are used as a framework for understanding and managing this balance. "Equitable" is specifically taken to mean "just and fair in the sense of being based on laws and accepted principles".

Resource directed measures

Resource directed measures (the management class, Reserve and resource quality objectives) are seen as the primary framework for facilitating sustainable development and implementing this policy. The management class in particular must capture the most desirable balance between use and protection and be based on an appropriate degree of stakeholder engagement.

Adaptive management

The Department subscribes to a cyclical adaptive management approach often categorised as "plan, implement, check and review". The pragmatic though prudent use of lower confidence management instruments in the present interim transitional phase is also encouraged. However, this must be in the interests of facilitating appropriate socio-economic development.

Allocatable water quality

The Department recognises that water quality can be "used". The "allocatable water quality" will typically be quantified in terms of individual water quality attributes (*e.g.* as concentrations or loads). If there is no allocatable water quality, the water resource will be regarded as "stressed" in respect of that attribute.

The Department will facilitate equitable access to water quality in accordance with current national imperatives and the principles of sustainable development. Accordingly, the Department will give particular emphasis to redress and recognise the principle of acceptable prejudice when determining an equitable allocation. This will apply particularly when re-allocation of water, or water quality, requires curtailing existing lawful use (through, for example, compulsory licensing). Gender equity, and especially rural gender equity, will also receive priority.

Source directed controls

The control and management of sources of pollution must be guided by the National Environmental Management Act (108:1998) as well as the management classes set for potentially affected water resources.

The precautionary approach is always applicable and will be balanced against socio-economic necessities. Preventing pollution in the first place will always be encouraged while pursuing the best practicable environmental option. Should some water quality degradation be inevitable, waste minimisation will be encouraged. The precautionary approach will be applied to point sources of pollution by enforcing uniform national minimum requirements or standards. The degree to which they may be enforced or relaxed will depend on the degree of water quality stress.

Monitoring

Sound water quality monitoring is essential for adaptive management. This should include monitoring of (a) overall national water quality status and trends, (b) compliance with resource quality objectives, (c) compliance with water use licence conditions, including monitoring of the affected water resource, and (d) remediation efforts.

Useful monitoring variables include stressors (*e.g.* physico-chemical, radiological, microbial) and responses (*e.g.* eutrophication, invertebrates & fish, toxicity).

The expensive nature of monitoring necessitates monitoring designs and implementation strategies that (a) maximise demonstrably useful information while minimising costs, and (b) support well-defined objectives and informed decision-making.

Monitoring objectives, design and implementation must be reviewed at regular intervals not exceeding five years.

Review

All monitoring should inform the periodic review of policy objectives, the policy itself and the associated implementation strategy and instruments. The degree to which individual catchment visions are being realised through catchment management strategies and the degree to which these are influencing achievement of national goals should also be reviewed.

HOW TO USE THIS DOCUMENT

If you want to …	Then …
Read a summary of the policy	Read **Section 1: Summary Policy**
Know what the policy aims to achieve	Read **Section 2.4: Vision and objectives**
Know what detailed procedures and software tools are available to implement the policy	Read **Section 2.7: Policy implementation**
See what the policy is on water use versus resource protection	Read **Section 1.3.3: Balancing the principles**
Find a definition	*For a principle*: Find the principle in the **Index (Section 8)** and go to the page number indicated in bold *For other terms*: Check the **Glossary (Section 6)**
Understand how water quality can be used and quantified	Read **Section 3.3: Resource directed management of water quality**
Understand how resource directed measures relate to this policy	*For a summary*: Read **Section 1.6: Resource Directed Measures** *For more detail*: Read **Section 4.8: Resource Directed Measures**
Understand how objectives for a water resource should influence how you deal with polluters and water users	*For a summary*: Read **Section 1.7: Source directed controls** *For more detail*: Read **Section 4.9: Source directed controls**
See a definition of adaptive management	Read **Section 5.5.1: Adaptive management**
See how to apply adaptive management	Read **Section 1.3.5: Adaptive management**, **Section 1.5.3: Progressive realisation** and **Section 1.8.3: Monitoring review**
Understand what sustainable development means	First read **Section 3.2: Water resource management** Then read **Section 5.3: Sustainable development** (for the enabling principles).
Understand how sustainable development should be facilitated	*For a summary*: Read **Section 1.6: Resource directed measures** *For more detail*: Read **Section 4.8: Resource directed measures**
See what, and how, water quality monitoring should be done	*For a summary*: Read **Section 1.8: Monitoring** *For more detail*: Read **Section 4.10: Monitoring**
See what should be periodically reviewed	*For a summary*: Read **Section 1.9: Review** *For more detail*: Read **Section 4.11: Review**

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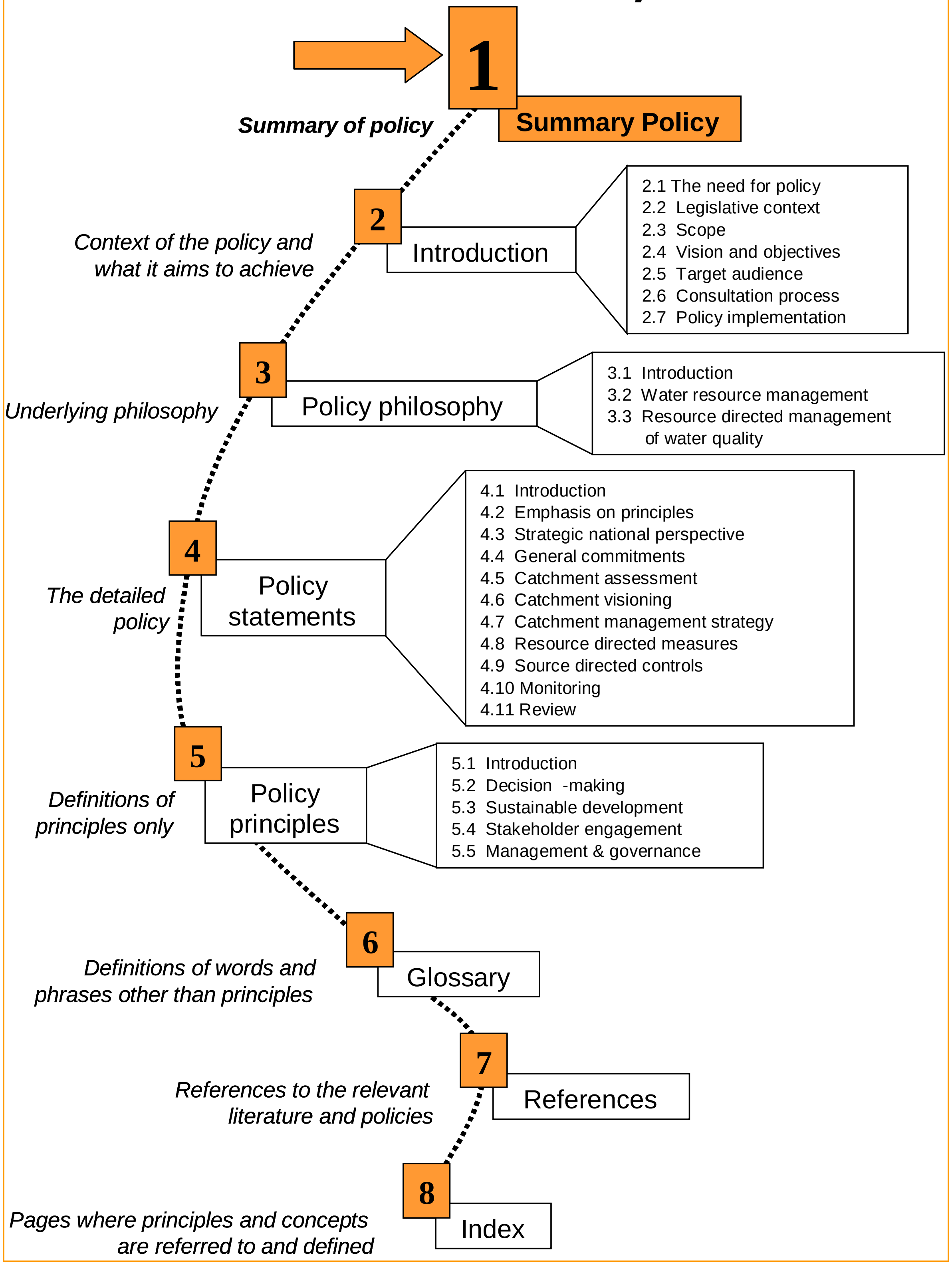
ACRONYMS

CMA	Catchment Management Agency
DWAF	Department of Water Affairs and Forestry
NWA (36:1998)	National Water Act
NEMA	National Environmental Management Act
RDM	Resource Directed Measure
RQOs	Resource Quality Objectives
RWQOs	Resource Water Quality Objectives

Document roadmap



SECTION 1: SUMMARY POLICY ON RDMWQ

PHOTO: K MURRAY

1.1 Introduction

1.1.1 Need for policy

The National Water Act (NWA (36:1998)) is an enabling Act that provides for drafting of supporting policies, strategies and legislation. This policy is one such supporting policy relating specifically to the resource directed management of water quality. This section is a summary of the complete policy that appears in subsequent sections of this document. The following issues create a specific need for clear policy:

- Balancing the degree to which water, and water quality, is used (*e.g.* for socio-economic development) with the degree of protection of water resources as natural systems (for current and future generations) requires both political and scientific considerations.
- The nature of the imbalance between the demand and supply of water, and water quality, is such that equitable allocation of these resources is not possible without management intervention.
- Resource directed management of water quality requires certain specialist skills and decision-making and is often complex and based on uncertain or incomplete data and information.
- Consistent nationwide application of legislation relating to management of water quality is essential.

1.1.2 Scope

This policy specifically focuses on measures to manage both the use and protection of the water quality component of inland water resources, including surface watercourses, groundwater, estuaries and wetlands. The specialised nature of water quality warrants addressing this component explicitly. However, the policy recognises that although water quality is the primary focus, it cannot, and should not, be managed in isolation. It is inextricably linked with water quantity (typically water flow) and the integrity of aquatic ecosystems, all collectively referred to in the NWA (36:1998) as the "resource quality".

This policy considers the management of water quality from the perspective of the water resource (making it "resource directed"). However, this perspective also influences the management of anthropogenic activities that modify the water quality in water resources, the so-called "source directed controls". The policy does not address source directed controls that do not relate directly to the water resource.

1.1.3 Broader alignment

This policy is about participatory management of the water quality component of water resources within the more general frameworks of integrated water quality management, integrated water resource management and, ultimately, integrated environmental management.

This policy also regards the overall strategies of continual improvement and adaptive management as essential frameworks for policy implementation. Specifically the "plan, implement, check and review" cycle provides a useful categorisation for activities relating to resource directed management of water quality (van Wyk *et al.*, 2003).

All aspects of this policy are aligned with, and give substance to, the principles described in the National Water Policy White Paper (DWAF, 1997a). The policy also supports the National Water Resource Strategy (DWAF, 2004b), specifically providing more detail relating to the management of water quality.

1.2 Vision and Objectives

1.2.1 Integrating water quality

The vision of this policy is to ensure that the water quality in South African water resources enables an equitable and sustainable balance to be achieved between its use by society and its protection as a critical component of a natural system so that the quality of life of all South Africans is improved and sustained in the long term.

The specific management objective of this policy is to provide effective guidance on how water quality considerations should be integrated into water resource management in general, hence the slogan "making water resource management water quality friendly".

1.2.2 Implementation strategy and instruments

The policy is regarded as providing 'guidance' (implying generality) not 'guidelines' (implying specificity). It will be supplemented with a detailed implementation strategy and management instruments, all of which are necessary to give specificity to the policy. The instruments comprise practical guidelines and procedures for specific applications that make resource directed management of water quality more accessible to the target audience.

1.2.3 Target audience

The Department of Water Affairs and Forestry ("the Department") has primary responsibility for the implementation of this policy.

This policy is therefore intended to provide guidance to those responsible for either recommendations or decision-making relating to the above vision and management objective within:

- The Department, both at head office and in Regional Offices,
- Water Management Institutions, especially catchment management agencies,
- Other government departments with related functions,
- Specialist consultant organisations, and
- Other interested or affected organisations.

1.3 Underlying Philosophy

1.3.1 Sustainable development

The ethic of sustainable development is at the core of this policy. It specifically endeavours to ensure that future generations can meet their own needs while promoting socio-economic development and improved quality of life for all in the current generation. This should be done in a manner that uses water resources in general, and water quality in particular, within the ability of the ecosystems to satisfy such needs now and in the future.

1.3.2 Enabling principles

This policy explicitly addresses the balance that should be achieved between the following principles that enable sustainable development:

- *Protection of water resources*: This focuses specific efforts on maintaining and improving the integrity of water resources and of their water quality in particular, and thus regaining or sustaining their capacity to provide goods and services.
- *Optimal water use*: This extends the principle of beneficial use of the NWA (36:1998) to strive to promote socio-economic development and hence improved quality of life resulting from the use of water, and water quality in particular, in a manner that leads to the best alternative use in the public interest.
- *Equity between generations*: This promotes socio-economic enhancement that does not compromise the basic rights of future generations to (a) sufficient water of adequate quality, and (b) healthy ecosystems.
- *Current equitable access*: This strives to fairly and justly balance the priority needs of the nation with other socio-economic developmental needs of the current generation by basing decisions relating to access to these water resource goods and services on the following priority order: (a) the Reserve, (b) honouring international obligations, (c) national strategic uses, (d) strategic future growth in special circumstances, and (e) inter-basin water transfers, and then other uses.
- *Environmental integration*: This strives to holistically consider all important interactions with, and within, ecosystems and water quality in particular.
- *Good governance*. This strives to ensure that all stakeholders (a) manage their affairs with integrity and in a lawful manner, and (b) apply accepted principles and procedures.

Although acknowledging the inevitable difficulties, the Department will strive for an equitable balance between use and protection of water resources that is just (*i.e.* based on legislation) and fair (*i.e.* based on accepted principles).

1.3.3 Balancing the principles

The current political imperative for socio-economic development necessitates that the balance between the use of water resources and their protection gives preference to, from an overall national perspective, their use for socio-economic development, especially for poverty eradication and redress of past inequities. However, under no circumstances should water resources be exploited to the extent that they are "unacceptably degraded" and unable to provide adequate water quality on a sustainable basis.

It is acknowledged that the quality of life of all South Africans is inextricably linked, directly and indirectly, with maintaining the integrity of aquatic ecosystems since these provide many of the goods and services upon which society depends (particularly good quality water). Accordingly, strict protection of selected aquatic ecosystems will occur when this is considered necessary to sustain the biodiversity and general integrity of those ecosystems.

This philosophy will be implemented primarily through "resource directed measures". These measures relate to the management class, the Reserve and associated resource quality objectives. These will comprise some of the most important instruments that will ultimately enable improvement of quality of life through effective water resource management.

1.3.4 Interim transitional phase

The Department acknowledges the comprehensive nature of resource directed measures as mandated by the NWA (36:1998) and that achievement of full-scale implementation will be gradual and time-consuming. The current need for socio-economic development is also acknowledged. Accordingly, this policy is deliberately pragmatic about the interim transitional phase.

1.3.5 Adaptive management

The Department acknowledges that:

- There is a national service delivery imperative, and
- Management of water resources is complex and multi-disciplinary, and
- Water resources are (a) in a state of continuous change and (b) are subject to unpredictable changes, and
- Decisions need to be made in situations where there is frequently insufficient or uncertain data and information.

Accordingly, the Department subscribes to a system of adaptive management that strives for continual management improvement in a dynamic yet systematic manner, by balancing robustness with a flexibility that allows for change when circumstances demand this.

In the spirit of such adaptive management, the Department will use pragmatic instruments and guidelines (typically associated with low confidence) as the basis for decision-making in the interim transitional phase. The objective is to avoid unnecessary delays in decision-making, particularly when in the interests of facilitating appropriate socio-economic development. These instruments will be progressively replaced by more accurate (and higher confidence) instruments when the demand arises. When using approximate methods of calculation as a basis for decision-making, the Department will openly acknowledge the known underlying assumptions and use independent sources of information or methods ("multiple lines of evidence") whenever this is feasible and cost-effective.

1.3.6 Allocatable water quality and stress

The Department recognises that, just as a quantity of water can be "used", so can water quality. For water to be regarded as "fit for use" for a number of different users in the same catchment, the water quality needs to satisfy the most demanding of those users. Typically this will be quantified in terms of individual water quality attributes. This is the basis for the concept of "allocatable water quality" which can be defined from two points of view. First, it can be regarded as that water quality, if any, that remains allocatable (available) to uses other than the strategic national priority uses listed above (the Reserve, etc, see Section 1.3.2) and current lawful uses (all contributing to current equitable access) (see Figure 1). It can also be more formally regarded as the maximum worsening change in any water quality attribute away from its present value that maintains it within a pre-determined range reflecting the desired future state (typically defined by a resource quality objective).

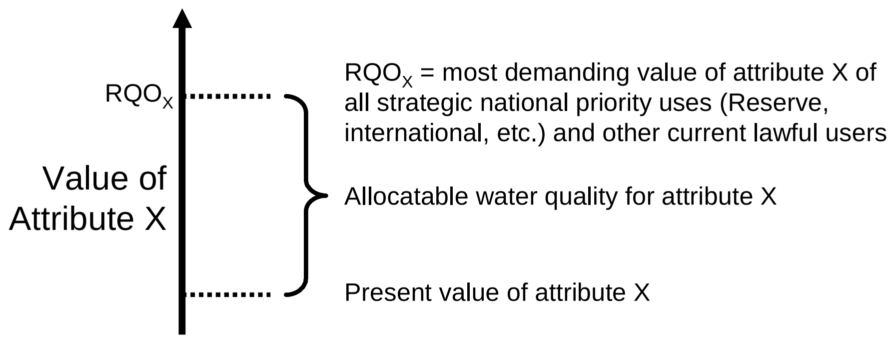


Figure 1. Simple conceptual illustration of allocatable water quality for an unstressed attribute.

It is also the Department's policy to continue to facilitate current equitable access to this remaining allocatable water quality in accordance with current national imperatives and the principles of sustainable development.

A water resource will be considered "stressed" in respect of a water quality attribute if, for that attribute, there is no allocatable water quality.

1.4 Strategic National Perspective

One objective of the Department is to improve the quality of life of all South Africans. On a broad national perspective, the Department recognises the interconnectedness of resource directed management of water quality, water resource management in general and the following particular challenges facing South African society:

- Climate change;
- HIV/AIDS;
- Poverty; and
- Past inequities.

Many other national imperatives are addressed in the policy either directly or indirectly (either through policy statements or policy principles). However, these four specific issues either affect water quality in water resources directly or can be addressed by effective management of such water quality.

The significant effects of climate change on evaporation rates, runoff, flow regimes, etc. will impact on the quality of water in South Africa's water resources. Impacts are also likely to be different in the various water management areas. Planning will take account of credible predictions relating to water quality to ensure that attainment of desired future states for water resources (reflected in their resource management classes) is feasible.

Besides the immeasurable human suffering caused by the HIV/AIDS pandemic, the Department also recognises that to perform its duties, it must take specific account of the many socio-economic effects of HIV/AIDS. These include demographic changes, increased inability to pay for services, increased risks to waterborne diseases in people with compromised immune systems and decreased productivity (Ashton and Ramasar, 2002). The Department recognises the need to work closely with the Department of Health in dealing with these issues in a spirit of co-operative governance.

The Department also recognises that poverty diminishes human dignity. Water is one of the most basic enabling elements of survival. The Department will therefore ensure sound application of the Reserve to address both basic human needs and the integrity of the ecosystems and aquifers that supply our water. The Department also recognises that water, and water quality in particular, is a critical enabling element for socio-economic enhancement. It will therefore give particular emphasis to water uses that demonstrably result in poverty eradication.

The Department recognises the enormously negative impacts past discriminatory policies have had on all South Africans. It therefore commits itself to addressing these in an equitable manner that ensures sustainable development and use of our water resources. Although equality is a principle enshrined in the Constitution, redress will always be considered with due diligence. In particular, until general government policy dictates otherwise, redress may carry a greater relative weight than equality in those catchments in which previous water allocations made prior to the current NWA (36:1998) were discriminatory. The Department also commits itself to applying gender equity, with special emphasis on rural gender equity.

1.5 Catchment Management

1.5.1 Catchment assessment

Catchment assessment is the process of collating, processing and interpreting data and information about water-related conditions, issues and developments in a catchment for the ultimate purpose of providing a sound technical basis for catchment management strategiess (DWAF 2003c). The catchment assessment should provide a statement on the present state of water quality, the degree of compliance with the vision, and corrective actions that are needed to improve or maintain water quality.

The catchment assessment should be appropriately flexible in its scope, be pragmatically consistent with the degree of water quality stress, and be carried out at an appropriate spatial scale. It must also address all necessary water quality issues, including those relating to the Reserve and current and future water uses and requirements.

1.5.2 Catchment visioning

Catchment visioning is the iterative process of evolving, over time, a more relevant and more detailed:

- Collective statement from all stakeholders of future aspirations regarding the relationship between the stakeholders, in particular their quality of life in its broadest sense, and the water resources in a catchment; and
- Strategy to move towards that vision, being either the catchment management strategy itself or one that directly supports it.

The Department regards catchment visioning as an important planning instrument for integrated water quality management. It is also an essential participatory management process for ensuring that use of the country's water resources is "in the public interest" (a specific mandate of the NWA (36:1998)). The Department will ensure that stakeholders have an understanding of the necessary concepts relating to resource directed management of water quality to enable their meaningful involvement.

The catchment vision should be progressively realised over time by applying adaptive management and prudent pragmatism within the catchment management strategy. The products of the catchment visioning exercise should inform, and be quantified by, classification of the resources and the setting of the associated resource quality objectives.

In the interim transitional phase, and under special circumstances, the Department will permit catchment visioning at lower levels of confidence (referring to confidence that can be placed in the appropriateness of the vision). The dangers of doing this will be explicitly acknowledged and carefully weighed against the advantages. For example, in catchments that are not water quality stressed (in respect of any variable of concern) the Department may permit catchment visioning with minimal levels of stakeholder engagement and less than ideal catchment assessment data in the interests of (a) cost-effectively initiating the longer-term progressive development and attainment of a vision and (b) preparing for a process that is more inclusive.

Furthermore, in the interim transitional phase, while recognising that water quality problems are more acute in some areas than in others, and that cost-effective use of human and financial resources is essential, the catchment management strategy will focus initial implementation on those management units in which the need is most urgent.

1.5.3 Catchment management strategy

Acknowledging the strategic nature of water management areas, the Department will ensure that catchment management agencies progressively establish and implement catchment management strategies. These will give effect to the National Water Resource Strategy (DWAF, 2004a) and give attention to water quality-related issues as described in this policy.

1.6 Resource Directed Measures

1.6.1 Confidence

The Department recognises the fundamental importance of (a) resource directed measures as a strategy contributing to sustainable development, and (b) establishing these resource directed measures with adequate confidence.

The Department recognises that there are many factors determining the required level of confidence. These include the immediate application of the outcome of the resource directed measure process, the degree of water quality stress, and the severity of impacts of water uses on water quality both at the present time and in the future.

It will be permitted to establish resource directed measures at different levels of confidence particularly during the interim transitional phase, with appropriate levels of caution. For example, if:

- A sense of urgency exists, or
- A culture of involvement in stakeholder engagement processes in the catchment is either lacking or is such that considerable preparatory groundwork is necessary,

these may be considered as reasons for adopting an initial approach of lower confidence. However, under all circumstances of resource directed measures being established at levels of confidence that are compromised for any of the above reasons, it is the Department's policy to explicitly acknowledge, and manage accordingly, the likely higher associated risks.

1.6.2 Resource management class

The resource management class must capture the most desirable long-term balance between protection of water resources, optimal water use, equity between generations and current equitable access (including honouring international obligations). This balance will be achieved for individual water resources through a resource classification system that applies the principle of environmental integration and takes cognisance of the catchment vision. However, an overall appropriate national balance of (a) strict protection of some resources on the one hand with (b) use (and possible degradation) of other resources on the other, will be necessary.

Special consideration will be given to resources that are vulnerable, sensitive or scarce and in an unimpacted or near-unimpacted state. Groundwater will be regarded as vulnerable by default unless it can be shown otherwise.

The sustained achievement of the resource management class is regarded as an essential requirement for (a) progressive achievement of the catchment vision, and (b) facilitating sustainable development.

Once a management class has been established, the Department may in future consider a more protective or more lenient management class to either enable stricter control or promote much-needed socio-economic development. This may be driven for example by a fundamental inability to implement the catchment management strategy and hence achieve the catchment vision. However, this will typically require considerable justification, possibly a re-consideration of the vision and careful attention to due process.

1.6.3 Resource quality objectives and Reserve

The Department recognises that, in setting resource quality objectives for a chosen management unit of a water resource, a technical process of integration of water quality, water quantity and ecosystem integrity, is necessary, the results of which will further inform the stakeholder engagement process. These objectives can include a wide variety of characteristics of the resource, some of which can refer explicitly to water quality. Until the classification system has been prescribed, provision is made by the NWA (36:1998) for determination of a preliminary class, a preliminary Reserve and preliminary resource quality objectives. These preliminary measures can be determined at different levels of confidence.

Once resource quality objectives have been published in the *Gazette*, or preliminary resource quality objectives determined, they must be given effect. To do so, the Department or water management institutions (such as catchment management agencies) may also set narrative or quantitative "resource water quality objectives" (either in-stream or in-aquifer). These may be set at a greater spatial resolution (*i.e.* closer together) and/or temporal resolution (*i.e.* more frequently monitored) than the resource quality objectives (preliminary or otherwise) to which they may be linked. The purpose of these will be to provide greater detail upon which to base management of water quality aimed at achieving and sustaining compliance with resource quality objectives.

In the interim transitional phase, the Department will use low confidence standard approaches and instruments to determine a preliminary classification of water resources nationwide based on water quality. This will be used to identify potential priority water resources exhibiting water quality stress. Preliminary resource quality objectives relating to water quality and resource water quality objectives will then be set for these priority resources using more accurate (higher confidence) approaches. This will provide initial impetus to the implementation of resource directed management of water quality in accordance with the intentions of the NWA (36:1998).

The Department recognises that some impacts on water quality, particularly those relating to conservative water quality variables, can have increasingly cumulative effects towards the most downstream reaches of surface water resources. Accordingly, the setting of resource quality objectives or resource water quality objectives for a particular catchment must take cognisance of that catchment's water quality issues (current and future) and those of upstream, and particularly downstream catchments as well as those linked through inter-basin transfers. All water quality-related objectives in such catchments must be mutually compatible.

1.7 Source Directed Controls

1.7.1 Resource perspective

Recognising that the exact nature of source directed controls depends on the management objectives that are set for local water resources, it is within the scope of this policy to give guidance on source directed controls from this perspective. However, it is also noted that the nature of source directed controls is significantly determined by the National Environmental Management Act (NEMA (107:1998)).

1.7.2 Precautionary approach

The precautionary approach entails ensuring that conservative decisions or actions are implemented which minimise the risk of unpredictable ecological impacts that may threaten sustainability when there is uncertainty regarding the likelihood of such impacts.

The Department will balance the ecological necessity of this approach with the water quality requirements, and associated socio-economic necessities, of current and proposed water uses. This will be particularly important in the interim transitional phase and in the absence of resource quality objectives for the potentially impacted water resource. The precautionary approach applies at many levels, including pollution prevention, waste minimisation and the differentiated approach.

1.7.3 Pollution prevention

Irrespective of the amount of allocatable water quality, the Department will strongly encourage water users to prevent pollution whenever possible, (*e.g.* by striving for a "zero effluent" state for water users producing effluents) by pursuing the best practicable environmental option. This is the option that provides the most benefit or causes the least damage to the environment as a whole, at a cost acceptable to society, in the long-term as well as in the short-term (NEMA (107:1998)).

Pollution prevention is aimed specifically at controlling the handling and discharge or disposal of hazardous substances. Toxicity, persistence and capacity for bioaccumulation or endocrine disruption present major threats to the receiving water environment. Where these are involved the differentiated approach below does not apply because of the difficulties associated with determining appropriate resource water quality objectives for these pollutants.

1.7.4 Waste minimisation

The Department acknowledges that some degradation of water quality in water resources is inevitable, and is sometimes necessary, for socio-economic development. Irrespective of the amount of allocatable water quality, cost-effective waste minimisation and water conservation will be encouraged at all times. For point sources such as waste discharges, the precautionary approach will also be applied by enforcing uniform national minimum requirements or standards by default, should they exist.

When non-point pollution sources are persistently responsible for unacceptable water quality degradation, the Department will approach the responsible authority, examine the causes of the problem and identify appropriate interventions to address the problem.

1.7.5 Differentiated approach

In catchments with no water quality stress, even if considerable allocatable water quality exists, the Department will apply the precautionary approach by enforcing, particularly in respect of point waste discharges, uniform national minimum requirements or standards by default, should they exist. However, these may be relaxed in special and equitable circumstances although the management class will have to be maintained.

In catchments with water quality stress, it is policy to (a) consider stricter requirements and/or (b) strictly regulate or prohibit unsustainable practices in order to comply with resource quality objectives and achieve the management class.

To protect water resources at a cost that is acceptable to society, the Department will first be guided first by the level of protection afforded by the resource management class (informed by catchment visioning) and associated resource quality objectives. This will apply to both point and non-point sources of pollution.

In the absence of resource quality objectives (preliminary or otherwise), the Department will enforce uniform national minimum requirements or standards, should they exist, in respect of point waste discharges. If the potentially impacted resource is vulnerable or sensitive to water quality degradation, the Department may act as though the water resource is water quality stressed, applying the precautionary approach as just described.

1.7.6 Remediation

Remediation (also referred to as rehabilitation) is regarded here as direct intervention in (a) degraded land, to minimise contamination risk to a water resource, or (b) a degraded water resource, to maintain or improve water quality in the water resource. In order to promote both optimal water use and protection of water resources, the Department will:

- Facilitate remediation of water resources, and sources of pollution (*e.g.* degraded land), especially in those catchments with existing water quality stress, where this is considered necessary, practical and equitable; and
- Apply the polluter pays principle.

The Department recognises that remediation can be extremely expensive and is sometimes impractical, for example in the case of some aquifers. The Department regards this as strong motivation for avoiding the need for remediation in the first place, by applying pollution prevention, waste minimisation and the differentiated approach with the emphasis stated above.

1.7.7 Water allocation

Whether referring to water quantity or water quality, the Department recognises the fundamental role that current equitable access (*i.e.* in the present generation) will play in poverty eradication. Accordingly, in its quest to appropriately balance the enabling principles of sustainable development, the Department will give particular emphasis to redress and recognise the principle of acceptable prejudice when determining an equitable allocation. This will apply particularly when re-allocation of water, or water quality, requires curtailing existing lawful use (through, for example, compulsory licensing).

Effective stakeholder engagement will be strongly encouraged and supported to ensure that all water allocation is in the public interest. In this process, socio-economic enhancement, and in particular the enabling principle designed to empower stakeholders to participate in decision-making processes, will be emphasised. Water conservation and gender equity will also receive high priority.

If the resource contains some allocatable water quality, an applicant will typically not be allocated all that is available. An appropriate fraction will be allocated that takes account of all the considerations in Section 27 of the NWA (36:1998), as well as:

- The approximate nature of, or confidence in, the determination of the allocatable water quality; and
- Unforeseen circumstances.

Because optimal water use issues in the context of water allocation go beyond the mandate of the Department, the Department will apply good governance and especially co-operative governance across the spectrum of stakeholder organisations.

1.7.8 Water use

The Department will strive to attain and maintain the designated resource management class of each water resource by, at least:

- Limiting water quality allocations to the available allocatable water quality, *i.e.* complying with resource quality objectives relating to water quality; and
- Adhering appropriately to uniform minimum requirements or standards, and;
- Not permitting continual deterioration of water quality that will result in an unacceptable trend that may potentially decrease its present management class.

Within the constraints of the allocatable water quality of the resource and the catchment management strategy, and until general government policy dictates otherwise, the Department's policy is to respond positively to water uses involving allocations that, specifically in respect of persons that were subject to past discriminatory practices,

- Actively redress previous discrimination, or
- Empower and uplift such persons by provision of a quality of water that demonstrably improves their quality of life.

1.8 Monitoring

Acknowledging the Department's mandate in terms of Chapter 14 of the NWA (36:1998) to create national monitoring systems for water resources, the Department will ensure that monitoring of water quality:

- Contributes meaningfully to the Department's efforts to facilitate sustainable development;
- Is explicitly linked to resource directed measures;
- Reflects the ecologically interdependent nature of water resources, including the dependence on water quantity, whenever appropriate; and
- Becomes an essential enabling component of effective integrated water quality management of South African water resources.

1.8.1 Monitoring variables

To achieve the above objectives, the Department recognises the following as providing useful data and information on water quality:

Stressor monitoring:

- Physico-chemical monitoring (typically inorganic variables but also organic and inorganic toxicants);
- Radiological monitoring,;
- Microbial monitoring (*e.g.* faecal microorganisms).

Response monitoring:

- Eutrophication monitoring;
- Biomonitoring (*e.g.* invertebrates and fish);
- Toxicity monitoring.

Furthermore, the Department recognises the importance of monitoring to some degree:

- The pressures on water quality (*e.g.* the nature of the water uses that impact on water quality),
- The social and economic impacts of water quality; and
- Decisive responses of society and government to these impacts; and
- Management performance.

In the interim transitional phase, monitoring efforts will focus primarily on stressor and response monitoring that reflects the status and trends of water quality in water resources. The monitoring of pressures, impacts and societal responses is a longer-term objective. But because such information can be very useful, it will be included in the transitional phase when necessary, simple and cost-effective.

1.8.2 Management principles

The Department acknowledges the expensive nature of both the initial design and ultimate implementation of any water quality monitoring programme and therefore commits itself to the principles of sound financial management, adaptive management and co-operative governance to ensure the monitoring remains focussed, cost-effective and sustainable. It will be ensured that:

- Each monitoring programme has well-defined objectives;
- Each monitoring design provides the maximum amount of demonstrably useful information at minimum cost;
- Data assessments and reports support informed decision-making, in particular related to (a) water quality guidelines that may be used and (b) uncertainties associated with observations;
- No duplication of effort occurs at any stage of implementation; and
- Partnerships will be created with appropriate stakeholders who will share costs and benefits.

1.8.3 Monitoring review

In the spirit of adaptive management, the Department will review, at regular intervals:

- The relevance of each programme's monitoring objectives; and
- The effectiveness with which these objectives have been achieved.

On this basis the programme's objectives, design or implementation strategy will be updated if necessary. Review intervals can be programme-specific but will not exceed five years.

1.8.4 National status and trends

The Department will establish national status and trends monitoring programmes that measure, assess and report on the current status and appropriate temporal trends of selected groups of water quality indicators in South African water resources. This will be done in a soundly scientific manner that will support strategic management decisions in the context of sustainable fitness for use of those water resources and the integrity of aquatic ecosystems.

The Department recognises the following strategic responsibilities that specifically motivate the need for monitoring programmes with a broad national perspective:

- Monitoring the overall national effectiveness of water quality management policies and strategies;
- Honouring international obligations and participation in appropriate global initiatives;
- Keeping abreast of international trends in emerging problems; and
- In the current interim transitional phase, the creation of monitoring capacity upon which further region-specific capacity creation can be based, for example as catchment management agencies become operational.

1.8.5 Performance

Acknowledging the importance of ensuring that water uses are such that resource management classes are attained and maintained, the Department will establish performance monitoring programmes that measure, assess and report on the degree of compliance with resource quality objectives.

Recognising the legal status of resource quality objectives, the Department will ensure that the overall process of resource quality objective compliance monitoring is scientific, and all individual procedures are adequately defensible by being applied consistently and objectively.

The degree to which compliance with resource quality objectives, or movement towards such compliance, is being achieved will intimately feed back into and drive the catchment management strategy.

1.8.6 Compliance

Although compliance monitoring relating directly to 'end-of-pipe' monitoring is largely outside the scope of this policy, the Department acknowledges the importance of such source directed controls. However, the Department will ensure that water quality monitoring in affected resources is included in water use authorisations when appropriate. These will be closely aligned with resource quality objectives relating to water quality and source management objectives.

Such monitoring provides an important information base for subsequent well-focussed corrective actions in cases where non-compliance is evident.

1.8.7 Remediation

The Department will measure, assess and report on the effects of local water quality remediation efforts in order to provide data and information on the effectiveness of those efforts. The Department will approach such monitoring in three possible ways, in order of decreasing priority:

- Incorporation into resource quality objective performance monitoring programmes;
- Incorporation into national status and trends monitoring programmes, if appropriate to a national perspective and consistent with the designs of those programmes;
- Design and implementation of temporary site-specific monitoring programmes tailored solely to provide data and information on the effectiveness of the remediation efforts.

1.8.8 Management performance

The Department will apply good governance and place special emphasis on the enabling principles of accountability and transparency. Accordingly, the Department will implement appropriate in-house monitoring of management performance. This is to ensure that deficiencies in management actions within the Department are identified and corrected as soon as possible.

The Department will also ensure that staff members are provided with adequate training and general institutional support to ensure that appropriate capacity is created to allow water resource managers to confidently take full responsibility and accountability for their actions.

1.9 Review

The Department will periodically review the relevance of the following:

- The original objectives of this policy; and
- The policy itself; and
- The appropriateness of the strategy and associated management instruments to implement the policy and achieve its objectives.

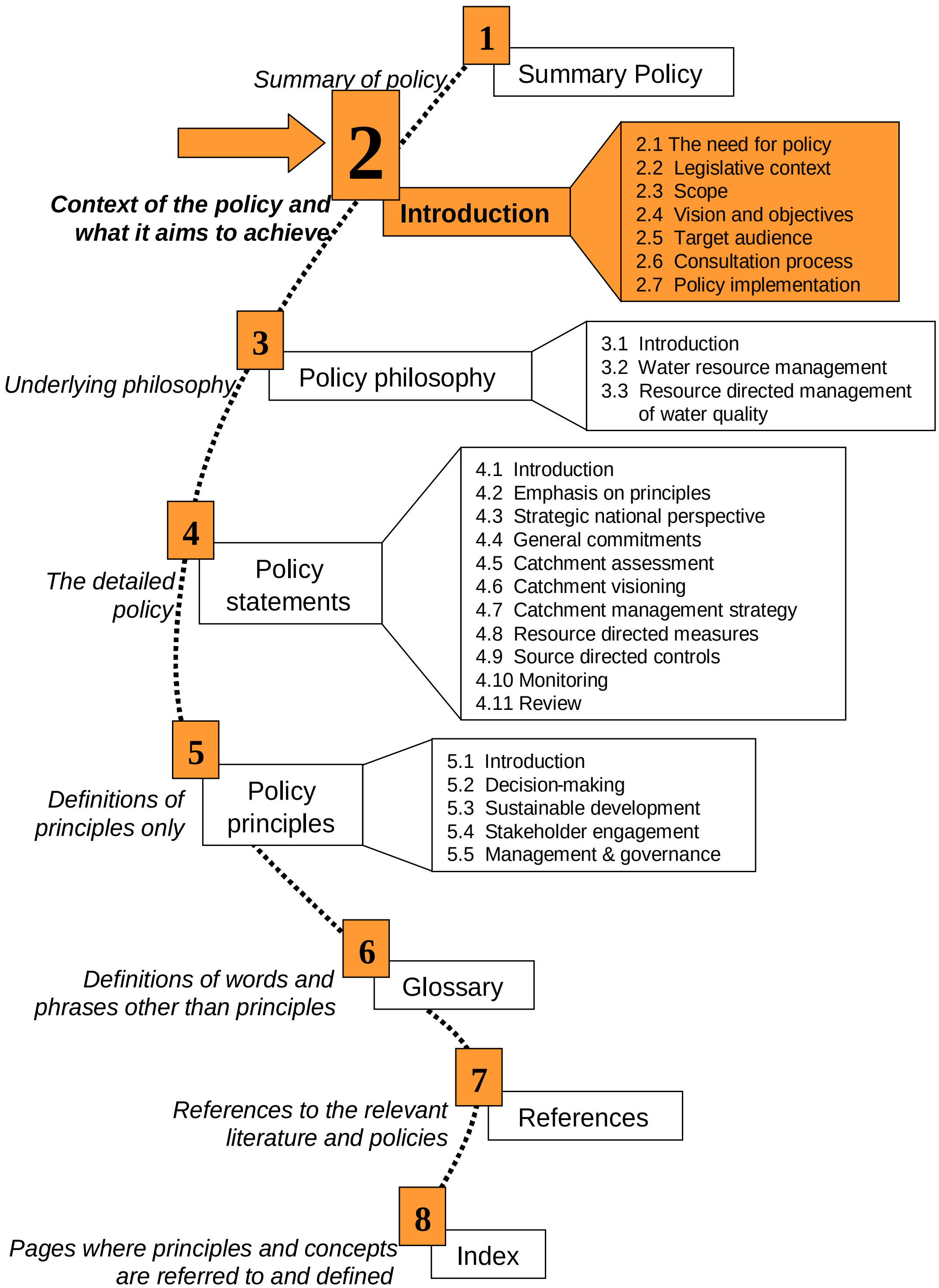
Any indication that creates cause for concern that any of the above is no longer relevant, should result in either (a) an appropriate change to the policy or strategy through effective stakeholder engagement, and/or (b) an improvement in confidence associated with management instruments.

The Department will also periodically examine:

- The degree to which individual catchment visions have been realised through implementation of their catchment management strategies; and
- The degree to which implementation of all catchment management strategies has influenced the achievement of national goals.

Changes to catchment visions, or associated catchment management strategies, through effective stakeholder engagement are encouraged to ensure that these remain relevant and focussed.

Document roadmap



SECTION 2: INTRODUCTION

PHOTO: K MURRAY

2.1 The need for policy

Significant responsibility

Freshwater availability in the southern African sub-region remains of particular concern because of its unpredictability due to floods and droughts and deteriorating water quality. Freshwater is an essential resource for national development. Its careful management is therefore critical. Estuaries, wetlands and groundwater are often vulnerable to degradation and their water quality is of particular importance and concern.

South Africa's water resources belong collectively to the nation. Since water is a national asset, a significant responsibility is placed on government in their capacity as the trustee of the nation's water resources. The responsibility rests specifically with the Department of Water Affairs and Forestry ("the Department") acting on behalf of the Minister of Water Affairs and Forestry. However, their responsibility extends to ensuring that water shared with countries beyond our borders is also managed considerately.

Why a policy is necessary

The following issues create a specific need for clear policy:

- Balancing the degree to which water, and water quality, is used (*e.g.* for socio-economic development) with the degree of protection of water resources as natural systems (for current and future generations) requires both political and scientific considerations.
- The nature of the imbalance between the demand and supply of water, and water quality, is such that equitable allocation of these resources is not possible without management intervention.
- Resource directed management of water quality requires certain specialist skills, while decision-making is often complex and may have to be based on uncertain or incomplete data and information.
- Consistent nationwide application of legislation relating to management of water quality is essential.

2.2 Legislative context

Relation to National Water Act

The National Water Act (36:1998) is an 'enabling' Act. That is, it provides broadly based legislation that requires drafting of supporting policies, legislation and strategies for its practical implementation. This policy document is such a policy in the context of resource directed management of water quality.

Relevant chapters

This policy gives substance specifically to the following chapters of the National Water Act:

- Chapter 1: Interpretation and fundamental principles.
- Chapter 2: Water management strategies.
- Chapter 3: Protection of water resources.
- Chapter 4: Use of water.
- Chapter 14: Monitoring, assessment and information.

It is not regarded as the role of this policy to address institutional issues in any depth. This is addressed specifically in this policy's implementation strategy (DWAF, 2006a).

Broader alignment

Although primarily focussed on the National Water Act and resource directed management of water quality in particular, at the time of writing this policy was also closely aligned with a broad spectrum of legislation and policy. An exhaustive list is not provided here. However, the following are the most relevant:

Legislation:

- The Constitution of South Africa (108:1996).
- National Environmental Management Act (107:1998).
- National Water Act (36:1998).

Policy:

- National Water Policy White Paper (DWAF, 1997a).
- Environmental Management Policy White Paper (DWAF, 1997b).
- Draft National Water Quality Management Framework Policy (DWAF, 2003a) (the policy most closely related to this policy).

This policy on resource directed management of water quality will be revised in future to accommodate new legislation or policy if necessary.

Related strategies include:

- National Water Resource Strategy (DWAF, 2004a).
- Source Management Strategy (DWAF, 2003d).
- Remediation Strategy (DWAF, 2004b).

2.3 Scope

Integrated water resource management

This policy is seen as one component of, and aligned with, integrated water resource management. The latter is, in turn, a component of integrated environmental management, as mandated by the National Environmental Management Act (107:1998).

Integrated water quality management

Integrated water quality management is a catchment-focussed, iterative yet systematic process of continual improvement of water quality management based on the dynamic cyclical process of "plan, implement, check and review" usually associated with management systems of the International Organisation for Standardization. This should seamlessly blend and align ("integrate") the following, both "horizontally" (within each spatial scale) and "vertically" (through all spatial scales):

At pollution source scale:

- Resource directed measures with source directed controls relating to water quality management, and

At local scale:

- The achievement of resource quality objectives, and resource water quality objectives in particular,
- Water services development plans, as required by the Water Services Act (108:1997),
- Integrated development plans, as required by the Municipal Systems Act (32:2000) and

At regional scale:

- The water quality component of catchment management strategies,
- The achievement of the water quality management goal within the catchment,
- The achievement of the catchment vision, and

At national scale:

- The National Water Resource Strategy (DWAF, 2004a),
- Nationally consistent approaches to resource directed measures and associated source directed controls,
- The achievement of national water quality management goals.

Scope of water resources

Although holistic water quality management necessarily includes the entire water cycle, this policy relates specifically to water resources falling under the National Water Act. These include watercourses, surface and groundwater, wetlands and estuaries.

Water quality management

Water quality management is the process of administering and controlling the physical, chemical, toxicological, biological (including microbiological) and aesthetic properties of the water in water resources that determine sustained:

- Healthy functioning of aquatic ecosystems; and
- Fitness for use (*e.g.* domestic, recreational, agricultural and industrial).

Fitness for use is a scientific judgement, involving objective evaluation of available evidence, of how suitable the quality of the water is for its intended use.

Resource directed management of water quality

This policy pertains more specifically to how water quality in water resources should be managed, particularly in respect of use and protection. It does not concern itself with the detailed management of those activities that cause impacts on water quality. However, it does address such "source management" (or "source directed controls") to the extent that such management should be driven directly by the requirements of the water resource.

Quality, quantity and ecosystems

The policy recognises that water quality is inextricably linked with water quantity (typically water flow) instream and riparian habitat and aquatic biota, all of which are collectively referred to in the NWA (36:1998) as the "resource quality".

Accordingly, many of the guiding principles are stated in a manner more broadly applicable than only water quality. This broader scope is also inevitable in some formal policy statements, although specific references are made to water quality whenever appropriate.

2.4 Vision and objectives

Vision

The vision of this policy is to ensure that the water quality in South African water resources enables an equitable and sustainable balance to be achieved between its use by society and its protection as a critical component of a natural system so that the quality of life of all South Africans is improved and sustained in the long term.

Management objective

The specific management objective of this policy is to provide effective guidance on how water quality considerations should be integrated into water resource management in general, hence the slogan:

"Making water resource management water quality friendly"

2.5 Target audience

Target audience

The Department of Water Affairs and Forestry has primary responsibility for the implementation of this policy.

This policy is therefore intended to provide guidance to those responsible for either recommendations or decision-making relating to the above vision and management objective within:

- The Department, both at head office and in Regional Offices;
- Water Management Institutions, especially catchment management agencies;
- Other government departments with related functions;
- Specialist consultant organisations; and
- Other interested or affected organisations.

2.6 Consultation process

Review and opportunities for comment

This policy has been subjected to a limited consultation process involving the Project Team, Project Management Committee, external Reviewers and Project Steering Committee as listed in this document. Comments were also received from other members of the Department, including Regional Offices. Opportunities to comment were also given to the Department of Environmental Affairs and Tourism and to the Department of Minerals and Energy.

This policy and associated management instruments are in the process of being rolled out to Regional Offices of the Department, to provide them with an opportunity to comment.

Previous versions of this policy have been reviewed technically and legally by a number of external reviewers whose comments have been incorporated in this version.

Distribution

The Department intends to further distribute this document to the target audience (see Section 2.5) by providing hard copies as well as making the document available on the Department's web site.

2.7 Policy implementation

2.7.1 General approach

Good governance

Because water quality is affected by, and in turn impacts on, other and stakeholders outside the immediate jurisdiction of the Department, successful implementation will depend heavily on good governance, especially the enabling principle of co-operative governance among government departments.

Guidance versus guidelines

Policy is regarded as providing 'guidance' (implying generality) not 'guidelines' (implying specificity) for decision-making. The above-mentioned management instruments are examples of such 'guidelines'.

Depth of understanding

This policy describes the underlying principles in a way that ultimately aims to achieve a greater quality of decision-making by creating a template for debate and hence a greater depth of understanding. It does this as follows.

- The enabling principles are presented in hierarchies that make explicit possible interrelationships between principles; and
- Each principle acknowledges the underlying values-based assumption that explains why the principle is worth striving for.

Initial pragmatic implementation

Although improved decision-making is the ultimate goal, the Department acknowledges that it will take many years to achieve full implementation of the policy. Accordingly, the Department is deliberately pragmatic about the interim transitional phase, in particular the need to ensure that the inability to fully implement the policy does not impede appropriate socio-economic development. The Department therefore encourages the pragmatic though prudent use of practical and simpler management instruments as a basis for decision-making in the interim phase. These will be progressively replaced by more accurate (and higher confidence) instruments when the demand arises.

2.7.2 Implementation strategy

"Who should do what by when"

Successful implementation of this policy is only possible with a detailed implementation strategy that describes "who should do what by when". The strategy describes (DWAF, 2006a):

- A first level of interpretation of this policy;
- Explicitly how water quality considerations should be incorporated into water resource management;
- Institutional arrangements and responsibilities for actions related to resource directed measures;
- How to give effect to resource directed measures in various water quality management scenarios;
- Capacity creation and maintenance; and
- An action plan with short- and medium-term tasks and time-frames.

2.7.3 Management instruments

Procedures and software decision-support

On the one hand management instruments comprise information documents and detailed procedures that allow the strategy to be implemented. Examples of recent developments include:

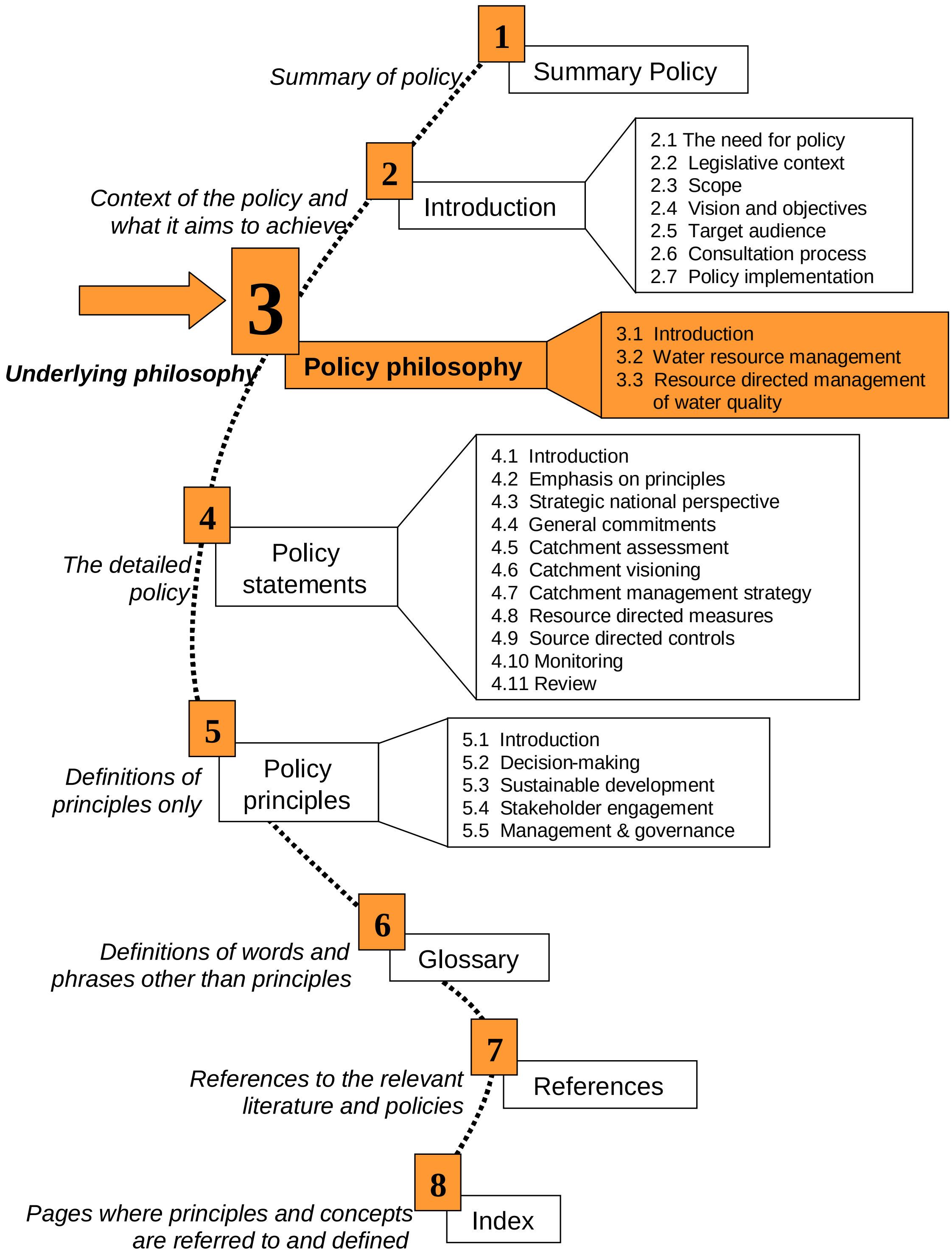
- Conceptual review of water use licence applications from a resource perspective;
- How to conduct a catchment visioning process;
- Guidelines for converting resource water quality objectives to end-of-pipe standards;
- Guidelines for water quality monitoring; and
- Guidelines for setting licence conditions (from a resource perspective).

Management instruments also include software tools that facilitate decision-making, such as:

- Guidelines for quantifying water quality stress and resource water quality objectives; and
- A multiple-criteria decision analysis tool that quantifies the extent to which one would expect a water use licence to be granted, given particular evidence. It also serves as a means to formalise the record of decision.

At the time of writing, the first editions of the above instruments were available and most were undergoing testing (DWAF, 2004c).

Document roadmap



SECTION 3: POLICY PHILOSOPHY

PHOTO: K MURRAY

Principles are indicated in italics.
Use the index to locate the definitions in Section 5 (Policy Principles).

3.1 Introduction

Scope of philosophy

This section describes, in general terms, the underlying philosophy of the policy. The philosophy is ultimately reflected in the principles (Section 5) and how they should be balanced in decision-making.

The philosophy relies heavily on *sustainable development* as a framework for water resource management that takes account of the current realities facing South Africa. For a more general overview of, and background to, the philosophy of sustainable development see DWAF (2006b).

Underlying tenets

First, the ethic of *sustainable development* should be at the core of every aspect of this policy. It should appear everywhere either explicitly or implicitly and, while it may vary in the degree to which it is applied in different circumstances, it should never be totally violated.

Secondly, current national imperatives relating to, for example, the need for sustained *socio-economic enhancement* will determine the degree to which *sustainable development* principles will actually be balanced on a national basis and in individual circumstances.

3.2 Water resource management

Sustainable development

Sustainable development in respect of water resource management seeks to ensure that future generations can meet their own water needs while promoting socio-economic development and improved quality of life for all in the current generation. This can only be done in a manner that uses water resources in general, and water quality in particular, within the ability of ecosystems to satisfy such needs now and in the future.

Broader NWA perspective

The philosophy of *sustainable development* is embodied in several sections of the National Water Act (36:1998). It is necessary to understand this broader context in order to understand the implementation of this philosophy within the more specific context of resource directed management of water quality.

Quality of life

Improving and maintaining the quality of life of all South Africans is the ultimate goal. This ideal is linked inextricably, both directly and indirectly, with maintaining the health of aquatic ecosystems.

Enabling principles

Sustainable development in the context of water resource management is enabled by six main principles:

- *Protection of water resources*;
- *Optimal water use*;
- *Equity between generations*;
- *Current equitable access*;
- *Environmental integration*; and
- *Good governance*.

Ensuring some, for all, forever, together

A number of principles are implicit in the Department's slogan: "Ensuring some, for all, forever, together".

- "Ensuring" refers to the Department's oversight role relating to policy, regulation and auditing.
- "Some, for all," refers primarily to *current equitable access*.
- "Forever" refers to *equity between generations*.
- "Together" refers to *effective stakeholder engagement* (an enabling principle of three of the above six main principles) and *good governance*

Need for socio-economic development

The current national imperative for socio-economic development requires the Department to view the balance between the use of water resources and their protection from a national perspective, and give explicit preference to their use for socio-economic development - especially for poverty eradication and the redress of past inequities. However, under no circumstances should water resources be exploited to the extent that they are "unacceptably degraded" and unable to provide adequate water quality on a sustainable basis.

Dependence on ecosystems

It is acknowledged that the quality of life of all South Africans is inextricably linked, both directly and indirectly, with maintaining the integrity of aquatic ecosystems since these provide many of the goods and services upon which society depends (particularly good quality water). Accordingly, strict protection of selected aquatic ecosystems will occur when this is considered necessary to sustain the biodiversity and general integrity of those ecosystems.

Resource directed measures

Resource directed measures comprise some of the most important instruments that enable improvement of quality of life and such protection of water resources. These measures relate to the management class, the associated resource quality objectives and the *Reserve*.

Management class and resource quality objectives

The intention of the classification system is to ensure that significant water resources are classified explicitly and in a way that seeks to achieve an equitable balance between protection and use. In particular, it serves as a 'first line of defence' against development that is potentially unsustainable.

It does this in the following ways:

- The resource quality objectives should specifically reflect the desired balance between the health of the aquatic ecosystems and the envisaged uses for water in the catchment. This implies a holistic and balanced consideration of social, economic and ecological factors (*i.e. environmental integration*).
- The resource quality objectives should be related to measurable variables that facilitate relevant monitoring.
- Ensuring that the determination of the class is informed by *effective stakeholder engagement* through a catchment visioning process is one mechanism to ensure that management decisions are likely to be "in the public interest" (a mandate of the National Water Act (36:1998)). It also ensures a degree of social, economic, political and ecological 'safety' by minimising the chances that a process might be "derailed" because some stakeholders feel marginalised.

The Reserve

The basic *human needs Reserve* and the *ecological Reserve* both contribute to *sustainable development* in a fundamental way:

- The basic *human needs Reserve* ensures that the current generation can meet its most basic domestic needs for water. This also addresses poverty reduction by helping to set aside the minimum quantity and quality of water needed to sustain a basic or subsistence-level quality of life. Determination of this *Reserve* represents an important application of the principle of *current equitable access*.
- The *ecological Reserve*, on the other hand, seeks to protect aquatic ecosystems in a manner that ensures that they can sustain their intrinsic structure, composition and functions into the future. This addresses the principle of *protection of water resources* and, through this, the principle of *equity between generations.*

Equitable balance

Decision-making by the Department will be based on the philosophy of finding an 'equitable balance' between issues that are in tension. This means finding a balance between competing requirements that is both:

- Just (*i.e.* based on legislation); and
- Fair (*i.e.* based on accepted principles).

The philosophy of *sustainable development* and current political realities combine to define the principles that are appropriate to finding an equitable balance.

Stakeholder engagement

In order to effectively implement a horizontally and vertically integrated approach to resource directed management of water quality, the Department is committed to engaging all stakeholders at all appropriate stages in a manner that is meaningful and cost-effective. Stakeholder engagement is also regarded as fundamental to establishing the most appropriate water uses ('best alternative uses'), and hence management class, that is in "the public interest" (the *optimal water use*). Catchment forums will play an important role in this process.

The most important mechanism for achieving *effective stakeholder engagement* is the catchment visioning process. This entails the development of a collective stakeholder statement of their aspirations (the vision) and a strategy to move towards that vision.

Interim transitional phase

It is inevitable that implementation of the above mechanisms will be gradual and time-consuming. However, the need for appropriate socio-economic development is such that this policy is deliberately pragmatic about the interim transitional phase. Adaptive management is regarded as an essential approach given the complexity and nature of water resources.

3.3 Resource directed management of water quality

Water quality-specific issues

All the above issues apply to water resource management in general and to resource directed management of water quality in particular. However, there are a number of issues that warrant special mention in respect of management of water quality. These are as follows:

Assimilative capacity

The term "assimilative capacity" refers to the capacity of a water resource to assimilate disposed waste, through processes such as dilution, dispersion, and chemical and biological degradation, without water quality changing to the extent that fitness for use or ecosystem health is impaired (DWAF, 1995). Importantly, the assimilative capacity of a water resource depends on many factors. These include chemical processes (*e.g.* adsorption), physical processes (such as aeration and sedimentation), and biological processes (*e.g.* uptake by plants and micro-organisms), and these processes can vary considerably in terms of their time-scales. "Assimilation" can occur by processes such as dilution, adsorption, degradation or metabolism to other (either less or more harmful) products, physical removal (*e.g.* via volatilisation) and biological absorption and transformation (*e.g.* bioaccumulation) (Roux *et al.*, 1999).

The accurate quantification of assimilative capacity in a way that allows it to be used as a useful management instrument is an extremely complicated process. While the Department acknowledges the existence of the general phenomenon of assimilative capacity, it is Departmental policy to use this as a routine management instrument only in the particular context of dilution capacity. This will specifically be related to the concept of allocatable water quality.

Allocatable water quality

Understanding the basic concept of allocatable water quality is complicated by the many water quality attributes that may be involved.

In general, each type of user in a catchment may require each of a number of attributes to fall within some pre-determined range for that water to be considered "fit for use". These attributes may vary from concentrations or loads of chemical substances, to biological responses (such as toxicity), and measures of physical pollution.

For water to be judged fit for use for a number of different users in the same catchment, the water quality needs to satisfy the most demanding of those users.

Just as a quantity of water can be "used", so can water quality. Typically, this will be quantified in terms of individual water quality attributes. This is the basis for the concept of "allocatable water quality", which can be defined from two points of view:

- First, it can be regarded as that water quality, if any, that remains allocatable (available) to uses other than the strategic national priority uses (Reserve, international obligations, etc.) and current lawful uses (see Figure 2.1).

- Secondly, it can also be more formally regarded as the maximum worsening change in any water quality attribute away from its present value, which will still maintain it within a pre-determined range that reflects the desired future state, typically defined by a resource quality objective (RQOs). If the present state is outside of the pre-determined range, the allocatable water quality is zero.

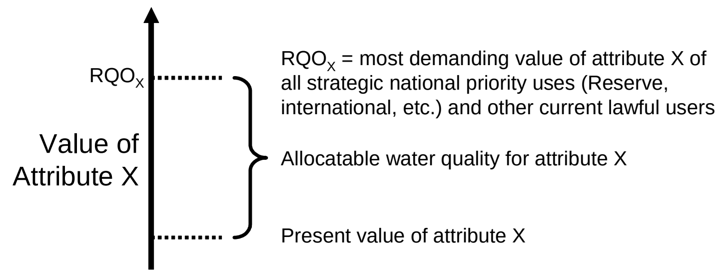


Figure 2.1: Simple conceptual illustration of allocatable water quality for an unstressed attribute.

A water resource will be considered "stressed" in respect of a water quality attribute if, for that attribute, there is no allocatable water quality.

Monitoring

Effective monitoring and reporting in respect of resource directed management of water quality is essential. To achieve this, the resource quality objectives chosen to represent the management class (and hence the catchment vision) should be clearly related to individual monitoring variables. These and other indicators must provide information that allows water resource managers to assess:

- The degree to which catchment management strategies are being successfully implemented; and
- The status of the resource from the perspective of *sustainable development*.

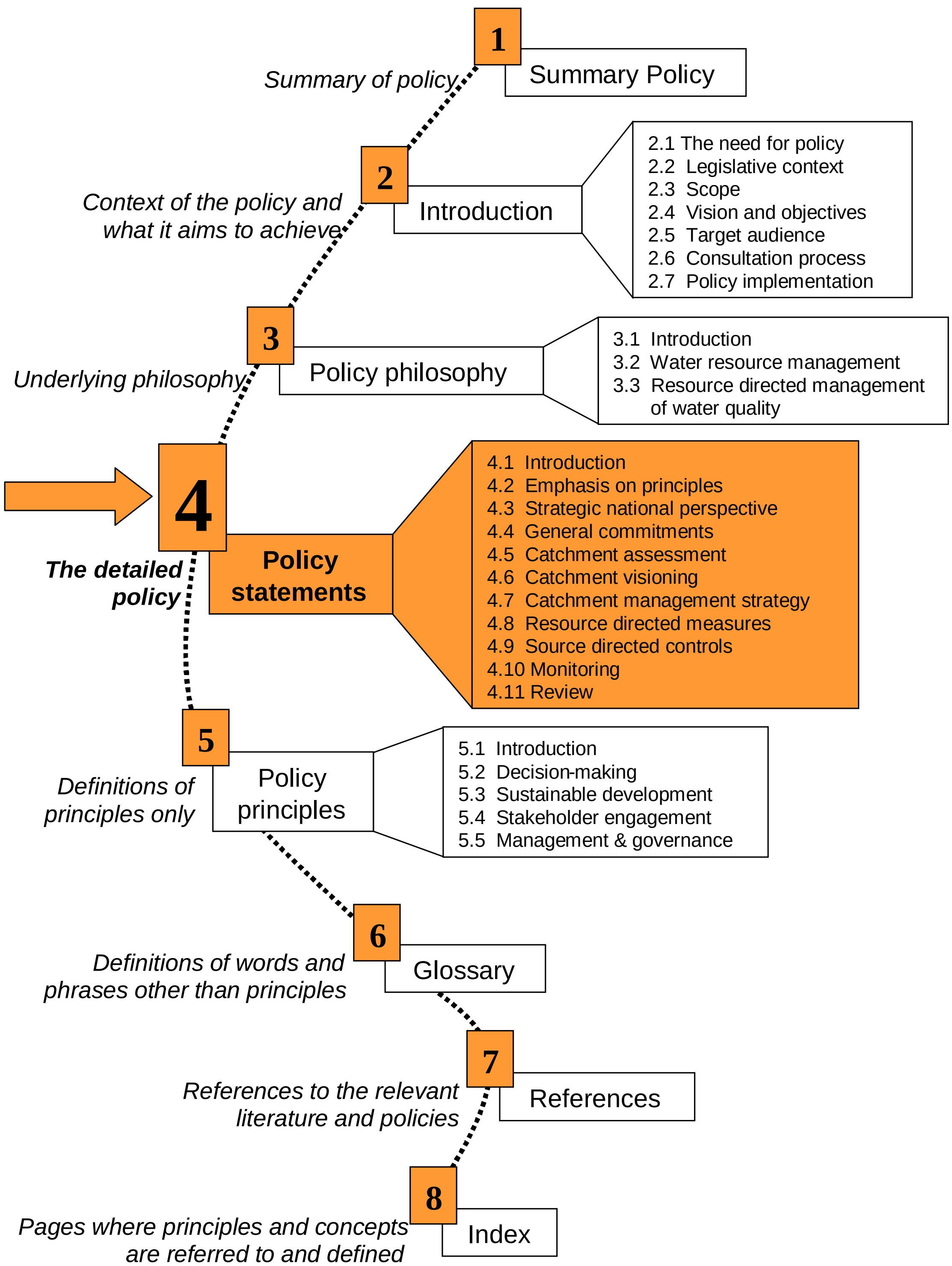
Monitoring in general should be adequate to allow an assessment of the effectiveness of implementation of the policy and associated strategy.

Importantly, this monitoring must feed back into regular review of policy and strategy so that they can be updated if necessary.

PSIR monitoring

The Department acknowledges that monitoring Pressures (P) on water quality, the State (S) of water quality, the Impacts (I) of inadequate water quality (on ecosystems and society), and the decisive Responses (R) of society to inadequate water quality, will ultimately be important in holistically assessing water quality. However, it also acknowledges that these should only be considered in the interim transitional phase if necessary, simple and cost-effective.

Document roadmap



SECTION 4: POLICY STATEMENTS

PHOTO: K MURRAY

Principles are indicated in italics.
Use the index to locate the definitions in Section 5 (Policy Principles).

4.1 Introduction

Structure

The sub-sections that follow first describe the emphasis that is placed on principles and then state the policy at two levels:

- The first is the Department's strategic perspective at national level. It addresses the broader issues facing the nation.
- The subsequent sub-sections deal with the second level, namely the specific resource directed management of water quality.

The overall strategies of continual improvement and adaptive management are regarded as essential frameworks for policy implementation. Specifically the "plan, implement, check and review" cycle provides a useful categorisation for activities relating to resource directed management of water quality (van Wyk *et al.*, 2003).

4.2 Emphasis on principles

4.2.1 Need for principles

Responsibility

Acknowledging the intricate and fundamental role of water quality in society, the Department embraces the responsibility placed upon it as the national custodian of South Africa's water resources.

Competition

Difficulties will typically arise out of competition between, and within, social, economic and ecological ideals. Notwithstanding the degree to which the National Water Act (36:1998) endeavours to restrict competition to some extent by allowing for the Reserve, demand for the remaining water will exceed supply, as it already does in many instances. The needs and preferences of water users for the limited supply of water will continue to differ across the country.

The problem of resource directed management of water quality is therefore reduced to finding approaches that can deal with such competition.

Equitable management of water quality

The Department envisions a solution lying in the phrase "equitable balance". This the Department understands as a "balance between competing requirements that is just and fair in the sense of being based on laws and accepted principles". This policy document strives to provide a systematic framework to enable equitable management of water quality.

'The rules of the game'

A strong emphasis has therefore been given in this document to the underlying principles of water resource management. The practical difficulties faced in everyday decision-making in resource directed management of water quality are significant. A clear description of underlying principles allows concise yet powerfully comprehensive policy statements to be made. The principles are, in effect, 'the rules of the game'.

Sources of principles

Many of the principles arise from, and are common to, a variety of policies and legislation, including the Constitution (108:1996) (see Section 2.2). The most important principles in the current context are those upon which decision-making is formally based. Other principles drive actions in management processes that create the environment in which these decisions can be made more effectively.

The most relevant principles occur in the National Water Policy White Paper (DWAF, 1997a). This document adds value to them by providing a more currently relevant interpretation of them in the context of resource directed management of water quality.

4.2.2 Applying the principles

Principles and values

The principles presented in this policy capture a basic value system that:

- Aims to improve the quality of life of all South Africans, and
- Is appropriate for water resource management in general and resource directed management of water quality in particular, and
- Strives for consistent and effective implementation of resource directed management of water quality policy nationwide.

The principles specifically reflect the policy philosophy that is presented in Section 3.

Administrative mechanisms

The very nature of the supply and demand imbalance, and the competitive nature of humans, is such that special administrative mechanisms will be necessary to ensure equitable management of water quality. The principles underpinning these mechanisms are well defined to make their application to resource directed management of water quality in particular as clear as possible. Misinterpretation and possible ambiguities are thereby minimised. Importantly, they should be clearly in line with the Constitution (108:1996) and other relevant legislation.

Should this ideal be achieved (demonstrably), the inevitable competition that will arise can be addressed in a constitutional and equitable manner.

Decision-making

Decision-making is a core function of the Department. Defining principles that enable sound decision-making will facilitate *good governance* and support alignment of the Department's decision-making process with the Promotion of Administrative Justice Act (3:2000). They will also facilitate the search for optimum solutions in situations where apparent contradictions may exist.

Sustainable development

Sustainable development should always be a conscious concept in the minds of decision-makers. Defining the enabling principles provides a basis for understanding the inevitable tensions that arise between them in practice. With time, the principles can not only be more readily associated with specific scenarios, but they will also be able to be balanced in a way that, ultimately, can demonstrably and defensibly be associated with *sustainable development*.

Stakeholder engagement

The new era of participatory government demands *effective stakeholder engagement*. Understanding the enabling principles, and their inter-relationships, will facilitate more efficient and effective engagement and hence decision-making that is truly in the public interest.

Management and governance

The generic principles that enable sound management and governance are crosscutting. Their application is as important for successful policy implementation as those enabling decision-making, striving for *sustainable development* or engaging with stakeholders.

Interim transitional phase

The Department acknowledges the comprehensive nature of resource directed measures as mandated by the NWA (36:1998) and that achievement of full-scale implementation will be gradual and time-consuming. The current need for socio-economic development is also acknowledged. Accordingly, this policy is deliberately pragmatic about the interim transitional phase.

In the spirit of *adaptive management*, the Department will use pragmatic instruments and guidelines (typically associated with low confidence) as the basis for decision-making in the interim transitional phase. The objective is to avoid unnecessary delays in decision-making, particularly when in the interests of facilitating appropriate socio-economic development. These instruments will be progressively replaced by more accurate (and higher confidence) management instruments when the demand arises.

4.3 Strategic national perspective

4.3.1 Quality of life

Quality of water and quality of life

A wide variety of properties of the water in a stream, river, impoundment, wetland, aquifer or estuary determine how well that water is suited for human use and for supporting the ecosystem comprising that resource. Dissolved chemicals corrode or scale water distribution systems. They subtly control the biological functioning of the animals and plants living in the water. Physically suspended solids clog drip irrigation systems, reduce light penetration into water bodies and interfere with fish respiration. Faecal pathogens increase human morbidity, in turn impacting on our productivity and hence our potential for social and economic development. A degraded water body assaults our aesthetic sense instead of providing us with a spiritual 'sense of place'. All impact ultimately on our quality of life as South Africans.

The water quality challenge

Controlling the physical, chemical, radiological, toxicological, biological and aesthetic properties that constitute the 'water quality' of our water resources in an equitable manner is an exciting challenge. It rates in importance and complexity with many of the other major challenges facing South Africans and cannot be considered in isolation of them. Impacts on water quality not only cut across all aspects of South African society, but also have obvious international interdependencies. This challenge knows no boundaries. Furthermore, water of adequate quality is not only fundamental to a good quality of life. It is central to life itself.

Optimism and realism

The Department recognises that striving to achieve the vision of this poilicy must be driven by optimism. This instinctively stimulates commitment and enthusiasm. In turn, these create an atmosphere in which problem solving can be genuinely creative.

Accordingly, the Department acknowledges the enormous challenges faced by South Africa, and indeed the whole African continent, in these early years of the 21st century. These challenges remind us that lofty ideals in water resource management may not be attainable if the broader issues that face society are not adequately addressed.

Pessimists might regard such realism as ultimately disabling. However, far from being disabling, these issues, if viewed positively, can give true purpose to life, an essential element of quality of life.

The Department therefore enthusiastically accepts its role in addressing these wider issues while searching for optimum solutions to the more immediately obvious concerns relating to ever-increasing demands for water, water resource degradation, and inadequate awareness of the natural environment.

4.3.2 National challenges

4.3.2.1 Climate change

Planning

The Department acknowledges that the significant effects of climate change on evaporation rates, runoff, flow regimes etc. will impact on the quality of water in South Africa's water resources. Impacts are also likely to be different in the various water management areas. It is therefore the Department's policy to ensure that planning will take account of credible predictions relating to water quality, to ensure that attainment of desired future states (reflected in the resource management class) for water resources is feasible.

4.3.2.2 HIV/AIDS

Demographics

Besides the untold human suffering brought upon individuals, families and communities alike, the Department recognises that the inevitable demographic changes caused by HIV/AIDS can have enormous social, economic and ecological implications for planning for the timely provision of water (Ashton and Ramasar, 2002):

- Inadequate supplies cause unnecessary hardship.
- Over-supply impacts negatively on *water conservation*, and hence on *protection of water resources* and *optimal water use*.

It is therefore the Department's policy to ensure that:

- Predictions of future demographic changes take adequate account of the HIV/AIDS pandemic, and that
- In particular, catchment visioning and catchment management strategies do the same.

Socio-economic profiles

Changes caused by HIV/AIDS in socio-economic profiles of communities receiving water supplies can cause difficulties in paying for these services (Ashton and Ramasar, 2002). This may lead to extra pressure being put on local water resources (surface waters and groundwaters) in communities where the use of such resources presents an apparent alternative. This may expose such communities to lower quality water with its concomitant health risks.

Water and general health

The Department recognises the central importance of water of good quality for *socio-economic enhancement* at all levels. In particular, it recognises the importance of maintaining adequate water quality, particularly microbial, in natural water resources used directly by communities without adequate treatment. Although this situation is improving rapidly throughout South Africa by the provision of formal water supplies, some poor communities remain directly dependent on natural water resources, either permanently or when formal supply systems break down. Under these circumstances, their vulnerability to waterborne diseases is increased. The recent outbreaks of cholera and typhoid have galvanised the Department's commitment to addressing its responsibilities in this regard.

Impacts on people with HIV/AIDS

People with compromised immune systems face far greater risk from waterborne diseases than healthy people. Inadequate water quality, particularly microbial, will increase the incidence of waterborne diseases and related mortalities (Ashton and Ramasar, 2002). In certain instances, a small risk of degradation of groundwater, albeit likely to be highly localised, exists when relatives are buried in places unsuitable for graveyards (Ashton and Ramasar, 2002). In communities where:

- Water is derived from local surface water or groundwater resources, and
- Such water is untreated or inadequately treated and used for domestic purposes,

the resource water quality can impact negatively on local health levels.

Co-operative governance

It is therefore the Department's policy to:

- Work closely with the Department of Health in a spirit of *co-operative governance* to address all the above issues, and
- To implement appropriate water quality monitoring programmes wherever this is feasible.

Decreased productivity

Decreased productivity of staff members infected with HIV/AIDS will occur and loss of skilled and semi-skilled staff leads to increased staff turnover across all sectors (Ashton and Ramasar, 2002). These result in:

- Increased training of new staff, and hence increased costs, and
- Potential inadequate execution of water resource management programmes (*e.g.* lack of continuity of water quality monitoring programmes), and
- Possible delays in achieving water resource management objectives.

It is therefore the Department's policy to ensure that such impacts are anticipated and properly planned for, to ensure continuity in the execution of programmes relating to resource directed management of water quality.

Perceptions of HIV/AIDS as a waterborne disease

HIV/AIDS is still perceived by some to be a waterborne disease. Although indicative of a desperate need for better health education, it also fundamentally undermines the ability of the Department to improve society's perception of the true value of water and water quality.

It is therefore the Department's policy to not only promote an understanding of the positive aspects of water and water quality but also to ensure that incorrect perceptions are effectively eliminated.

4.3.2.3 Poverty

Poverty, dignity, sustainable development

The Department recognises that poverty:

- Diminishes human dignity, a quality that is specifically respected and protected by the Constitution (108:1996).
- Is associated with a vulnerability that can prevent the poor from achieving *current equitable access* to water resources.
- Significantly hampers efforts to apply the principle of *protection of water resources* and hence achieve at all times *sustainable development*, because the poor are usually more concerned with satisfying simple short-term physiological needs (water, food, shelter, etc.) than satisfying the much higher self-actualisation needs associated with protecting the natural environment for its intrinsic value (or for future generations). (This is an interpretation of Maslow's hierarchy of needs (Maslow, 1970).)

It is therefore the Department's policy to place poverty eradication efforts as a high priority.

Reserve

Accordingly, as an essential first step towards poverty eradication, it is the Department's policy to apply with vigour the concept of the *Reserve* to ensure that:

- Basic human needs are met for all South Africans, and
- The health of the ecosystems that supply this water is ensured.

Water as an enabling element

The Department recognises the core importance of water of good quality for *socio-economic enhancement* at all levels. It is therefore policy to give particular emphasis to developments in which the socio-economic enhancements demonstrably result in poverty eradication. The Department also recognises the need to further develop and refine procedures to create sustainable capacity in all stakeholders, particularly the poor, to ensure that they are empowered to take their rightful place in *effective stakeholder engagement*.

Corruption

The Department recognises the utterly unacceptable nature of corruption in all its forms and the particularly disastrous consequences in situations when resources are limited. It is therefore the Department's policy to prevent corruption by meticulously ascribing to the principles of *good governance* at all times .

4.3.2.4 Racial inequities

Commitment

The Department recognises the enormously negative impacts past racial policies have had on South Africans. It therefore commits itself to addressing these in an equitable manner in its efforts to achieve *sustainable development* of the nation's water resources.

Equitable allocation meta-principle

It is the Department's policy to apply the following enabling principles relating to *equitable allocation* of water quality:

- *Sustainable development* is an overriding principle that should not be totally violated under any circumstances.

- *Equality* (non-discrimination) is also an overriding principle that may not be violated, except in one particular instance: *Redress* will always be considered with *due diligence*. In particular, until general government policy dictates otherwise, *redress* may carry a greater relative weight than *equality* in those catchments in which previous water allocations made prior to the current National Water Act (36:1998) were discriminatory.

4.3.2.5 Gender inequities

Inadequate role of woman

The Department recognises the inadequate degree to which women have been permitted to play a role in water resource management in general and rural water affairs in particular. Accordingly, it is the Department's policy to ascribe vigorously to the principle of *gender equity* and to apply *redress* and *equality* appropriately to achieve an ultimate equitable state. Special attention will be given at local level to ensuring that *rural gender equity* is achieved.

4.4 General commitments

4.4.1 Introduction

To principles

The Department is committed to the policy principles as defined in this document, particularly to encourage debate and hence deeper understanding, and to their gradual introduction and application as described in this policy.

To integrated water quality management

The sequence of sub-sections that follow is broadly aligned with the dynamic cyclical process of "plan, implement, check and review". The Department:

- Recognises the appropriateness of this for integrated water quality management, and
- Commits itself to the following principles of integrated water quality management.

    Effective stakeholder engagement
    Sustainable development
    Adaptive management
    General legislative alignment
    Sound financial management

To effective stakeholder engagement

In particular, the Department commits itself to the principles of *effective stakeholder engagement* at appropriate stages of the integrated water quality management process, particularly when this is closely aligned with catchment visioning. Furthermore, the Department is committed to giving effect to this, in line with the National Water Act (36:1998), by devolving and decentralising decision-making responsibilities through the creation of water management institutions, and catchment management agencies in particular. The Department also acknowledges the important role that will be played by catchment forums in representing the interests of individual stakeholders.

To general legislative alignment

The Department commits itself to the principle of *general legislative alignment* and the related principle of *co-operative governance*. In the In the specific context of resource directed management of water quality context in particular, it recognises the critical importance of these principles in ensuring co-ordination in planning and water use authorisations.

4.4.2 Decision-making

4.4.2.1 Principle-based decision-making

Overarching policy

It is the Department's policy to apply *principle-based decision-making*, whenever appropriate, to resource directed management of water quality.

Principle inclusiveness

It is specifically policy to ensure that all relevant principles are identified. Relevant principles include those that are:

- Specifically noted in the Constitution (108:1996), any other appropriate Act (applying *general legislative alignment*), or in this policy as being relevant in the given context, or
- Agreed by consensus among all stakeholders as being relevant (through *effective stakeholder engagement*).

Principles that guide decisions should not necessarily be limited to those that are described in this document.

Due diligence

It is policy to regard a principle as having received "due diligence" when:

- It is defined so by other relevant legislation, if any, (applying *general legislative alignment*), and
- All stakeholders agree by consensus that this is so (through *effective stakeholder engagement*) and it does not conflict with any legislation (*general legislative alignment*), and
- It is consistent with any relative weighting assigned to it.

Integrated balance

It is policy to regard the relative balance (weighting) given to principles as appropriate when:

- A relevant weighting has been applied as described in this policy, or
- All stakeholders agree by consensus that this is so (through *effective stakeholder engagement*) and it does not conflict with any legislation (*general legislative alignment*).

Given the complexities of decision-making in resource directed management of water quality created by having to consider multiple issues, it is the Department's policy to apply recognised quantitative or qualitative multi-criteria decision-analysis techniques whenever feasible and appropriate.

Due process

It is policy to regard a process or procedure as having been executed with *due process* when:

- Existing guidelines for the process have been adhered to, or, should such guidelines not exist,
- All stakeholders agree by consensus that this is so (through *effective stakeholder engagement*) and it does not conflict with any legislation (*general legislative alignment*).

4.4.2.2 Multiple lines of evidence

Managing uncertainty

The Department acknowledges that quantities used as a basis for resource directed management of water quality:

- Are often based on approximate methods of calculation, and
- Have uncertainties (or confidence levels) that are difficult to quantify.

When using such quantities as a basis for decision-making, the Department will:

- Openly acknowledge the known underlying assumptions of such calculations, to ensure decision-making is informed, and
- Use multiple lines of evidence (*i.e.* independent sources of information or methods of calculation) whenever this is feasible and cost-effective, and
- Balance this approach with the need for simplicity, particularly in the interim transitional phase.

4.5 Catchment assessment

Definition

Catchment assessment is the process of collating, processing and interpreting data and information about water-related conditions, issues and developments in a catchment for the ultimate purpose of providing a sound technical basis for catchment management strategies (DWAF 2003c).

Enabling principles

The following main principles enable catchment assessments:

- *Effective stakeholder engagement*,
- *General legislative alignment*,
- *Environmental integration*, and
- Prudent pragmatism.

Needs of the Act

The Department acknowledges the need to meet certain requirements prescribed by Section 9 of the National Water Act (36:1998) regarding the contents of catchment management strategies. It is the Department's policy to meet these needs by applying the enabling principles of catchment assessment with special emphasis on *effective stakeholder engagement* reflected in a preliminary catchment visioning exercise. The principle of *general legislative alignment* will also be applied, particularly in ensuring alignment with the Promotion of Access to Information Act (2:2000). Catchment assessment is regarded as one of the planning functions of integrated water quality management.

Understand to improve

The Department acknowledges the complexities and uncertainties associated with water resource management and therefore the need for a sound understanding of catchment processes and issues. It is therefore the Department's policy to improve understanding by striving for a holistic comprehension of all catchment processes and issues, based on adequate and objective observations far as this is much as possible. This should occur before catchment management decisions are taken that are intended to improve the current state of water resources. This, in effect, applies the principle of *environmental integration*. However, this will be balanced with *prudent pragmatism*.

Flexibility in scope

The Department acknowledges specifically the need for *flexibility* in the scope of catchment assessment studies (DWAF, 2003c). In particular, they should take appropriate account of:

- The *Reserve*;
- Other user requirements as reflected in the outcome of the catchment visioning process;
- Catchment size;

- Management requirements that may vary from catchment wide status and trends to more detailed 'cause-effect' information;
- Spatial and temporal resolution within each catchment aligned with the management requirements; and
- The possible iterative and evolving nature of catchment assessments.

Spatial scale

It is the Department's policy to ensure that catchment assessments take place on a spatial scale that appropriately balances:

- The complexities of catchment management;
- The principle of *environmental integration*; and
- The need to devolve water quality management to the lowest practical level.

Water quality issues and requirements

The Department regards a catchment assessment as the primary source of initial information on:

- Water quality issues,
- Water quality aspects of the Reserve,
- Water uses, current and future, and hence
- Water quality requirements, both current and future.

The catchment assessment study should therefore characterise the water quality requirements within the catchment to a degree of detail that can adequately inform the ongoing catchment visioning process, and resource directed measures (RDMs). The catchment assessment should specifically provide a statement on the present state of water quality, the degree of compliance with the vision and highlight those corrective actions that are needed to improve or maintain water quality.

Models

The Department encourages the use of computer models as tools for supporting decisions relating to resource directed management of water quality. However, it is the Department's policy to apply *prudent pragmatism* and use less input resource intensive (possibly qualitative) approaches when the required degree of confidence in the results warrants this. This will be done in a manner equivalent to, and consistent with, that outlined below for determining RDMs at different levels of confidence.

Data assessment

To facilitate the evolving catchment visioning process, the Department encourages a presentation of data and associated assessments that is:

- Simple and easy to understand by non-experts; and
- Accurate and unambiguous to ensure that misinterpretation is avoided or minimised.

4.6 Catchment visioning

Definition

Catchment visioning is the iterative process of evolving, over time, a more relevant and more detailed:

- Collective statement from all stakeholders of future aspirations of the relationship between the stakeholders, in particular their quality of life in its broadest sense, and the water resources in a catchment, and
- Strategy to move towards that vision, being either the catchment management strategy itself or one that directly supports it.

Overarching policy

The Department regards the catchment visioning process as an essential planning instrument that drives all aspects and all stages of integrated water quality management.

The Department specifically acknowledges that catchment visioning is an indispensable component of any strategy, at any level. It also plays an essential part in ensuring that use of the country's water resource is "in the public interest" (a specific mandate of the National Water Act (36:1998)), by facilitating participative management and focussing on the quality of life, in its broadest sense, of stakeholders.

Accordingly, it is the Department's policy to:

- Actively promote and apply all the enabling principles of catchment visioning; and to
- Ensure that the process is socially, economically, politically and ecologically 'safe' (*i.e.* unlikely to be 'derailed' because some stakeholders may feel marginalized).

Enabling principles

The following main principles enable catchment visioning:

- *Effective stakeholder engagement*;
- *Principle-based decision-making*;
- *Adaptive management*;
- *General legislative alignment*;
- *Creative problem solving*; and
- *Prudent pragmatism*.

Nature of the vision

It is the Department's policy to ensure that each catchment vision and associated strategy is:

- Acknowledged by all stakeholders as iteratively improving (*i.e.* subject to *adaptive management* principles) based on a "co-evolution of understanding", and
- Reached by consensus, and
- Strongly principle-based (applies *principle-based decision-making* and *general legislative alignment*), and
- Well aligned with the National Water Resource Strategy (DWAF, 2004a) and other national visions and strategies.

Vision and strategy contents

Stakeholders will be encouraged to encapsulate in their vision statement and associated strategy, their considerations relating to *sustainable development* and, in particular, *protection of water resources*, *optimal water use*, *current equitable access* and *equity between generations*.

Meaningful involvement

The Department will apply the principles of *awareness creation* and *empowerment through information* by ensuring stakeholders have an understanding of the water quality management concepts that are necessary to enable their meaningful involvement.

Common visioning

The Department acknowledges that a sense of common purpose promotes buy-in and hence ownership, co-operation and accountability in efforts to move towards a vision. It is therefore the Department's policy to strive for a vision statement and a corresponding strategy that is accepted with consensus among all stakeholders.

Progressive realisation

It is the Department's policy to facilitate a progressive realisation of the vision in accordance with the principles of:

- *Adaptive management*;
- *Creative problem solving*; and
- *Prudent pragmatism*.

Furthermore, in the interim transitional phase, recognising that water quality problems are more acute in some areas than in others, and that cost-effective use of human and financial resources is essential, the catchment management strategy will focus initial implementation on those management units in which the need is most urgent.

Relationship with catchment assessments

It is the Department's policy to ensure that preliminary catchment visioning determines the initial scope of catchment assessment studies (that describe the local context) that these, in turn, facilitate refined catchment vision statements and strategies.

RDMs and catchment management strategy

Similarly, it is the Department's policy to ensure that the products of the catchment visioning exercise can adequately inform both:

- The determination of resource directed measures (RDMs), *i.e.* classification, resource quality objectives and the Reserve; and
- The progressive development of a catchment management strategy.

Again, the Department recognises the iterative nature of the RDMs and catchment management strategy feeding back into the catchment visioning process.

Lower confidence approaches

The Department acknowledges the need to apply *prudent pragmatism* in special circumstances, and especially in the interim transitional phase, to permit catchment visioning at lower levels of confidence (referring to the level of confidence that can be placed in the appropriateness of the vision).

The dangers of doing this will be explicitly acknowledged and carefully weighed against the advantages. For example, in catchments that are not water quality stressed (in respect of any variable of concern) the Department may permit catchment visioning with minimal levels of stakeholder engagement and less than ideal catchment assessment data in the interests of (a) cost-effectively initiating the longer-term progressive development and attainment of a vision and (b) preparing for a later process that is more inclusive.

Relative emphasis on principles

The Department acknowledges that two main factors determine the degree of confidence that can be placed in the process and ultimate vision, namely:

- The level and effectiveness of stakeholder engagement; and
- The availability of relevant catchment data, and water quality data in particular.

Under circumstances when low confidence is considered acceptable, it is the Department's policy to carry out the catchment visioning process:

- Within practical yet realistic time limits; and
- With readily available expertise, data and information.

Within the limits of these constraints, the enabling principles associated with *effective stakeholder engagement* are given the following relative emphasis:

- Efficiency and cost-effectiveness (relating to the principle of *engagement efficiency and effectiveness*) are given high priority by minimising direct engagement with stakeholders.
- Although *environmental integration* is regarded as important, the degree of attention afforded to it will be restricted to the expertise and experience of those taking part in the process and to the use of readily available data.
- *Comprehensive consultation* will be compromised by decreasing stakeholder engagement as the acceptable degree of confidence decreases. Nevertheless, it is the Department's policy to strongly encourage officials to express the likely perspectives of the water users in the catchment to the best of their abilities.
- The enabling principles of c*onstructive co-operation* will be articulated at the start of the process and officials will adhere to them in their discussions in an effort to begin creating an enabling environment for a subsequent process that will increase the confidence in the result.

4.7 Catchment management strategy

Overarching policy

The Department acknowledges:

- The strategic nature of water management areas because of their large temporal and spatial scales, and
- The complexities, uncertainties and hence risks associated with water quality management on such scales, and
- The importance of devolving water quality management efforts to the lowest practical level.

Accordingly, it is the Department's overarching policy in respect of the water quality component of catchment management strategies to:

- Give effect to the National Water Resource Strategy (DWAF, 2004a), and
- Sub-divide the water management area into practically manageable units, and

Effectively manage for the chosen management class by giving effect to resource quality objectives, resource water quality objectives and the Reserve, through the definition and equitable attainment of source management objectives (DWAF, 2003b), and

- Strongly encourage the clear and consistent application of all the processes and policy principles of this policy on resource directed management of water quality, particularly related to the following:
  Integrated water quality management process
  Catchment visioning process
  Sustainable development
  Adaptive management
  Effective stakeholder engagement
  General legislative alignment
  Creative problem solving
  Good governance

Adaptation of these principles to catchment-specific circumstances is specifically encouraged when this may be needed or applicable to convey greater clarity or improve relevance.

Catchment visioning

It is the Department's policy to ensure that the catchment management strategy is firmly guided by catchment visioning taking place for:

- The smaller water management units within a catchment, and
- The water management area as a whole.

Phased implementation

Recognising that:

- Water quality problems in some areas are more acute than others, and
- Cost-effective use of human and financial resources (both from local sources and from the Department) is essential,

it is the Department's policy to encourage initial implementation, particularly in the interim transitional phase, in those management units in which the need is most urgent.

4.8 Resource directed measures

Importance

The Department acknowledges:

- The statutory requirements of resource directed measures (RDMs), comprising the resource classification system, determination and implementation of the Reserve and determining and complying with resource quality objectives (RQOs); and
- The fundamental importance of these measures in applying the principle of *sustainable development*.

Independence

It is the Department's policy to ensure an adequate degree of independence and objectivity in:

- The resource classification system,
- Determining the Reserve, and
- Determining RQOs,

in order to ensure that:

- Local catchment priorities are appropriately balanced with broader spatial and temporal perspectives (*e.g.* at water management area level and/or national level), and
- RDMs are consistently applied nationwide.

Local knowledge

Notwithstanding the need for a degree of independence, it is the Department's policy to ensure that local knowledge is effectively used in RDMs.

4.8.1 Degree of confidence

Levels of confidence

The Department acknowledges the importance of a comprehensive understanding of catchment processes, based on adequate and objective observations, and hence the importance of establishing RDMs with good confidence in their accuracy.

Nevertheless, in the interim, in the absence of highly confident RDMs, it is the Department's policy to apply *prudent pragmatism* by permitting, in special circumstances, RDMs at lower confidence levels.

Factors affecting confidence

It is recognised that there are many factors determining the degree of confidence that should be achieved in any particular RDM sub-process. Among others, these factors may include the following:

- The immediate objective to which the outcome of the RDM process is to be applied.
- The degree of water quality stress.
- The likely impact of proposed water uses on water quality. This will depend on both the nature of the water use, the ecological importance (including scarcity) and the sensitivity of the water resource.

It is therefore the Department's policy to define and apply RDMs to lesser degrees of confidence based on the degree to which the above factors apply on a case-by-case basis. Due consideration will also be given to any other factors that might influence the acceptable degree of confidence.

Accountability

Furthermore, if:

- A sense of urgency exists, or
- A culture of involvement in stakeholder engagement processes in the catchment is either lacking or and is such that considerable preparatory groundwork is necessary,

these may be considered as reasons for adopting an approach of lower confidence. However, under all circumstances of RDMs being established at levels of confidence that may be compromised for any of the above reasons, it is the Department's policy to explicitly acknowledge, and manage accordingly, the likely higher associated risks. Accordingly, it is policy to give particular emphasis to a *precautionary approach* and *adaptive management* and, within the latter, a special emphasis to *receptiveness* and *flexibility* in subsequent management.

Compatibility

The chosen level of confidence for RDMs will define the minimum level of confidence required for all aspects of RDMs, from catchment visioning through to determining resource quality objectives. For example, if high confidence resource quality objectives are required, related processes upon which these depend must also be done to a high level of confidence, not lesser levels. Equivalently, a low confidence catchment visioning process will not warrant a high confidence determination of the class and resource quality objectives.

4.8.2 Allocatable water quality

Quantification

It is the Department's policy to quantify, whenever possible and appropriate, the allocatable water quality in terms of individual water quality variables of concern, including biological and/or ecosystem effects. These variables are determined by the water users (both current and future) in the catchment.

Confidence

The Department recognises that the confidence that can be placed in the accuracy of the allocatable water quality depends on the confidence that can be placed in the following three factors:

- The objectives (*e.g.* resource quality objectives).
- Knowledge of the current state of water quality.
- The flow patterns upon which allocatable water quality loads might be based.

Interim measures

Since allocatable water quality is defined in terms of objectives, interim measures may be necessary when the latter are not available and urgency dictates that some measure, albeit conservative or with low confidence, of allocatable water quality is required (*e.g.* a measure of the degree of stress is required).

Initial estimate

Under these circumstances it is the Department's policy to use as an initial estimate, preliminary RQOss related to water quality defined in terms of, for example, the target water quality range, or other criteria, defined for the South African water quality guidelines (when available and appropriate) for the water users.

4.8.3 Water quality stress

Indicators of stress

The Department recognises the need to determine whether or not a water resource is able to adequately meet the needs of water users in respect of their water quality requirements. The Department recognises the allocatable water quality as an appropriate indicator. A positive amount for a water quality attribute means that the resource is unstressed; a negative amount for a water quality attribute means that it is stressed.

Confidence

The Department recognises that the confidence that can be placed in the calculated degree of stress is determined by the degree of confidence that can be placed in, or the accuracy of, the allocatable water quality.

Iterative nature

The Department acknowledges the iterative nature of:

- On the one hand, defining stress in terms of objectives and, on the other hand,
- Basing the level of confidence with which these objectives should be determined on the degree of water quality stress.

Accordingly:

- Should the determination of stress based on an initial estimate of allocatable water quality, indicate that the water resource is stressed, and
- This is considered unreasonably biased towards *protection of water resources*, (*i.e.* too conservative),

the Department will encourages determination of said objectives with greater accuracy.

4.8.4 Resource management class

Sustainable development

The Department regards the resource management class as capturing the most desirable long-term balance between *protection of water resources*, *optimal water use*, *equity between generations* and *current equitable access*. This balance should be achieved with adequate consideration of *environmental integration* and application of *effective stakeholder engagement*. The sustained achievement of the resource management class is then regarded as a minimum requirement (or 'first line of defence') that facilitates *sustainable development*.

Special considerations

Special consideration will be given to resources that are vulnerable, sensitive or scarce and in an unimpacted or largely-unimpacted state. Groundwater will be regarded as vulnerable by default unless it can be shown otherwise (DWAF, 2000).

Spatial scale

It is the Department's policy to sub-divide resources into management units for which single objectives are sensible from a management and ecological point of view. However, the interdependence of such units will also be considered. It is also acknowledged that resource units practical for resource directed management of water quality may differ from those chosen for water quantity management.

National balance

An overall appropriate national balance of strict protection of some resources on the one hand with use (and possible degradation) of other resources on the other, will be necessary.

Relation to pollution

It is the Department's policy to regard the classification system as the primary mechanism for making the definition of pollution in the National Water Act (36:1998) (see Glossary) operational in the current context of resource directed management of water quality. As a consequence, this allows for different levels of impact for different water resources, through their alignment with the catchment visions.

Attaining the class

If the present state of a water resource is worse than the management class, it is the Department's policy to attain the management class in an equitable manner over an achievable time period. Emphasis will be placed on appropriate source directed controls.

4.8.5 Resource quality objectives (RQOs) and the Reserve

Overarching policy

It is the Department's policy, as mandated by the National Water Act (36:1998), to:

- Determine either numerical or narrative RQOss that reflect the desired water quality, water quantity and aquatic ecosystem quality for a chosen management class; and
- Determine a Reserve, including satisfying basic human needs and protecting aquatic ecosystems.

Integration of quantity and quality

The Department recognises that, in setting resource quality objectives for a chosen management unit of a water resource, a technical process of integration of water quality, water quantity and ecosystem integrity, is necessary, the results of which will further inform the stakeholder engagement process. These objectives can include a wide variety of characteristics of the resource, some of which can refer explicitly to water quality.

Preliminary RQOs

Until the classification system has been prescribed, provision is made by the NWA (36:1998) for determination of a preliminary class, a preliminary Reserve and preliminary resource quality objectives. These can be done at different levels of confidence.

Giving effect to RQOs through RWQOss

Once resource quality objectives have been published in the *Gazette*, or preliminary resource quality objectives have been determined, they must be given effect. To do so, the Department or water management institutions (such as catchment management agencies) may also set narrative or quantitative "resource water quality objectives (RWQOs)" (either in-stream or in-aquifer). These may be set at a greater spatial resolution (*i.e.* closer together) and/or temporal resolution (*i.e.* more frequently monitored) than the resource quality objectives (preliminary or otherwise) to which they may be linked.

The purpose of these will be to provide greater detail upon which to base management of water quality that is aimed at achieving and sustaining compliance with resource quality objectives.

Catchment compatibility

The Department recognises that some impacts on water quality, particularly those relating to conservative water quality variables, can have increasingly cumulative effects towards the most downstream reaches of surface water resources. Accordingly, the setting of resource quality objectives or resource water quality objectives for a particular catchment must take cognisance of that catchment's water quality issues (current and future) and those of upstream and particularly downstream catchments as well as those linked through inter-basin transfers. All water quality-related objectives in such catchments must be mutually compatible.

Interim transitional phase

In the interim transitional phase, the Department will consider using low confidence standard approaches and instruments to determine a preliminary classification of water resources nationwide based on water quality. This will be used to identify potential priority water resources that exhibit water quality stress.

Preliminary water quality objectives relating to water quality and resource water quality objectives will then be set for these priority resources using more accurate (higher confidence) approaches. This will provide initial impetus to the implementation of resource directed management of water quality in accordance with the intentions of the NWA (36:1998).

Modification of RQOs or RWQOss

In accordance with the principle of *flexibility*, an enabling principle of *adaptive management*, RQOs or RWQOs may be revised, following *due process*, in the following circumstances:

- The baseline ecological data upon which RQOs or RWQOs have been based change because new and better data become available. In such instances, new RQOs or RWQOs may be set based on the more relevant ecological data.
- Significant changes in the catchment vision, established following *due process* and full application of the enabling principles of catchment visioning create an inconsistency with current RQOs and/or RWQOs.
- Water treatment technology improves and becomes more cost-effective, allowing changes to what is regarded as the best practicable environmental option. Applying the principle of *optimal water use*, current RQOs or RWQOs may therefore be made more stringent in favour of *protection of water resources*.
- Political decisions (*e.g.* increased emphasis on socio-economic development in selected catchments), such as those based on presidential and national imperatives.

4.9 Source directed controls

4.9.1 Introduction

Relation to resource directed measures

Although at different ends of a spectrum of management focus, the Department recognises that source directed controls are driven by the resource directed measures in place, in particular the resource quality objectives. This policy therefore provides direction to source directed controls from this perspective. However, it is also noted that the nature of source directed controls is significantly determined by the National Environmental Management Act (107:1998).

Determining resource directed measures comprises part of the planning function within the "plan, implement, check, review" cycle. Source directed controls and monitoring comprise the "implement" function.

Co-operative governance

The Department acknowledges that source directed controls necessarily go far beyond the scope of resource directed management of water quality. It is therefore the Department's policy to apply the principles of *co-operative governance* and *general legislative alignment*.

4.9.2 Hierarchy of decision-making

Overarching policy

As an example of *principle-based decision-making*, it is the Department's policy to apply the series of principles in the priority order below (*pollution prevention*, *waste minimisation*, etc.) in the general context of integrated water quality management (van Wyk *et al.*, 2002a).

The Department will generally balance the ecological necessity of applying the *precautionary approach* with the water quality requirements, and associated socio-economic necessities, of current and proposed water uses. This will be particularly important in the interim transitional phase and in the absence of resource quality objectives for the potentially impacted water resource.

The *precautionary approach* applies at many levels. Even *pollution prevention* and *waste minimisation* can be regarded as an application of this principle.

Pollution prevention

Irrespective of the amount of allocatable water quality, the Department will strongly encourage water users to *prevent pollution* whenever possible (*e.g.* by striving for a "zero effluent" state for water users producing effluents) by pursuing the best practicable environmental option. This is the option that provides the most benefit or causes the least damage to the environment as a whole, at a cost acceptable to society, in the long-term as well as in the short-term (NEMA (107:1998)).

Pollution prevention is aimed specifically at controlling the handling and discharge or disposal of hazardous substances. Where a substance or effluent exhibits characteristics of toxicity, persistence and capacity for bioaccumulation or endocrine disruption, these are regarded as presenting major threats to the receiving water environment. Where these threats are involved, the differentiated approach below does not apply because of the difficulties associated with determining appropriate resource water quality objectives for these pollutants.

Waste minimisation

The Department acknowledges that some degradation of water quality in water resources is inevitable, and is sometimes necessary, for socio-economic development. Irrespective of the amount of allocatable water quality, cost-effective *waste minimisation* and *water conservation* will be encouraged at all times. For point sources such as waste discharges, the *precautionary approach* will also be applied by enforcing uniform national minimum requirements or standards by default, should they exist.

When non-point pollution sources are persistently responsible for unacceptable water quality degradation, the Department will approach the responsible authority, examine the causes of the problem and identify appropriate interventions to correct the problem.

Differentiated approach

In catchments with no water quality stress, even if considerable allocatable water quality exists, the Department will apply the *precautionary approach* by enforcing, particularly in respect of point waste discharges, uniform national minimum requirements or standards by default, should they exist. However, these may be relaxed in special and equitable circumstances although the management class will still have to be maintained.

In catchments with water quality stress, it is policy to (a) consider stricter requirements and/or (b) strictly regulate or prohibit unsustainable practices in order to comply with resource quality objectives and achieve the management class.

To protect water resources at a cost that is acceptable to society, the Department will generally be guided by the level of protection afforded by the resource management class (informed by catchment visioning) and associated resource quality objectives. This will apply to both point and non-point sources of pollution.

In the absence of resource quality objectives (preliminary or otherwise), the Department will enforce uniform national minimum requirements or standards, should they exist, in respect of point waste discharges.

If the potentially impacted resource is vulnerable or sensitive to water quality degradation, the Department may act as though the water resource is water quality stressed, applying the *precautionary approach* as just described.

Remediation

Finally, again in order to promote both *optimal water use* and *protection of water resources*, the Department will:

- Facilitate *remediation* of water resources, and sources of pollution (*e.g.* degraded land), especially in catchments with existing water quality stress, where this is considered necessary, practical and equitable, and
- Apply the *polluter pays* principle.

The Department recognises that *remediation* can be extremely expensive and may sometimes be totally impractical, for example in the case of some aquifers. The Department regards this as strong motivation for avoiding the need for *remediation* in the first place, by applying of *pollution prevention, waste minimisation* and the differentiated approach with the emphasis stated above.

4.9.3 Water allocation

Emphasis on redress

Whether referring to water quantity or water quality, the Department recognises the fundamental role that application of the principle of *current equitable access*, and its enabling principles, will play in poverty eradication. Accordingly, in its quest to appropriately balance the enabling principles of *sustainable development*, it is the Department's policy to give particular emphasis to the principle of *redress* and recognise the principle of *acceptable prejudice* when considering *equitable allocation*. This will apply particularly when re-allocation of water, or water quality, requires curtailment of existing lawful uses (*e.g.* through compulsory licensing).

Public interest

Effective stakeholder engagement will be strongly encouraged and supported to ensure all water allocation is in the public interest. In this process, *socio-economic enhancement*, and in particular the enabling principle relating to *empowerment to participate*, will be emphasised. *Water conservation* and *gender equity* will also receive high priority.

Fraction allocated

If the resource contains some allocatable water quality, an applicant will typically not be allocated all that is available. An appropriate fraction may be allocated that takes account of all the considerations in Section 27 of the NWA (36:1998), as well as:

- The approximate nature of, or confidence in, the determination of the allocatable water quality, and
- Unforeseen circumstances.

4.9.4 Water use

Principle-based decision-making

Acknowledging the need to make recommendations or decisions that are consistent and defensible, it is the Department's policy to apply the principles of *principle-based decision-making* in the process of evaluating and granting (or not granting) authorisations for water use.

Resource management class ('first line of defence')

On the one hand, the Department will strive to attain and maintain at least the designated resource management class of each water resource by, at least:

- Limiting water quality allocations to the available allocatable water quality, *i.e.* complying with resource quality objectives; and
- Adhering appropriately to uniform minimum requirements or standards.

'Second line of defence'

It is also the Department's policy not to permit deterioration of water quality that will result in an unacceptable trend that may potentially decrease its present management class.

Furthermore, in cases where the class has been designated and the existence of some allocatable water quality has been established, this will not be taken to mean *sustainable development*, and *pollution prevention* and *waste minimisation* in particular, have been adequately considered. It is the Department's policy to ensure that each water use, and the overall (possibly inter-sectoral) suite of water uses, takes appropriate account of the enabling principles of *sustainable development* in all instances, even when within the limits defined by the resource quality objectives of the designated class. This can be regarded as a 'second line of defence' against development that may potentially be unsustainable.

Economic good

The Department recognises that the allocatable water quality can be regarded as an economic good because both rivalry and excludability can apply. Rivalry exists because water users can compete for its use. Excludability exists because once a water allocation has been made to a particular user, that user can exclude use of that water by other users.

Socio-economic impact

It is the Department's policy to determine and evaluate the socio-economic impact of a proposed water use by applying the principles of *environmental integration* and *general legislative alignment* and by ensuring an appropriate level of *effective stakeholder engagement*.

The Department is committed to facilitating socio-economic development in South Africa through the principle of *optimal water use*. The implications of not granting an authorisation for a water use, and thereby possibly sacrificing *optimal water use* with potentially significant socio-economic enhancements, will be carefully considered. Previous investments by water users will also be considered. The following options may also be considered:

- Increasing the allocatable water quality of the resource within the resource water quality objectives that have been set, or
- Obtaining more accurate measurements of this.

Redress and optimal water use

Within the constraints of the allocatable water quality of the resource and the catchment management strategy, and until general government policy dictates otherwise, the Department's policy is to respond positively to water uses involving allocations that, specifically in respect of persons that were subject to past discriminatory practices,

- Actively *redress* previous discrimination; or
- Empower and uplift such persons by provision of a quality of water that demonstrably improves their quality of life.

Authorisation period

Applying the *precautionary approach* and *adaptive management*, the authorisation period may be shortened when necessary to allow for reasonable reassessment of the conditions of the authorisation in the light of:

- Improved understanding of the natural changes in water quality when this may initially have been inadequate, or
- The future availability of improved effluent treatment technologies that may mitigate negative impacts on the resource or improve the degree of *water conservation*.

Authorisation review

As mandated by the National Water Act (36:1998), it is the Department's strict policy to review authorisations on a regular basis with the period between reviews being not more than five years.

Transparent governance

It is also the Department's policy to apply the principle of *transparent governance* to ensure that reasons for decisions can be made available by retaining a formal written record of decision. It is not the Department's policy to pursue *transparent governance* with the express purpose of enabling peer pressure on transgressors. Furthermore, the Department will not purposefully adopt the approach of "name and shame", preferring to engage with transgressors directly.

4.10 Monitoring

4.10.1 Introduction

Mandate

Within the limited scope of this policy, and specifically relating to resource water quality, the Department embraces the mandate of the National Water Act (36:1998) (Chapter 14) to provide for the collection of appropriate data and information necessary to assess:

- The quality of water resources;
- *Remediation* initiatives;
- Compliance with resource quality objectives; and
- The health of aquatic ecosystems.

Ecological integration

It is the Department's policy to ensure that monitoring of water quality:

- Contributes meaningfully to the Department's efforts to facilitate sustainable development, and
- Is explicitly linked to Resource Directed Measures, and
- Reflects the ecologically interdependent nature of water resources, including the dependence on water quantity, whenever appropriate, and
- Becomes an essential enabling component of effective integrated water quality management of South Africa’s water resources.

Measuring effectiveness

From the perspective of integrated water quality management, the Department regards water quality monitoring in water resources as providing the most directly relevant information for measuring the effectiveness of integrated water quality management. This occurs at different scales:

- National status and trends monitoring provides a higher-level integrated picture of the overall national effectiveness.
- Performance monitoring compares actual water resource quality with pre-determined resource management objectives (such as resource quality objectives and the Reserve), providing information at the spatial and temporal scale for which such objectives have been defined.
- Licence compliance monitoring in affected water resources provides the local site-specific information that is required to determine the effectiveness of source directed controls.

Water quality variables

The Department recognises the following as providing useful data and information on water quality:

Stressor monitoring:

- Physico-chemical monitoring (typically inorganic variables but also organic and inorganic toxicants);
- Radiological monitoring;
- Microbial monitoring (*e.g.* faecal microorganisms).

Response monitoring:

- Eutrophication monitoring;
- Biomonitoring (*e.g.* invertebrates and fish);
- Toxicity monitoring.

Beyond water quality

Furthermore, the Department recognises the importance of monitoring to some degree:

- The pressures (P) on water quality (*e.g.* the nature of the water uses that impact on water quality);
- The social and economic impacts (I) of water quality; and
- Decisive responses (R) of society and government to these impacts.

These, with monitoring the state (S) of water quality, comprise so-called PSIR monitoring. In the interim transitional phase, monitoring efforts will focus primarily on stressor and response monitoring that reflects the status and trends of water quality in water resources. The monitoring of pressures, impacts and societal responses is a longer-term objective. But because such information can be very useful, it will be included in the transitional phase when necessary, simple and cost-effective.

Management principles

The Department acknowledges the expensive nature of both the initial design and ultimate implementation of any water quality monitoring programme and therefore commits itself to the principles of *sound financial management*, *adaptive management* and *co-operative governance* to ensure that monitoring remains focussed, cost-effective and sustainable. It will be ensured that:

- Each monitoring programme has well-defined objectives;
- Each monitoring design provides the maximum amount of demonstrably useful information at minimum cost;
- Data assessments and reports support informed decision-making, in particular related to (a) water quality guidelines that may be used and (b) uncertainties associated with observations;
- No duplication of effort occurs at any stage of implementation; and
- Partnerships will be created with appropriate stakeholders who will share costs and benefits.

Access to information

Applying the principle of *general legislative alignment*, and in line with, and subject to, the Access to Information Act (2:2000) and the National Water Act (36:1998), it is the Department's policy to ensure that data collected in national monitoring programmes and any other programmes for which the Department or catchment management agencies have responsibility, will be made available upon a reasonable request for access. Reasonable charges for the provision of such data may be imposed.

Data management

It is the Department's policy to ensure that data management systems are appropriately cost-effective and able to adequately meet all of the requirements of national programmes and other regional monitoring programmes.

Monitoring review

Flexibility of design and *receptiveness* to new procedures, two enabling principles of *adaptive management*, are critical to sustaining a sound focus for any monitoring and its cost-effectiveness. Although monitoring programmes should be strongly focussed on well-defined objectives, management objectives and their associated requirements will change over time. New sampling, analytical, data storage, assessment and reporting techniques might also be developed. It is therefore the Department's policy to review, at regular intervals:

- The relevance of each programme's monitoring objectives; and
- The effectiveness with which they have been achieved.

On this basis the programme's objectives, design or implementation strategy will be updated if necessary.

Review intervals can be programme-specific but will not exceed five years.

4.10.2 National status and trends

Definition

It is the Department's policy to establish national status and trends monitoring programmes that measure, assess and report on the current status and appropriate temporal trends of selected groups of water quality indicators in South African water resources. This will be done in a soundly scientific manner that will support strategic management decisions in the context of sustained fitness for use of those water resources and the integrity of aquatic ecosystems.

National perspective

The Department recognises the following strategic responsibilities that specifically motivate the need for a national monitoring perspective:

- Monitoring the overall national effectiveness of water quality policies and strategies that themselves are usually regionally focussed;
- *Honouring international obligations* and participation in appropriate global initiatives;
- Keeping abreast of international trends in emerging problems;
- In the current interim transitional phase, the creation of monitoring capacity upon which further region-specific capacity creation can be based, for example as catchment management agencies (CMAs) become operational.

Delegation to CMAs

It is the Department's policy to take primary responsibility for these national monitoring programmes. However, delegation of the responsibility for implementation and associated data management to CMA will occur as and when they are created and adequate capacity is created within these CMA. It will be regarded as important that all such monitoring undertaken by the CMA addresses the objectives of the national monitoring programme as well as their own needs, as defined in their catchment management strategy.

Data assessment

The Department encourages the production of information products for the national monitoring programmes that contain assessments and presentation of data that demonstrably achieve the objectives of the monitoring programme and that are:

- Simple and easy to understand by non-experts; and
- Accurate and unambiguous to ensure that misinterpretation is avoided.

4.10.3 Performance

Definition

Acknowledging the significant importance of ensuring that water uses are such that each water resource remains within its resource management class, it is the Department's policy to establish performance monitoring programmes that measure, assess and report on the degree of compliance with resource quality objectives (RQOs).

Monitoring design

It is the Department's policy to ensure the design for RQOs compliance monitoring is appropriately catchment-focussed. Furthermore, the design should:

- Take account of any intermediate management objectives that may exist, for example resource water quality objectives or source management objectives, and
- Be consistent with, and help implement, the catchment management strategy.

Legal defensibility

The Department recognises the fundamental legal status of RQOs. It is therefore the Department's policy to ensure that the overall process of RQOs compliance monitoring is scientific, and all individual procedures are adequately defensible by being consistently and objectively applied.

Responsibility

It is the Department's policy to delegate the management and financial responsibility for RQOs compliance monitoring to catchment management agencies.

4.10.4 Compliance

Definition

Although compliance monitoring relating directly to 'end-of-pipe' monitoring is largely outside the scope of this policy, the Department acknowledges the importance of such source directed controls. However, it is the Department's policy to ensure that water quality monitoring in affected resources is included in water use authorisations when appropriate. These will be closely aligned with RWQOss, source management objectives and RQOss. Such monitoring provides an important information base for subsequent well-focussed corrective actions in cases where non-compliance is evident.

4.10.5 Remediation

Overarching policy

It is the Department's policy to measure, assess and report on the effects of *remediation* efforts in order to provide data and information on the effectiveness of those efforts. It is the Department's policy to approach such monitoring in three possible ways, in order of decreasing priority:

- Incorporation into performance monitoring programmes, since remediation should typically be driven by (1) inadequate compliance with RQOss or intermediate management objectives, for example, RWQOss or source management objectives, or (2) threats to such compliance.

- Incorporation into national status and trends monitoring programmes, if (1) the effects of the remediation are sufficiently relevant to the abovementioned national perspectives, and (2) the existing national monitoring designs are such that they will provide adequate information without modification.
- Design and implementation of temporary site-specific monitoring programmes tailored solely to provide data and information on the effectiveness of the remediation efforts. These should ultimately be phased out and incorporated, if necessary, into performance monitoring programmes.

4.10.6 Management performance

Good governance It is the Department's policy to apply the principle of *good governance* and place special emphasis on the enabling principles of *accountable governance* and *transparent governance*. Accordingly, it is the Department's policy to implement appropriate in-house monitoring of management performance. This is to ensure that any deficiencies in management actions within the Department are identified and corrected as soon as possible.

Capacity creation It also the Department's policy to ensure that staff members are provided with adequate training and general institutional support to ensure that appropriate capacity is created that will allow water resource managers to confidently take full responsibility for their actions.

4.11 Review

Policy review Reviewing is the last function in the "plan, implement, check, review" cycle that feeds back into the planning function (catchment assessments, catchment visioning, Resource Directed Measures, catchment management strategies, etc.)

In accordance with the principles of *adaptive management*, it is the Department's policy to periodically and in a holistic way review the appropriateness (*i.e.* current relevance) of the following:

- The original objectives of this policy, and
- The policy itself, and
- The appropriateness of the strategy and associated management instruments to implement the policy and achieve its objectives.

Any indication that creates cause for concern that one or more of the above are no longer relevant, should result in either (a) an appropriate change to the policy or strategy through *effective stakeholder engagement* and/or (b) an improvement in confidence associated with management instruments.

Corrective actions If there is any indication that creates cause for concern that objectives are not being achieved, and there is no reason to suspect that this policy or its associated strategy are inappropriate, it is the Department's policy to institute management actions that address the relevant shortcomings.

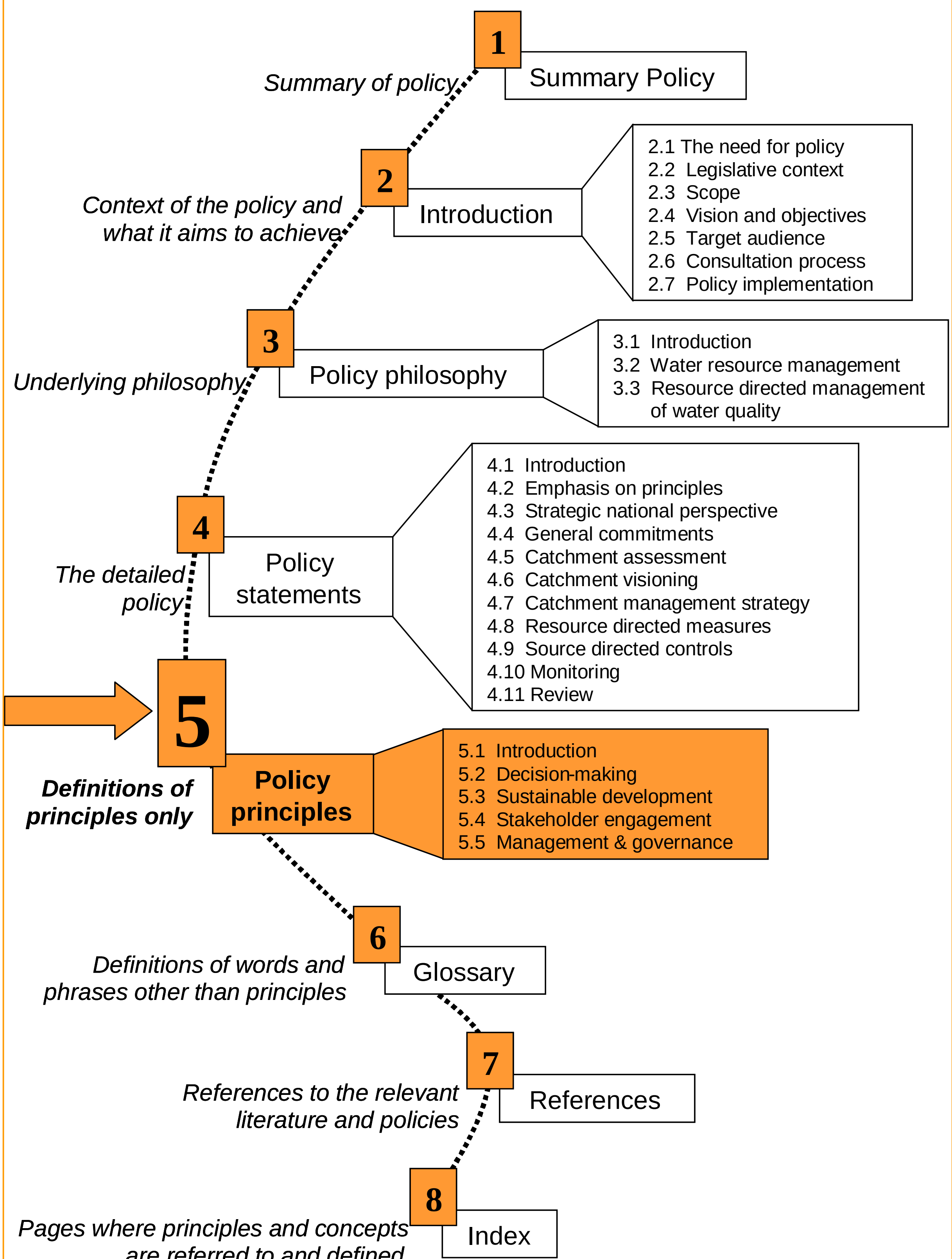
Catchment visions

The Department will also periodically examine:

- The degree to which individual catchment visions have been realised through implementation of their catchment management strategies, and
- The degree to which implementation of all catchment management strategies has influenced the achievement of national goals.

Changes to catchment visions, or to associated catchment management strategies, through *effective stakeholder engagement* are encouraged to ensure that these remain relevant and focussed.

Document roadmap



SECTION 5: POLICY PRINCIPLES

PHOTO: K MURRAY

5.1 Introduction

Thinking tools

This section formally defines all the principles referred to in previous policy statements. It also defines hierarchies of enabling principles where appropriate. These help to identify and more fully understand those principles between which some tension may exist.

The principles and hierarchies are presented as thinking tools intended to stimulate debate and a deeper common understanding. Their application will be guided by policy and the specific circumstances of individual scenarios.

Ultimate aim

The ultimate aim of such a presentation of principles is that through debate and refinement they will eventually become entrenched in the management of water resources and thereby facilitate a more structured and consistent application of legislation nationwide.

Internal consistency

The individual principles presented here may seem to differ somewhat from the way that they are presented in other documents. This is mainly to achieve internal consistency within this document. However, as a whole, the assemblage of principles presented here should not conflict with the overall general intentions of other relevant documents.

Hierarchy

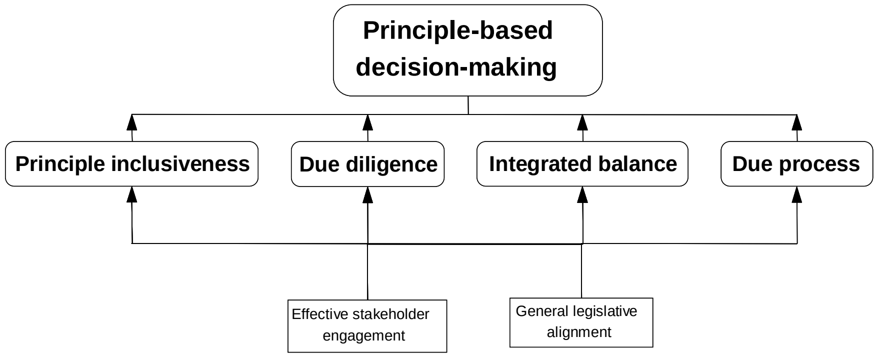
Within a given hierarchy, each level of principles 'enables' those above them. At any level in the hierarchy, 'applying a principle' means considering the principle itself and all enabling principles below it. A specific consequence of this is that if a policy statement makes reference to a principle, by implication, it also refers to all of that principle's enabling principles.

Index

Principles are identified in the policy text using italics. Because they do not appear in this section in any particular order, an index is provided at the end of this document to indicate those pages on which principle definitions occur.

5.2 Decision-making

5.2.1 Principle-based decision-making



Definition

Acknowledging the need to make decision-making more systematic and consistent, *principle-based decision-making* strives to base choices or decisions in a fair and just manner on a firm foundation of commonly understood and accepted principles (including risk-based) with a view to:

- Facilitating objective consensus seeking, as far as this is possible; and
- Ensuring the defensibility of decisions.

The following principles enable *principle-based decision-making*:

Principle inclusiveness

Acknowledging that consideration of all relevant principles is essential for defensibility, *principle inclusiveness* strives to ensure that all relevant principles are considered and this is done in line with current legislation (*e.g.* considering the legal status of the Reserve).

Due diligence

Acknowledging that adequate consideration must be afforded each relevant principle, *due diligence* ensures that each principle is afforded an appropriate degree of attention.

Integrated balance

Acknowledging that, in any given context, principles may compete and, in different contexts, they may vary in their relative importance, *integrated balance* strives to consider relevant principles in a balanced manner with a relative importance being afforded to each, appropriate to the context.

Due process

Acknowledging the importance of consistency and objectivity, *due process* strives to carry out procedures in accordance with legislation, in particular the Promotion of Administrative Justice Act (3:2000) or agreed guidelines.

The following principles are enabling principles of the above four principles:

Effective stakeholder engagement

As defined in section 5.4.1.

General legislative alignment

As defined in section 5.5.2.

5.2.2 Creative problem solving

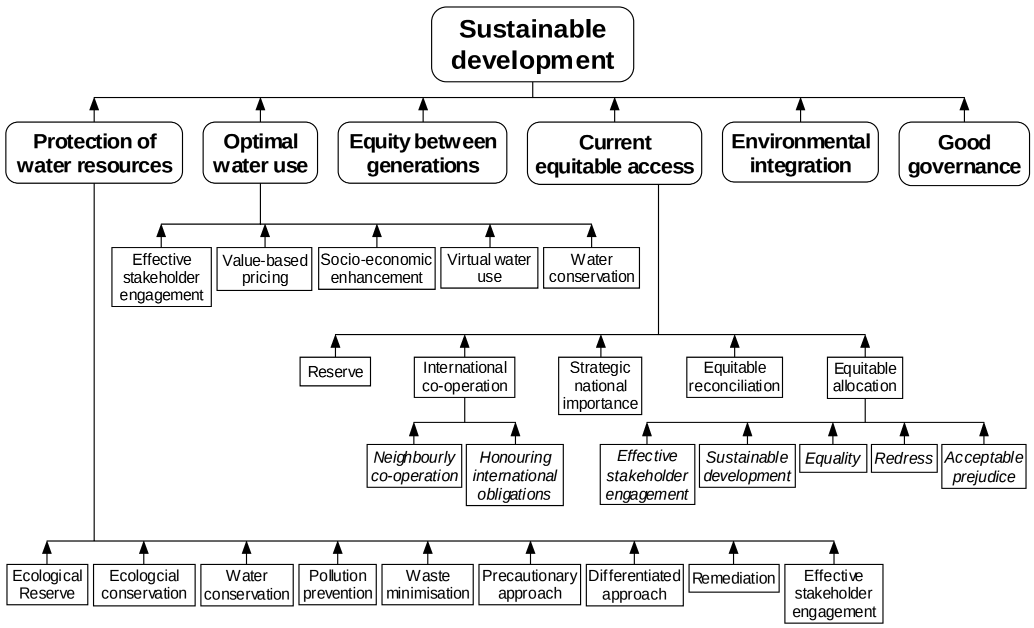
Definition

Acknowledging:

- The complex technical and social challenges facing water quality managers, and
- The need to question the use of compromise as the most immediately obvious solution to a problem,

creative problem solving strives for imaginative thinking in the search for optimum win-win solutions to problems in a technical, socio-economic and ecological sense (*e.g.* in taking account of the balance sought between protection and use).

5.3 Sustainable development



Definition

Acknowledging that:

- Ecological, socio-economic and political factors are interdependent,
- National and international stakeholders deserve just and fair access to the benefits of our shared water resources,
- Future generations have the same basic rights as ourselves,
- Growth is not possible without development,
- All life is dependent, either directly or indirectly, on the healthy functioning of aquatic ecosystems,
- Most kinds of water uses impact negatively on the health of ecosystems, and
- Demand for ecosystems services often exceeds supply and that these ecosystems are limited in their capacity to provide these services,

sustainable development endeavours to ensure that future generations can meet their own needs while promoting socio-economic development and improved quality of life for all in the current generation. This should be done in a manner that uses water resources in general, and water quality in particular, within the ability of the ecosystems to satisfy such needs now and in the future.

Legal requirement

Sustainable development is explicitly promoted by the Constitution (108:1996), and the National Water Act (36:1998) and is given legal effect by the National Environmental Management Act (107:1998).

Classification of principles

Sustainable development is traditionally seen as requiring a balance between ecological, social and economic considerations. Figure 5.1 illustrates such a classification for the enabling principles of *sustainable development* based strictly on the definitions that follow. It simply illustrates that sometimes the lower level principles that may need to be balanced in order to achieve *sustainable development* can occur in quite different realms.

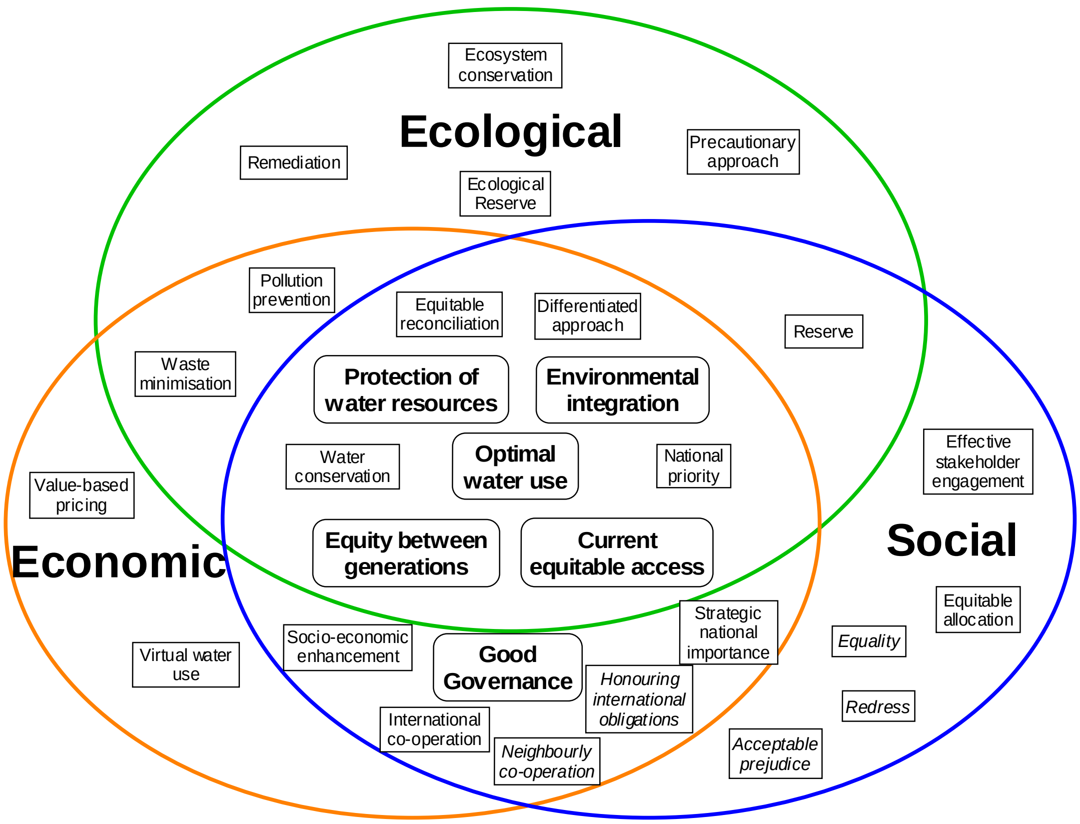


Figure 5.1: Possible classification of sustainable development principles as ecological, economic or social. (The formatting of individual principles corresponds to the hierarchy illustrated above).

5.3.1 Protection of water resources

Definition

Acknowledging that:

- All life is dependent, either directly or indirectly, on the healthy functioning of aquatic ecosystems, and
- Although many aquatic ecosystems exhibit some resilience to negative impacts, their ability to recover has limits, and
- Demand for the benefits from the associated water resources frequently exceeds supply, and that
- There is potential for water resources to be over-utilised for excessive short-term benefits that will compromise their ability to sustain the long-term provision of these benefits,

protection of water resources focuses specific efforts on maintaining and improving the integrity of water resources and of their water quality in particular, and thus regaining or sustaining their capacity to provide goods and services.

The following principles enable *protection of water resources*:

Ecological Reserve

Acknowledging that the health of aquatic ecosystems in a particular management class must be maintained to enable them to sustain intrinsic ecological functions, the *ecological Reserve* strives to ensure that an appropriate quantity and quality of water is reserved for the healthy functioning of aquatic ecosystems.

Ecological conservation

Acknowledging that the current generation has a moral responsibility to protect the healthy functioning of ecosystems, including their chemical, physical and biological processes, and biodiversity, *ecological conservation* strives to maintain the integrity of natural ecosystems in their own right and in particular their natural water quality because of its intrinsic value. *Ecological conservation* is explicitly promoted in the Constitution (108:1996).

Water conservation

As defined in Section 5.3.2.

Pollution prevention

("Prevention is better than cure.") Acknowledging:

- The potential for irreversible negative impacts, and
- Potentially expensive and long-term remediation during which time those water resources are unable, or have reduced capacity, to provide benefits,

pollution prevention entails avoiding:

- Degradation of water resources, and water quality in particular, in the first place, and
- Further degradation of that which may already have been impacted negatively.

Pollution prevention is explicitly promoted in the Constitution (108:1996), the National Water Act (36:1998) and the National Environmental Management Act (107:1998).

Waste minimisation

Acknowledging that degradation of water resources can often not be avoided altogether, *waste minimisation* strives to reduce waste produced as much as is economically and socially possible. Typically this involves such approaches as recycling and re-use of waste or water containing waste, waste recovery, waste treatment (such as detoxification or neutralisation) and the use of cleaner technologies and best management practices.

Precautionary approach

Acknowledging that when a lack of scientific certainty exists regarding impacts, there is a risk of unpredictable negative ecological impacts, the *precautionary approach* ensures that risk-averse and conservative decisions or actions are implemented to minimise these risks. Equivalently, this lack of certainty will not be used as a reason for postponing cost-effective measures to prevent the impacts.

Differentiated approach

Acknowledging that catchments differ fundamentally:

- In an ecological sense, and
- In the way they are used, and
- In the extent of such use,

the *differentiated approach* strives to ensure that catchment-specific conditions are taken into account in all management decisions.

Remediation

Acknowledging:

- The current degraded, and deteriorating, state of some water resources, and that
- Attempts to improve the quality of some of these water resources will require more actions than controlling current active water use,

remediation strives to intervene directly in (a) degraded land, to minimise contamination risk to a water resource, or (b) a degraded water resource, to maintain or improve water quality in the water resource. (Remediation is sometimes also referred to as rehabilitation.)

Effective stakeholder engagement

As defined in section 5.4.1.

5.3.2 Optimal water use

Definition

Acknowledging that growth is not possible without development, *optimal water use* strives to promote socio-economic development and hence improved quality of life resulting from the use of water, and water quality in particular, in a manner that leads to the best alternative use in the public interest.

The best alternative use applies in two contexts:

- Each individual water use should provide for a very favourable socio-economic development and improved quality of life (*i.e.* be a beneficial use, as implied in the National Water Act (36:1998)).
- The overall portfolio of water uses should be an optimal combination of such individual uses. For example, at the highest level, a favourable balance between inter-sectoral uses should be achieved.

The following principles, when appropriately balanced, enable *optimal water use*.

Effective stakeholder engagement

As defined in section 5.4.1.

Value-based pricing

As defined in section 5.5.7.

Socio-economic enhancement

Acknowledging that:

- Social benefits (such as skills development, job creation, wealth creation and improved health levels), and
- Direct economic gains

impact positively on the general well-being and quality of life of people, leading to:

- An increased likelihood of further investment either financially or in kind, and
- Improved perceptions of the value of good water quality,

socio-economic enhancement strives to support initiatives that result in such social benefits, economic gains, poverty eradication and improved quality of life.

Virtual water use

Acknowledging that an holistic perspective of optimal water use is important, *virtual water use* strives to ensure that the costs and benefits of using alternative, even foreign, sources of water to achieve desired local socio-economic advantages are carefully considered.

For example, this includes considering importing agricultural products from other regions or even other countries where less (or no) water quality stress exists. In other words, the costs associated with importing such a product from an area under less water stress should be weighed against the costs of producing that product locally, especially when the local area is water stressed.

Water conservation

Acknowledging that water scarcity and deteriorating water quality significantly worsens the potential impacts of wasting water and water quality (*i.e.* reducing water quality for no demonstrable benefit), *water conservation* strives for efficient use and minimising such waste.

5.3.3 Equity between generations

Definition

Acknowledging that future generations have the same basic rights as ourselves to:

- Sufficient water of adequate quality; and
- Healthy ecosystems,

equity between generations promotes socio-economic enhancement that does not compromise these rights.

This principle, sometimes referred to as "inter-generational equity", underpins the Department's vision of "ensuring some, for all, forever, together".

5.3.4 Current equitable access

Definition

Acknowledging that:

- The current generation of national and international stakeholders deserve just and fair access to the benefits of our water resources, and
- A wide variety of needs and preferences exist relating to access to the goods and services of our water resources, and water quality in particular, and
- *Equity between generations* is more likely to be achieved if equitable access exists in the current generation,

current equitable access strives to fairly and justly balance the priority needs of the nation with other socio-economic developmental needs of the current generation by basing decisions relating to access to these water resource goods and services on the enabling principles below.

This principle is sometimes referred to as "intra-generational equity".

The following principles, when appropriately balanced, enable *current equitable access*:

Reserve

Acknowledging the importance of:

- The basic human needs of all the people of South Africa, and
- The appropriate water needs of ecosystems to enable them to sustain intrinsic ecological functions,

the *Reserve* strives to ensure an appropriate quantity, quality and assurance of water for these two purposes.

The basic human needs *Reserve* is a basic right to all and, with the *ecological Reserve*, enjoys priority.

International co-operation

Acknowledging that:

- South African water resources are part of the global water cycle, and
- Our water resources cannot be managed in isolation, and that
- Two thirds of our land area lies in international catchments that are shared with our neighbours (Turton, 2003),

international co-operation promotes responsible management of our water resources in a globally sustainable and co-operative manner.

The following, potentially competing, principles enable *international co-operation*:

Neighbourly co-operation: Acknowledging that our neighbouring countries deserve fair access to the benefits of our shared water resources, *neighbourly co-operation* promotes sharing of these benefits in a spirit of mutual co-operation.

Honouring international obligations: Acknowledging our integral part in the international community, *honouring international obligations* strives to live up to and abide by formal obligations relating to our water resources on a global scale.

Strategic national priority

Acknowledging that some water needs are of fundamental importance at a national level, the meta-principle *strategic national priority* applies the following relative importance to the above principles and other priorities:

- First, the *Reserve*, then
- *Honouring international obligations*, then
- Strategic uses (such as electricity generation), then
- Strategic future growth (in special circumstances), then
- Inter-basin transfers.

Equitable reconciliation

Acknowledging the Department's commitment to holistic and integrated water resource management, *equitable reconciliation* strives to find an 'equitable balance' between the water quality that can reasonably be supplied with the water quality requirements of all water users. This will be done in a way that is just and fair in the sense of being based on laws and accepted principles.

Equitable allocation

Acknowledging:

- The severity of the inequalities of the past in South Africa, and that
- The remaining allocatable resource, relating to water quality in particular, (*i.e.* remaining after the strategic national priorities have been addressed) can be regarded as an economic good, and that
- Flexibility in the level of protection is provided by the management class,

equitable allocation strives to ensure that decisions regarding the allocation (or non-allocation) of that remaining resource are just and fair by being soundly based on the following enabling principles.

Effective stakeholder engagement: As defined in section 5.4.1.

Sustainable development: As defined in section 5.3. The iterative nature of *equitable allocation* of resources and *sustainable development* itself is inevitable. The allocation of a portion of a resource (that is regarded as an economic good) to current water users may threaten *sustainable development* directly by challenging the principle of *protection of water resources*. Therefore *equitable allocation* is an enabling principle of *sustainable development*.

However, to minimise this threat:

- In the absence of a formal resource classification the enabling principles of *sustainable development*, and their relative importance, must be extremely carefully considered for every allocation decision. This is because the 'first line of defence' (*i.e.* the formal classification) does not yet exist. In this scenario, *sustainable development* can be directly threatened by an inappropriate allocation decision.

- When a formal resource classification is available, and hence a 'first line of defence' exists for *sustainable development*, the enabling principles of *sustainable development* remain the most appropriate criteria upon which to base allocation decisions. In effect, this provides a 'second line of defence' for *sustainable development*, *i.e.* at a finer resolution.

Therefore, *sustainable development* must be an enabling principle of *equitable allocation* in both these scenarios.

Equality: Acknowledging that everyone is constitutionally entitled to the full and equal enjoyment of all rights and freedoms, *equality* strives for non-discrimination on the basis of race, gender, sex, pregnancy, marital status, ethnic or social origin, colour, sexual orientation, age, disability, religion, conscience, belief, culture, language or country of birth.

Redress: Acknowledging:

- The severity of past inequalities in South Africa, and
- The need to fast-track achievement of equality,

redress justly promotes preferential consideration being given to persons that were subject to such past discriminatory practices.

Note that, by this definition, *redress* contradicts the principle of *equality*. Nevertheless, *redress* is regarded as a temporary principle that is relevant at this point in our history, since it is aimed ultimately at fast-tracking the achievement of *equality*. It might also be noted that *redress* is constitutional (Section 9(2)).

Acceptable prejudice: Acknowledging that in some cases allocations involve inevitable negative impacts on some stakeholders or aquatic ecosystems, *acceptable prejudice* accepts these allocations if the impacts are such that they are not significantly detrimental to those stakeholders or aquatic ecosystems.

5.3.5 Environmental integration

Definition

Acknowledging that:

- All physical, chemical and biological components, particularly including those comprising water quality, and the processes within natural water resources directly or indirectly affect, or are affected by, ecological, social and economic factors, and
- The effects of, or on, ecological, social and economic factors can be either harmful or beneficial and these effects can be expressed in either monetary or non-monetary terms,

environmental integration holistically considers all important interactions with, and within, ecosystems and water quality in particular.

Environmental integration also includes the consideration of:

- Public, scientific and technical issues, and
- All possible options related to an envisaged development.

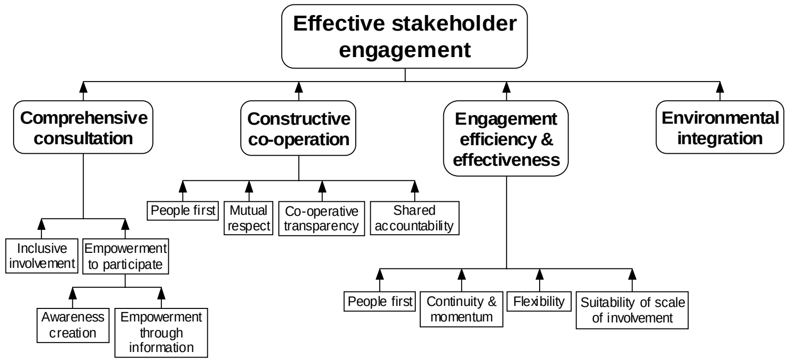
5.3.6 Good governance

Definition

As defined in Section 5.5.5.

5.4 Stakeholder engagement

5.4.1 Effective stakeholder engagement



Definition

Acknowledging that decisions relating to water quality allocation should be made "in the public interest", *effective stakeholder engagement* strives for ongoing mutually beneficial interaction between all stakeholders or their representatives. It aims to create an enabling environment for their meaningful and constructive engagement during all stages of projects and processes. It is done specifically so that the decision-maker can make a decision that considers the needs and preferences of all stakeholders.

Stakeholders vs. role players

A distinction is made between stakeholders and role players in this process. 'Stakeholders' are those who have a direct interest in or directly affect, or are affected by, water resources in general and water quality in particular (often referred to as "Interested and Affected Parties"). 'Role players' may include the stakeholders, government departments (often the decision-maker), stakeholder engagement facilitators and technical specialists.

The definition and interpretation of this principle and the enabling principles that follow are based largely on DWAF (2001a) and van Wilgen *et al.,* (2003). The term 'stakeholders' should be assumed to mean 'stakeholders or their representatives'.

Comprehensive consultation

Acknowledging that:

- Water quality management in a complex socio-economic and political setting requires co-operation between the various resource users; and
- All stakeholders must be included if the consultative process is to be socially and politically sound and legitimate,

comprehensive consultation endeavours to establish what is "in the public interest" by:

- Engaging and consulting all stakeholders, and
- Empowering them to make informed choices,

thus enabling them to articulate their needs and preferences in a meaningful and constructive manner.

The following principles enable *comprehensive consultation*:

Inclusive involvement: Acknowledging that co-operation between all stakeholders is essential, *inclusive involvement* aims to engage all stakeholders in a manner that ensures that all views are given due consideration and that no person is marginalised.

Empowerment to participate: Acknowledging:

- The importance of inclusive involvement, and that
- Confident and empowered stakeholders contribute more effectively,

empowerment to participate strives to ensure that all stakeholders have the capacity to contribute meaningfully.

Empowerment through information: Acknowledging that empowerment of stakeholders is essential, *empowerment through information* promotes the timely provision of appropriate information to stakeholders in an accessible language and terminology.

Awareness creation: Acknowledging the importance of:

- Empowering stakeholders, and
- Creating trust and co-operation among all stakeholders,

awareness creation strives to make stakeholders aware of all relevant issues in a clear and truthful manner.

Constructive co-operation

Acknowledging that a positive approach to facing and dealing with issues with confidence is vastly preferable to conflict, *constructive co-operation* strives for a combined effort by all role payers that is positively productive.

The following principles enable *constructive co-operation:*

People first ("*Batho pele*"): Acknowledging the need for the facilitator to set an impeccable example in service delivery, applying the principles of *people first* (as defined in section 5.4.2) encourages other role players to behave with similar integrity.

Mutual respect: Acknowledging the positive reciprocal effects of respect for others, *mutual respect* strives for each role player to acknowledge and respect the knowledge (in all its forms), wisdom, culture, language, abilities, concerns and inputs of other role players.

Co-operative transparency: Acknowledging the importance of honesty and openness in creating trust among all stakeholders, *co-operative transparency* promotes forthright discussion with no "hidden agendas".

Shared accountability: Acknowledging the need for all role players to accept their due responsibility, *shared accountability* between role players promotes an acceptance of the need for acknowledging and sharing their respective commitments, costs and benefits of stakeholder engagement as well as a shared accountability for the successes and failures of the process. This is particularly relevant to the decision-maker who must consider all stakeholder needs and preferences and then make a decision, even if there is not complete consensus.

Engagement efficiency and effectiveness

Acknowledging that the capacity and resources of all role players are valuable and often limited, *engagement efficiency and effectiveness* promotes the focussed use of these resources while respecting the individual efforts and contributions of role players.

The following principles enable *engagement efficiency and effectiveness*:

People first ("*Batho pele*"): Acknowledging the need for the facilitator to set an impeccable example in service delivery, applying the principles of *people first* (as defined in section 5.4.2) encourages other role players to behave with similar efficiency and effectiveness.

Continuity and momentum: Acknowledging the importance of:

- Keeping all role players focussed, and
- Maintaining a clear goal-driven process,

continuity and momentum of the process ensures that:

(1) all role players

- Are involved continuously throughout the process,
- Receive ongoing feedback and have many opportunities for comment,
- Exchange information and share and evaluate ideas, and that

(2) monitoring and evaluation of progress occurs.

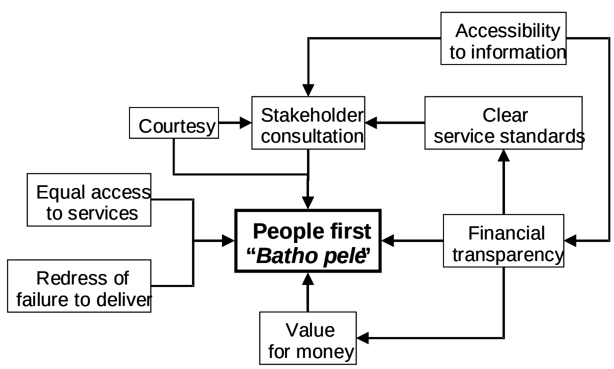
Flexibility: As defined for the adaptive management process (section 5.5.1).

Suitability of scale of involvement: Acknowledging the need for cost-effectiveness, *suitability of scale of involvement* ensures that financial and other resources committed to the process are in proportion to the potential impacts and possible interest.

Environmental integration

As defined for *sustainable development* (see section 5.3.5).

5.4.2 People first ("Batho pele")



Definition

Acknowledging that all stakeholders have a right to efficient and cost-effective service delivery, *people first* adheres to a service delivery code of practice that places a high priority on meeting the needs and preferences of stakeholders.

Source of principles

The following enabling principles are marginally adapted from those published by the Department of Public Services and Administration (www.dpsa.gov.za). As originally described, they apply specifically to service delivery by Government departments to the people of South Africa. The interpretation adopted here is that the enabling principles are applicable in any situation in which a service is being delivered. Accordingly, for example, "citizen" is replaced with "stakeholder" and "public service" is replaced with "service". *People first* amounts to a service delivery code of conduct and practice by people to people. Examples of such services include the following:

- Those offered by the facilitator of a stakeholder engagement process; or
- The services offered directly by a DWAF official or directorate or catchment management agency official to an applicant applying for a water use licence.

As defined here, service delivery does not apply to those goods and services supplied by a water resource. The service is supplied by a person or organisation.

The following principles enable *people first*:

Stakeholder consultation

Acknowledging that services must be focussed and effective, *stakeholder consultation* endeavours to establish directly from stakeholders the level and quality of services they want.

Clear service standards

Acknowledging the need for effective consultation, publishing *clear service standards*, including continual improvement and the associated monitoring informs stakeholders on what they can reasonably expect to receive.

Equal access to services

Acknowledging the need for *equality* among all stakeholders particularly physically, socially, economically and culturally disadvantaged persons, *equal access to services* strives to provide all stakeholders with equivalent access to the services to which they are entitled.

Courtesy

Acknowledging the need for effective consultation and ultimate service delivery, *courtesy* promotes politeness and consideration in all dealings with stakeholders.

Accessibility to information

Acknowledging the need for openness, transparency and efficient and effective consultation, *accessibility to information* involves facilitating the availability of complete, accurate and timely information on:

- The services stakeholders are entitled to receive and
- On the management process that will be followed.

Financial transparency

As defined for sound financial management (section 5.5.3).

Redress of failure to deliver

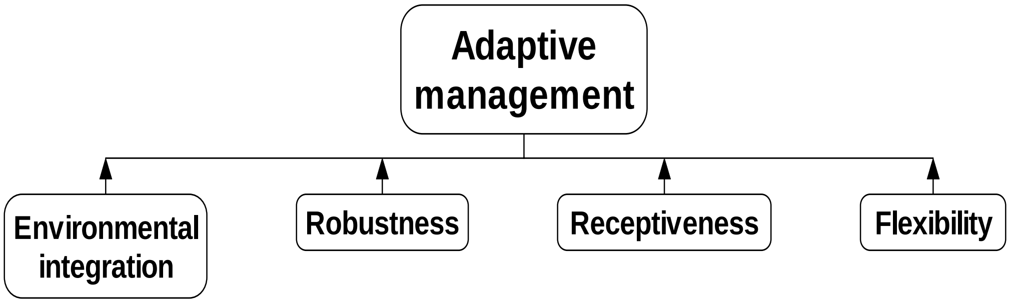
Acknowledging the need for efficient and effective service delivery, *redress of failure to deliver* promotes remedying problems efficiently and effectively.

Value for money

Acknowledging the right that stakeholders have to expect efficient and effective expenditure, *value for money* focuses on ensuring that capacity and resources are used wisely.

5.5 Management and governance

5.5.1 Adaptive management



Definition

Acknowledging that:

- Management of water resources is complex and multi-disciplinary, and
- Decisions need to be made in situations where there is frequently insufficient or uncertain data and information, and that
- Water resources are (1) in a state of continuous change and (2) are subject to unpredictable changes,

adaptive management strives for continuous management improvement in a dynamic yet systematic manner by balancing robustness with a flexibility that allows for change when circumstances may demand this.

Plan, implement, check & review

The dynamic cyclical process of "plan, implement, check, review" is an example of a system to which adaptive management is eminently applicable.

The following principles enable *adaptive management*:

Environmental integration

As defined in section 5.3.5.

Robustness

Acknowledging the need for any process to be perceived as consistent, *robustness* specifically strives for fundamental approaches that are soundly based, systematic and undeviating in their core objectives.

Receptiveness

Acknowledging that, in complex or uncertain situations, dynamic management (not complacency) is essential, *receptiveness* promotes:

- An open-minded consideration of new ideas (a 'push to change'), and
- Alertness to changes within a water resource that may signal the necessity for new approaches (a 'pull to change') to be developed and applied.

Flexibility

Acknowledging that:

- In complex situations, initial approaches may not be perfect, and
- Water resources change in predictable and unpredictable ways,

flexibility enables acceptance and the ability to adopt new and better ideas, or simply different management approaches that allow adaptation to changing circumstances when necessary.

5.5.2 General legislative alignment

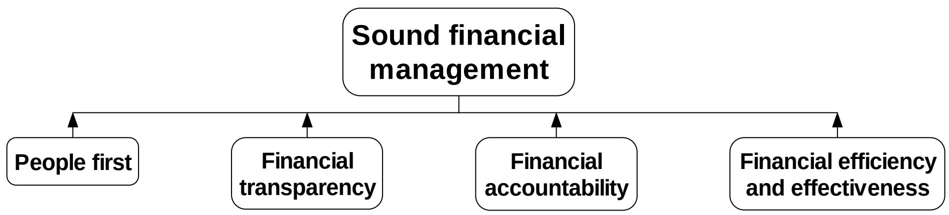
Definition

Acknowledging the presence and importance of legislation other than that of most immediate relevance, namely the National Water Act (36:1998), *general legislative alignment* strives to ensure that actions and decisions taken in accordance with the National Water Act support, or at least do not conflict with, other legislation. Such legislation may vary from Acts to ordinances, bylaws and other local regulations.

The following principle enables *general legislative alignment*:

Co-operative governance: As defined in section 5.5.5.

5.5.3 Sound financial management



Definition

Acknowledging the rightful expectations of financial contributors, such as tax payers, to achieving maximum benefits for the original purpose for which their contributions were intended, *sound financial management* strives for ethically correct and effective administration and control of all revenue, expenditure, assets and liabilities.

The following principles enable *sound financial management*:

People first ("*Batho pele*"): As defined in section 5.4.2.

Financial transparency

Acknowledging the importance of honesty and openness, *financial transparency* promotes financial procedures that can be confidently confirmed as sound by independent auditors.

Financial accountability

Acknowledging the importance of a sense of responsibility, *financial accountability* strives to encourage all financial officers to take full responsibility and accountability for their financial decisions.

Financial efficiency and effectiveness

Acknowledging that financial resources are frequently the most important factor limiting growth and development and hence that 'every Rand counts', *financial efficiency and effectiveness* strives to ensure that such resources are used to achieve the best *value for money*. Efficient administration is specifically promoted by the Promotion of Administrative Justice Act (3:2000).

5.5.4 Prudent pragmatism

Definition

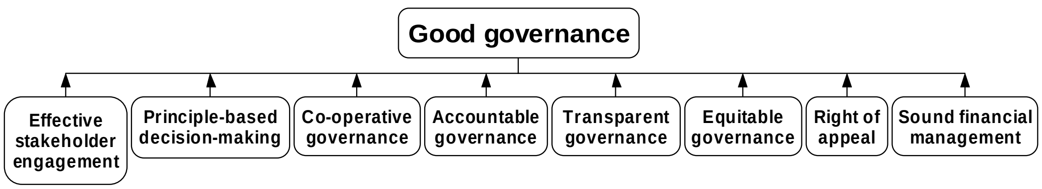
Acknowledging that:

- Implementation of many aspects of the National Water Act (36:1998) is time-consuming and expensive, and
- On-going water management and use is essential to growth and development, and
- Procrastination can have lasting significant negative impacts on *socio-economic enhancement*,

prudent pragmatism strives to apply with caution more practical (*i.e.* simpler and faster) methods as a basis for decision-making when appropriate.

The following principle enables *prudent pragmatism*:

Precautionary approach: As defined in section 5.3.1.



5.5.5 Good governance

Definition

Acknowledging the importance of integrity at all levels of management, *good governance* strives to ensure that all stakeholders:

- Manage their affairs with integrity and in a lawful manner, and
- Apply accepted principles and procedures.

Good governance is specifically promoted by the Promotion of Administrative Justice Act (3:2000).

The following principles enable *good governance*:

Effective stakeholder engagement

As defined in section 5.4.1.

Principle-based decision-making

As defined in section 5.2.1.

Co-operative governance

Acknowledging:

- The complexity of water resource management in South Africa, and that
- Many government organisations have related and even overlapping responsibilities for such management, and that
- Alignment with a common goal is essential to ultimate successful management,

co-operative governance strives to ensure that organs of state and spheres of government manage related affairs in a collectively constructive and co-operative manner.

Accountable governance

Acknowledging the need for all role players to accept their due responsibility, *accountable governance* strives to create an ethic of taking full responsibility for actions, particularly in accordance with the Promotion of Administrative Justice Act (3:2000) and Promotion of Access to Information Act (2:2000).

Transparent governance

Acknowledging the importance of honesty and openness, *transparent governance* promotes:

- Application of procedures that are open to scrutiny, and
- Keeping an adequate 'record of decision' giving reasons for the decision that can be made available in accordance with the Promotion of Administrative Justice Act (3:2000) and Promotion of Access to Information Act (2:2000).

Equitable governance

Acknowledging the importance of being just and fair, *equitable governance* strives to ensure that governance is based on accepted procedures and principles.

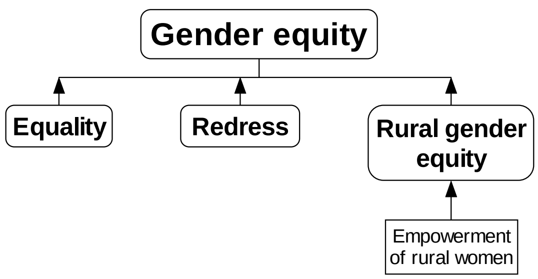
Right of appeal

Acknowledging the importance of an independent judicial system, *right of appeal* strives to ensure that an appropriate system is in place that enables appeals to be heard against decisions made by the Department.

Sound financial management

As defined in section 5.5.3.

5.5.6 Gender equity



Definition

Acknowledging:

- The severity of the inequalities of the past in South Africa, and specifically,
- The degree of discrimination against women in the past, and
- The unique role played by rural women, in particular, in local water affairs,

gender equity strives to ensure that women are afforded their rightful place in water, and water quality, management at all levels.

Social construct

It is recognised that gender is a social construct defining relations, including power relations, which define social function on the basis of sex (Schreiner, 2001).

The following principles enable *gender equity*:

Equality

As defined for *equitable allocation* (section 5.3.4)

Redress

As defined for equitable allocation (section 5.3.4)

Rural gender equity

Acknowledging:

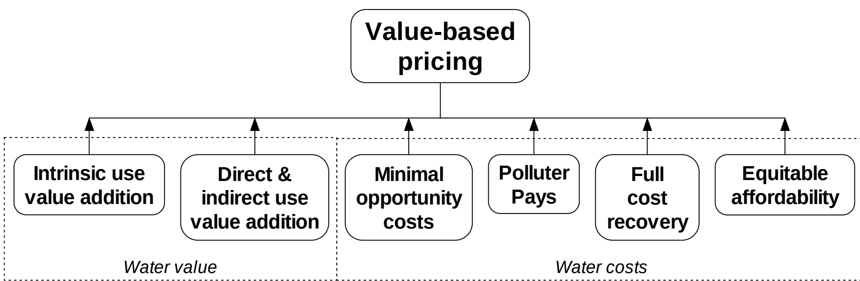
- The logistical and physical difficulties often associated with water collection and transport in rural communities, and
- The traditional responsibility of women to perform these tasks, and
- The traditional responsibility of women relating to provision of health care to their families, and
- The significance of these responsibilities, and
- The importance of local culture relating to gender issues,

rural gender equity strives to ensure that women in rural communities are afforded their rightful place in local water quality management.

The following principle enables *rural gender equity*:

Empowerment of rural women: Acknowledging that the nature of their responsibilities relating to the provision of water and health care to their families makes rural women natural primary stakeholders in local water quality management, *empowerment of rural women* strives to empower such women to contribute meaningfully to local water quality management to a degree that is commensurate with this responsibility.

5.5.7 Value-based pricing



Definition

Acknowledging that if water prices reflect the true value of water, it will be used more efficiently, *value-based pricing* strives to price water in a manner that reflects its true economic value, *i.e.* financial, social and ecological.

The following principles enable *value-based pricing* (King, 2003):

Intrinsic use value addition

Acknowledging that water can have a spiritual value, *intrinsic use value addition* strives to ensure that the contribution that water makes to our spiritual well-being is considered.

Direct & indirect use value addition

Acknowledging that the material use of water can add to its value, *direct & indirect use value addition* strives to ensure that the contribution that water makes to the net benefits of either productivity or income generation (financial and social-economic) through direct and indirect use is considered.

Minimal opportunity costs

Acknowledging that individual water uses should be considered holistically, *minimal opportunity costs* strives to ensure that the costs (financial, socio-economic and ecological) associated with the opportunity that may be lost by allocating water quality to a particular user over another are minimised.

Polluter pays

Acknowledging that polluters should not impact on ecosystem health, or lead to costs for other water users as a result of their pollution, *polluter pays* strives for "internalisation of externalities" (see glossary) to ensure that those responsible for ecological degradation are accountable for costs, in proportion to the impact caused, relating to:

- *Remediation*,
- Preventative measures to reduce or prevent further degradation,
- Production losses by others, and
- Human health impacts.

Full cost recovery

Acknowledging the basic importance of sustainable financial viability, *full cost recovery* strives to ensure that the financial costs (capital, operation and maintenance) incurred in the supply of water, and water quality in particular, are fully recovered.

Equitable affordability

Acknowledging the importance of a "level playing field", *equitable affordability* strives to minimise unfair competition for the productive use of water, and water quality, for socio-economic development.

The following principles enable *equitable affordability*:

Equality: As defined in section 5.3.4.

Redress: As defined in section 5.3.4.

SECTION 6: GLOSSARY

Allocatable water quality. The maximum worsening change in any water quality attribute away from its present value that maintains it within a pre-determined range reflecting the desired future state (typically defined by a resource quality objective). If the present value is already at or outside the pre-determined range, this indicates that none is allocatable and that (a) reduced pollution loads relating to the affected attribute(s) and/or (b) remediation of the resource may be necessary.

Best practicable environmental option. Defined by the National Environmental Management Act (107:1998) as the option that provides the most benefit, or causes the least damage to the environment as a whole, at a cost acceptable to society, in the long-term as well as in the short-term.

Decision-making. An intellectual activity comprising the making of a rational choice between alternatives.

Degradation. Reduction in quality.

Equality. As defined in Section 9 of the Constitution, equality implies that decisions regarding water resources may not discriminate on the basis of race, gender, sex, pregnancy, marital status, ethnic or social origin, colour, sexual orientation, age, disability, religion, conscience, belief, culture, language or country of birth.

Equitable. Fair and just in the sense of being based on laws and accepted principles.

Equity. The quality of being equitable.

Fitness for use. A scientific judgement, involving objective evaluation of available evidence, of how suitable the quality of water is for its intended use or for protecting the health of aquatic ecosystems.

Internalisation of externalities. Externalities, also called external costs, spill-overs or social costs, are costs generated by a producer but paid for by someone else. A typical example is a water user that discharges polluted water into a stream. The downstream user may then need to treat the water before it can be used. This treatment in effect means that the downstream user is paying part of the production costs of the upstream user. Internalising these externalities means the polluter should be responsible for these costs. (Adapted from www.csir.co.za/era/policy/Ap_inte.html.)

Management instruments. Detailed procedures and guidelines that enable the strategy to be implemented.

Meta-principle. A principle providing guidance on the relative importance of principles.

Minimum requirements. A regulation or standard set by the Department that specifies the very least that should be complied with.

Monitoring. The measurement, assessment and reporting of selected properties of water resources in a manner that is focussed on well-defined objectives. These monitoring objectives should also be clearly linked to water resource management objectives.

Monitoring design. The definition of all aspects necessary for successful implementation of a monitoring programme. These include the monitoring variables, sampling site selection, sampling methods, sampling frequency, analytical procedures, data assessment, reporting formats, etc.

Policy. Guidance for decision-making and action that helps to set priorities and hence allocate human and financial resources.

Pollution. Defined by the National Water Act as the direct or indirect alteration of the physical, chemical or biological properties of a water resource so as to make it:

1. Less fit for any optimal water use for which it may reasonably be expected to be used, or
2. Harmful or potentially harmful to (a) the welfare, health or safety of human beings, (b) any aquatic or non-aquatic organisms, (c) the resource quality or (d) to property.

Preliminary classification. An interim classification of a water resource established in the absence of the formal classification system required by Section 12 of the National Water Act. A preliminary classification is permitted in terms of Section 14.

Preliminary resource quality objectives. An interim resource quality objective established in the absence of the formal classification system required by Section 12 of the National Water Act. Preliminary resources quality objectives are permitted in terms of Section 14.

Principle. A statement providing guidance on what should be strived for, typically acknowledging an underlying values-based assumption.

Quality of life. Physical, psychological, social, cultural, religious and material wellbeing.

Redress. To put right by compensation. In the current context, to redress is to explicitly favour persons that were subject to past discriminatory practices. It contradicts explicitly the principle of equality. It is, nevertheless, constitutional (Section 9(2)).

Reserve. Defined by the National Water Act as the quantity and quality of water required:

1. To satisfy basic human needs by securing a basic water supply, as prescribed under the Water Services Act (108:1997), for people who are now or who will in the reasonably near future, be (a) relying upon, (b) taking water from or (c) being supplied from, the relevant water source; and
2. To protect aquatic ecosystems in order to secure ecologically sustainable development and use of the relevant water resource.

Since the Reserve is a legally binding quantity, it is typically not subject to rivalry. However, its very nature creates excludability since water uses not encompassed by basic human needs and maintaining aquatic ecosystem health are explicitly excluded. Therefore, the Reserve is strictly a quasi-public good.

Resource quality. Includes all aspects of water quantity, water quality and aquatic ecosystem quality, the latter including the quality of in-stream and riparian habitats and aquatic biota.

Resource quality objectives (RQOs). Numeric or descriptive (narrative) goals for resource quality within which a water resource must be managed. These are given legal status by being published in a *Government Gazette*.

Resource water quality objectives (RWQOs). Numeric or descriptive (narrative) in-stream (or in-aquifer) water quality objectives typically set a finer resolution (spatial or temporal) than RQOss that provide greater detail upon which to base management of water quality

Source Management Objectives. Objectives relating to (a) incremental reduction, (b) maintenance or, under special circumstances, (c) incremental increase in waste loads, calculated to give effect to resource water quality objectives. They refer to the water resource management unit as a whole, not to specific water users, though they do consider technical, economic and administrative realities.

Stakeholder. An individual, group or organisation that has an interest in, or is affected by, an initiative and who may therefore affect the outcome of an initiative.

Strategic use. A water use (such as electricity generation) of strategic national importance as defined in the National Water Resource Strategy or designated as such by the Minister.

Strategy. Broad course of action focussed on the implementation of a policy.

Stress, water quality. A state in which the water quality is inadequate for the desired or designated water use. For many uses, water quality stress exists when there is no allocatable water quality.

Stressed water resource. A water resource for which the demand for benefits exceeds the supply. This can apply to either the quantity of water or the allocatable water quality.

Vulnerability: Susceptibility to harm.

Waste. Defined by the National Water Act as including any solid material or material that is suspended, dissolved or transported in water (including sediment) and which is spilled or deposited on land or into a water resource in such volume, composition or manner as to cause, or to be reasonably likely to cause, the water resource to be polluted.

Water allocation. The apportionment of water or allocatable water quality among water users.

Watercourse. Defined by the National Water Act as a river or spring, a natural channel in which water flows regularly or intermittently, a wetland, lake or dam into which, or from which, water flows and any collection of water that the Minister may declare to be a watercourse. Furthermore, reference to a watercourse includes, where relevant, its bed and banks.

Water Management Institution. Defined by the National Water Act as a catchment management agency, a water user association, a body responsible for international water management or any person who fulfils the functions of a water management institution in terms of the Act.

Water quality. The physical, chemical, radiological, toxicological, biological and aesthetic properties of water that (1) determine its fitness for use or (2) that are necessary for protecting the health of aquatic ecosystems. Water quality is therefore reflected in (a) concentrations of substances (either dissolved or suspended), (b) physico-chemical attributes (*e.g.* temperature), (c) levels of radioactivity and (d) biological responses to those concentrations, physico-chemical attributes or radioactivity.

Water resource. Defined by the National Water Act as including a watercourse, surface water, estuary or aquifer.

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Principles in *italics*; Definitions on **bold** pages.

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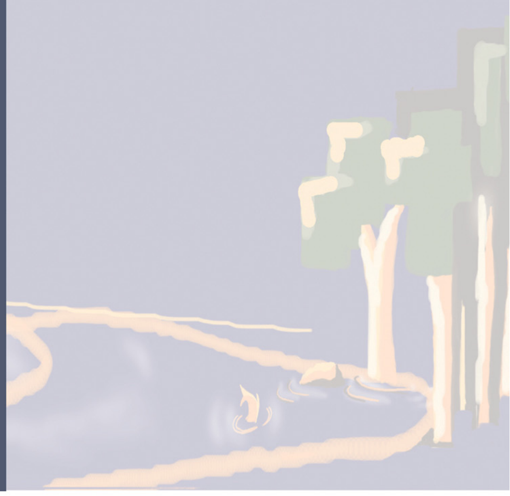

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DOCUMENT INDEX

Reports as part of this project:

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1.2	National and International Literature Survey and Contextual Review
1.3	Glossary of terminology often used in the Resource Directed Management of Water Quality
1.4	Volume 1: *Policy Document Series*
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1.8	Implementation Plan

Bold type indicates this report

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EXECUTIVE SUMMARY

"Making water resource management water quality friendly"

Policy implementation

This strategy provides the general implementation plan for the resource directed management of water quality policy ("the Policy") (DWAF, 2005a). It describes "who should do what by when" and is presented in a way that explicitly links the Policy and its principles with specific management approaches and instruments to facilitate its practical implementation.

Sustainable development

The link between the adaptive "Plan-Implement-Check-Review" cycle of Integrated Water Quality Management (IWQM) and sustainable development is described as well as how this plays out at various levels (varying from short-term to long-term).

An approach to balancing the principles of sustainable development is also proposed. In particular, how this should be done to achieve socio-economic development is presented. An example is also presented of how strict protection of ecosystems can be achieved where appropriate. A simple familiarisation plan for inexperienced practitioners is also proposed.

Institutional arrangements

How the institutions will evolve during the phased decentralisation of water management roles and responsibilities from the Department to Clusters and catchment management agencies (CMAs) is described. Specific challenges and institutional implications are identified. The phases include:

- Phase 1: Post restructuring (current,
- Phase 2: Decentralisation to Clusters,
- Phase 3: CMAs establishment, and
- Phase 4: Fully functional CMAs.

Roles and responsibilities within the Department for IWQM management functions are presented as well as roles played by external stakeholders, and local, regional and national government departments.

The various facets of institutional capacity are also identified.

Summary strategies

Summary strategies are provided for a series of well-defined scenarios. In each case, the reader is (a) referred to associated enabling principles in the Policy and (b) provided with references to guidelines and further reading that will provide the necessary detail.

Scenarios include:

- Catchment assessment,
- Catchment visioning,
- Determining resource directed measures (RDM), including addressing issues of confidence, and water quality variables of concern, and

- Giving effect to RDM, including developing catchment management strategies, attaining a management class, maintaining a management class, managing point and non-point sources, water use authorisation, long-term non-compliance with resource quality objectives (RQOs), non-compliance with licence conditions and remediation.

Water quality monitoring is also addressed.

Capacity creation and maintenance

Capacity creation for the short-term and long-term as well as internal and external to DWAF is described. The short-term strategy focuses on empowering external stakeholders and creating knowledgeable DWAF staff. The long-term strategy focuses on adapting to changing external stakeholder demands (for awareness and empowerment) and refining and improving the capabilities of DWAF staff. The ultimate aim is to facilitate creation of a learning institution in which appropriate knowledge is created.

A three-dimensional approach to empowering DWAF staff for sustainable management is also proposed (objective empowerment, competence, and subjective empowerment).

Action Plan

An immediate action plan is proposed to "kick start" appropriate data collection and information generation in support of resource directed management of water quality. It is based on defining resource water quality objectives (RWQOs) in priority catchments that can begin to generate nationally consistent water quality information in anticipation of determination of RQOs when the classification system is developed.

The development of a detailed capacity creation plan is also recommended.

Management approaches

A brief summarised description is also provided (in the appendix) of management approaches available to IWQM practitioners. These include:

- Regulatory (general authorisations, command-and-control – *ad hoc* licensing, compulsory licensing, RQOs, Reserve, directives, etc. – , and economic – pricing strategy, waste discharge charge system), and
- Non-regulatory (civil society, self-regulatory, and supportive).

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ACRONYMS

CMAs	Catchment Management Agency
CMS	Catchment Management Strategy
CSD	Committee for Sustainable Development
DBSA	Development Bank of South Africa
DEAT	Department of Environmental Affairs & Tourism
DME	Department of Minerals & Energy
DoA	Department of Agriculture
DTI	Department of Trade & Industry
DWAF	Department of Water Affairs & Forestry
ECA	Environment Conservation Act
EMS	Environmental Management System
EMPR	Environmental Management Plan Report
IDPs	Integrated Development Plan
ISO	International Organization for Standardization
ISP	Internal Strategic Perspective
IWQM	Integrated Water Quality Management
IWRM	Integrated Water Resource Management
NQF	National Qualifications Framework
NWA (36:1998)	National Water Act
NWRS	National Water Resource Strategy
P&R	Policy and Regulation
PGDS	Provincial Growth and Development Strategy
PSIR	Pressure-State-Impact-Response
RDM	Resource Directed Measures
RDMWQ	Resource Directed Management of Water Quality
RO	Regional Office (DWAF)
RQOs	Resource Quality Objective
RWQOs	Resource Water Quality Objective
SAQA	South African Qualifications Authority
SDCs	Source Directed Controls
SMO	Source Management Objective
WDCS	Waste Discharge Charge System
WMIs	Water Management Institutions
WQ	Water Quality
WQM	Water Quality Management
WRM	Water Resource Management
WSDPs	Water Services Development Plan

SECTION 1: SUMMARY STRATEGY

1.1 Introduction

The objective of this strategy is the implementation of the resource directed management of water quality policy ("the Policy") (DWAF, 2005) of the Department of Water Affairs and Forestry ("the Department"). It addresses "who should do what by when", explicitly linking the Policy to management approaches and management instruments to facilitate its practical and pragmatic implementation. It is also the intention that, in some contexts, this strategy presents a first level of interpretation of the policy.

Simultaneous review of this strategy with the Policy every five years in respect of objectives and effectiveness is recommended.

1.2 Sustainable development

1.2.1 Integrated water quality management

Integrated water quality management should be implemented in a cyclical process aimed at continual improvement (fundamental to the principle of adaptive management). This cycle occurs at a number of different levels. They range from individual (local) source and resource management initiatives (short-term) through re-consideration of the catchment management strategy (medium-term) to re-consideration of the resource directed measures and vision (long-term).

The principles of sustainable development apply at all stages. However, the designated resource management class is the 'first line of defence' against development that is unsustainable. The 'second line of defence' is embodied in the catchment management strategy and its implementation through resource directed measures, individual source directed controls and resource management initiatives.

1.2.2 Balancing the principles

The emphasis placed by the Policy on socio-economic development means that particular attention must be paid to the principles of current equitable access, optimal water use and environmental integration.

Current equitable access is achieved by first determining the Reserve and then allocating water quality to national priorities. The remainder is then allocated equitably, and with emphasis on optimal water use, to other users. Less emphasis is given to protection of water resources by accepting some degree of impact though not to the extent that the resource becomes unacceptably degraded and unsustainable.

When strict protection of water resources is warranted, the resource will typically be classified as Natural. In this case, it is the principles of protection of water resources, and by implication, equity between generations, that receive most emphasis. Importantly, this does not preclude other water uses. However, these water uses must be such that their impact on water quality is minimal and well within the ability of the ecosystem to sustain the provision of goods and services in order to maintain the management class.

As an example of how this emphasis might be applied, a related strategic national recommendation has been made in respect of freshwater biodiversity (DWAF, 2005n).

Balancing sustainable development principles is complex. To gradually increase the familiarity of practitioners with these principles, it is recommended that less experienced practitioners should first simply practice identifying what factors and actions refer to which principle. With experience, the explicit application of these principles in resource directed measures will become more evident.

1.3 Institutional arrangements

1.3.1 Phase institutional change

Institutional arrangements are dominated by transition to full decentralisation to catchment management agencies (CMAs) over four phases: *Phase 1* follows the recent restructuring of DWAF. Decision-making is shared between P&R and Regional Clusters, while systems are being developed and piloted. *Phase 2* is characterised by completion, or near-completion, of piloting and the establishment of stable macro-systems. As a result, further decision-making and implementation is transferred to the Regional Clusters, while the proto-CMAs take on those current regional cluster functions that centre on water use management and coordination. In *Phase 3* proto-CMAs are transferred, along with their functions and staff, from DWAF into the CMAs within the first 2 years. The CMAs are then formally established. In *Phase 4*, fully functional CMAs are established, with the majority of WRM implementation roles and responsibilities within the CMAs (including Responsible Authority functions).

1.3.2 Management effort

In Phases 1 and 2, management effort is reasonably evenly spread between P&R, Clusters and proto-CMAs. In Phase 3, with the establishment of the CMAs, all roles and responsibilities of the proto-CMAs are transferred to the CMAs along with a continuing shift of roles and responsibilities from P&R to Clusters to CMAs. P&R takes on new responsibilities centred on oversight and support – co-ordination, collaboration and transfer of information between CMAs, Clusters and P&R. In Phase 4, the CMAs is established and stabilised and now bears the majority of water quality management effort.

1.3.3 Institutional implications

Phases 2 and 3 will present the greatest challenges relating to capacity. Broad institutional capacity building will be required. When the CMAs become established, mentoring by DWAF and the Clusters will be particularly important.

1.3.4 Institutional roles

Water quality management inherently requires the management of activities and resources that are the mandate of other government departments or property of private sector entities. Key institutions include stakeholders, and local, regional and national government departments.

1.3.5 Institutional capacity

The process for building institutional capacity should (a) be carefully planned, and (b) establish coherent, simple and stable systems, introducing as much routine as available the capacity is able to deal with.

1.4 Implementation strategies

Resource directed management of water quality can occur in a very wide variety of contexts. The following sub-sections briefly summarise strategies in well-defined scenarios.

1.4.1 Catchment assessment

Catchment assessments should engage with stakeholders constructively, take cognisance of legislation such as the Promotion of Access to Information Act (2:2000), be appropriately integrative in their data collections and assessment, and be pragmatic in the allocation of financial and human resources according to the level of confidence required.

1.4.2 Catchment visioning

Catchment visioning is an indispensable component of this strategy and integrated water resource management in general. Although this strategy primarily addresses water quality management, visioning must encompass resource quality holistically and clearly identify how water quality issues contribute.

The context of the vision must be principle-based and should be the strategy to move towards the vision. Relevant legislation goes well beyond the National Water Act (36:1998). Stakeholders must be engaged in a way that (a) facilitates meaningful contributions, and (b) develops a sense of buy-in and, preferably, ownership. Catchment visioning initiatives should be carried out to a level of confidence appropriate to the circumstances.

1.4.3 Resource directed measures

1.4.3.1 General issues

The necessary degree of confidence required to determine of the management class, resource quality objectives (RQOs) and the Reserve must be determined by considering factors relating to:

- The immediate purpose of the RDM sub-process,
- The present ecological state,
- Potential changes in water quality, and
- Potential impacts of changes in water quality (*e.g.* relating to the ecological, social and economic sensitivity).

Appropriate water quality variables ('variables of concern') must be identified, which depend on:

- The nature of the individual water uses and their impacts,
- Ecosystem requirements, and
- The RQOs (both narrative and quantitative) that may exist.

The chosen variables must be:

- Representative of the water quality that matters the most to overall ecosystem health,
- Socially relevant and acceptable (*e.g.* relating to human health),
- Economically appropriate, and
- Institutionally sound and consistent across organisations.

1.4.3.2 Determining the resource management class and RQOs

Stakeholders must be empowered to make meaningful contributions. Specifically in respect of water quality, they must be sufficiently well-informed in respect of:

- The meaning and value of water quality in respect of (a) constituents, and (b) associated ecological responses and social and economic impacts of worsening water quality.
- The relationship between aquatic ecosystems and water quality, and
- The effects of their water uses on water quality and hence downstream users.

To facilitate integration across catchments, account must be taken of current and potential impacts upstream, downstream and on catchments receiving or donating water via inter-basin transfers.

Care should be taken to ensure that achievable RQOs (relating to water quality) are defined.

1.4.3.3 Giving effect to RDM

In general, the RDM need to be translated into strategies and actions that:

- Achieve the objectives set for the water resource,
- Manage causes of adverse impacts on water quality, guided by RQOs, resource water quality objectives (RWQOs) and source management objectives, the latter given effect through source directed controls (SDCs), and
- Remediate water resources where necessary.

The following sub-sections provide examples.

1.4.3.4 Catchment management strategies

The catchment management strategy (CMS) is the operational strategy that gives effect to RDM. The development of the CMS must be issues driven and aligned with Water Services Development Plans (WSDPs) and Integrated Development Plans (IDPs).

A water quality framework plan must form part of the CMS. It must include a water quality allocation plan that allocates the source management objective (SMO) load reductions (or increases) to priority sectors in the catchment. These must be based on resource water quality objectives (RWQOs) that support the attainment of RQOs.

1.4.3.5 Attaining a management class

In catchments that are stressed in respect of water quality, the first step is to establish a performance monitoring programme that quantifies the degree of stress. The strategy is primarily one of reactive management to minimise current impacts by engaging individual water users or responsible authorities. Specific management approaches include compulsory licensing, directives, strict regulation, prohibition of land use, remediation, waste discharge charge system, and encouraging general cooperation and awareness.

1.4.3.6 Maintaining a management class

In catchments that are unstressed in respect of water quality, allocatable water quality must still be sensibly distributed among water users, while taking due consideration of all the enabling principles of sustainable development. The strategy is mainly one of proactive management to ensure the water quality impacts of new developments are within the capacity of the water resource to absorb these inputs. Reactive management is likely to be necessary to ensure existing water users maintain their impacts on water quality within agreed limits. Regular assessment of monitoring data should be undertaken to determine when reactive management is necessary.

1.4.3.7 Managing point sources

The catchment management strategy will dictate the general nature of the required source directed controls. However, it is specifically the RQOs and RWQOs in place that determine the precise actions to be taken. Use of appropriate existing guidelines and Best Practices relating to the water use and, in particular, water resource protection should be encouraged, especially for new water users. The general strategy in respect of self-regulatory mechanisms is to encourage the adoption of ISO 14000 standards with the aim of increasing in-house responsible environmental management. New uses must be in accord with the catchment vision and associated RDM and can only be authorised if there exists allocatable water quality. After a licence is issued, a compliance monitoring programme must be established as soon as possible. However, complying with such licence conditions should never be regarded as guaranteeing attainment of RQOs.

1.4.3.8 Managing non-point sources

The overall management strategy is to place emphasis on improved management of the overall land use causing water quality impacts. In general, the approach used to manage the water quality effects of dense settlements should be used as a basis for dealing with non-point sources responsible for water quality problems. This entails engaging with the responsible authorities and reaching agreement on appropriate interventions.

1.4.3.9 Water use authorisation

The general strategy must be to streamline processing of water use authorisations, preferably using a simple screening protocol that will fast-track granting of water use authorisations when impacts are likely to be low.

The choice of end-of-pipe licence conditions relating to water quality for users discharging water containing waste into the water resource should depend on the degree of water quality stress. If the water resource has significant allocatable water quality (*i.e.* is not stressed or threatened), then end-of-pipe licence conditions can be based on effluent standards, although the applicant will typically not be allocated all that is available.

If the water resource is only slightly unstressed (*i.e.* threatened), then end-of-pipe licence conditions can be based on at least the following considerations:

- End-of-pipe effluent uniform national minimum requirements or standards (should they exist).
- End-of-pipe effluent targets back-calculated from downstream RWQOs or RQOs (DWAF, 2005j).

Effective use must be made of available software decision support (*e.g.* DWAF, 2005m).

1.4.3.10 Long-term non-compliance with RQOs

The following strategy should be applied when there is consistent non-achievement of RQOs over long periods (five years). First, the appropriateness of the source directed controls should be investigated. For example:

- Consider whether (a) National Water Act Schedule 1 uses or (b) uses occurring under general authorisations may be responsible.
- If uses under general authorisations are causing problems, also consider changing the conditions for defining general authorisations to make them stricter in that area (following due process).
- Also examine whether or not water users, especially those discharging waste into the water resource, are taking all reasonable steps to minimise their impacts.
- Consider the possibility of illegal water use.

If the degree of source management is considered adequate, then consider whether or not the determination of the RQOs was based on a water quality dataset that was sufficiently representative of the resource.

If the water quality dataset used for the RQOs is considered to be sufficiently representative of current times, then the appropriateness of the class itself can be questioned and revised if necessary (again following due process).

1.4.3.11 Non-compliance with licence conditions

Compliance with specific water use licence conditions may not be occurring and this may be suspected as being responsible for non-compliance with RQOs and/or RWQOs. In this case, the regulatory procedures described in the Source Management Strategy should be applied.

1.4.3.12 Remediation

Responsibility for costs lies with those who caused the impact. However, when they cannot be made responsible (*e.g.* cannot be identified), for example in so-called "legacy cases", the Department may need to assume responsibility. Given the inevitable expense of remediation, particularly when groundwater is involved, the need for remediation should be carefully prioritised to ensure cost-effectiveness, based on the following considerations:

- The most desirable time frame for achieving the designated management class.
- The current and intended use of the water resource.
- The positive and negative socio-economic impacts, and
- The precautionary approach.

1.4.4 Water quality monitoring

The objectives of monitoring for resource directed management of water quality are (DWAF, 2005d): *To measure, assess and report on a regular basis the status and trends broadly relating to water quality in water resources, and their management, in a manner that will support balanced decision-making and planning in the contexts of fitness for use and aquatic ecosystem integrity in the Catchment Management Agency's quest for sustainable development.*

The most pressing programmes will be water quality monitoring programmes that provide information that is directly and immediately useful to water resource managers. These include the following:

- Performance monitoring of RQOs or RWQOs.
- Compliance monitoring of water use licence conditions.
- Baseline monitoring for the ecological Reserve.
- National water quality status and trends monitoring.

More holistic information than just resource quality is required to properly manage (a) the resource, (b) those impacting on the resources and (c) those impacted by the resource. Monitoring that genuinely supports decision-making related to sustainable development must therefore go well beyond just water quality (DWAF, 2005d). The Pressure-State-Impact-Response (PSIR) framework can be used to provide a structure for the broader monitoring required. A phased approach will be important with priority given initially to (a) state monitoring followed by (b) pressure monitoring (or those activities impacting on water quality) and then (c) impact monitoring (of resource, societal and economic impacts of inadequate water quality) and finally (d) response monitoring (referring to the decisive responses of society) which further improves the understanding of the impacts of inadequate water quality.

1.4.5 Capacity creation and maintenance

Two specific dimensions must be addressed in order to create appropriate capacity:

- *Time dimension (short-term & long-term)*.
- *Internal-external dimension*: Capacity must be created both within the Department and Water Management Institutions (WMIs) and in external stakeholders.

The most demanding of the above two dimensions is the time dimension. There is a desperate need to facilitate better resource directed management of water quality immediately. The strategy must be to move from pragmatic, and perhaps low confidence, decision-making initially to doing things better (with greater confidence) in the longer-term. In effect, the short-term requirements should be met using management instruments that are currently available. However, the long-term strategy must be to move towards more fundamental "knowledge creation".

Knowledge can be defined as the *capacity for informed action*. It should be the ultimate aim to create a "learning environment" within the water sector and within the Department in particular. The learning principles proposed by Roux *et al.* (2006) for good ecosystem governance should form the basis of any detailed capacity creation strategy relating to the resource directed management of water quality. These are summarised as follows: "*Good ecosystem governance requires positively persistent and adaptive people with a culture of empathy for other knowledge systems and levels. Their knowledge must be transdisciplinary, moulded by a common future focus, acquired by patiently engaging their prior knowledge and learning by doing in an environment of social knowledge sharing.*"

Attention must also be given to ensuring that management is sustainable. The empowerment required to achieve this includes objective empowerment (improved opportunities), competence (basic skills) and subjective empowerment (self-confidence). All three must be addressed for a capacity creation strategy to be successful. Training must include a wide variety of conceptual outcomes relating to understanding all facets of water quality and familiarity with currently available management instruments (especially software and other guidelines that can facilitate better water quality management).

Existing training courses relating specifically to resource directed management of water quality should continue to be made available on an annual basis (or on demand based on the level of staff turnover). They should be extended and enhanced as and when necessary. Refresher courses should also be offered.

Communication mechanisms such as the use of posters, pamphlets, and newsletters should be reviewed on an annual basis to (a) create awareness among new staff members and external stakeholders (like other government departments), and (b) maintain awareness among experienced water resource managers.

1.4.6 Action plan

1.4.6.1 Resource water quality objectives

It is important that nationally consistent information be generated relating to water quality that can begin to provide a sound basis for more focused catchment assessments, catchment planning, catchment visioning exercises and ultimately catchment management strategies.

Initial efforts must focus on water resources currently experiencing water quality stress. A software facility exists that helps to determine the degree of water quality stress in watercourses (DWAF, 2005p). This inherently "low-confidence" decision support tool should be used to prioritise such surface water resources on a national basis on the basis of their degree of water quality stress.

The next phase will be to begin the process of determining management objectives that can better focus water resource management in the immediate future. Catchments should be identified in which there are (a) adequate financial and human resources, and (b) commitment to the process from relevant regional offices of the Department or CMAs. The level of confidence required to determine RWQOs should then be assessed (medium or high confidence). The appropriate procedures should then be followed to determine RWQOs at appropriate locations in the water resources (DWAF, 2005i).

Once the RWQOs have been determined, a suitable performance monitoring programme must be implemented as soon as possible. It will also be essential that the necessary source directed controls be identified and that these become firmly embodied in the catchment management strategy.

1.4.6.2 Capacity creation

An initiative should be started that will produce a detailed capacity creation plan that includes the following:

- Explicit recommendations that will move the Department towards becoming a learning organisation.
- Detailed recommendations that expand on the proposed short- and long-term strategy.
- Explicit consideration of the learning principles proposed by Roux *et al.* (2006).
- Explicit attention to objective and subjective empowerment and increasing basic competencies.
- Resources (financial and human) required for such capacity creation, and
- Detailed time plan that expands on that given in this strategy.

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EXECUTIVE SUMMARY

"Making water resource management water quality friendly"

Policy implementation

This strategy provides the general implementation plan for the resource directed management of water quality policy ("the Policy") (DWAF, 2006a). It describes "who should do what by when" and is presented in a way that explicitly links the Policy and its principles with specific management approaches and instruments to facilitate its practical implementation.

Sustainable development

The link between the adaptive "Plan-Implement-Check-Review" cycle of Integrated Water Quality Management (IWQM) and sustainable development is described as well as how this plays out at various levels (varying from short-term to long-term).

An approach to balancing the principles of sustainable development is also proposed. In particular, how this should be done to achieve socio-economic development is presented. An example is also presented of how strict protection of ecosystems can be achieved where appropriate. A simple familiarisation plan for inexperienced practitioners is also proposed.

Institutional arrangements

How the institutions will evolve during the phased decentralisation of water management roles and responsibilities from the Department to Clusters and catchment management agencies (CMAs) is described. Specific challenges and institutional implications are identified. The phases include:

- Phase 1: Post restructuring (current,
- Phase 2: Decentralisation to Clusters,
- Phase 3: CMAs establishment, and
- Phase 4: Fully functional CMAs.

Roles and responsibilities within the Department for IWQM management functions are presented as well as roles played by external stakeholders, and local, regional and national government departments.

The various facets of institutional capacity are also identified.

Summary strategies

Summary strategies are provided for a series of well-defined scenarios. In each case, the reader is (a) referred to associated enabling principles in the Policy and (b) provided with references to guidelines and further reading that will provide the necessary detail.

Scenarios include:

- Catchment assessment,
- Catchment visioning,
- Determining resource directed measures (RDMs), including addressing issues of confidence, and water quality variables of concern, and

- Giving effect to RDMs, including developing catchment management strategies, attaining a management class, maintaining a management class, managing point and non-point sources, water use authorisation, long-term non-compliance with resource quality objectives (RQOs), non-compliance with licence conditions and remediation.

Water quality monitoring is also addressed.

Capacity creation and maintenance

Capacity creation for the short-term and long-term as well as internal and external to DWAF, is described. The short-term strategy focuses on empowering external stakeholders and creating knowledgeable DWAF staff. The long-term strategy focuses on adapting to changing external stakeholder demands (for awareness and empowerment) and refining and improving the capabilities of DWAF staff. The ultimate aim is to facilitate creation of a learning institution in which appropriate knowledge is created.

A three-dimensional approach to empowering DWAF staff for sustainable management is also proposed (objective empowerment, competence, and subjective empowerment).

Action Plan

An immediate action plan is proposed to "kick start" appropriate data collection and information generation in support of resource directed management of water quality. It is based on defining resource water quality objectives (RWQOs) in priority catchments that can begin to generate nationally consistent water quality information in anticipation of determination of RQOs when the classification system is developed.

The development of a detailed capacity creation plan is also recommended.

Management approaches

A brief summarised description is also provided (in the appendix) of management approaches available to IWQM practitioners. These include:

- Regulatory (general authorisations, command-and-control – *ad hoc* licensing, compulsory licensing, RQOs, Reserve, directives, etc. – , and economic – pricing strategy, waste discharge charge system), and
- Non-regulatory (civil society, self-regulatory, and supportive).

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ACRONYMS

CMAs	Catchment Management Agency
CMS	Catchment Management Strategy
CSD	Committee for Sustainable Development
DBSA	Development Bank of South Africa
DEAT	Department of Environmental Affairs & Tourism
DME	Department of Minerals & Energy
DoA	Department of Agriculture
DTI	Department of Trade & Industry
DWAF	Department of Water Affairs & Forestry
ECA	Environment Conservation Act
EMS	Environmental Management System
EMPR	Environmental Management Plan Report
IDPs	Integrated Development Plan
ISO	International Organization for Standardization
ISP	Internal Strategic Perspective
IWQM	Integrated Water Quality Management
IWRM	Integrated Water Resource Management
NQF	National Qualifications Framework
NWA (36:1998)	National Water Act
NWRS	National Water Resource Strategy
P&R	Policy and Regulation
PGDS	Provincial Growth and Development Strategy
PSIR	Pressure-State-Impact-Response
RDM	Resource Directed Measure
RDMWQ	Resource Directed Management of Water Quality
RO	Regional Office (DWAF)
RQOs	Resource Quality Objectives
RWQOs	Resource Water Quality Objectives
SAQA	South African Qualifications Authority
SDC	Source Directed Control
SMO	Source Management Objective
WDCS	Waste Discharge Charge System
WMA	Water Management Area
WMI	Water Management Institution
WQ	Water Quality
WQM	Water Quality Management
WRM	Water Resource Management
WSDP	Water Services Development Plan

SECTION 1: SUMMARY STRATEGY

1.1 Introduction

The objective of this strategy is the implementation of the resource directed management of water quality policy ("the Policy") (DWAF, 2006a) of the Department of Water Affairs and Forestry ("the Department"). It addresses "who should do what by when", explicitly linking the Policy to management approaches and management instruments to facilitate its practical and pragmatic implementation. It is also the intention that, in some contexts, this strategy presents a first level of interpretation of the policy.

Simultaneous review of this strategy with the Policy every five years in respect of objectives and effectiveness is recommended.

1.2 Sustainable development

1.2.1 Integrated water quality management

Integrated water quality management should be implemented in a cyclical process aimed at continual improvement (fundamental to the principle of adaptive management). This cycle occurs at a number of different levels. They range from individual (local) source and resource management initiatives (short-term) through re-consideration of the catchment management strategy (medium-term) to re-consideration of the resource directed measures and vision (long-term).

The principles of sustainable development apply at all stages. However, the designated resource management class is the 'first line of defence' against development that is unsustainable. The 'second line of defence' is embodied in the catchment management strategy and its implementation through resource directed measures, individual source directed controls and resource management initiatives.

1.2.2 Balancing the principles

The emphasis placed by the Policy on socio-economic development means that particular attention must be paid to the principles of current equitable access, optimal water use and environmental integration.

Current equitable access is achieved by first determining the Reserve and then allocating water quality to national priorities. The remainder is then allocated equitably, and with emphasis on optimal water use, to other users. Less emphasis is given to protection of water resources by accepting some degree of impact though not to the extent that the resource becomes unacceptably degraded and unsustainable.

When strict protection of water resources is warranted, the resource will typically be classified as Natural. In this case, it is the principles of protection of water resources, and by implication, equity between generations, that receive most emphasis. Importantly, this does not preclude other water uses. However, these water uses must be such that their impact on water quality is minimal and well within the ability of the ecosystem to sustain the provision of goods and services in order to maintain the management class.

As an example of how this emphasis might be applied, a related strategic national recommendation has been made in respect of freshwater biodiversity (WRC, 2006).

Balancing sustainable development principles is complex. To gradually increase the familiarity of practitioners with these principles, it is recommended that less experienced practitioners should first simply practice identifying what factors and actions refer to which principle. With experience, the explicit application of these principles in resource directed measures will become more evident.

1.3 Institutional arrangements

1.3.1 Phase institutional change

Institutional arrangements are dominated by transition to full decentralisation to catchment management agencies (CMAss) over four phases: *Phase 1* follows the recent restructuring of DWAF. Decision-making is shared between P&R and Regional Clusters, while systems are being developed and piloted. *Phase 2* is characterised by completion, or near-completion, of piloting and the establishment of stable macro-systems. As a result, further decision-making and implementation is transferred to the Regional Clusters, while the proto-CMAsCMAss take on those current regional cluster functions that centre on water use management and coordination. In *Phase 3* proto-CMAs are transferred, along with their functions and staff, from DWAF into the CMAs within the first 2 years. The CMAs are then formally established. In *Phase 4*, fully functional CMAs are established, with the majority of WRM implementation roles and responsibilities within the CMAs (including Responsible Authority functions).

1.3.2 Management effort

In Phases 1 and 2, management effort is reasonably evenly spread between P&R, Clusters and proto-CMAs. In Phase 3, with the establishment of the CMAs, all roles and responsibilities of the proto-CMAs are transferred to the CMAs along with a continuing shift of roles and responsibilities from P&R to Clusters to CMAs. P&R takes on new responsibilities centred on oversight and support – co-ordination, collaboration and transfer of information between CMAs, Clusters and P&R. In Phase 4, the CMAs is established and stabilised and now bears the majority of water quality management effort.

1.3.3 Institutional implications

Phases 2 and 3 will present the greatest challenges relating to capacity. Broad institutional capacity building will be required. When the CMAs become established, mentoring by DWAF and the Clusters will be particularly important.

1.3.4 Institutional roles

Water quality management inherently requires the management of activities and resources that are the mandate of other government departments or property of private sector entities. Key institutions include stakeholders, and local, regional and national government departments.

1.3.5 Institutional capacity

The process for building institutional capacity should (a) be carefully planned, and (b) establish coherent, simple and stable systems, introducing as much routine as available the capacity is able to deal with.

1.4 Implementation strategies

Resource directed management of water quality can occur in a very wide variety of contexts. The following sub-sections briefly summarise strategies in well-defined scenarios.

1.4.1 Catchment assessment

Catchment assessments should engage with stakeholders constructively, take cognisance of legislation such as the Promotion of Access to Information Act (2:2000), be appropriately integrative in their data collections and assessment, and be pragmatic in the allocation of financial and human resources according to the level of confidence required.

1.4.2 Catchment visioning

Catchment visioning is an indispensable component of this strategy and integrated water resource management in general. Although this strategy primarily addresses water quality management, visioning must encompass resource quality holistically and clearly identify how water quality issues contribute.

The context of the vision must be principle-based and should be the strategy to move towards the vision. Relevant legislation goes well beyond the National Water Act (36:1998). Stakeholders must be engaged in a way that (a) facilitates meaningful contributions, and (b) develops a sense of buy-in and, preferably, ownership. Catchment visioning initiatives should be carried out to a level of confidence appropriate to the circumstances.

1.4.3 Resource directed measures

1.4.3.1 General issues

The necessary degree of confidence required to determine of the management class, resource quality objectives (RQOs) and the Reserve must be determined by considering factors relating to:

- The immediate purpose of the RDM sub-process,
- The present ecological state,
- Potential changes in water quality, and
- Potential impacts of changes in water quality (*e.g.* relating to the ecological, social and economic sensitivity).

Appropriate water quality variables ('variables of concern') must be identified, which depend on:

- The nature of the individual water uses and their impacts,
- Ecosystem requirements, and
- The RQOs (both narrative and quantitative) that may exist.

The chosen variables must be:

- Representative of the water quality that matters the most to overall ecosystem health,
- Socially relevant and acceptable (*e.g.* relating to human health),
- Economically appropriate, and
- Institutionally sound and consistent across organisations.

1.4.3.2 Determining the resource management class and RQOs

Stakeholders must be empowered to make meaningful contributions. Specifically in respect of water quality, they must be sufficiently well-informed in respect of:

- The meaning and value of water quality in respect of (a) constituents, and (b) associated ecological responses and social and economic impacts of worsening water quality.
- The relationship between aquatic ecosystems and water quality, and
- The effects of their water uses on water quality and hence downstream users.

To facilitate integration across catchments, account must be taken of current and potential impacts upstream, downstream and on catchments receiving or donating water via inter-basin transfers.

Care should be taken to ensure that achievable RQOs (relating to water quality) are defined.

1.4.3.3 Giving effect to RDMs

In general, the RDMs need to be translated into strategies and actions that:

- Achieve the objectives set for the water resource,
- Manage causes of adverse impacts on water quality, guided by RQOs, resource water quality objectives (RWQOs) and source management objectives, the latter given effect through source directed controls (SDCs), and
- Remediate water resources where necessary.

The following sub-sections provide examples.

1.4.3.4 Catchment management strategies

The catchment management strategy (CMS) is the operational strategy that gives effect to RDMs. The development of the CMS must be issues driven and aligned with Water Services Development Plans (WSDPs) and Integrated Development Plans (IDPs).

A water quality framework plan must form part of the CMS. It must include a water quality allocation plan that allocates the source management objective (SMO) load reductions (or increases) to priority sectors in the catchment. These must be based on resource water quality objectives (RWQOs) that support the attainment of RQOs.

1.4.3.5 Attaining a management class

In catchments that are stressed in respect of water quality, the first step is to establish a performance monitoring programme that quantifies the degree of stress. The strategy is primarily one of reactive management to minimise current impacts by engaging individual water users or responsible authorities. Specific management approaches include compulsory licensing, directives, strict regulation, prohibition of land use, remediation, waste discharge charge system, and encouraging general cooperation and awareness.

1.4.3.6 Maintaining a management class

In catchments that are unstressed in respect of water quality, allocatable water quality must still be sensibly distributed among water users, while taking due consideration of all the enabling principles of sustainable development. The strategy is mainly one of proactive management to ensure the water quality impacts of new developments are within the capacity of the water resource to absorb these inputs. Reactive management is likely to be necessary to ensure existing water users maintain their impacts on water quality within agreed limits. Regular assessment of monitoring data should be undertaken to determine when reactive management is necessary.

1.4.3.7 Managing point sources

The catchment management strategy will dictate the general nature of the required source directed controls. However, it is specifically the RQOs and RWQOs in place that determine the precise actions to be taken. Use of appropriate existing guidelines and Best Practices relating to the water use and, in particular, water resource protection should be encouraged, especially for new water users. The general strategy in respect of self-regulatory mechanisms is to encourage the adoption of ISO 14000 standards with the aim of increasing in-house responsible environmental management. New uses must be in accord with the catchment vision and associated RDMs and can only be authorised if there exists allocatable water quality.

After a licence is issued, a compliance monitoring programme must be established as soon as possible. However, complying with such licence conditions should never be regarded as guaranteeing attainment of RQOs.

1.4.3.8 Managing non-point sources

The overall management strategy is to place emphasis on improved management of the overall land use causing water quality impacts. In general, the approach used to manage the water quality effects of dense settlements should be used as a basis for dealing with non-point sources responsible for water quality problems. This entails engaging with the responsible authorities and reaching agreement on appropriate interventions.

1.4.3.9 Water use authorisation

The general strategy must be to streamline processing of water use authorisations, preferably using a simple screening protocol that will fast-track granting of water use authorisations when impacts are likely to be low.

The choice of end-of-pipe licence conditions relating to water quality for users discharging water containing waste into the water resource should depend on the degree of water quality stress. If the water resource has significant allocatable water quality (*i.e.* is not stressed or threatened), then end-of-pipe licence conditions can be based on effluent standards, although the applicant will typically not be allocated all that is available.

If the water resource is only slightly unstressed (*i.e.* threatened), then end-of-pipe licence conditions can be based on at least the following considerations:

- End-of-pipe effluent uniform national minimum requirements or standards (should they exist).
- End-of-pipe effluent targets back-calculated from downstream RWQOs or RQOs (DWAF, 2004j).

Effective use must be made of available software decision support (*e.g.* DWAF, 2004k).

1.4.3.10 Long-term non-compliance with RQOs

The following strategy should be applied when there is consistent non-achievement of RQOs over long periods (five years). First, the appropriateness of the source directed controls should be investigated. For example:

- Consider whether (a) National Water Act Schedule 1 uses or (b) uses occurring under general authorisations may be responsible.
- If uses under general authorisations are causing problems, also consider changing the conditions for defining general authorisations to make them stricter in that area (following due process).
- Also examine whether or not water users, especially those discharging waste into the water resource, are taking all reasonable steps to minimise their impacts.
- Consider the possibility of illegal water use.

If the degree of source management is considered adequate, then consider whether or not the determination of the RQOs was based on a water quality dataset that was sufficiently representative of the resource.

If the water quality dataset used for the RQOs is considered to be sufficiently representative of current times, then the appropriateness of the class itself can be questioned and revised if necessary (again following due process).

1.4.3.11 Non-compliance with licence conditions

Compliance with specific water use licence conditions may not be occurring and this may be suspected as being responsible for non-compliance with RQOs and/or RWQOs. In this case, the regulatory procedures described in the Source Management Strategy should be applied.

1.4.3.12 Remediation

Responsibility for costs lies with those who caused the impact. However, when they cannot be made responsible (*e.g.* cannot be identified), for example in so-called "legacy cases", the Department may need to assume responsibility. Given the inevitable expense of remediation, particularly when groundwater is involved, the need for remediation should be carefully prioritised to ensure cost-effectiveness, based on the following considerations:

- The most desirable time frame for achieving the designated management class.
- The current and intended use of the water resource.
- The positive and negative socio-economic impacts, and
- The precautionary approach.

1.4.4 Water quality monitoring

The objectives of monitoring for resource directed management of water quality are (DWAF, 2006c): *To measure, assess and report on a regular basis the status and trends broadly relating to water quality in water resources, and their management, in a manner that will support balanced decision-making and planning in the contexts of fitness for use and aquatic ecosystem integrity in the Catchment Management Agency's quest for sustainable development.*

The most pressing programmes will be water quality monitoring programmes that provide information that is directly and immediately useful to water resource managers. These include the following:

- Performance monitoring of RQOs or RWQOs.
- Compliance monitoring of water use licence conditions.
- Baseline monitoring for the ecological Reserve.
- National water quality status and trends monitoring.

More holistic information than just resource quality is required to properly manage (a) the resource, (b) those impacting on the resources and (c) those impacted by the resource. Monitoring that genuinely supports decision-making related to sustainable development must therefore go well beyond just water quality (DWAF, 2006c). The Pressure-State-Impact-Response (PSIR) framework can be used to provide a structure for the broader monitoring required. A phased approach will be important with priority given initially to (a) state monitoring followed by (b) pressure monitoring (or those activities impacting on water quality) and then (c) impact monitoring (of resource, societal and economic impacts of inadequate water quality) and finally (d) response monitoring (referring to the decisive responses of society) which further improves the understanding of the impacts of inadequate water quality.

1.4.5 Capacity creation and maintenance

Two specific dimensions must be addressed in order to create appropriate capacity:

- *Time dimension (short-term & long-term)*.
- *Internal-external dimension*: Capacity must be created both within the Department and Water Management Institutions (WMIs) and in external stakeholders.

The most demanding of the above two dimensions is the time dimension. There is a desperate need to facilitate better resource directed management of water quality immediately. The strategy must be to move from pragmatic, and perhaps low confidence, decision-making initially to doing things better (with greater confidence) in the longer-term. In effect, the short-term requirements should be met using management instruments that are currently available. However, the long-term strategy must be to move towards more fundamental "knowledge creation".

Knowledge can be defined as the *capacity for informed action*. It should be the ultimate aim to create a "learning environment" within the water sector and within the Department in particular. The learning principles proposed by Roux *et al.* (2006) for good ecosystem governance should form the basis of any detailed capacity creation strategy relating to the resource directed management of water quality. These are summarised as follows: "*Good ecosystem governance requires positively persistent and adaptive people with a culture of empathy for other knowledge systems and levels. Their knowledge must be transdisciplinary, moulded by a common future focus, acquired by patiently engaging their prior knowledge and learning by doing in an environment of social knowledge sharing.*"

Attention must also be given to ensuring that management is sustainable. The empowerment required to achieve this includes objective empowerment (improved opportunities), competence (basic skills) and subjective empowerment (self-confidence). All three must be addressed for a capacity creation strategy to be successful. Training must include a wide variety of conceptual outcomes relating to understanding all facets of water quality and familiarity with currently available management instruments (especially software and other guidelines that can facilitate better water quality management).

Existing training courses relating specifically to resource directed management of water quality should continue to be made available on an annual basis (or on demand based on the level of staff turnover). They should be extended and enhanced as and when necessary. Refresher courses should also be offered.

Communication mechanisms such as the use of posters, pamphlets, and newsletters should be reviewed on an annual basis to (a) create awareness among new staff members and external stakeholders (like other government departments), and (b) maintain awareness among experienced water resource managers.

1.4.6 Action plan

1.4.6.1 Resource water quality objectives

It is important that nationally consistent information be generated relating to water quality that can begin to provide a sound basis for more focused catchment assessments, catchment planning, catchment visioning exercises and ultimately catchment management strategies.

Initial efforts must focus on water resources currently experiencing water quality stress. A software facility exists that helps to determine the degree of water quality stress in watercourses (DWAF, 2004i). This inherently "low-confidence" decision support tool should be used to prioritise such surface water resources on a national basis on the basis of their degree of water quality stress.

The next phase will be to begin the process of determining management objectives that can better focus water resource management in the immediate future. Catchments should be identified in which there are (a) adequate financial and human resources, and (b) commitment to the process from relevant regional offices of the Department or CMAs. The level of confidence required to determine RWQOs should then be assessed (medium or high confidence).

The appropriate procedures should then be followed to determine RWQOs at appropriate locations in the water resources (DWAF, 2006d).

Once the RWQOs have been determined, a suitable performance monitoring programme must be implemented as soon as possible. It will also be essential that the necessary source directed controls be identified and that these become firmly embodied in the catchment management strategy.

1.4.6.2 Capacity creation

An initiative should be started that will produce a detailed capacity creation plan that includes the following:

- Explicit recommendations that will move the Department towards becoming a learning organisation.
- Detailed recommendations that expand on the proposed short- and long-term strategy.
- Explicit consideration of the learning principles proposed by Roux *et al.* (2006).
- Explicit attention to objective and subjective empowerment and increasing basic competencies.
- Resources (financial and human) required for such capacity creation, and
- Detailed time plan that expands on that given in this strategy.

SECTION 2: INTRODUCTION

This section:

- Illustrates policy-strategy-management relationships (**2.1**),
- Summarises associated frameworks and strategies (**2.2**),
- States the scope of this strategy (**2.3**), and
- Shows how to use this document (2.**4**).

2.1 The policy

Implementation plan

This strategy is the implementation plan for the resource directed management of water quality policy ("the Policy") (DWAF, 2006a) of the Department of Water Affairs and Forestry ("the Department"). In cases where detailed management instruments are available for specific purposes, these are clearly referenced (and not duplicated in this document). The following figure illustrates the relationship between the Policy, this strategy and the associated management instruments.

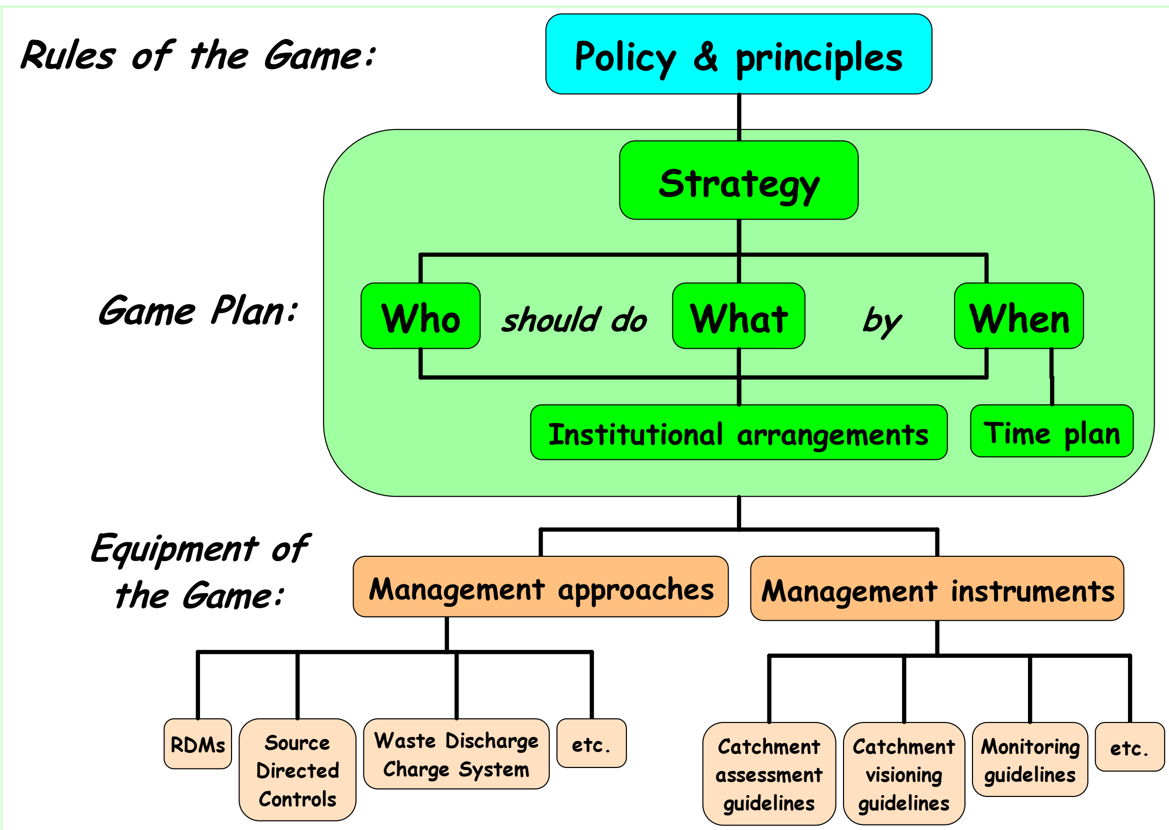


Figure 2.1. Illustration of relationship between the Policy, this strategy and the management approaches and instruments.

2.2 Associated frameworks and strategies

Adaptive management

The Policy advocates an adaptive management approach to achieve continual improvement in integrated water quality management. Strategic adaptive management is also specifically promoted by the national water resource strategy (DWAF, 2004a). One common manifestation of adaptive management is the "Plan, Implement, Check and Review" process. The review step specifically feeds into a re-planning step making the overall process cyclical.

Integrated water resources management

The Policy and therefore this strategy are inherently aligned with integrated water resources management (IWRM).

National water resource strategy (NWRS)

The National Water Act (Act No. 36 of 1998) (NWA (36:1998)) explicitly states that South Africa's water resources must be protected, used, developed, conserved, managed and controlled in accordance with the national water resource strategy (NWRS) (DWAF, 2004a). Therefore, any strategy addressing a subset of water resource management, such as resource directed management of water quality, must be consistent with the NWRS. This strategy is not only aligned with the NWRS, but expands considerably on issues related to water quality.

Source management strategy

A draft strategy for management of water uses (or sources of impacts on water) has been developed (DWAF, 2003c). The strategy for resource directed management of water quality (contained in this document) must inform implementation of the source management strategy. In particular, resource directed measures (RDMs) should set the objectives to be achieved in water resources, which in turn influence the "source directed controls". Alignment between the two strategies is therefore important.

Remediation strategy

Development of a remediation strategy is currently in progress (www.sa-remediation.co.za). This includes remediation of degraded land that may pose a risk to water quality in water resources. As described above for the source management strategy, the exact nature of any local remediation strategy must be determined by the RDMs in place.

Catchment management strategies

A catchment management strategy addresses water resource management at the spatial scale of water management areas. The NWRS provides the conceptual and technical framework for all catchment management strategies. This resource directed management of water quality strategy is intended to provide input to the development of the water quality component of catchment management strategies.

2.3 Scope

Water resources

The scope of this strategy is defined by the Policy. In particular, the water resources include watercourses, surface and groundwater, wetlands and estuaries.

2.4 Review

Simultaneous review

Review of this strategy must take place at least every five years. Furthermore, it should be done at times that ensure the results of the review are available to inform planned reviews of other related strategies, particularly the National Water Resource Strategy.

The Policy is explicit about review of not only this strategy but the Policy itself. The Policy, its objectives and the effectiveness of this strategy must be reviewed simultaneously. This includes examining the degree to which catchment visions have been achieved. The Policy document should be consulted for more detail.

2.5 How to use this document

Who	To establish who has, or will have, responsibility for specific RDM-related actions (associated with water quality), see **Section 5: Institutional Arrangements**.
What	Technically what needs to be done is described in the following sections: • Determining and giving effect to RDM: **Section 6: Implementation Strategies.** • Water quality monitoring supporting both routine decision-making and sustainable development: **Section 6.5.3: Monitoring.** • Capacity creation: **Section 7: Capacity Creation & Maintenance**.
When	Time scales depend on what aspect of the strategy is being implemented. • Decentralisation of Departmental responsibilities: **Section 5: Institutional Arrangements**. • Implementing the monitoring programmes related to sustainable development: **Section 6.5.3: Monitoring**.
Approaches	General approaches, both regulatory and non-regulatory, which enable resource directed management of water quality are briefly summarised in **Appendix: Management Approaches**.
Instruments	Management instruments such as guidelines and software decision support, as well as recommended further reading, are referenced **in the associated sub-sections**.

SECTION 3: OBJECTIVES

This section defines the formal objective of this strategy.

Vision

The vision of the Policy is to ensure that the water quality in South African water resources enables an equitable and sustainable balance to be achieved between its use by society and its protection as a critical component of a natural system so that the quality of life of all South Africans is improved and sustained in the long-term (DWAF, 2006a).

Strategy objective

The objective of this strategy is the comprehensive implementation of the policy on the resource directed management of water quality (DWAF, 2006a). This will comprise practical approaches:

- That ensure water quality considerations are appropriately incorporated into all water resource management initiatives, and
- That are ecologically, socially, economically and institutionally sustainable.

It is also the specific intention that this strategy:

- Demonstrates a first level of interpretation of the policy, and
- Is explicitly linked to policy statements and principles, and
- Is explicitly linked to detailed guidelines that comprise the necessary management instruments.

SECTION 4: SUSTAINABLE DEVELOPMENT

This section describes (1) how integrated water quality management can be implemented to achieve sustainable development (**4.1** and **4.2**) and (2) how the enabling principles of sustainable development should be applied in different circumstances (4**.3**).

4.1 Integrated Water Quality Management

"Part of our poverty is due to poor management of our natural resources"

Wangari Maathai, Nobel Peace Prize Laureate, 2004.

Multi-level continual improvement cycles

Van Wyk *et al.* (2002) have proposed an integrated water quality management (IWQM) model for South Africa. This is based on the cyclical "Plan, Implement, Check and Review" process.

Adaptive management

A cyclical process aimed at continual improvement (fundamental to the principle of adaptive management) plays out at a number of different levels, each relevant to a different time scale. Success at one level depends on successful implementation at lower levels.

IWQM process and principles

The principles of sustainable development apply at all stages of the IWQM process illustrated in Figure 4.1. However, the designated resource management class is the 'first line of defence' against development that might be unsustainable. The 'second line of defence' is embodied in the catchment management strategy and its implementation through resource directed measures, individual source directed controls and resource management initiatives.

Monitoring

Monitoring using a holistic series of sustainability indicators that go beyond simply water quality (and beyond resource quality) is necessary (See Section 6.5.3: Water quality monitoring). Assessment of these indicators provides the basis for corrective actions and, if necessary, for strategic review.

Stakeholder engagement

Effective stakeholder engagement is fundamental to sustainable development. It should occur at all stages of the overall IWQM process. It is particularly important during the catchment visioning process.

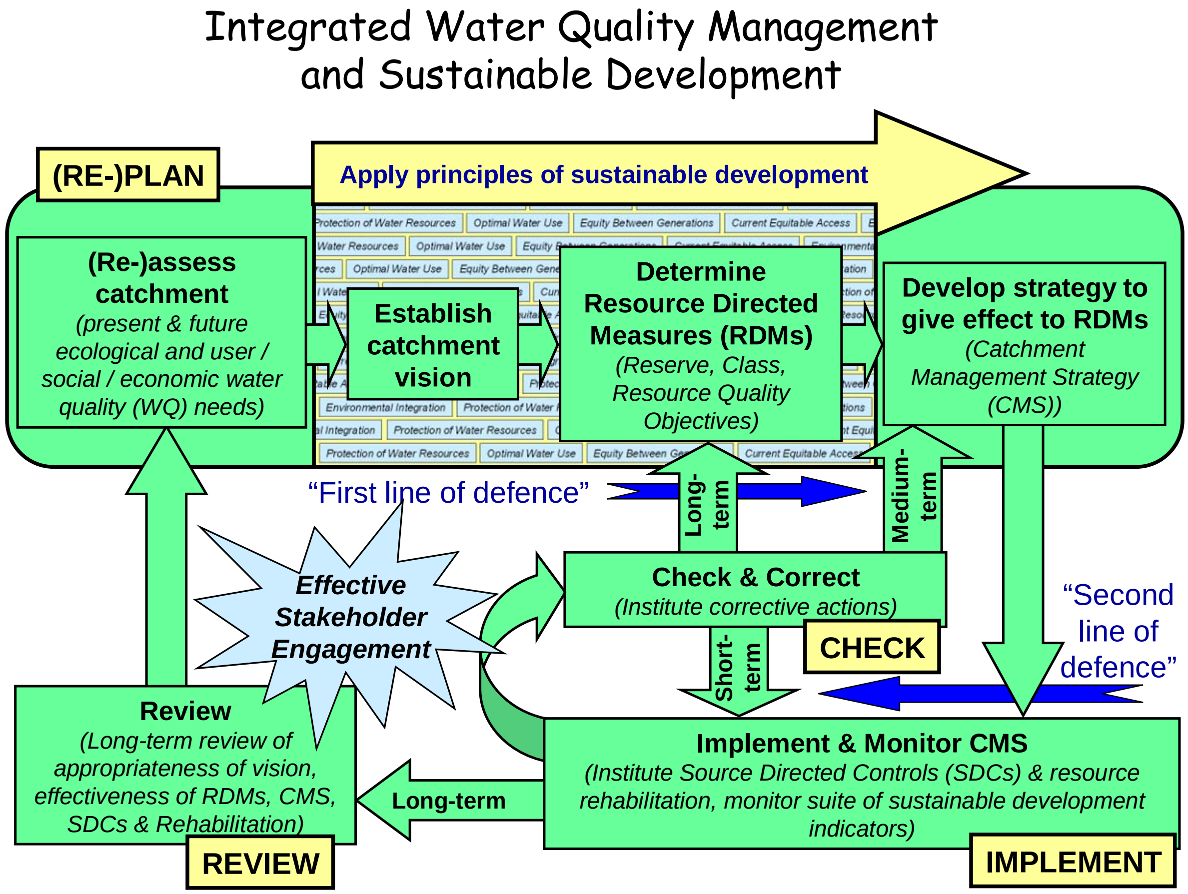
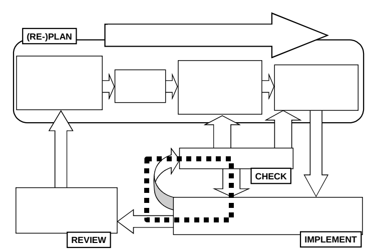


Figure 4.1: Illustration of the relationship between the integrated water quality management process and sustainable development.

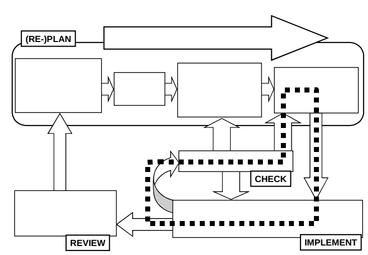
Individual initiatives (short-term cycle)

At the lowest level, **individual (local) source and resource management initiatives** must cycle through the Plan-Implement-Check steps on a relatively short time scale (typically one year or less). Cycling at this level typically occurs with individual water users and resource management initiatives (like remediation).

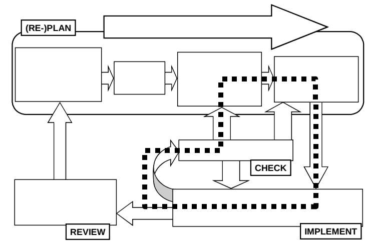


Re-consideration of the CMS (medium-term cycle)

The catchment management agency (CMAs) must implement the CMS on the same cyclical basis, checking it periodically (on, for example, a three- to -five year basis) to track its efforts to attain the management classes (as defined by their RQOs) designated for water resources under its jurisdiction. The successful implementation of the CMS depends heavily (but not solely) on the successful implementation of the individual short-term source and resource management initiatives. Persistent failure of these to achieve targets set by the CMS may prompt re-consideration of the CMS.

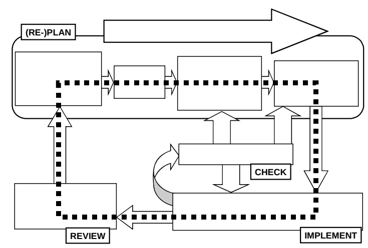


Re-consideration of the RDM (long-term cycle)



Persistent failure of the CMS to attain the management class and the RQOs, may lead to re-consideration of the RDMs. However, this should only occur when there is good reason to believe that no reasonable (*i.e.* practical and affordable) CMS can possibly give effect to the RDMs. In this case, the RDMs themselves, in particular the management class, can be reconsidered and changed (following due process). One motivation for this may be that the original dataset upon which the RDMs were based may be inappropriate for present conditions.

Reviewing catchment vision (long-term cycle)



Reviewing the catchment vision is the highest strategic level at which the continual improvement process occurs within a particular catchment. This should be reviewed on a time scale of about five years. It will be closely, if not inextricably, linked to the RDMs, especially the management class and associated RQOs. Once revised, all lower level cycles (relating to the RDMs, the CMS and individual source and resource management initiatives) may need to be re-considered (*i.e.* re-planned, implemented and monitored, checked and corrected, etc.). That is, the cyclical process then shifts back to medium-term and short-term continual improvement cycling.

4.2 Planning and operational sequences

Establishing versus achieving the vision

Effective stakeholder engagement is a fundamental principle enabling sustainable development. At the highest level this engagement manifests itself in determining the catchment vision. However, it is important that establishing the vision and striving for it are two different phases and processes. In effect, the former occurs in the planning phase and the latter in the operational phase.

Planning sequence

Ideally, planning begins with a catchment vision that is developed by all stakeholders in the catchment (see Figure 4.2). RDMs are then determined and established that accord with this vision. A CMS is then developed to give effect to the RDMs that focus on specific individual source management initiatives (SDCs) and resource management initiatives (such as remediation).

Operational sequence

Once these are in place, the operational sequence begins. The SDCs and remediation initiatives give effect to the strategy, which in turn gives effect to the RDMs, and which in their turn, give ultimate effect to the vision.

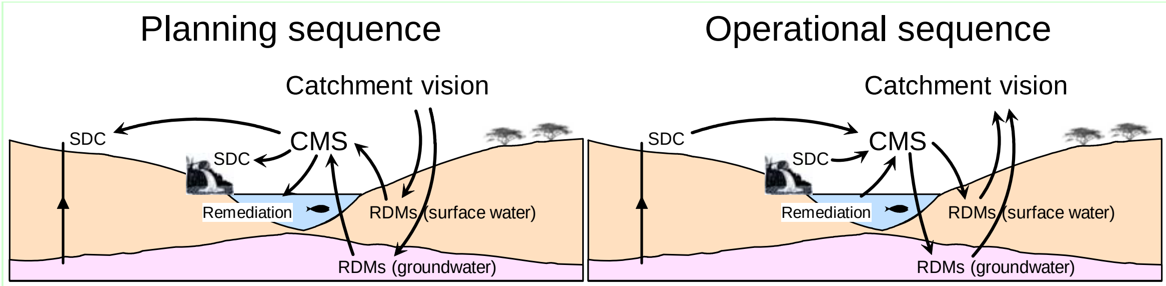


Figure 4.2: Planning sequence from catchment visioning to source directed controls and remediation, and the subsequent operational sequence from implementing the latter to achieve the vision.

4.3 Balancing the principles

The Policy

The Policy lists six enabling principles of sustainable development:

- Protection of water resources,
- Optimal water use,
- Equity between generations,
- Current equitable access,
- Environmental integration, and
- Good governance.

The Policy further states that, from an overall national perspective, the balance between use of water resources and their protection must give preference to their use for socio-economic development, especially for poverty eradication and redress of past inequities.

However, the Policy also states that strict protection of selected aquatic ecosystems will occur when this is considered necessary to sustain their biodiversity and general integrity.

Good governance

Good governance is always important. Effective stakeholder engagement is a critical factor and all stakeholders must manage their affairs with integrity and in a lawful manner and apply accepted principles and procedures.

Emphasis on socio-economic development

Emphasis on socio-economic development means that special attention is paid to the principles of current equitable access, optimal water use and environmental integration.

Current equitable access is achieved by first determining the Reserve and allocating water quality to national priorities. The remainder is then allocated equitably to other users who ideally use their water optimally. Less emphasis is given to protection of water resources by accepting some degree of impact though not to the extent that the resource becomes unacceptably degraded and unsustainable.

In effect, this will be achieved when resources are classified as being either moderately used/impacted or heavily used/impacted (*i.e.* not as Natural).

Emphasis on protection of water resources

When strict protection is warranted, the resource will typically be classified as Natural. In this case, it is the principles of protection of water resources, and by implication, equity between generations, that receive most emphasis. Importantly, this does not preclude other water uses. However, these other water uses must be such that their impact on water quality is minimal and remains well within the ability of the ecosystem to sustain the provision of goods and services.

As an example of how this emphasis might be applied, a related strategic national recommendation has been made in respect of freshwater biodiversity (WRC, 2006). A panel of riverine ecologists and representatives from Department of Water Affairs and Forestry (DWAF), Department of Environmental Affairs and Tourism (DEAT), National Department of Agriculture (NDA), and Department of Provincial and Local Government (DPLG) recommended that:

- "*The quantitative target for freshwater conservation in South Africa is to maintain (and restore where necessary) at least 20% of the country's water resources in a Natural Class, where Natural Class refers to the highest level of protection awarded by DWAF's Water Resource Classification System.*
- *National custodian departments will identify up to 10% of water resources (50% of the target) for conservation, based on the national and strategic importance of such resources. The remainder of the national conservation target would be satisfied through delegation to sub-national levels [spheres] of government.*"

Strategy for experienced practitioners

As the 'first line of defence' against development that is unsustainable, more experienced practitioners in the field of water quality management should ensure that balancing of the principles of sustainable development manifests appropriately in the resource directed measures.

As the 'second line of defence' once the class and resource quality objectives have been established, achieving equitable allocation of water, and water quality in particular, practitioners should continue to apply the principles enabling sustainable development. This can be done by, for example, ensuring that water use is optimal and that there is holistic consideration of all important interactions with, and within, ecosystems (the environmental integration principle).

Strategy for inexperienced practitioners

It is not possible to sensibly "balance principles" unless one can clearly recognise the application of different principles in site-specific contexts. Accordingly, less experienced practitioners should first simply practice identifying the factors and actions that refer to each principle. For example, an action or decision that deliberately ensures that a specific economic activity can reach its full potential while using water quality very efficiently is a good example of optimal water use. On the other hand, a decision that specifically prevents a particular human activity that impacts negatively on water quality from occurring is an example of applying the principles of protection of water resources and optimal water use.

Once this is achieved, attention can be given to the concept of "balancing" these principles in which some are given preference over others.

SECTION 5: INSTITUTIONAL ARRANGEMENTS

This section describes how the institutions for water resource management will decentralise over time and how roles and responsibilities will change.

5.1 Introduction

Dependence on co-operation

The success of integrated water resource management (IWRM) in general, and resource directed management of water quality in particular, will depend heavily on co-operation between all stakeholders. This section identifies those stakeholders and describes the changing arrangements of the encompassing institution. For more detail consult DWAF (2005b).

Underlying principles

The Policy describes a variety of principles that have direct relevance to institutional structure and function (DWAF, 2006a). These include people first ("*Batho pele*") and sustainable development (including current equitable access, equity between generations, etc.). The National Water Act (36:1998) also demands decentralisation and subsidiarity of water resource management.

5.2 Phased institutional change

Phase 1: Post restructuring (current)

Phase 1 follows the recent restructuring of DWAF. Decision-making is shared between P&R and Regional Clusters, while systems are being developed and piloted. P&R is responsible for piloting of RDM and the compulsory licensing process, while the approaches are being developed. Through the piloting process, significant implementation responsibility is delegated to the Clusters and proto-CMAs. Similarly water quality planning and management will be strongly supported by P&R as capacity is built in the Clusters.

Challenges: Iterative establishment of stable systems and their piloting.

Phase 2: Decentralisation to Clusters

Phase 2 is characterised by completion, or near-completion, of piloting and the establishment of stable macro-systems[1]. As a result, further decision-making and implementation is transferred to the Regional Clusters, while the proto-CMAs take on those current regional cluster functions that centre on water use management and coordination.

Accordingly the proto-CMAs are implementing most WRM responsibilities (except Authorisation and RDM). This phase is sometimes circumvented.

Challenges: Capacity in Clusters and proto-CMAs and coordination with P&R.

[1] Macro-systems are the broader conceptual and strategic systems that lead to the establishment of the institutional structures. Systems (or micro-systems), as defined here, pertain to those systems (often internal) that provide the detailed institutional processes and dynamics, resulting in stable and fully established institutions with clear differentiation of roles and responsibilities.

Phase 3: CMAs establishment

Proto-CMAs are transferred, along with their functions and staff, from DWAF into the CMAs within the first 2 years. The CMAss are then formally established. They then start to assume the role of Responsible Authority. DWAF takes on new responsibilities centred on oversight and support.

Challenges: Coordination of widely distributed roles and responsibilities, especially in respect of development of catchment management strategies and water use authorisation.

Phase 4: Fully functional CMAs

A fully functional CMAs has now been established, with the majority of WRM implementation roles and responsibilities within the CMAs (including Responsible Authority functions). The relationships between the CMAs, Regional Clusters and P&R are well established, and the systems and processes within and between these institutions are stable. DWAF has assumed the role of oversight and support of systems, process, institutions and institutional arrangements.

Challenges: Building and maintaining capacity within the subsidiary institutions (especially maintenance of consistency and development of information transfer, review and feedback systems under changing circumstances).

5.3 Roles and responsibilities

5.3.1 Management functions

Visioning

Visioning is a strategic process that guides strategy development (DWAF, 2006b). It feeds back into both RDMs and the CMS. Conducted at catchment level, it informs the classification process during Phases 1 and 2. In Phase 3, visioning is conducted on behalf of the CMAs (*e.g.* by a catchment forum), as preparation for the CMS (DWAF, 2005b).

Resource directed measures

The water resource classification system is a national strategy and is therefore seated in P&R: RDM. Determining the Class is initially the responsibility of RDM piloting in P&R (Phase 1) and is delegated to the Clusters from Phase 2 onwards. When the water resource is only of local significance (*i.e.* not of national importance), the recommendation of Class may be delegated to the CMAs.

From Phase 2 onwards, establishment of stable systems of coordination and co-operation, review and information transfer between CMAs (proto-CMAs), Clusters and RDMs, is a function of P&R, which gradually moves towards increasing institutional oversight and support.

Once a stable classification system has been developed, its implementation becomes relatively routine, and the responsibility for achieving this is passed to the Clusters (Phase 2 onwards). Determination of the Reserve is a technical process, and therefore may be delegated to the CMAs once established (Phase 4). Similarly, for resources that are only regarded to be of local significance (and possibly for all resources), determination of the RQOs may be delegated to the CMAs during Phase 4. Gazetting the Reserve and the RQOs is the responsibility of P&R.

Water Resource Management strategies

The National Water Resource Strategy is the responsibility of P&R (Strategic Coordination). As with the classification system, the institutional transfer of information both feeding into the NWRS and informing processes and decisions at the regional and local levels, requires the establishment of sound and stable coordination and co-operation systems and the development of appropriate relationships based on close institutional fit. Establishment of these systems and relationships starts during Phase 2, and is completed and stabilised during Phase 3.

P&R (National Water Resource Planning) has developed and maintains an initial, interim strategy for catchment management, the ISP (Phases 1 and 2). By Phase 3, the ISP is superseded by the CMS, the development of which is one of the initial functions of the CMAs (Phase 3). The CMAs gazettes the CMS after review by DWAF.

The abstraction allocation plan and the plan for allocatable water quality are catchment level decision-support tools. They are determined by P&R (Integrated Water Resource Planning) during Phases 1 and 2, when they are partly captured in the ISP. In Phases 3 and 4 they are determined by the CMAs (as part of the CMS).

Authorisation

The overall water use authorisation process (application, evaluation and authorisation) will ultimately be the responsibility of the CMAs (Phase 4). However, in the interim, responsibility is divided between P&R (Water Use), Regional Clusters and the CMAs (proto-CMAs).

Control and enforcement

Development of directives, initially the responsibility of P&R (Water Use), will be delegated to Clusters, ultimately with CMAs involvement (Phase 4). Ultimately, the CMAs will ultimately be responsible for control and enforcement.

Management approaches

Compulsory licensing will be the responsibility of Clusters for resources of national importance. Responsibility for those of local importance may be shared with CMAs.

The Waste Discharge Charge System (WDCS) is initially the responsibility of P&R (Water Use), being transferred to Clusters and ultimately to CMAs when stable.

Self regulation and awareness approaches are primarily CMAs responsibilities although these can also be applied at national and regional levels by P&R (Water Use) and Clusters.

Monitoring

Monitoring related to sustainable development is the responsibility of P&R (Information Management) with Cluster and ultimately CMAs involvement. Performance monitoring (of RQOs) is carried out by Clusters and, ultimately, by the CMAs. Compliance monitoring is catchment-based and achieved principally through self-regulation (with auditing by the Clusters and CMAs).

Review

Reviews of all systems will be conducted by P&R during Phase 1. However, multiple levels of review are anticipated by Phase 3, with review of issues of national significance/strategic nature conducted by various P&R components with some functions delegated to Clusters and CMAs.

Oversight and support

Oversight and support is necessary for national consistency. It is both *technical* (*e.g.* implementation of the WDCS) and *institutional* (*e.g.* development of institutional systems and capacity to enable the CMAs to perform its Responsible Authority functions). It also involves a significant *monitoring and review component* and a *support component* to address identified issues or problems through, for example, capacity building. These responsibilities are principally seated in P&R, supported by Clusters, becoming a core function of P&R from Phase 3 onwards.

5.3.2 Management effort

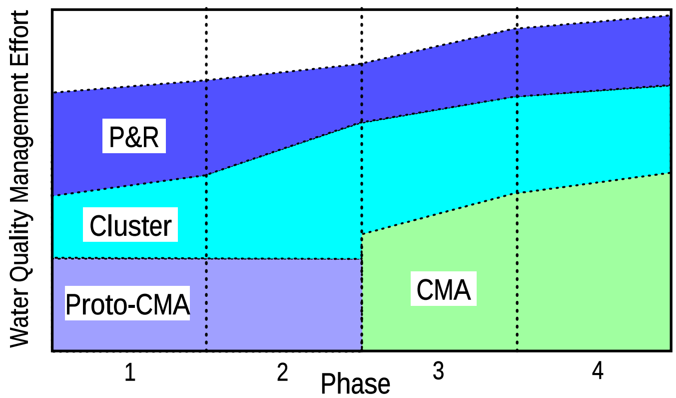


Figure 5.1: Evolving management effort during transition phases (DWAF, 2005b).

Phases 1 and 2

Figure 5.1 illustrates the shift in water quality management effort through the transition phases consistent with the shifting roles and responsibilities. Management effort is reasonably evenly spread between P&R, Clusters and proto-CMAs during Phase 1, with a progressive transfer of responsibilities from P&R to the Clusters during Phase 2.

Phase 3

With the establishment of the CMAs, all roles and responsibilities of the proto-CMAs are transferred to the CMAs along with a continuing shift of roles and responsibilities from P&R to Clusters to CMAs. P&R takes on new responsibilities centred on oversight and support – co-ordination, collaboration and transfer of information between CMAs, Clusters and P&R.

Phase 4

The CMAs is established and stabilised and now bears the majority of water quality management effort. The roles and responsibilities of the Clusters have shifted further (some to the CMAs, with new responsibilities coming down from P&R), with the Clusters taking on an increasing responsibility and capacity in collaboration, information transfer, review and assessment. The functions of P&R have been further focussed, with roles and responsibilities centred on oversight and support.

5.4 Institutional implications

Phase 1

The management cycle is largely coordinated and partly implemented by P&R, in co-operation with the Clusters. The cycle involves RDM (classification system and implementation), Integrated Water Resource Planning (strategy development), Water Use (authorisation and regulation) and Information Management (monitoring and review), with Strategic Coordination assuming oversight of the process. These groups are relatively well capacitated and resourced (generally supported by professional service providers), and coordination is efficient, implying that the piloting processes in this phase are likely to be successful (DWAF, 2005b).

Phase 2

Shifting responsibilities to the Clusters (and proto-CMAs) during this phase introduces potential problems, because their capacity and expertise tends to be limited. Although stable macro-systems are established, detailed institutional processes and dynamics (*i.e.* micro-systems) are not yet fully developed. There may therefore be some initial institutional instability unless this is carefully phased and supported by broad institutional capacity building. However, as both the proto-CMAs and the regional cluster are still contained within DWAF (*i.e.* decentralisation is not yet complete), collaboration, communication and capacity is more easily achieved.

Phase 3

Nineteen CMAs will be established and will take on key planning responsibilities. In effect, these become the interface between the P&R (RDMs) and the high-level visioning process on the one hand, and authorisation on the other. The CMAs will be new, young organisations with limited capacity and resources (although transfer of staff and resources from proto-CMAs does strengthen the new CMAs). In addition, mentoring by DWAF and the Clusters will be required. Accordingly, a range of challenges present themselves and hinge on (a) the resources and capacity in the new CMAs, (b) systems of mentoring, decision making and information flow between the CMAs, Clusters and P&R, and (c) wider review and contextualisation of institutions and roles and responsibilities.

Phase 4

The CMAss are fully established and their systems, capacity and resources are stable. The people within the institution should have grown as capacity is improved, and roles and responsibilities are defined: capacity building of the CMAs staff over 5 years ensures that the institution evolves and the roles and responsibilities are refined according to the management needs and requirements of the WMA.

5.5 Institutional roles

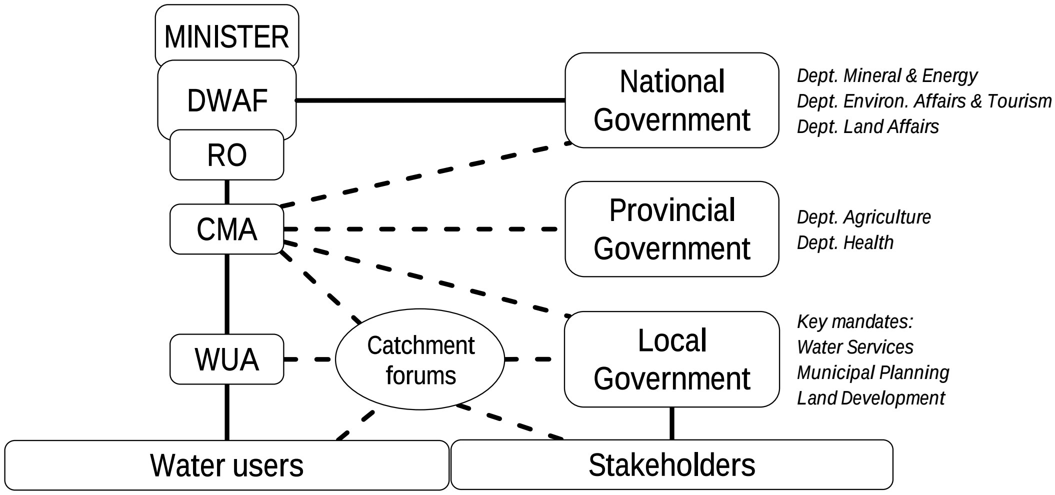


Figure 5.2: Primary institutional relationships (DWAF, 2005b).

Key players

Water quality management inherently requires the management of activities and resources that are the mandate of other government departments or property of private sector entities. Figure 5.2 indicates the key institutions relevant for RDMWQ, with the CMAs / DWAF as the main focus of this management attention.

Resource directed measures

The process of development and establishment of the classification system is consultative ("consensus seeking process") and requires input from other national government departments and from interested and affected local and national agencies (*e.g.* WUAs, Forums, national representative bodies). DWAF achieves this consultation through the CMAs/proto-CMAs.

Determination of the Reserve and the RQOs may be conducted at the CMAs/Cluster level. As this is largely a technical process, participation by peripheral agencies is not a prerequisite. However, local government and other local agencies (*e.g.* WUAs) may be involved in the technical process.

Water Resource Management strategies

The establishment of the NWRS by National Government (DWAF) necessitates co-operative government with other National Government departments, such as DEAT, Department of Finance, Department of Agriculture and DME.

The development of a CMS involves regional and national government and local agencies (*e.g.* local government, Water User Associations and Forums). Engagement with Provincial Government (e.g. Office of the Premier, Ministry of Agriculture and perhaps Nature Conservation) forms an important component of the review, assessment and harmonisation of the CMS. Brokerage of this relationship is principally undertaken by the Cluster.

Water use authorisation

The application process requires some consultation at a local level with water users and dischargers (including local government). Similarly, evaluation and authorisation require consultation and co-operation with local, regional and national departments. As such, the water use authorisation process comments on, and is informed and influenced by other processes, such as the development of the EMPR within the mining sector (a requirement of DME) or the requirements of the Environmental Conservation Act of DEAT for waste disposal (e.g. landfills).

Control and enforcement

Control and enforcement functions of the CMAs require the establishment of co-operative governance frameworks with the local agencies (local government, justice, law enforcement). Establishment of the water management directives requires close co-operation with the national and regional bodies responsible for development and implementation of management and control measures in the WMA (commonly DEAT, DoA, and local and regional government).

Compulsory licensing

Compulsory licensing is inherently a co-operative process that must engage the developmental and spatial planning priorities of other government departments. The linkage with Local Government is critical in terms of integrated development planning (including water services) and local economic development, while Provincial and National Government is key in supporting people with access to water and other productive resources (including land reform, agricultural resource protection, etc).

Waste Discharge Charge System

The emerging nature of the WDCS necessitates close co-operation with National Treasury. Moreover, engagement at the local level is necessary to give effect to the mitigation element, requiring close co-operation with water users, dischargers and impacted communities/enterprises. In developing and reviewing the charge system, co-operation and engagement of DME (mining sector), DTI, DEAT (Environment Conservation Act) and DoA will ensure harmonisation and consistency of the system with other relevant legislation and control and management approaches.

Self-regulation and awareness

Development of self-regulation and the creation of awareness require the development of co-operative governance at the local level between the CMAs, local government and WUA, specific users and dischargers.

Monitoring and review

Monitoring related to sustainable development requires consistency with, and input from CSD, DBSA and various levels of national strategy.

Performance monitoring requires close co-operation with local government, WUA, forums and individual users/dischargers.

Compliance monitoring and monitoring of the water management institutions are largely internal functions conducted at varying levels (CMAs, Regional Clusters, P&R). Development of co-operative governance relationships is not a pre-requisite, although the involvement of local, provincial and national government and other agencies in the appropriate review process could be beneficial.

5.6 Institutional Capacity

Types of institutional capacity

Institutional capacity includes:

- *Policy and legal capacity*.
- *Planning and managerial capacity*.
- *Organisational and procedural capacity*.
- *Financial capacity*.
- *Human and infrastructural capacity*.
- *Networks and associations*.
- *Stakeholders.*

Consult DWAF (2005b) for more detail.

Institutionally orientated approach

The process for building institutional capacity should (a) be carefully planned, and (b) establish coherent, simple and stable systems, introducing as much routine as the available capacity is able to deal with. For example, see the strategy proposed for water use authorisation (Section 6.5.2.7).

SECTION 6: IMPLEMENTATION STRATEGIES

This section is an interpretation of how the Policy should be implemented in a variety of scenarios. It is the technical link between the Policy and the management instruments.

6.1 Introduction

Technical link between Policy and instruments

The following sub-sections briefly summarise how the Department will ultimately integrate the technical aspects of resource directed management of water quality into broader water resource management. It is this technical implementation that the institutional arrangements, action plan, and capacity creation, aim to facilitate.

Each of the strategy sub-sections provides direct references to the associated management instruments.

Common themes

The technical theme throughout is primarily "making water resource management water quality friendly". Specifically, this strategy focuses on achieving this through resource directed measures (RDMs).

- First, it does this by briefly addressing how water quality should be taken into account in the determining the management class, resource quality objectives (RQOs) and the Reserve.
- Secondly, it addresses how RDMs should be incorporated into a catchment management strategy to ensure the management class, RQOs and the Reserve, and hence the catchment vision, are achieved and maintained.

Another common thread that extends from the Policy through this strategy to the management instruments is consistency with the philosophy of sustainable development.

Sustainable development guidelines

The Policy should be consulted for a more detailed discussion on the philosophy and enabling principles of sustainable development relating directly to water resource management, and to water quality management in particular. The generic philosophy of sustainable development should also be consulted for more general background information on the concept of sustainable development (DWAF 2004h).

6.2 Catchment assessment

Primary purpose

A catchment assessment is an important planning function of integrated water quality management and hence integrated water resource management in general. Its primary purpose is to provide useful information on a catchment for the following:

- Catchment visioning.
- Resource directed measures.
- Water quality management programmes and plans.
- Catchment management strategies.
- Source directed controls (particularly source-specific management interventions).
- The National Water Resource Strategy (NWRS).
- Institutional development.
- Water quality reconciliation foresight and scenario planning.
- Water resource development.

Interpretation of enabling principles

Practitioners should familiarise themselves with the enabling principles of catchment assessment in the Policy. They should ensure that the process is guided by these principles. For example:

- The nature of engagement with stakeholders should always be constructive and be at a level that ensures the catchment visioning process in particular (and subsequent efforts to attain that vision) are adequately supported.
- Catchment assessment is about collating information and making it available. Take cognisance of legislation such as the Promotion of Access to Information Act (2:2000).
- Catchment assessments must be appropriately integrative in their data collections and assessment. Consider the "state" of water quality, the causes of deteriorating water quality ("pressures"), the ecological and socio-economic consequences (the "impacts") of this and the reactions of society, in both the public and private sector (the "responses"). (See Section 6.5.3: Water quality monitoring)
- Although human and financial resources must be pragmatically allocated to catchment assessments, this must also demonstrate good judgement and be based on the level of confidence required.

Level of confidence

The level of confidence that should be strived for in a catchment assessment study should be determined primarily by the degree of confidence required for the processes or applications it is intended to support.

Management instruments	Conceptual introduction Catchment assessment studies	DWAF, 2003d DWAF, 2003e

6.3 Catchment visioning

Importance

One core tenet of the National Water Act is participatory management of water resources *(Principle: Effective Stakeholder Engagement)*. The degree of stakeholder engagement is likely to increase in importance and frequency in the near future as water resources are classified and associated resource quality objectives are defined. The Department also recognises that good governance depends intimately on effective stakeholder engagement.

Catchment visioning is an essential planning tool that drives all aspects of integrated water resource management and is an indispensable component of this strategy. Although this strategy primarily addresses water quality management, visioning must encompass resource quality holistically and clearly identify how water quality issues contribute.

Interpretation of enabling principles

Individuals who are responsible for initiating and facilitating a catchment visioning process should familiarise themselves with the enabling principles of the process described in the Policy. They should ensure that these principles are applied appropriately to the process at all times.

Vision content principles

The content of the vision (including the associated objectives hierarchy) should also be strongly principle-based *(Principle: Principle-based Decision-Making)*. In particular, all stakeholders should be:

- Familiar with the enabling principles of sustainable development as described in the Policy, and
- Encouraged to incorporate these either explicitly or implicitly into their vision.

Sustainable development

Awareness should be created of the philosophy and principles of sustainable development *(Principle: Sustainable Development)*. Consideration of sustainable development should be facilitated by:

- Investigating creative techniques that open up debate, discussion and problem solving. These should be open-minded and positive and have a common future focus in which stakeholders have true ownership. (*Principle: Creative Problem Solving*),
- Instilling a desire to put effort into finding "win-win" solutions to problems that at first sight may seem unsolvable, and
- Providing stakeholders with all the necessary ecological, social and economic information to ensure informed decisions are made *(Principle: Environmental Integration)*.

Other legislation

In defining the vision, and in particular in the subsequent process of its achievement, cognisance must be taken of all legislation that may be relevant. This will go well beyond the National Water Act (36:1998). For example, this may include environmental management, conservation, biodiversity, etc. *(Principle: General Legislative Alignment)*.

Buy-in and ownership

South African stakeholders are becoming more acutely aware of their rights in respect of being consulted. Any perceived deficiency in this regard can result in an implementation strategy being derailed or delayed. This can be particularly problematic if the dissatisfied stakeholders would have played an important implementation role.

For this reason the strategy of the Department will be to apply the principles of effective stakeholder engagement described in the Policy. Furthermore, the Department's strategy will, whenever appropriate, do more than merely "consult" stakeholders. It will engage them with the intention of:

- Allowing them to contribute meaningfully to the formulation of the vision,
- Creating at least a sense of buy-in, and
- Preferably enabling a significant feeling of ownership in the subsequent achievement of the vision.

Confidence levels

Establishing an effective stakeholder base is time consuming and potentially costly. This may create a tension with the need to make water resource management decisions quickly and effectively. Catchment visioning initiatives should therefore be carried out to a level of confidence that is appropriate to the circumstances. Confidence, in the current context, refers to the degree to which stakeholders can comfortably rely on:

- The vision adequately reflecting their future aspirations, and
- The associated objectives hierarchy being practically implementable.

Catchment visioning will necessarily need to be pragmatic, but this pragmatism must also be sensible in its choice of priorities (*Principle: Prudent Pragmatism*).

Confidence determined by enabled processes

The degree of confidence in catchment visioning is ultimately determined by the degree of confidence required for the processes it is immediately intended to enable. For example, in the absence of a management class and where a need exists for low confidence resource water quality objectives, a low confidence catchment visioning exercise is acceptable.

Subsequent movement towards achieving the vision should be understood by all to require a management approach that takes account of current uncertainties and adapts to future changes that may be unpredictable *(Principle: Adaptive Management)*.

In those instances where a low confidence catchment visioning exercise is performed, this should always be seen as laying the groundwork for a future process that should ultimately provide greater confidence.

Management instruments	Catchment visioning Public participation	DWAF 2006b DWAF, 2001a;DWAF, 2001b

6.4 Resource directed measures

6.4.1 Introduction

6.4.1.1 General issues

RDM determination

An "RDM determination" for a water resource refers collectively to the following sub-processes:

- Determination of the resource management class and resource quality objectives (RQOs), and
- Determination of the Reserve (basic human needs and ecological).

These are described in sub-sections below.

Determination & legal establishment

"Determination" of RDMs is a largely technical process including primarily ecological, social and economic issues. Having been so determined, the legally binding act of setting the RDMs requires approval by the Minister or the delegated authority.

Importance

The importance of a water resource management unit, in particular relating to quality of life and all factors that determine this, ultimately guides the level of protection required and the degree of confidence that is required in the RDM sub-process. Relating to water quality, the following issues should be considered:

- *Ecological importance*. A high biodiversity of biota and habitats in a resource unit increases its ecological importance. This importance is further increased if these biota or habitats are rare. The water quality may be an important component of such habitats.
- *Social importance*. This is the extent to which the local human population and downstream users depend on water of particular quality. For example, such uses may include recreation, drinking, laundry, stock watering and various religious and cultural practices. They may also regard the water as simply having aesthetic value.
- *Economic importance*. This refers to the extent to which water of a particular water quality should be accessible for economic activities such as agriculture and industry, and more specifically those activities that are associated with significant job creation and hence an increased potential for poverty eradication.

Consideration of all three dimensions of importance is critical for achieving sustainable development *(Principle: Environmental Integration)*.

Sensitivity

The sensitivity associated with a water resource management unit also determines the level of protection that is required. Relating to water quality, the following issues may increase the level of protection required:

- *Ecological sensitivity*. Biota or ecological processes may respond significantly to very small changes in water quality. Estuaries and wetlands are examples of systems that usually have a high ecological sensitivity.
- *Social sensitivity*. Local or downstream users may rely on a demanding water quality range for social activities and small deviations from this range may cause potential problems.
- *Economic sensitivity*. Economic activities of water users may be negatively affected by small changes in water quality.

Vulnerability

Besides importance and sensitivity, vulnerability is also used particularly for groundwater to represent its susceptibility to contamination (expressed as a likelihood or probability). It depends largely on the nature of the unsaturated zone that overlies groundwater. The greater the vulnerability of a groundwater resources the greater the level of protection that is warranted.

6.4.1.2 Confidence

Confidence levels

Table 6.1 shows some factors that can determine the level of confidence that should ultimately be associated with the outcome of any proposed RDM sub-process. Each relevant factor should be considered and weighed against other relevant factors. (Note: Different factors will be relevant in different circumstances, while some factors may not be relevant in certain instances. Also, the factors are not all mutually exclusive, *i.e.* there may need to be some degree of overlap in their interpretation.) ***The final level of confidence chosen should be based on the factor that demands the highest level of confidence.***

Risk

The level of confidence required is closely related to the risk of problems occurring. The higher the potential risk, the greater the confidence in the RDM sub-process should be.

Table 6.1: General and water quality-related factors determining the degree of confidence that should be associated with any single proposed RDM sub-process that is associated with a particular water resource unit.

FACTOR	DEGREE TO WHICH FACTOR APPLIES		
Factors related to the immediate purpose of the RDM sub-process			
Confidence required in a subsequent process to be enabled (*i.e.* informed) by the RDM sub-process	Low	Medium	High
Required for water use allocation plan in catchment management strategy?	No		Yes
Required for compulsory licensing?	No		Yes
Number of applications for water use licences currently being processed in the resource unit.	One	Few	Many
Factors related to the present ecological state (PES)			
Present ecological importance and sensitivity (EIS) of resource unit (directly related to the degree of protection of the water resource considered necessary)	Low / Local	Medium / Regional	High / National/ International
Degree of present water quality stress (if this can be quantitatively determined)	Unstressed	Stressed	
Factors related to potential changes in water quality			
Potential negative impact of the proposed water use(s) on water quality (may be dependent on EIS)	Low	Medium	High
General likelihood of developments in the short- and medium-term that may impact negatively on water quality	Low	Medium	High
Vulnerability of resource	Low	Medium	High
Degree to which water resource is already used (in terms of water quality impact)	Minimal	Medium	High
Factors related to potential impacts of changes in water quality			
Severity of potential impact of changes in water quality on existing social or economic users (may be dependent on EIS)	Low	Medium	High
Spatial scale of potential impact of changes in water quality	Highly localised	Fairly local	Regional
CONFIDENCE THAT SHOULD BE ACHIEVED IN THE PROPOSED RDM SUB-PROCESS	**LOW**	**MEDIUM**	**HIGH**

6.4.1.3 Variables of concern

Beyond water quality

A main objective of this strategy is to "ensure water quality considerations are appropriately incorporated into all water resource management initiatives" (see Section 3: Objectives). This requires thinking beyond water quality.

The causes and effects (impacts) of deteriorating water quality must also be considered if a truly integrated approach to water quality management is to be implemented successfully.

Water quality variables

Nevertheless, at the most fundamental and obvious level, "incorporating water quality considerations" often means choosing indicators that reflect those water quality properties that are relevant to the situation being considered. Identifying "variables of concern" may depend on:

- The nature of the individual water uses and their impacts on water resources (and therefore may need to be established through stakeholder engagement).
- Ecosystem requirements.
- The RQOs or preliminary RQOs (both narrative and quantitative) that may exist for the water resource unit in question. These necessarily reflect desired resource quality in general, some of which will relate directly to water quality. Although specific water quality attributes may often be explicit in the RQOs, it must be ensured that all RQOs are properly interpreted to ensure that all important water quality variables of concern are chosen.

New mindset

A conscious effort should be made to move away from a common traditional mindset that chemical variables are the only water quality variables of importance. The following should also be considered:

- Microbial variables such as *E. coli* are useful indicators of faecal contamination. Faecal contamination is problematic when water is used for domestic purposes because human health can be affected.
- In certain circumstances, like when a known source of toxicants exists or is suspected, measurement of the toxicity of water to selected organisms (such as algae, *Daphnia*, or fish) can provide information not easily obtained by the usual chemical methods.

Sustainability

The other objective of this strategy is to ensure the approaches adopted to implement it are "ecologically, socially, economically and institutionally sustainable" (see Section 3: Objectives). In respect of water quality variables specifically, this means ensuring the variables are:

- Representative of the water quality that matters the most to overall ecosystem health.
- Socially relevant and acceptable. (Human health is one obvious consideration).
- Economically appropriate. (Consideration should be given to more than just the financial costs. The broader economic implications relating to causes and effects of water quality need to be considered).
- Institutionally sound. (Different organisations are often likely to be stakeholders. Variable levels of capacity relating to either measurements of the chosen variables, or interpretation of their data, across different organisations must be aligned).

Management instruments	RDM manuals Monitoring Determining water quality stress	DWAF, 1999 DWAF, 2006c DWAF, 2004e
Further reading	Introductory manual Variables of concern	DWAF, 2005c DWAF, 2004l

6.4.2 Resource water quality objectives

Short-term measures

Because the determination of the class and associated RQOs (Section 6.4.3) is time-consuming (because of their formality and the need to follow due process), appropriate interim measures should be taken to facilitate water quality management in the short-term.

In those water resources requiring immediate attention, resource water quality objectives (RWQOs) can be defined at selected strategic locations. As far as possible, and when human, financial and time resource permitting, their determination should apply the same principles that will underpin the determination of RQOs (when the classification system becomes established). In so doing, these RWQOs serve two purposes: (a) they facilitate short-term water quality management, and (b) they form a basis for the ultimate determination for formal RQOs.

In the short-term, these RWQOs are then regarded for most practical purposes as (preliminary) RQOs and interim management objectives can then be defined to facilitate their gradual attainment (equivalent to the strategy for "attaining a management class" (see Section 6.5.2.3).

6.4.3 Determining the resource management class and RQOs

Fundamental importance

Having water resources classified into specific present and desired future categories is arguably the most fundamental concept of future water resource management. This is because it will provide the main framework of criteria upon which the Department can make decisions regarding the appropriate balance between use and protection in the quest for sustainable development. The role of water quality issues in this process is as important as water quantity and other resource quality attributes. *(Principle: Sustainable Development)*.

Essential management objectives

Resource quality objectives (RQOs) are management objectives, the monitoring of which will allow stakeholders to establish whether the designated management class is being attained or maintained. This makes them essential tools for effective water resource management.

Setting RQOs is intimately related to designating the management class. They define the limits of the chosen class and take account of all users, as well as the Reserve, and are extremely important sustainability indicators.

Familiarisation with principles

All stakeholders and decision makers who are involved in the classification process should familiarise themselves with the enabling principles of sustainable development as outlined in the Policy. It is precisely the relative application of these principles for which a balance must be found.

Effective stakeholder engagement

Effective stakeholder engagement in the classification process is essential. See the Policy for details on the enabling principles. The stakeholder engagement process must be embodied in a catchment visioning exercise (see Section 6.3).

Those stakeholders that rely on water of particular quality are important because it is such reliance that often needs to be balanced against the need to protect aquatic ecosystem health. RQOs must reflect this balance. *(Principle: Effective Stakeholder Engagement)*

Empowering stakeholders

Stakeholders must be empowered to make informed inputs into the process. In respect of the water quality component of their resources, if necessary, they must be adequately informed about the following:

- The meaning and value of water quality in respect of (a) constituents contained in the water, and (b) associated ecological responses (such as diminished ecosystem integrity) and social and economic impacts of worsening water quality (for example on human health).
- The relationships between aquatic ecosystems and water quality.
- The effects of their water uses on water quality and hence downstream users.

Although general statements can usually be made about these issues, more convincing and empowering information can only come from a detailed understanding of water quality-related processes that are specific to the catchment in question. This can only come from catchment assessments (see Section 6.2: Catchment Assessment) and holistic water quality monitoring (see Section 6.5.3: Water quality monitoring). The information should be communicated to stakeholders through effective channels such as catchment forums.

Integration across catchments

Although a class and associated RQOs may be specific to sub-catchments or even Level II Ecoregions within a water management area, they must also take account of current and potential impacts:

- Upstream, and
- Downstream, and
- On catchments receiving or donating water via inter-basin transfers.

In such cases, stakeholders from such catchments must also be engaged *(Principles: Environmental Integration & Effective Stakeholder Engagement)*.

Achievable RQOs

Care should be taken to ensure that achievable RQOs (relating to water quality) are properly defined. This may necessitate at least a preliminary consideration of interim water quality objectives for the resource – these will link the formal RQOs to conditions that might be imposed on individual water uses. Affected stakeholders must feel comfortable that these interim objectives, and hence the RQOs, are achievable progressively over a specified period of time *(Principle: Prudent Pragmatism)*.

Management instruments	Empowering stakeholders (catchment assessment)	DWAF, 2003d
	Empowering stakeholders (monitoring)	DWAF, 2006c
	Resource water quality objectives	DWAF, 2004e&p
	SA water quality guidelines	DWAF, 2001c

6.4.4 Determining the Reserve

Basic right

The National Water Act defines the Reserve as the quantity and quality of water required (a) to satisfy basic human needs and (b) to protect aquatic ecosystems, in order to secure ecologically sustainable development and ensure sustained use of the relevant water resource. The Reserve is also dependent on the designated management class *(Principle: Sustainable Development)*.

Familiarisation with principles

All stakeholders are concerned with Reserve determinations relating to water quality should familiarise themselves with the Reserve-related issues in the Policy. Both the ecological and basic human needs Reserve will contribute in a fundamental way to achieving sustainable development if they are properly determined and applied.

Variables of concern

When choosing the variables to represent those attributes of water quality that are relevant to the Reserve, cognisance should be taken of the comments in sub-section 6.4.1.3 (Variables of concern) above.

Management instruments	Water quality guidelines (aquatic ecosystems) Water quality guidelines (domestic use) Water quality guidelines and fitness-for-use categories	DWAF, 2002 WRC, 1998; DWAF, 1996 DWAF, 2004f
Further reading	Introductory overview Biotic response	DWAF, 2005c Malan and Day, 2005

6.5 Giving effect to resource directed measures

6.5.1 Introduction

Sustainable development

Having determined the RDMs it is important that these guide water resource management, both by the Department and by catchment management agencies (CMAs), effectively and efficiently. Even though the management class is the 'first line of defence' against development that may be unsustainable, giving effect to RDMs (or 'making RDMs operational') continues to require explicit consideration of the principles of sustainable development. This is the 'second line of defence' because these remain the guiding principles even when the management class has been attained and is being maintained. (See Figure 4.1.)

Translating RDM

In general, the RDMs need to be translated into strategies and actions that:

- Achieve the objectives set for the water resource,
- Manage causes of water quality impacts, guided by RQOs, resource water quality objectives (RWQOs), interim objectives and source management objectives (SMOs), the latter given effect through source directed controls (SDCs), and
- Remediate water resources where this may be necessary.

In practice, the SDCs will be the main focus of efforts to give effect to RDMs. However, the following sub-sections give specific emphasis to translation of RDMs to SDCs. The SDCs *per se* are not the focus of this strategy. Rather, this strategy describes how the overall source management strategy in a catchment should be determined by the RDMs, including RWQOs, that are in place.

Proactive and reactive

RDMs must guide SDCs in both a proactive and reactive manner:

- Proactive management focuses on measures that will prevent or minimise future water quality problems. For example, this involves the Department and/or CMAs using RDMs to assess future developments that may impact on water quality.
- Reactive management focuses on managing existing sources of negative impact on water quality to achieve the RDMs.

6.5.2 Scenarios

6.5.2.1 Introduction

Strategies

The following sub-sections each identify a specific scenario for which a strategy is presented that will help to implement the policy on resource directed management of water quality.

6.5.2.2 Catchment management strategies

Scenario	A catchment management agency (CMAs) is assumed to have been established and that a catchment management strategy (CMS) must now be developed progressively for its water management area (WMA).

Importance of principles

The CMAs is responsible for developing the CMS. All involved in this process should familiarise themselves with the Policy relating to CMS and their associated principles. They should ensure that all principles are appropriately reflected in:

- The process of developing the CMS, particularly relating to effective stakeholder engagement not being an exclusive process in any way, and
- The CMS itself, either explicitly or implicitly.

Alignment

The development of the CMS must be issues driven and must be aligned with Water Services Development Plans (WSDPs) and Integrated Development Plans (IDPs).

Catchment assessment

A catchment assessment study will need to be undertaken to ensure the various stages of the development of the CMS can be based on a sound understanding of the catchment and optimal use of local knowledge. (See Section 6.2: Catchment Assessment).

RDM not determined

The CMS is the operational strategy that gives effect to RDMs (see Figure 4.2). If RDMs are not yet in place, then the CMS should include a sub-strategy to request the Department to determine the RDMs, or co-ordinate, the determination, and setting of RDMs. The Policy should be consulted in respect of RDMs and appropriate choices must be made in respect of:

- Practical spatial management units for water quality.
- The levels of water quality stress.
- Degrees of confidence required in RDMs.

Relevant sections of this strategy should be consulted for general guidance on RDM determinations (Section 6.5).

ISP

Existing Internal Strategic Perspectives (ISPs) can be regarded as precursors to the CMS in each WMA. However, these have not been developed with adequate stakeholder engagement nor do they take adequate account of water quality. It is therefore essential that mechanisms be put in place to engage with stakeholders, beginning with catchment visioning exercises. The associated overview and situation assessment reports can be used as a basis and, in many cases, instead of a formal catchment assessment report, at least during the initial phases. However, the lack of water quality data requires the collecting, assessing and reporting of data that will fill this gap. (See 8: Action Plan.)

Resource Water Quality Objectives (RWQOs)

Resource water quality objectives (RWQOs) are management objectives that support the attainment of resource quality objectives (RQOs). In particular, they should be chosen to allow a more detailed level of water quality management to be implemented over an appropriate time frame so that the RQOs are achieved and/or maintained. The RWQOs relate to those variables that will be monitored over time to enable accurate assessment of the effectiveness of the water quality management actions (SDCs and remediation) in the catchment. While both spatial and temporal RWQOs should be used for surface waters, groundwater monitoring is likely to be based more on temporal RWQOs (*i.e.* RWQOs targets defined at selected boreholes at specified time intervals, *e.g.* annually). RWQOs may need to be developed for each "variable of concern" (see Section 6.4.1.3: Variables of concern).

Source management objectives (SMO)

Based on the RWQOs, source management objectives (SMOs) must also be developed. These are technical objectives that provide mechanisms for achieving the RWQOs (DWAF, 2003a). They may include the following:

- Pollution load reductions (for stressed catchments).
- Pollution load maintenance (in threatened catchments).
- Pollution load increases (in unstressed catchments).

The SMOs must balance the ideal load targets with technical, economic and administrative realities. They outline what needs to be done but not how and by whom it will be done.

Water quality management framework plan	The water quality management framework plan outlines the approach to water quality management in the water management area as a whole. It is strategic in nature and should clearly account for linkages with other components of the CMS (such as water quantity and other attributes of resource quality). The water quality framework plan also includes a water quality allocation plan that allocates the SMO load reductions (or increases) to priority water use sectors in the catchment. In deciding on this allocation plan, sustainable development and the hierarchy of decision-making (the enabling principles for which are described in the Policy) should be applied.
Implementation plan	A water quality management implementation plan must specify management actions, roles and responsibilities, resources required and time frame. The plan should aim to mitigate the adverse impacts on water quality that may be associated with priority sectors in the catchment in order to give effect to the load allocation plan.

Management instruments	Conceptual introduction	DWAF, 2005a
	Source management objectives	DWAF, 2003a
	Water quality management framework plan	DWAF, 2003a
	Converting RWQOs to end-of-pipe standards	DWAF, 2004j
	Complex wastewater discharges	DWAF, 2005d
	Non-point source impacts	DWAF, 2001d
	Effluent discharge impacts	DWAF, 1995
	Determining water quality stress	DWAF, 2004e

6.5.2.3 Attaining a management class

Scenario	A water resource has recently been designated a specific management class and the present state of the resource is actually worse than the designated class. In effect, the catchment is therefore water quality stressed.

Responsibility	It is primarily the responsibility of the CMAs, or the Department in the interim, to achieve compliance with RQOs. However, all stakeholders, particularly individual water users, have valuable roles to play and bear important responsibilities.
Performance monitoring (RQOs)	A performance monitoring programme must be established as soon as possible, in order to establish the degree to which RQOs (or RWQOs) relating to water quality are not being achieved.
Interim objectives	An equitable and achievable time frame must be chosen to achieve compliance with the RQOs or RWQOs. Interim objectives relating to water quality can be defined (see Figure 6.1) so that milestones can be set at specific times (*e.g.* annually) to enable a steady phased improvement.

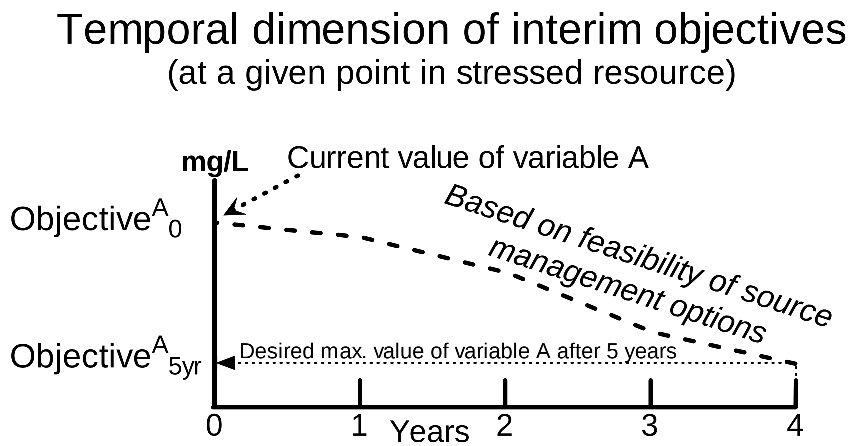


Figure 6.1: Illustration of how interim objectives may vary over time for a specified point in a stressed resource at specified time intervals (points 1, 2 or 3 of Figure 6.2). If the point is where an RQOs is defined (point 3), the final objective equals the RQOs.

High resolution spatial objectives

Management objectives can also be set at a higher spatial resolution throughout the catchment (see Figure 6.2), which will provide more detail on the spatial variability of variables of concern (specifically those associated with RQOs). Each can also have interim (temporal) objectives that provide milestones at specific times. These objectives will typically be resource water quality objectives (RWQOs) that were not set as formal (gazetted) RQOs (see Section 6.4.2: Resource water quality objectives).

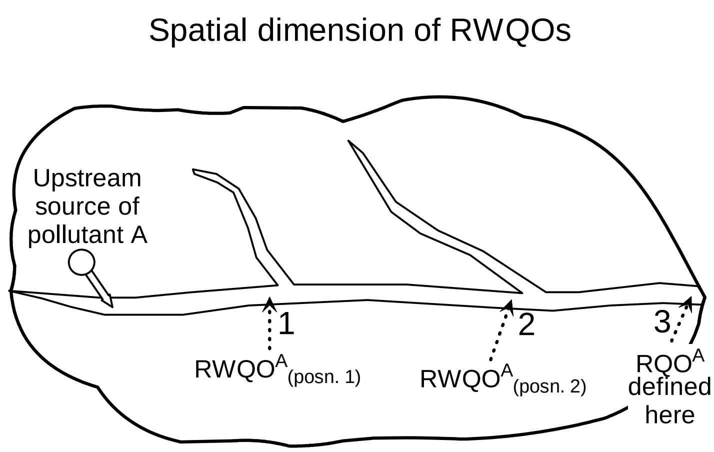


Figure 6.2: Illustration of where RWQOs might be defined.

Reactive then proactive	Primarily reactive management will be required to minimise the adverse impacts of existing water users by engaging individual water users or responsible authorities. Although all such impactors should be engaged in an equitable manner, those that are considered to be causing the greatest impacts should be engaged with greater urgency. Specific management approaches include compulsory licensing, directives, strict regulation, prohibition of land use, remediation, waste discharge charge system (and other financial provisions provided for by Chapter 5 of the Act) and encouraging general cooperation and awareness. Proactive management will also be important to manage the water quality impacts of new developments.
Overall strategy	Overall, the approaches described in the Source Management Strategy (DWAF, 2003c) should be adopted to manage causes of water quality impacts. However, the precise nature of these SDCs (*e.g.* concerning the variables of concern, end-of-pipe standards or targets, monitoring frequency, etc.) will depend on the downstream RQOs. The strategies described below for point and non-point sources and remediation should be applied (Section 6.5.2.5, 6.5.2.6 and 6.5.2.10).

Management instruments	Performance monitoring	DWAF, 2006c
	Managing water quality impacts of settlements	DWAF, 2001e
	Source management strategy	DWAF, 2003c

6.5.2.4 Maintaining a management class

Scenario	The present state of a water resource corresponds to the desired state (*i.e.* the designated management class). This is equivalent to saying that the RQOs are being achieved. Depending on how close individual water quality variables are to the RQOs, the water resource may be unstressed or only have limited allocatable water quality. Performance monitoring of RQOs and compliance monitoring of individual licence conditions are assumed to be in place.

Second line of defence	Allocatable water quality must still be sensibly distributed among water users, taking due consideration of all the enabling principles of sustainable development. (See Section 6.5.2.7: Water use authorisation)
Proactive then reactive	Maintaining a management class will require mainly proactive management to ensure that the water quality impacts of new developments remain within the overall capacity of the water resource. Reactive management is likely to be necessary to ensure that existing water users maintain their impacts on water quality within agreed limits. As with attaining a management class (Section 6.5.4.3), cognisance should also be taken of the financial provisions provided for by Chapter 5 of the Act.

Assessment of monitoring data	Regular assessment of monitoring data should be undertaken on a number of levels: • Performance monitoring data to confirm that the water quality at the specific points at which RQOs are defined remains in compliance with the RQOs. • Compliance monitoring data to confirm that the water quality at specific points at which RWQOs are defined remains in compliance with the RWQOs. • End-of-pipe monitoring to confirm that water quality remains in compliance with any end-of-pipe standards or targets that may have been imposed as licence conditions. • Other monitoring data, for example socio-economic, are being provided by licensees as specified in their licence conditions.
Non-compliance	In all cases, the data should be examined to detect possible existing non-compliance, or trends towards possible future non-compliance, so that appropriate actions can be taken promptly. (See Section 6.5.2.5: Managing point sources and Section 6.5.2.6: Managing non-point sources.)

Management instruments	Performance and compliance monitoring Determining allocatable water quality	DWAF, 2006c DWAF, 2004e

6.5.2.5 Managing point sources

Scenario	A management class, Reserve, RQOs and interim objectives have been established for a water resource and source directed controls for one or more point sources must be implemented to attain or maintain the class.

Localised initial impact	Water users whose actual or potential initial impact on a local water resource is highly localised (at so-called "point sources") are usually more easily managed than those whose impact is more diffuse (from "non-point sources"). The CMS will dictate the general nature of the required source directed controls. However, it is specifically the RQOs and interim objectives in place that determine the precise actions to be taken.
Proactive approach to problems	Use of appropriate existing guidelines and Best Practices relating to the water use and, in particular, water resource protection should be encouraged, especially for new water users. Practical, economically feasible, and equitable time periods should be set in consultation with individual water users for such implementation. These time periods should be consistent with the time frame chosen to achieve the RQOs.

ISO 14000 standards

The general strategy in respect of self-regulatory mechanisms is to encourage the adoption of ISO 14000 standards. The aim is to increase in-house responsible environmental management by water users and hence facilitate the quest for sustainable development. The Department should work closely with such organisations to ensure that this results in pollution prevention, waste minimisation and continual improvement in compliance with licence conditions and attainment of interim objectives and RQOs.

Water use authorisation

New water uses must be in accord with the catchment vision and associated RDMs and can only be authorised if there exists allocatable water quality (see Section 6.5.2.7: Water use authorisation). Every effort should be made to streamline the processing of water use authorisations, preferably using a simple screening protocol that will fast-track the granting of authorisations when their impacts are likely to be low.

Compliance monitoring

After a licence has been issued, a compliance monitoring programme must be established as soon as possible. End-of-pipe licence conditions are particularly important and their careful monitoring and surveillance is a core function of compliance monitoring. However, complying with such licence conditions should never be regarded as guaranteeing attainment of RQOs, which should be monitored independently (in a performance monitoring programme) (DWAF, 2006c).

Management actions

Table 5.2 describes what management actions might be appropriate depending on the compliance and non-compliance with RQOs, RWQOs (at a higher spatial resolution) and end-of-pipe conditions. The phrase "engage transgressor" is taken to mean the following: *Approach transgressor, identify causes of problems, identify effective interventions and associated outcomes, agree on time scales consistent with achieving interim objectives, RWQOs and RQOs, implement and monitor*.

Table 6.2: Recommended actions based on compliance with RQOs, RWQOs and end-of-pipe licence conditions for authorised point sources.

Compliance with			Initial action	Medium-term action if initial action unsuccessful
RQOs	**RWQOs**	**Ends-of-pipe**		
No	No	No	Engage transgressors (*i.e.* initially assume authorised point sources are the only causes of RWQOs and RQOs non-compliance). **Priority: High.**	Consider prosecution of transgressors.
No	No	Yes	Consider existence of other sources (*e.g.* unauthorised, general authorisations, NWA Schedule 1 uses) upstream of RWQOs. **Priority: High.**	Consider stricter end-of-pipe standards. As last resort consider remediation.
No	Yes	Yes	Consider existence of other sources (*e.g.* unauthorised, general authorisations, NWA Schedule 1 uses) downstream of RWQOs. **Priority: High.**	Consider recalculation of RWQOs. As last resort consider remediation or reconsider suitability of RQOs.
No	Yes	No	Engage transgressors and consider existence of other sources (*e.g.* illegal uses, general authorisations, NWA Schedule 1 uses) downstream of RWQOs. **Priority: High.**	Consider recalculation of RWQOs. Consider prosecution of transgressors.
Yes	No	No	Engage transgressors. **Priority: Medium.**	Consider prosecution of transgressors.
Yes	Yes	No	Engage transgressors. **Priority: Medium.**	Consider prosecution of transgressors. Consider relaxation of end-of-pipe standards if RQOs will not be compromised.
Yes	No	Yes	Consider existence of other sources (*e.g.* illegal, general authorisations, NWA Schedule 1 uses) upstream of RWQOs. **Priority: Medium.**	Consider recalculation of RWQOs.
Yes	Yes	Yes	Continue routine surveillance of monitoring data. (Class attained.)	

Management instruments	Compliance monitoring design Compliance monitoring (end-of-pipe standards) Compliance monitoring (licence conditions) Decision support (water use authorisation) Resource water quality objectives Determining allocatable water quality Source management strategy	DWAF, 2006c DWAF, 2004j DWAF, 2004g DWAF, 2004k DWAF, 2004e DWAF, 2004e DWAF, 2003c
Further reading	Virtual water use	Earle and Turton, 2005; Allan, 2005

6.5.2.6 Managing non-point sources

Scenario	A management class, Reserve, RQOs and RWQOs have been established for a water resource and source directed controls for one or more non-point sources must be implemented to attain or maintain the class.

Land use management

Non-point sources usually cannot be managed in the same way as point sources simply because there is not a localised point of initial impact that can be monitored. Emphasis is rather on improved management of the overall land use or other dispersed activity causing the impact. Typical significant non-point sources from which surface runoff enters local surface waters or from which downward percolation into groundwater occurs, are:

- Agricultural land.
- Dense settlements, both formal and informal.
- Industrial and mining complexes.

New water uses

Notwithstanding the lack of a localised point of initial impact, new applications for water use should be assessed as described above for point sources. In particular, they must be in accord with the catchment vision and associated RDMs and can only be authorised if there exists allocatable water quality.

Reactive approach

In general, the same approach used for managing the water quality effects of dense settlements should provide the basis for dealing with non-point sources responsible for water quality impacts (DWAF, 2001). The water users or responsible authorities should be approached; the likely causes of the problems examined, evaluated, and appropriate interventions chosen to address the problems that have been identified. The specific outcomes of these interventions, such as achieving specified RWQOs, should also be identified. An agreement should be reached on when the responsible authority will implement the interventions. Should the interventions not be implemented, or the agreed outcomes not be reached, the Department can issue a directive or write a letter asking the authority to implement the interventions. Should this not be successful, the matter should be referred to the appropriate Directorate (DWAF, 2005b).

Local authority capacity gaps

Sometimes water quality problems from non-point sources (such as dense settlements) can be a direct result of a capacity gap in a local authority (DWAF, 2001). This capacity gap can relate to mandate, or be legal, organisational, technical, financial, procedural, or relate to networking capacity.

Although raising awareness, increasing payment levels for local services and building local authority capacity seem obvious solutions, they may not constitute the most cost-effective approach to achieve short- to medium-term gains.

A more appropriate response may be to make conditional bridging finance available (in co-operation with other departments) to ensure water resources are protected and the above capacity gap is addressed within a specified time period (DWAF, 2001).

The intervention must be subject to the following conditions:

- Financial assistance must be for a limited term and be once-off.
- Interventions, *e.g.* in dense settlements causing the water quality problems, should focus on high priority settlements (such as those whose downstream RWQOs are least in compliance).
- Any finance should be "ring-fenced" to ensure it is used only for the intended purpose.
- Interventions should be linked to fiscal responsibility and institutional capacity development.
- The role of target communities must be emphasised.
- Interventions should be linked to performance criteria, like RWQOs.

Management actions

Similar to the table above for point sources, Table 6.3 describes what types of specific management actions might be appropriate depending on the compliance and non-compliance with RQOs and higher spatial resolution RWQOs downstream of non-point sources.

Table 6.3: Recommended actions based on compliance with RQOs and RWQOs for known non-point sources.

Compliance with		Initial action	Medium-term action if initial action unsuccessful
RQOs	**RWQOs**		
No	No	Engage responsible authority or water user (*i.e.* initially assume these sources are the only causes of RWQOs and RQOs non-compliance). **Priority: High.**	Consider prosecution of transgressors. Consider existence of other sources (*e.g.* illegal, general authorisations, NWA Schedule 1 uses) upstream of RWQOs. If none, consider remediation.
No	Yes	Consider existence of other sources (*e.g.* unauthorised, general authorisations, NWA Schedule 1 uses) downstream of RWQOs. **Priority: High.**	Consider recalculation of RWQOs. As a last resort reconsider suitability of RQOs.
Yes	No	Consider existence of other sources (*e.g.* illegal, general authorisations, NWA Schedule 1 uses) upstream of RWQOs. **Priority: Medium.**	Engage responsible authority or water user. Consider recalculation of RWQOs.
Yes	Yes	Continue routine surveillance of monitoring data. (Class attained.)	

Management instruments	Managing water quality impacts of settlements	DWAF, 2001e
	Source management strategy	DWAF, 2003c
	Non-point source impacts	DWAF, 2001d
	Determining allocatable water quality	DWAF, 2004e

6.5.2.7 Water use authorisation

Scenario	An application for a water use licence has been received by the Department.

New water uses

New applications for water use that will potentially impact on water quality must be assessed as described in the Policy and following the procedures in the Source Management Strategy. New uses must be in accord with the catchment vision and associated RDMs and can only be authorised if there exists allocatable water quality. Every effort should be made to streamline the processing of water use authorisations, preferably using a simple screening protocol that will fast-track the granting of authorisations when impacts are likely to be low. Effective use should be made of available software decision support (*e.g.* DWAF, 2004k).

Equitable allocation

If some allocatable water quality exists, the applicant will typically not be allocated all that is available. An appropriate fraction may be allocated that takes account of all the considerations in Section 27 of the National Water Act, and addressed in the software decision support system (DWAF, 2004k), as well as:

- The approximate nature of, or confidence in, the determination of the allocatable water quality.
- Unforeseen circumstances.

End-of-pipe licence conditions

The choice of end-of-pipe licence conditions for users that discharge water containing waste into the water resource should depend on the degree of water quality stress. Appropriate variables of concern should be selected and monitored at suitable intervals (DWAF, 2006c; DWAF, 2004g).

If the water resource has significant allocatable water quality (*i.e.* is not stressed or threatened), then end-of-pipe licence conditions can be based on effluent standards.

If the water resource is only slightly unstressed (*i.e.* threatened), then end-of-pipe licence conditions can be based on at least the following considerations.

- End-of-pipe effluent uniform national minimum requirements or standards (should they exist).
- End-of-pipe effluent targets back-calculated from downstream RWQOs or RQOs (DWAF, 2004j).

In accordance with the Policy, these should be regarded as multiple lines of evidence. They may be apparently contradictory. The Department must attempt to rationalise such contradictions, taking cognisance of underlying assumptions, inherent uncertainties and local conditions. This should form the basis of an equitable final choice of end-of-pipe conditions.

Insufficient allocatable water quality

If insufficient allocatable water quality exists, then the following are some available options:

- Stricter regulation can be imposed.
- The prospective water use can be modified (*e.g.* through appropriate effluent management and/or treatment) to ensure that any allocated water quality is not exceeded.
- Allocatable water quality can be traded with another nearby water use.
- The concept of "virtual water use", an enabling principle of optimal water use, can be considered (see Policy). Although internationally the concept has not been formally developed for water quality, moving the production of products that place high demands on water quality to another locality that is not water quality stressed, and then importing those products, could relieve the pressure on local water quality.
- Compulsory licensing, following due process and stakeholder engagement. This can be invoked if it is regarded as necessary, and as a last resort, to achieve a more appropriate balance of application of the enabling principles of sustainable development.
- Prohibition of water use. In certain instances the authorisation to use the water can be revoked.

Management instruments	Conceptual review of licence applications	DWAF, 2004l
	Converting RWQOs to end-of-pipe standards	DWAF, 2004j&p
	Determination of RWQOs and stress	DWAF, 2004e&p
	Determining allocatable water quality	DWAF, 2004e
	Compliance monitoring design	DWAF, 2006c
	Compliance monitoring (licence conditions)	DWAF, 2004g
	Software decision support (water use authorisation)	DWAF, 2004k
	Source management strategy	DWAF, 2003c
Further reading	Virtual water use	Earle and Turton, 2005; Allan, 2005

6.5.2.8 Long-term non-compliance with RQOs

Scenario	A management class and its associated RQOs have been in place for a considerable period (*e.g.* more than five years) and a performance monitoring programme indicates that one or more RQOs are consistently not being achieved.

Appropriateness of source directed controls

First consider whether or not the likely causes of the non-compliance with RQOs can be better managed. There are a number of possible causes:

- Consider whether (a) National Water Act Schedule 1 uses or (b) uses that occur under general authorisations may be responsible. If so, apply approaches that educate such users about their water use and their impacts on downstream users. Efficient use, in particular, should be strongly encouraged at all times.

- If uses under general authorisations are causing problems, also consider changing the conditions used to define general authorisations in order to make them stricter in that area. (This must follow due process and may therefore take time). However, this will result in some of the water uses now requiring licensing. It must be ensured that (a) those new uses are those causing the non-compliance with RQOs, and (b) appropriate conditions can be associated with such licences that will allow effective monitoring.
- Also examine whether or not water users, especially those discharging waste into the water resource, are taking all reasonable steps to minimise their impacts (for example applying self-regulatory approaches, using cleaner production technologies and Best Practices, complying with licence conditions, etc.). If not, apply appropriate source directed controls using suitable regulatory or other management approaches (see for example Sections 6.5.2.5 and 6.5.2.6).
- The possibility of illegal water use should also be considered and, if suspected, appropriate steps should be taken to end such activities.

Appropriateness of RQOs

If the degree of source management is considered adequate, then consider whether or not the determination of the RQOs was based on a water quality dataset that was sufficiently representative. In particular, the general hydrological behaviour, land use and climatic conditions in the time period covered by the dataset should be adequately representative of current times. If this is considered not to be so, a case can be made to determine new RQOs based on a more representative dataset. However, this process, and their subsequent legal establishment, must follow due process and will take time. (See Figure 3.1 and associated text).

Appropriateness of class

If the water quality dataset used for the RQOs is considered to be sufficiently representative of current times, then the appropriateness of the class itself can be questioned and revised if necessary. This must also follow due process and will take time. This must at least include effective and inclusive stakeholder engagement. (See Figure 3.1 and associated text.)

6.5.2.9 Non-compliance with licence conditions

Scenario

A water use authorisation (licence) and the associated compliance monitoring programme is in place for a given water user. However, specific conditions in the licence are consistently not being complied with and these are suspected to be responsible for non-compliance with RQOs and/or RWQOs.

Responsibility

It is the responsibility of the licensee (the water user) to comply at all times with the licence conditions associated with the water use. It is the responsibility of the Department or CMAs to enforce such compliance (*e.g.* in accordance with Part 10 of the Act (NWA (36:1998)).

Source directed controls	The actions described in Table 6.2 and 6.3 can be applied. For more detail, the Source Management Strategy should be consulted. See also Appendix: Management Approaches.

Management instruments	Source management strategy	DWAF, 2003c

6.5.2.10 Remediation

Scenario	Reduction in water resource quality is occurring, or has already occurred, and remediation is necessary to (a) attain or maintain a management class, or (b) comply with the Reserve and/or RQOs. For example, remediation may be considered necessary if source directed controls alone are not achieving, or are not likely to achieve, the RQOs (or RWQOs) that have been set for the resource.
Responsibility	Responsibility for costs lies with the polluter. However, when the polluter cannot be made responsible (*e.g.* cannot be identified), for example in so-called "legacy cases", the Department may need to assume responsibility. The Department may also invoke remediation measures at its own cost when this is seen as a high priority and the polluter is unable to contribute immediately. The Department can then later recover such costs from the polluter.
Setting priorities	Given the inevitable expense of remediation, particularly when groundwater is involved, the need for remediation should be carefully prioritised to ensure cost-effectiveness, based on the following considerations: • The most desirable time frame for achieving the designated management class. • The current and intended use of the water resource. • The positive and negative socio-economic impacts. • The precautionary approach.
Management instruments	See www.sa-remediation.co.za (work in progress).

6.5.3 Water quality monitoring

Purpose

In its simplest sense, monitoring should be seen as measuring progress in order to provide useful management information (DWAF, 2006c). In the current context of resource directed management of water quality, this specifically means measuring the progress towards achieving the vision of the Policy (see Section 3: Objectives).

Objectives

The objectives of monitoring for resource directed management of water quality are (DWAF, 2006c) are:

To measure, assess and report on a regular basis the status and trends broadly relating to water quality in water resources, and their management, in a manner that will support balanced decision-making and planning in the contexts of fitness for use and aquatic ecosystem integrity in the Catchment Management Agency's quest for sustainable development.

Water quality monitoring programmes

The most pressing programmes will be water quality monitoring programmes that provide information that is directly and immediately useful to water resource managers. These include the following:

- Performance monitoring of RQOs and RWQOs.
- Compliance monitoring against end-of-pipe standards or targets.
- Baseline monitoring for the ecological Reserve.
- National water quality status and trends monitoring.

In some instances such monitoring already exists to some extent. However, this will need to be sustained, modified, or extended, to be aligned with any newly defined RQOs and associated RWQOs.

Each of these kinds of monitoring programmes exists in its own right with its own well-defined objectives (DWAF, 2006c).

Beyond water quality

More holistic information than just resource quality is required to properly manage (a) the resource, (b) those impacting on the resources and (c) those impacted by the resource (DWAF, 2006c). Consistent with the principle of environmental integration, a key component and enabling principle of sustainable development, monitoring that genuinely supports decision-making related to sustainable development must therefore go well beyond just water quality.

PSIR framework

The Pressure-State-Impact-Response (PSIR) framework, used in South Africa for state of environment reporting, can be used to provide a structure for the broader monitoring required (DWAF, 2006c). The four categories refer to those human activities that cause negative impacts on water quality (pressures), the actual state of the water quality (state), the impacts of deteriorating water quality on ecosystem health and fitness for use (impacts) and the decisive reactions of society, including government, to these negative impacts, that aim to solve or mitigate water quality problems (responses).

Phased implementation

It is important that a phased approach be taken to implement the PSIR monitoring programmes. Accordingly, the following are recommended in order of decreasing priority for the initial stages of implementation (see Figure 6.3).

- *State monitoring*. This is by far the most important monitoring that should be initiated in a water management area. Essentially, it requires performance monitoring of resource quality objectives supplemented by compliance monitoring (of licences). Once in place, the results of this will drive the more detailed design of the following monitoring programmes.
- *Pressure monitoring*. This will become important once a good picture is obtained of the state of water resources. It will allow more focussed source directed controls to be imposed.
- *Impact monitoring*. This information will begin to provide a broader spectrum of information on impacts of water quality.
- *Response monitoring*. This will provide further insight into (a) the impacts on society and (b) the real needs and priorities of society. This can be the last type of monitoring to be implemented.

Spatial scales

Each monitoring programme should be implemented in such a way as to achieve continual improvement by cycling through design, implementation and review stages (see Section 4.1). In each case, implementation is assumed to include data acquisition, data management and storage, and information generation and dissemination.

Management instruments	Guidelines for monitoring and auditing National strategic framework	DWAF, 2006c DWAF, 2004c

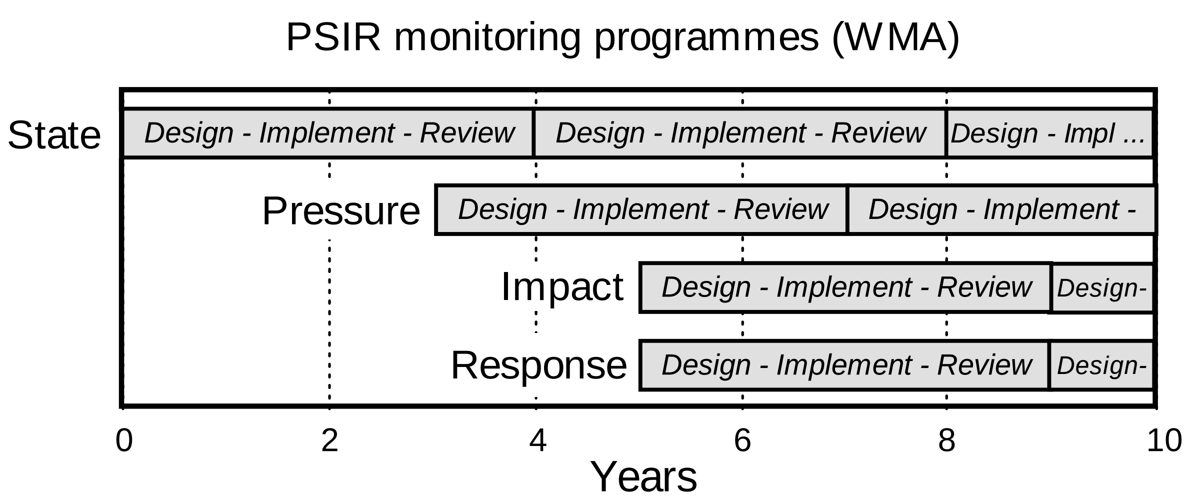


Figure 6.3: Phased implementation timetable for PSIR monitoring programmes.

SECTION 7: CAPACITY CREATION & MAINTENANCE

This section describes a knowledge-based philosophy and general strategy for creating and maintaining capacity.

7.1 Introduction

Definition

Capacity creation is the process whereby people are enabled to better perform defined functions either as individuals, through improved technical skills and/or professional understanding, or as groups by aligning their activities to achieve common purpose (Breen *et al.*, 2004).

Two dimensions

Two specific dimensions must be addressed in order to create appropriate capacity:

- *Time dimension (short-term and long-term)*: Specific technical capacity is required immediately to facilitate efficient water resource management for certain well-defined scenarios in the short-term. However, more sophisticated capacity will be required in the long-term to enable a more complete implementation of the National Water Act (36:1998). There are also changing demands on institutional capacity as roles and responsibilities evolve and water resource management becomes more decentralised (see Section 5.6: Institutional Capacity).
- *Internal-external dimension*: Capacity must be created both within the Department and Water Management Institutions (WMI) and amongst external stakeholders.

Legislative context

A number of frameworks (including Acts and involving various authorities) exist that are intended to guide the training aspects of capacity creation. These include the South African Qualifications Authority (SAQA) that is responsible for the National Qualifications Framework (NQF). The Skills Development Act (Act No. 97 of 1998) provides the institutional framework for skills development strategies integrated with the NQF.

FETWater

The Framework Programme for Education and Training in Water (FETWater) is an initiative of the Department and the Water Research Commission in collaboration with UNESCO and the Flemish Government (DWAF, 2004b). FETWater provides an overarching programme within which capacity creation for resource directed management of water quality can be undertaken.

7.2 Knowledge creation

7.2.1 Introduction

Framework

The most demanding of the above two dimensions is the time dimension. There is a desperate need to facilitate better resource directed management of water quality immediately. However, this strategy also focuses on moving gradually over time towards doing things better, even if this requires radical changes in the capacity creation philosophy within the Department. In effect, the short-term requirements should be met using management instruments that are currently available and in the spirit of adaptive management. However, the long-term strategy must be to move towards more fundamental "knowledge creation".

Creating a learning environment

In practical terms, knowledge can be defined as the *capacity for informed action*. This is obviously required both within the Department and in external stakeholders. It is assumed here that an ideal ultimate aim is to create a "learning environment" within the water sector and within the Department in particular. This should facilitate "good governance" in general, though for current purposes, this is specifically in the context of water quality management.

Learning principles

Knowledge management and learning are complex disciplines. The reader is referred to Roux *et al.* (2006) for a discussion of the key concepts of knowledge, learning and ecosystem governance. They also propose (a) the type of knowledge that should be created, (b) the best processes for doing so, and (c) the characteristics of good learners. They use these to further propose a series of principles to create appropriate learning environments for ecosystem governance.

Summary of principles

Roux *et al.* (2006) propose the following summary of the principles:

"*Good ecosystem governance requires positively persistent and adaptive people with a culture of empathy for other knowledge systems and levels. Their knowledge must be transdisciplinary, moulded by a common future focus, acquired by patiently engaging their prior knowledge and learning by doing in an environment of social knowledge sharing.*"

These principles should form the basis of any detailed capacity creation strategy relating to the resource directed management of water quality.

7.2.2 Short-term strategy

For external stakeholders

The ultimate aim is to empower external stakeholders to contribute efficiently and meaningfully to water quality management. The following are priority short-term actions:

- Stakeholders must be made aware of (a) their rights relating to water and to water quality in particular and (b) new concepts in the NWA (36:1998). This must "inform, create understanding and win support and buy-in to change perceptions, attitudes and behaviour" (DWAF, 2001).
- Protocols must be developed and implemented that go further than more awareness creation. Communication for effective stakeholder engagement will necessarily need to be focussed on specific projects about which an informed decision needs to be made (DWAF, 2001). However, generic protocols must exist that provide guidance.

For Departmental & WMI staff

The ultimate aim is to create knowledgeable staff with the capacity for informed action and decision-making. However, this must be balanced with the need for immediate decision-making capabilities. The following short-term actions address these:

- Simple procedures and guidelines for well-defined scenarios must be developed and adopted as soon as possible to address current bottlenecks in decision-making.
- Training must include emphasis on core concepts, including basic principles.
- Learning-by-doing and interaction with stakeholders, peers and mentors should be facilitated to begin the long-term process of knowledge creation.
- The relative emphasis on theoretical and experiential learning must be balanced to meet both short-term and long-term aims (Roux *et al.*, 2006).

The following are some specific career-related considerations (Roux *et al.*, 2006):

- All three of the career paths in the Department should be addressed (specialist, line function and strategic policy function).
- Opportunities for learning and personal development should be provided that are appropriate to the career stage (early, middle and late).

7.2.3 Long-term strategy

For external stakeholders

Long-term actions aim primarily at adapting to changing demands:

- Awareness creation and empowerment protocols must be adapted on the basis of experience and changing demands of stakeholders.

For Department & WMI staff

Long-term actions aimed at Departmental staff must also adapt to changing circumstances:

- The simple procedures and guidelines must be adapted and refined to maintain, and extend where appropriate, their effectiveness.
- The effectiveness of all aspects of training and learning should be monitored to determine the degree to which management in general is successfully changing from being reactive to proactive.
- This monitoring should provide the basis for review and refinement of learning approaches.

Table 7.1: Summary of short- and long-term actions to address (a) external stakeholders and (b) Departmental and Water Management Institution (WMI) staff.

To address	Short-term actions	Long-term actions
External stakeholders	• Awareness creation (water rights, NWA (36:1998) concepts). • Develop protocols to empower stakeholders to contribute effectively.	• Adapt and update awareness creation mechanisms. • Adapt and update empowerment protocols.
Internal Department and WMI staff	• Develop and implement simple procedures and guidelines. • Teach core concepts (including principles). • Facilitate learning-by-doing. • Facilitate learning through social interaction.	• Adapt and update simple procedures and guidelines. • Monitor effectiveness (reactive to proactive management) and review regularly.

7.3 Empowerment for sustainable management

7.3.1 Introduction

Operational

The above sub-section focussed on the fundamental concept of knowledge creation and overall strategies for achieving it. This sub-section is more operational. It addresses some of the more basic competences and types of empowerment that are required.

Dimensions of empowerment

Cook (1997) proposed a relatively simple model highlighting three important and interdependent dimensions of empowerment:

- ***Objective empowerment***. This refers to the individual's movement from oppression to influence and opportunity in organisational terms. This can occur through promotion, exposure to information, job enrichment, exposure to opportunities, and use of reward systems that support personal development.
- ***Competence***. This refers to possessing the necessary skills to carry out functions successfully. These refer to technical skills, interpersonal relationships, and self-management.
- ***Subjective empowerment***. This manifests in a sense of confidence, motivation, enjoyment of the challenge of other's high expectations, and reliance on one's own initiative.

Sustainable management requires that all three dimensions receive attention.

7.3.2 Strategy

7.3.2.1 Empowerment

3-Dimensional empowerment

The strategy of the Department should be to carefully consider and address the degree to which all stakeholders, both internal and external, are empowered in all three of the above dimensions.

7.3.2.2 Competence

Basic skills

The first essential prerequisite is basic competence (skills). All involved in integrated water quality management in the Department should receive appropriate training to improve this basic skills needed to implement IWQM. These should be aligned with the NQF, *i.e.* have well-defined outcomes and associated assessment criteria.

Conceptual outcomes

Attention needs to be given to achieving at least the following basic conceptual outcomes, which focus on giving effect to water quality aspects of resource directed measures (RDMs). In all instances the underlying theme should be "Creating a quality life for all South Africans", the central message of the Department’s water quality management communication strategy (DWAF, 2001).

Outcomes should include a clear conceptual understanding of:

- The fundamental role that the resource management class will play in future water resource management, in particular its role in striving for sustainable development.
- The role of RQOs and RWQOs and their relationship with the management class.
- The special characteristics of groundwater quality and the interactions between groundwater and surface water. Misconceptions about groundwater must be dispelled.
- Basic mathematical modelling approaches.
- The intention of the ecological and basic human needs Reserve.
- The concept of allocatable water quality.
- The socio-economic value of good quality water.
- Water quality-related monitoring required for holistic IWQM.
- How to communicate water quality issues to the general public in stakeholder engagement initiatives.
- The catchment visioning process.
- Co-operative governance – how to forge a working partnership between science, government and society.
- Collaborative learning and knowledge sharing – how to engage people around future building and problem solving given disciplinary, cultural and contextual diversity.

Such formal "learnerships" can also be made available to external stakeholders.

Training courses

The training courses already exist (DWAF, 2005s) for DWAF regional officers (and catchment management agency staff) that address:

- Catchment visioning,
- Determination of RWQOs, stress and allocatable water quality,
- Assessment of applications for water use, and
- The Policy.

These should continue to be made available on an annual basis (or on demand based on staff turnover) by the appropriate Directorate (DWAF, 2005b).

They should be extended to include monitoring and the philosophy of sustainable development (ensuring that this is ultimately included in decision-making). Refresher courses should also be made available on an annual basis to more experienced practitioners.

These courses should be structured so that feedback can be obtained on the suitability of the various management instruments. This should in turn feed back into the review phases of the plan-implement-check-review cycle to determine whether or not fundamental updating might be necessary.

User-friendly documentation

Communication mechanisms such as the use of posters, pamphlets, and newsletters should be reviewed on an annual basis to (a) create awareness among new staff members and external stakeholders (such as other government departments) and (b) maintain awareness among experienced water resource managers. Existing documentation should be re-circulated from time to time and new formats developed when appropriate.

7.3.2.3 Objective empowerment

Objective empowerment

The second prerequisite is that the working environment is appropriately empowering. Those involved in IWQM, within the Department, CMAs or external stakeholders, should collaborate to identify the characteristics of such an enabling environment. Guidelines should be developed for all stakeholders, internal and external (*e.g.* see (DWAF, 2005s)). The following are some considerations:

- Mechanisms for better exposure to water quality-related data and information, and
- Access to resources to implement adequate water quality monitoring.

7.3.2.4 Subjective empowerment

Subjective empowerment

The approaches adopted above for both competence and objective empowerment should be designed in such a way that outcomes relating to increased self-confidence and motivation are also assessed.

7.3.2.5 Supportive approaches

Creating capacity and increasing awareness

A number of supportive approaches can be adopted by the Department and CMAs to create capacity and increase awareness both within and outside the Department:

- Research and development can be supported.
- Create education and awareness programmes.
- Training of Departmental officials and external stakeholders.
- Greater involvement in land-use planning.

7.3 Institutional capacity

Multi-faceted

Institutional capacity is multi-faceted and requires the broader framework (beyond just water quality) to developed in a phased manner as many roles and responsibilities devolve to CMAs over time. DWAF (2005b) should be consulted for more detail.

SECTION 8: ACTION PLAN

This section describes immediate actions that should be taken that will facilitate implementation of the Policy.

8.1 Introduction

Priority actions

Previous sections of this strategy provide summarised and generic strategies in individual scenarios and contexts. In contrast, this section recommends specific priority actions that should be implemented in the immediate future. The primary purpose is to "kick start" appropriate data collection and information generation to support resource directed management of water quality.

8.2 Resource water quality objectives

Introduction

The current Internal Strategic Perspectives (ISPs) concentrate primarily on water quantity (flow) issues and provide only marginal information on water quality. It is important that nationally consistent information be generated relating to water quality that can begin to provide a sound basis for more focused catchment assessments, catchment visioning exercises and ultimately catchment management strategies.

Cost-effectiveness

It is important to ensure optimum use of financial and human resources and maximise service delivery where it is most urgently needed. Therefore initial efforts must focus on those water resources currently experiencing water quality stress (*i.e.* the current water quality is inadequate for the desired water uses).

Prioritise national surface water resources

A software facility exists that facilitates the determination of the degree of water quality stress in watercourses (DWAF, 2004i). This is inherently a "low confidence" decision support tool because it is based on generic water quality guidelines. This tool should be used to prioritise such surface water resources on a national basis on the basis, based on degree of water quality stress. This will require the following:

- Identifying the most appropriate spatial scale (*e.g.* tertiary catchment).
- Obtaining appropriate flow and quality data for the major watercourses.
- Using the software to identify the specific water quality variables which indicate water quality stress and to quantify the extent and possible severity of this stress.

Given the low confidence nature of this approach, the results can be reported in a simple colour-coded spatial format that highlights those water resources that are stressed in respect of water quality.

Determine RWQOs

The next phase will be to begin the process of determining management objectives that can better focus water resource management in the immediate future (see Section 6.4.2: Resource water quality objectives).

Focusing on the priority water resources, an assessment should be made of available national and local financial and human resources that can be channelled towards determining RWQOs. Stressed catchments should be identified in which there are (a) adequate financial and human resources and (b) commitment to the process from relevant regional offices of the Department or CMAs. Co-operative governance should guide interactions with any relevant upstream (or downstream) water management areas.

The level of confidence required for determining RWQOs should then be assessed (medium or high confidence). The appropriate procedures should then be followed to determine RWQOs at appropriate locations in the water resources (DWAF, 2006d).

Monitoring

Once the RWQOs have been determined, a suitable performance monitoring programme must be implemented as soon as possible. This will enable water resource managers to monitor the effectiveness of subsequent source directed controls aimed at minimising impacts on water quality (see Section 6.5.2.3: Attaining a management class).

Catchment management strategies

It will also be essential to ensure that the necessary source directed controls are identified and that these are firmly embodied in the catchment management strategy. The following will be required to achieve this:

- Determine the source management objectives (SMOs) from the RWQOs (DWAF, 2003a).
- Translate these SMOs into a water quality management framework that allocates load reductions to specific sectors (DWAF, 2003a).
- Ensure that this framework becomes an integral part of the catchment management strategy.

In the interim the simplest approach to managing point source waste discharges in unstressed water resources will be to apply uniform national minimum requirements or standards (should they exist) in end-of-pipe licence conditions. (See Section 6.5.2.7: Water use authorisations.)

8.3 Capacity creation

Capacity creation plan

An initiative should be started that will produce a detailed capacity creation plan, which includes the following:

- Explicit recommendations that will move the Department towards a learning organisation.
- Detailed recommendations that expand on the short- and long-term strategy summarised in Table 6.1.
- Explicit consideration of learning principles (Roux *et al.*, 2006).
- Explicit attention to objective and subjective empowerment and increasing basic competencies.
- Resources (financial and human) required for such capacity creation.
- Detailed time plan that expands on that given in this strategy.

SECTION 9: GLOSSARY

Allocatable water quality. The maximum worsening change in any water quality attribute away from its present value that maintains it within a pre-determined range reflecting the desired future state (typically defined by resource quality objectives). If the present value is already at or outside the pre-determined range, this indicates that none is allocatable and that (a) reduced pollution loads relating that affected attribute(s), and/or (b) remediation of the resource may be necessary.

Allocation plan, water quality. A part of a water quality management framework plan, developed as a sub-strategy of a catchment management strategy, which specifies how allocatable water quality will be apportioned among water users in the water management area.

Capacity building. The process whereby people are enabled to better perform defined functions either as individuals, through improved technical skills and/or professional understanding, or as groups aligning their activities to achieve common purpose (Breen *et al.*, 2004).

Compliance monitoring programme. A monitoring programme designed to measure, assess and report on a regular basis the degree to which individual water users are remaining within (*i.e.* complying with) the conditions defined in their water use authorisations (licences).

Decision-making. An intellectual activity comprising the making of a rational choice between alternatives.

Ecoregion. Relatively large area of land and water that contains geographically distinct assemblages of natural communities.

Effluent standards. Generic (*i.e.* not site-specific) values of water quality variables that can be used for end-of-pipe licence conditions.

Effluent targets. Site-specific values of water quality variables that can be used for end-of-pipe licence conditions, typically back-calculated from downstream RWQOs or RQOs.

Equitable. Fair and just in the sense of being based on laws and accepted principles.

Equity. The quality of being equitable.

Fitness for use. A scientific judgement, involving the objective evaluation of available evidence, of how suitable the quality of water is for its intended use or for protecting the health of aquatic ecosystems.

Internalisation of externalities. Externalities, also called external costs, spill-overs or social costs, are costs generated by a producer but paid for by someone else. A typical example is a water user that discharges polluted water into a stream. The downstream user may then need to treat the water before it can be used. This treatment in effect means that the downstream user is paying part of the production costs of the upstream user. Internalising these externalities means the polluter should be responsible for these costs. (Adapted from www.csir.co.za/era/ policy/Ap_inte.html.)

Management approaches. General courses of action, including formal regulatory command-and-control methods and self-regulatory and supportive mechanisms, which enable the strategy to be implemented.

Management instruments. Detailed procedures, guidelines and software decision support that enable the strategy to be implemented.

Minimum requirements. A regulation or standard set by the Department that specifies the very least that should be complied with.

Minister. The Minister of Water Affairs and Forestry.

Monitoring. The measurement, assessment and reporting of selected properties of water resources in a manner that is focussed on well-defined objectives. These monitoring objectives should also be clearly linked to water resource management objectives.

Monitoring design. The definition of all aspects necessary for successful implementation of a monitoring programme. These include the monitoring variables, sampling site selection, sampling methods, sampling frequency, analytical procedures, data assessment, reporting formats, etc.

Non-point source. A source of pollution whose initial impact on a water resource occurs over a wide area or long river reach (like un-channelled surface runoff from agricultural land or a dense settlement).

Performance monitoring programme. A monitoring programme designed to measure, assess and report on a regular basis the degree to which present resource quality conforms to resource quality objectives (RQOs) and hence whether a water resource is within its designated management class, or improving towards it or deteriorating away from it.

Point source. A source of pollution whose initial impact on a water resource is at a well-defined local point (such as a pipe or canal).

Preliminary classification. An interim classification of a water resource established in the absence of the formal classification system required by Section 12 of the National Water Act. A preliminary classification is permitted in terms of Section 14.

Preliminary resource quality objectives. An interim resource quality objective established in the absence of the formal classification system required by Section 12 of the National Water Act. Preliminary resources quality objectives are permitted in terms of Section 14.

Remediation. Direct intervention in (a) degraded land, to minimise contamination risk to a water resource, or (b) a degraded water resource, to maintain or improve water quality in the water resource.

Reserve. Defined by the National Water Act as the quantity and quality of water required:

1. to satisfy basic human needs by securing a basic water supply, as prescribed under the Water Services Act (Act No. 108 of 1997), for people who are now or who will in the reasonably near future, be (a) relying upon, (b) taking water from or (c) being supplied from, the relevant water source; and

2. to protect aquatic ecosystems in order to secure ecologically sustainable development and use of the relevant water resource.

Since the Reserve is a legally binding quantity, it is typically not subject to rivalry. However, its very nature creates excludability since water uses not encompassed by basic human needs and maintaining aquatic ecosystem health are explicitly excluded. Therefore, the Reserve is strictly a quasi-public good.

Resource quality. Includes all aspects of water quantity, water quality and aquatic ecosystem quality, the latter including the quality of in-stream and riparian habitats and aquatic biota.

Resource quality objectives (RQOs). Numeric or descriptive (narrative) goals for resource quality within which a water resource must be managed. These are given legal status by being published in a Government Gazette.

Resource water quality objectives (RWQOs). Numeric or descriptive (narrative) in-stream (or in-aquifer) water quality objectives typically set at a finer resolution (spatial or temporal) than RQOs, and that provide greater detail upon which to base management of water quality.

Source Management Objectives. Objectives relating to (a) incremental reduction, (b) maintenance or, under special circumstances, (c) incremental increase, in pollution loads calculated to give effect to resource water quality objectives. They refer to the water resource management unit as a whole, not to specific water users, though they do consider technical, economic and administrative realities.

Schedule 1 use. A permissible use of water as described in Schedule 1 of the National Water Act.

Stakeholder. An individual, group or organisation that has an interest in, or is affected by, an initiative and who may therefore affect the outcome of an initiative.

Stewardship. The provision of supervision and guidance.

Stress, water quality. A state in which the water quality is inadequate for the desired or designated water use. For many uses, water quality stress exists when there is no allocatable water quality.

Stressed water resource. A water resource for which the demand for benefits exceeds the supply. This can apply to either the quantity of water or to the allocatable water quality.

Vulnerability: Susceptibility to harm.

Waste. Defined by the National Water Act as including any solid material or material that is suspended, dissolved or transported in water (including sediment) and which is spilled or deposited on land or into a water resource in such volume, composition or manner as to cause, or can be expected to be reasonably likely to cause, the water resource to be polluted.

Watercourse. Defined by the National Water Act as a river or spring, a natural channel in which water flows regularly or intermittently, a wetland, lake or dam into which, or from which, water flows and any collection of water that the Minister may declare to be a watercourse. Furthermore, reference to a watercourse includes, where relevant, its bed and banks.

Water Management Institution. Defined by the National Water Act as a catchment management agency, a water user association, a body responsible for international water management, or any person who fulfils the functions of a water management institution in terms of the Act.

Water quality. The physical, chemical, radiological, toxicological, biological and aesthetic properties of water that (1) determine its fitness for use or (2) that are necessary for protecting the health of aquatic ecosystems. Water quality is therefore reflected in (a) concentrations of substances (either dissolved or suspended), (b) physico-chemical attributes (*e.g.* temperature), (c) levels of radioactivity and (d) biological responses to those concentrations, physico-chemical attributes or radioactivity.

Water resource. Defined by the National Water Act as including a watercourse, surface water, estuary or aquifer.

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Annexure A:
Management Approaches

This appendix summarises the various management approaches and instruments that are available to water resource managers.

A1.1 Introduction

Acts

Although the Constitution (Act No. 108 of 1996) and the National Environmental Management Act (Act No. 107 of 1998) refer to resource management, the National Water Act (Act No. 36 of 1998) is the highest level of legislation addressing water resource management and water quality management specifically and in detail. The NWA (36:1998) is therefore the "first port of call" for describing available regulations in the current context.

Source directed controls

The approaches described below are usually applied in the context of source directed controls and explicitly strive to give effect to resource directed measures (RDM).

Hierarchy of decision-making

The hierarchy of decision-making (described in the Policy) provides an overall framework that is based on the relative importance of a number of enabling principles of "protection of water resources", which in turn is one of the five main enabling principles of sustainable development. This framework should lie behind all decisions relating to source management objectives, setting resource water quality objectives and the water quality management plan of the catchment management strategy.

Descriptions, not strategies

The following sections merely provide brief descriptions of the range of instruments that are available to responsible authorities in giving effect to RDM. They do not describe specific strategies for their implementation as this will differ from one situation to the next.

A1.2 Regulatory

A1.2.1 General authorisations

Introduction

The NWA (36:1998) provides for the general authorisation of water use (NWA (36:1998): Section 39) that allows the use of water without the need for a licence under certain circumstances and in certain catchments. Only registration of the water use is required.

Objective

The definition of general authorisations attempts to balance the following issues:

- The need to limit the administrative burden of licensing (and other potential negative impacts of this burden, such as delays) to those water uses that are important.
- The need to ensure an adequate degree of regulatory control is created in respect of protection of water resources, optimal water use and current equitable access.

Changes

By making the conditions upon which general authorisations are based more stringent more water users would be required to apply for authorisations. This may provide the Department with extra control over such users and hence allow better management in a stressed catchment. However, since general authorisations are published in the Government Gazette, changing them cannot be made on an ad hoc basis. They must follow due process at all times.

A1.2.2 Command-and-control

Introduction

The command-and-control approach relies on regulatory mechanisms that are implemented on water users to enforce achievement of management objectives (van Wyk *et al.*, 2002). The following are some such mechanisms.

Water use licensing

The NWA (36:1998) provides for formal authorisation of water use (Section 40) and describes the relevant factors that must be taken into account (Section 27).

No licence may be issued without a preliminary Reserve and due consideration of its requirements. Besides this, the following should be used as a more general basis for water authorisation recommendations and decisions, in decreasing order of priority.

- Catchment management strategy (CMS), in particular resource water quality objectives (RWQOs). If these do not exist, then use the following.
- RDM, especially RQOs relating to water quality, or RWQOs. If these do not exist, then use the following.
- Preliminary RDM, especially preliminary RQOs relating to water quality. If these do not exist, then use the following.
- A catchment vision, with (a) relevant aspects of current state and behaviour of water quality in the management unit understood, (b) assessment of potential impact available and (c) preliminary Reserve (basic human needs and ecological) determined. The enabling principles of sustainable development must be very carefully considered.

In all cases, RDM and a catchment vision must have been determined with a degree of confidence that is appropriate to the resource management unit (see Section 6.4.1.2: Confidence). If this has not been the case, then RDM or a catchment vision of adequate confidence must be determined first.

Compulsory licensing

The NWA (36:1998) provides for a "compulsory licensing" mechanism in which existing water users in an area may be requested to re-apply for an authorisation to use water (Section 43). This can be invoked if it is regarded as necessary, and as a last resort, to achieve a more appropriate balance of application of the enabling principles of sustainable development (see Policy (DWAF, 2005)). Therefore, in the process of such re-consideration, the following must be taken into account:

- The catchment vision and all stakeholder concerns.
- RDM in place. In the current context, these measures should be have been determined with a significant degree of confidence.
- Any Departmental Water Allocation Policy.
- The degree of water quality stress and the allocatable water quality.

Resource Quality Objectives (RQOs)

Since RQOs will be described in the *Government Gazette* (NWA (36:1998): Section 13), they become "command-and-control" regulatory tools to which all stakeholders (*i.e.* including the Department) are formally bound. Monitoring programmes must be put in place to ensure that they are achieved and maintained (see Section 6.5.3: Monitoring). Since RQOs are the most important sustainability indicators relating to water resources, and water quality in particular, conforming to RQOs becomes one of the most important endeavours that will ensure at least a basic degree of sustainable development.

Reserve

Once the classification system has been published in the *Government Gazette* the NWA (36:1998) also provides for the Reserve to be formally published in the *Government Gazette* (Section 16). The Reserve therefore also becomes a "command-and-control" management instrument to which all stakeholders are formally bound.

"Pollution prevention" directives

The NWA (36:1998) also provides for directives (*e.g.* Section 19) given in terms of the Act to be issued by a catchment management agency to any person who fails to take reasonable measures to prevent pollution from occurring, continuing or recurring. This situation is relevant specifically to the application of the "pollution prevention" principle that enables protection of water resources and hence sustainable development. These directives may be issued on the basis of evidence of transgression provided by compliance monitoring. As such, directives comprise a regulatory mechanism for making RDM operational.

Management instruments	Software decision support Monitoring guidelines	DWAF, 2004k DWAF, 2006c

A1.2.3 Economic

Introduction

Economic regulatory instruments rely on incentives and disincentives to achieve management objectives. These are provided for by the NWA (36:1998) in Section 56(6). These approaches are based on the polluter pays principle, another enabling principle of protection of water resources and hence of sustainable development. The polluter pays principle requires the "internalisation of externalities" (see Glossary) to ensure that those responsible for significant ecological impacts are accountable for costs in proportion to the impact.

Pricing strategy

The original pricing strategy (DWAF, 1998) addressed the establishment of charges only for those NWA (36:1998) Section 21 water uses that can be expressed in volumetric terms regarding annual quantities abstracted, stored or reducing streamflow (typically "consumptive uses"). Those uses that can potentially cause significant changes in water quality were not explicitly dealt with except to note that a waste discharge charge system would need to be developed. Nevertheless, the following were noted (though translated here into the principles as defined in the Policy) as shaping the overall strategy:

- Current equitable access.
- Protection of water resources, including the ecological Reserve and pollution prevention.
- Financial sustainability (through applying sound financial management).
- Optimal water use.

Waste discharge charge system (WDCS)

The WDCS has three distinct purposes, involving three different water use charges:

- *Management cost recovery*. This water use charge must cover the costs of water resource management activities related to waste discharge.
- *Mitigation cost recovery*. This water use charges must cover the quantifiable costs of infrastructure or other measures for mitigation of existing impacts of waste discharge.
- *Discourage waste discharge.* This water use charge must act as a disincentive to the discharge of waste.

A guarantee will also be retained by the Department in order to finance possible remediation of failed or abandoned activities that have impacted negatively on water resources.

Further reading	Draft Pricing Strategy	DWAF, 2004d

A1.3 Non-regulatory

A1.3.1 Civil society

Peer pressure

An enabling principle of good governance is transparent governance (see Policy). This promotes (a) the application of procedures that are open to scrutiny, and (b) keeping an adequate "record of decision". This will inevitably lead to peer pressure on those who are responsible for unacceptable reduction of water quality. Therefore, ensuring transparency, without sacrificing rights to confidentiality that may exist, can be an effective mechanism for regulating transgressors.

"Name and shame"

Another mechanism that can bring about peer pressure is to explicitly name transgressors to allow those who have been impacted or other interested parties to bring pressure to bear on the transgressor. This is also referred to as "management by shame" (van Wyk, *et al.*, 2002). However, antagonising transgressors in this way can have negative ramifications.

Duty of care

To provide for a specific regulatory mechanism that facilitates peer pressure, the National Environmental Management Act (107 of 1998) places a general "duty of care" on each citizen to take reasonable measures to prevent pollution or environmental degradation. Furthermore, "any person may institute and conduct a prosecution in respect of any breach or threatened breach of any duty", if this is either "in the public interest" or "in the interest of protection of the environment".

A4.3.2 Self-regulatory

ISO 14000 and sustainable development

The ISO 14000 family of standards on environmental management was developed to provide a practical toolbox to assist in the implementation of actions supportive to sustainable development (http://www.iso.org). In today's global economy, organisations are increasingly being called upon to demonstrate sound management of economic, social and ecological issues. Evidence suggests that this "triple bottom line" results in advantages in financing, insurance, marketing, regulatory treatment and other areas (http://www.iso.org). An Environmental Management System (EMS) is a structured approach to addressing the ecological bottom line.

ISO 14000 family

The ISO 14000 family comprises about 25 documents covering the following (http://www.iso.org):

- Implementing environmental management systems,
- Conducting environmental audits and other related investigations,
- Evaluating environmental performance,
- Using environmental declarations and claims,
- Conducting life cycle assessments, and
- Addressing environmental aspects in products and product standards.

ISO 14001

ISO 14001 is the world's most recognised EMS framework that helps organisations both to manage better their impacts on the environment and to demonstrate sound environmental management.

Management instruments	ISO 14000 SABS ISO	http://www.iso.org SABS ISO 14001

A4.3.3 Supportive

Constructive influence

The Department can also act in a supporting role to constructively influence water users to be appropriately aligned with RDM. It will inevitably need to work closely, in a spirit of co-operative governance, with other government departments and organisations. Support can be provided in a number of ways:

Research & development

Research and development can be supported, both in kind and financially, to build capacity both within and outside the Department in areas that will give better effect to RDM. This should be done in close collaboration with local and international organisations that can act as co-funders and those that can perform the technical aspects of the work. The South African Water Research Commission and various international donor agencies can be used in this role.

Education

Education and awareness programmes can be used to:

- Raise the awareness of water users and communities to the value of water, and good water quality in particular.
- Create awareness within neighbouring countries to further develop and improve their policies and strategies relating to resource directed management of water quality.
- Empower water users to understand their water resources better and recognise how to protect them and hence create a culture of stewardship of the water resource.
- Raise the principle of protection of water resources, particularly relating to water quality, to a national priority.

Training

Training of officials within the Department and external stakeholders can increase their basic skills and understanding and contribute significantly to overall capacity creation. (See also Section 7: Capacity Creation & Maintenance.)

Land-use planning

The Department should be intimately involved in land-use planning decisions, particularly with those that can result in impacts on water quality (*e.g.* through runoff or direct discharges into water resources). Planning guidance should be provided to optimise associated socio-economic development while affording an appropriate level of protection to water resources through RDM.

Further reading	Groundwater Quality Protection for Farmers Artificial Groundwater Recharge Managing Water Quality: How Users can Participate.	Conrad and Colvin, 2000 Murray, 2003 DWAF, 2003f

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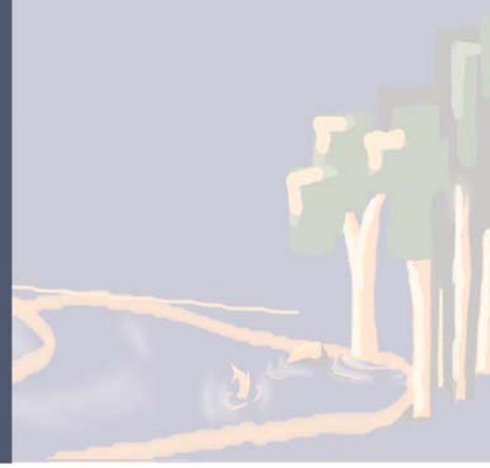

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1.7.6	Introduction to the Resource Directed Management of Water Quality
1.8	Implementation Plan

Bold type indicates this report

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EXECUTIVE SUMMARY

The past decade has seen significant changes to the institutional arrangements, water governance and organisational responsibilities in the water resources management sector. This is likely to continue for the next decade with the establishment of catchment management agencies (CMAs). The management of resource water quality within this dynamic environment requires clarity and strengthening of the institutional roles and responsibilities for the different elements of the water resource management process.

This report is part of a larger project that will develop a policy and strategy for resource directed management of water quality (RDM-WQ). It focuses on institutional and organisational issues, with the objective of clarifying roles and responsibilities. While the discussion is aligned with the specific areas of focus of the RDM-WQ project, it engages the broader water quality management environment, because organisational and institutional issues cannot be viewed in isolation.

Water quality management must be viewed against the management cycle of resource directed measures (RDM), catchment visioning, catchment planning and strategy, source directed controls (including authorisation, economic instruments and cooperation), ending with monitoring, evaluation and review.

When considering roles and responsibilities, it is important to distinguish the development of policies/regulation and “custodianship” of the systems from the implementation of these policies, systems and related processes. The responsibilities for the same elements of the management process above, differ fundamentally between the policy and implementation roles. Typically, DWAF Policy & Regulation (P&R) Branch would be responsible for policy and developing systems, while DWAF Regional Offices (and later on CMAs) would be responsible for implementation with support from P&R.

While the lead responsibility for the development of methodologies for RDM (including the development of RWQO) remains with D:RDM, the approaches, tools and models must be consistent with and interface with the tools and models used in catchment assessment and planning, because it is only through prudent catchment planning and water use management that these objectives can be achieved. It is therefore appropriate for Integrated WR Planning (specifically WRPS) to work in partnership and support RDM through the development of relevant catchment planning models that can be used both to develop RQOs and to conduct catchment level water quality assessments.

The implementation of these tools should be through the DWAF Regional Offices or CMA, but it is critical that P&R provide adequate support for this process. Here D:RDM should play a key role in supporting the implementation of the process, while D:WRPS should support the technical implementation of the models they have developed (in order to ensure organisational efficiency).

There is also an important interface between catchment level planning and the management of waste related water use (from both point and non-point sources). While the approaches and models for translation of RWQOs into management objectives and acceptable loads at a catchment level should be led by Integrated WR Planning (WRPS), the development of discharge standards and best practice at a source level should be led by Water Use (RP&W). There must however be close alignment and consistency in the catchment water quality models (for catchment planning) and those used to evaluate local source related impacts (for authorisation purposes).

A number of additional challenges will be faced with the decentralisation of functions to CMAs in cooperation with other water sector institutions, particularly those that are related to changing institutional structures and arrangements, and the associated shifting roles and responsibilities. Successfully addressing these challenges and surmounting the related hurdles requires significant institutional and personnel capacity building and the establishment of stable systems.

To facilitate this process, each approach to implementing RDM-WQ should be informed by capacity and resources and should strive to achieve maximum simplicity.

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ACRONYMS

AEV	Acute Effect Value
CAS	Catchment Assessment Study
CEV	Chronic Effect Value
CMAs	Catchment Management Agencies
DEAT	Department of Environmental Affairs & Tourism
DEMC	Desired Ecological Management Class
DME	Department of Minerals & Energy
DWAF	Department of Water Affairs & Forestry
Ecospecs	Ecological Specifications
EI&S	Ecological Importance and Sensitivity
EISC	Ecological Importance and Sensitivity Category
EMP	Environmental Management Plan
IDP	Integrated Development Plan
ISP	Internal Strategic Perspectives
IWQS	Institute for Water Quality Studies (now referred to as Resource Quality Services)
IWRM	Integrated Water Resource Management
NGO	Non Governmental Organisation
NWA (36:1998)	National Water Act
NWRS	National Water Resource Strategy
PESC	Present Ecological Status Category
PDEA	Provincial Department of Environmental Affairs
RC	Reference Condition
RDM	Resource Directed Measures
RDWQM	Resource Directed Water Quality Management
RDWQMP	Resource Directed Water Quality Management Policy
RQOs	Resource Quality Objectives
RWQOs	Resource Water Quality Objectives
RQS	Resource Quality Services (part of DWAF)
SDC	Source Directed Controls
SEA	Strategic Environmental Assessment
SIC	Standard Industrial Classification
TWQR	Target Water Quality Range
WMA	Water Management Area
WQM	Water Quality Management
WRC	Water Research Commission
WSA (108: 1997)	Water Services Act
WUA	Water User Association

SECTION 1: INTRODUCTION

1.1 Background

Changing Institutional Context

The promulgation of the National Water Act (NWA: 36 of 1998) initiated considerable institutional change in the water resources management (WRM) sector. While many of the required changes have taken place, others are still ongoing. Importantly, the Act requires the progressive establishment of representative water management institutions (WMIs) for decentralised and participatory WRM decision making, particularly catchment management agencies (CMAs) and water user associations (WUAs).

DWAF Restructuring

The institutional changes and emerging functional responsibilities required by the NWA led to the organisational restructuring of the Department of Water Affairs and Forestry (DWAF) between 2000 and 2003. DWAF is also establishing a Branch for Infrastructure Management; this will lead towards the establishment of a National Infrastructure Agency in 2008. The DWAF regions are still aligning their organisational structures in the establishment of ongoing WRM, proto-CMA and infrastructure operations components. Proto-CMAs have been established for all of the 19 water management areas (WMA) that will lead to the establishment of CMAs over the next 5 years.

Making IWRM Work

The NWA is founded on the principles of sustainable, equitable and optimal water resources protection, development and utilisation, reflecting the international acceptance of the philosophy of integrated water resources management (IWRM). While this is conceptually elegant, IWRM poses some serious institutional, organisational and governance challenges. These are particularly evident in the integrated management of water quantity, quality and ecological health, as well as the coherent management of resource protection, resource planning and water use management.

Institutional and Organisational Arrangements

Before going any further, it is important to recognise the clear distinction between institutions and organisations. Institutions refer to the set of rules and relationships between groups in society (or the WRM sector in this case), while organisations refer to the structured cooperation between groups and individuals (representing the players within these rules). Institutional arrangements in a sector therefore represent the combination of legislation and regulations, policies and guidelines, administrative structures and relationships, economic and financial arrangements, political processes, customs and key participants. An organisation consists of the strategy (mandate), structure (responsibilities), systems, skills and culture of a formal entity with a statutory legal persona, which acts within this institutional context.

Water Governance

Water governance refers to the range of political, social, economic and administrative systems (including institutions and organisations) that are in place to develop and manage water resources, and the delivery of water services, at different levels of society. Good water governance depends upon predictability, inclusion, representivity, accountability, efficiency, effectiveness, social equity and justice. It requires open and transparent policy making, a professional bureaucracy and a strongly engaged civil society.

Cooperative Government

Chapter 3 of the South African Constitution requires that the 3 distinctive, interdependent and interrelated spheres of government (and all organs of state) must conduct their activities in the national interest and within the spirit of cooperation.

Cooperative Governance

It is important to note then that cooperative government is only one part of the wider concept of governance, which includes civil society and the private sector. This is particularly important in the context of resource directed measures, where national provincial and local levels of government promulgate and administer legislation with wide-ranging impacts on water in the environment, resource quality and, specifically, water quality.

Roles and Responsibilities

It is apparent from the above that there is and will continue to be significant change of the institutional arrangements, water governance and organisational responsibilities in the water resources management sector. However, without clarity (and strengthening) in these areas, particularly around defined roles and responsibilities, the possibilities for effective management and decision making for water resources and their quality will be seriously jeopardised.

1.2 Purpose of this Report

Objectives of the Report

This report is part of a larger project that will develop a policy and strategy for resource directed management of water quality (RDMWQ). It focuses on institutional and organisational issues (acknowledging the dynamic nature of the sector), with the objective of clarifying roles and responsibilities. While the discussion is aligned with the specific areas of focus of the RDMWQ project, in has to engage the broader water quality (and in fact the water resources management) environment, because organisational and institutional issues cannot be viewed in isolation.

Linkage to the Technical Tasks

Figure 1.1 provides the decision-making framework for resource directed management of water quality (RDMWQ). The associated management instruments to give effect to the policy on RDMWQ that were developed as part of the RDMWQ project, are indicated by the dotted blue lines.

The RDMWQ management instruments are super-imposed on the management process of water resources as applied by DWAF in those areas where the management instruments were designed to be applied.

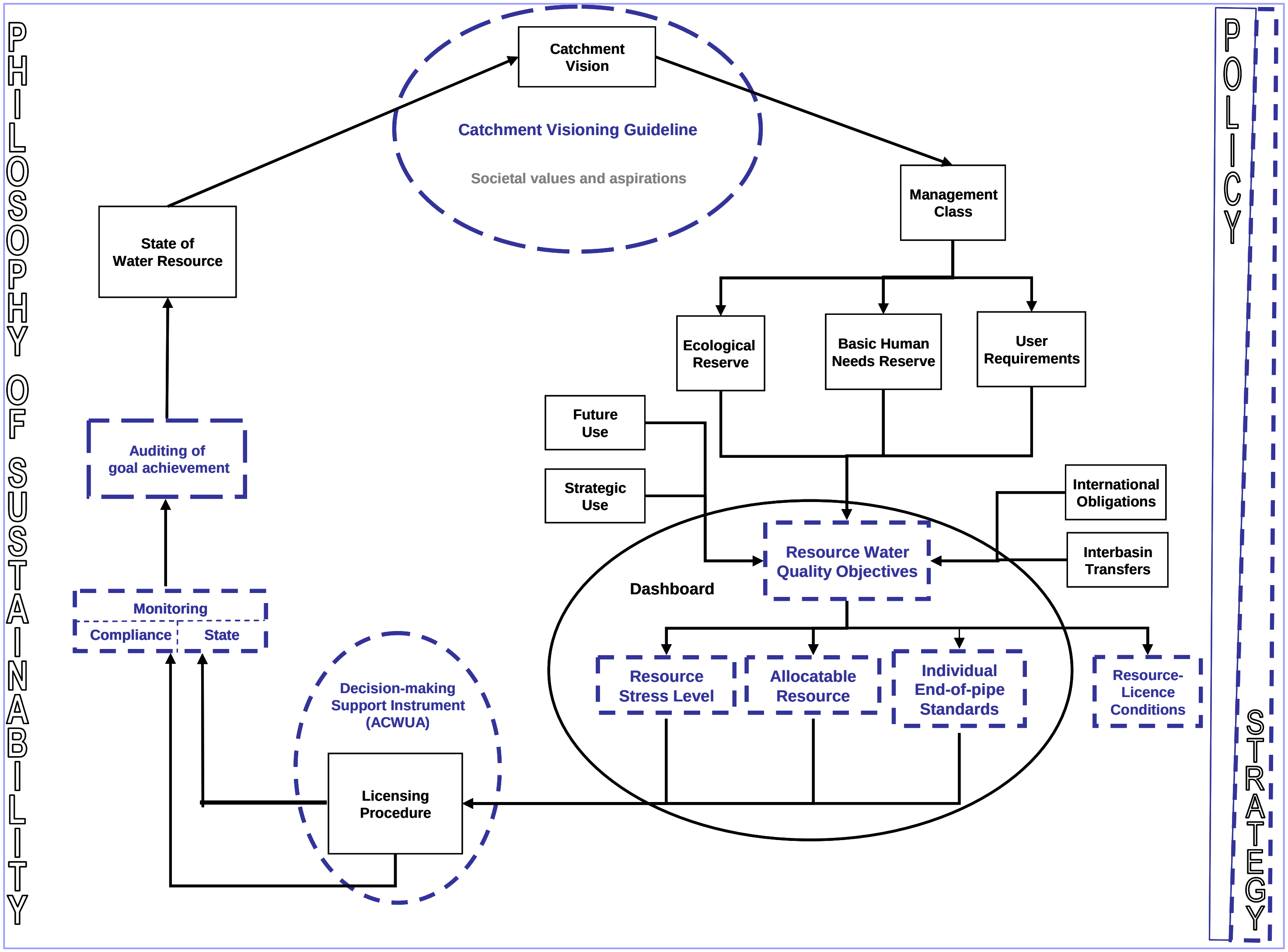

Figure 1.1: Decision-making framework and management instruments to operationalise Resource Directed Management of Water Quality.

SECTION 2: WATER QUALITY MANAGEMENT PROCESSES

2.1 Integrated Water Quality Management

Introduction

In order to clarify the roles and responsibilities around the resource directed management of water quality, it is necessary to examine the water quality management process and associated elements for which responsibilities may differ.

Integrated WQM within IWRM

Water quality management is a fundamental part of WRM, and as such the concept of IWRM may be focused into integrated water quality management (IWQM). This implies coherent analysis and decision making between water quality, quantity and ecological health, the adoption of decentralised decision making, effective stakeholder participation and engagement, and consideration of the technical, social and economic aspects in decisions around water resource quality.

Phases of IWQM

Figure 2.1 outlines four broad phases in the IWQM process, namely:

Plan: resource objectives and catchment strategies (including plans) are developed, based on catchment assessment and visioning processes.

Do / Implement: effect is given to the strategies through source directed controls and related instruments, according to a clear decision making hierarchy.

Check: water resources are monitored and the effects of the strategies (i.e. success or failure) are assessed.

Act: objectives, strategies and decisions are reviewed and adapted according to the needs and conditions within the WMA.

Plan

The planning component occurs at the national, regional and local level. The visioning process is integral to both the national and the local context, as it informs and sets the boundaries within which the strategy development occurs. Determination of the resource class, the Reserve and RQOs, establishes a basis for local and regional strategy development. The development of the CMS, an initial function of the CMA, is based on catchment visioning and informed by the RDM. Other important components of the CMS are plans for allocation (water allocation and allocatable water quality) and water management plans.

Implement (Do)

The strategy (and the plans contained therein) is given effect during the implementation component. The authorisation process, which involves application, evaluation and authorisation, and the specific licensing conditions that arise from the authorisation process, are informed by the CMS. Similarly, the CMS may require a Compulsory Licensing approach within the WMA to achieve the Class and RQOs, thereby giving effect to the CMS. Control and enforcement, regulation and the Waste Discharge Charge System (WDCS) flow out of the authorisation process, ensuring (control and enforcement, and regulation) or encouraging compliance with the authorisation conditions and ensuring achievement of the CMS water quality and water management objectives.

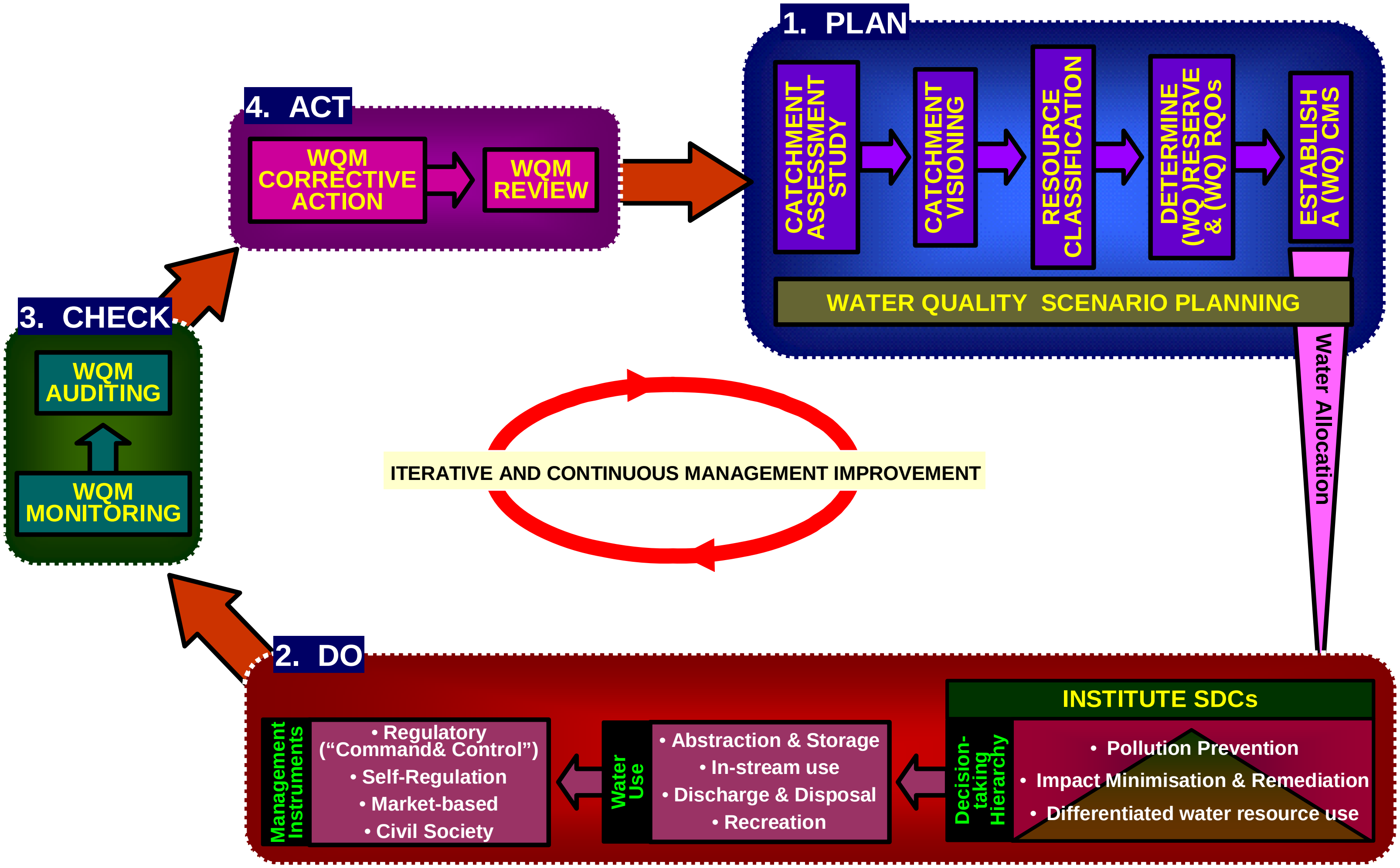

Figure 2.1: Conceptual IWQM Process.

Check

The check process involves monitoring on a number of fronts. Sustainable development monitoring focuses on national strategy and the visioning process and assesses the sustainability, effectiveness and efficiency of the strategy. Water resource monitoring occurs at the level of the WMA and assesses the sustainability, efficiency and effectiveness of the CMS in achieving the catchment vision, and assesses the success and appropriateness of the authorisation, control and enforcement, and regulation processes. Compliance monitoring occurs at the sub-catchment level to ensure compliance of users and effluent dischargers with the authorisation stipulations and the conditions of licensing.

Review (Act)

The adaptive process involves review of the outcomes of monitoring and adaptation of the requisite components of the management cycle. While the check component focussed on the issues of planning at national and local level and issues of implementation, the adapt component of the management cycle involves feed-back to all other parts of the cycle. The adapt component of the cycle also reviews the monitoring process (check component), feeding back to ensure consistency, sustainability, effectiveness and efficiency within the check component.

2.2 Catchment Based Water Quality Management

Elements of the IWQM Process

While the broad IWQM process provides a useful framework for adaptive management, a number of key elements and activities have institutional implications that are associated with each of these phases. The following discussion briefly highlights the more important elements from an institutional perspective.

Resource Directed Measures

Resource directed measures (RDM) refer to water resources ***classification***, ***Reserve*** determination and the establishment of ***resource quality objectives*** (RQOs). The purpose of water resources classification is to seek a balance *between the need to protect and sustain water resources on the one hand, and the need to develop and use them on the other*. Furthermore, classification must be achieved *through a process of consensus seeking amongst water users and other stakeholders*, where *the public trust places the responsibility on Government to make sure that environmental interests are represented*. Together, these clearly outline the spirit and intent of RDM, and imply significant institutional processes and responsibilities that will be re-examined in the next Chapter. In the following figure, colours represent the groups of functions described below.

Catchment Visioning and Assessment

Catchment Visioning is a consultative approach that helps to reach agreement on an appropriate balance between protection and use, and is based on an understanding of the catchment characteristics gained through ***catchment assessment***. It should create the link between RDM and catchment planning.

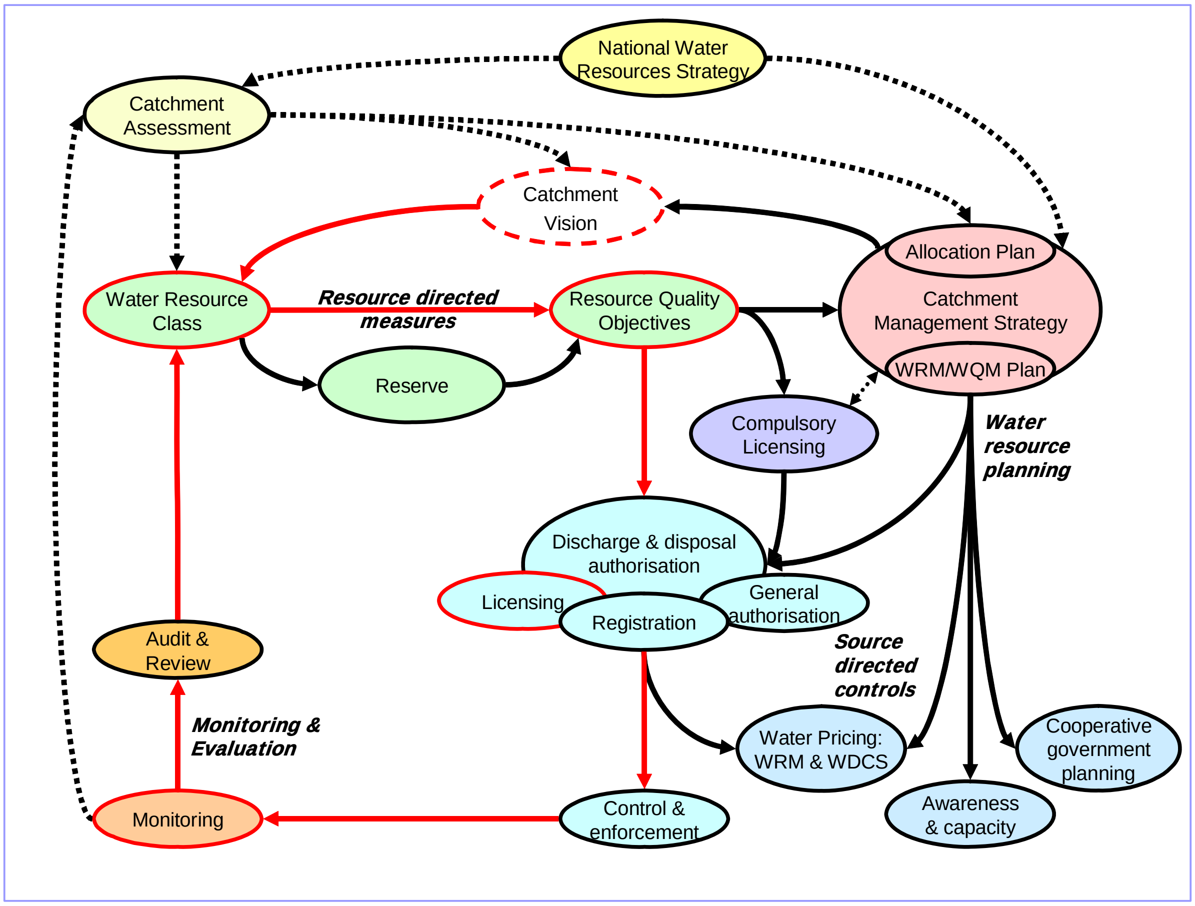

Figure 2.2: Catchment Water Resource / Quality Management Process.

Water Resources Planning

Recognising the impacts that land and water use activities have on water resources, catchment level water resource planning has been adopted. This is given effect through the ***catchment management strategy*** (CMS), with its associated water allocation plan and possible WRM / WQM plans. The CMS provides the framework for all management (developed by the CMA) within a WMA, and DWAF / CMA must give effect to the CMS in performing their functions. Because the CMS must give effect to the class (and must indicate the implications of specific RQOs), there is a necessary iterative process between the CMS and RMD (including catchment visioning), in order to ensure balance between protection and utilisation. Before a CMA is established, DWAF has developed an internal strategic perspective (ISP) for each WMA, which is now being extended to include water quality considerations.

Source Directed controls

Source directed controls refer to the ***authorisation*** (regulatory) approaches that are used to manage water use (particularly the discharge and disposal of waste), and include registration of water uses, general authorisation, licenses, standards for waste discharge, management practises, impact assessments and related ***control and enforcement***. They also include approaches based on economic incentives (***waste discharge charge system***), civil society (***awareness and capacity***) and cooperative planning (***cooperative government***).

Where a catchment is stressed or redress is required, ***compulsory licensing*** provides a process for reallocating entitlement (authorisation) to water or the disposal of waste, by requiring all users to reapply for licences within a new allocation framework. This links the catchment planning process to the authorisation process.

Monitoring and Evaluation

Monitoring and evaluation of water resource quality and the implementation of the CMS and regulatory requirements are critical to resource directed management of water quality. However, the ***audit and review*** process is fundamental to adaptive management in achieving realistic objectives.

RDMWQ Project Focus

The RDMWQ project has focused primarily on the development of policies and instruments for the management cycle highlighted by red arows, namely visioning, classification (and RQOs), authorisation, monitoring and auditing.

Broader Focus for Institutional Roles

While this is appropriate and there are other projects developing policies and tools for the other elements of the cycle, the entire process must be conceptualised in order to fully understand the potential institutional and organisational roles and responsibilities. These responsibilities are explored in the next chapter.

SECTION 3: WQM ROLES AND RESPONSIBILITIES

3.1 Introduction

Distinction between Regulatory Framework and Implementation

When considering roles and responsibilities, it is important to distinguish the development of policies/regulation and "custodianship" of the systems from the implementation of these policies, systems and related processes. The responsibilities for the same elements of the process described in the previous section differ fundamentally between the policy/regulation and implementation roles. A further important issue is that while the regulatory framework and associated systems (such as classification and compulsory licensing) are being developed, early (or pilot) implementation is part of the system development responsibility rather than the implementation responsibility.

Initiators of Change

The drivers of institutional change and restructuring are grounded in a number of high-level governing principles. Particularly important here are the principle of *Batho Pele* (which is both service orientated and user focussed), the high-level commitment to participatory management, and a general move within national government away from operations and towards strategic engagement, all result in the National Water Act centring on the principles of equitability, efficiency and sustainability.

Catchment Management Agencies

The purpose of establishing CMAs is to delegate water resource management to the regional or catchment level and to involve local communities in WRM decision making, within the framework of the national water resource strategy. They will take over the responsibilities for implementing WRM, except for WR infrastructure management that will still be done by other institutions. The Minister of DWAF acts on behalf of the CMA until a functioning CMA has been established.

Role of DWAF within a Changing Environment

As CMAs are progressively established and WRM implementation functions are decentralised, DWAF will increasingly focus on policy, regulation, sector coordination and institutional oversight, representing the Minister's custodial role in WRM. The role of the DWAF Policy and Regulation (P&R) Branch will evolve over time, by delegating certain implementation functions, while the functions of the DWAF Regions will shift significantly from the current implementation through "proto-CMAs" to a more regulatory and support role once the CMAs are established.

3.2 DWAF Organisational Structure

DWAF Organisational Structure

Following the DWAF restructuring process, the organisational structure presented in Figure 3.1 has been established (although these are still undergoing some change). The relevant components in P&R have the following WRM responsibilities:

- ***Strategic Coordination***: *to* promote coherence in the development of WRM policies and strategies, in line with DWAF priorities.
- ***Institutional Oversight***: to ensure an enabling environment for water management institutions and stakeholder participation.
- ***Resource Directed Measures***: provide a framework to ensure sustainable utilisation of water resources in order to meet ecological, social and economic objectives.
- ***Integrated Water Resources Planning***: ensures the availability of adequate quality water through the prudent management and development of water resources.
- ***Water Use***: provides an enabling environment for the management of all categories of water use, to meet the objectives of equity and efficiency.
- ***Information Management***: to develop and maintains the systems and programmes for data and information acquisition, assessment and management.

The relevant components within the Regions Branch have the following WRM responsibilities:

- ***Regional Coordination and Support***: promotes coherence, improves communication and ensures support to the DWAF regions in the implementation of WRM operations, in line with DWAF priorities.
- ***Regional Offices***: ensure the implementation of WRM policy, strategies, regulations and programmes by DWAF and other institutions.
- ***Proto-CMAs***: operate as the CMA until the CMA is properly established, performing the Initial CMA functions and water use management functions on behalf of the CMA.

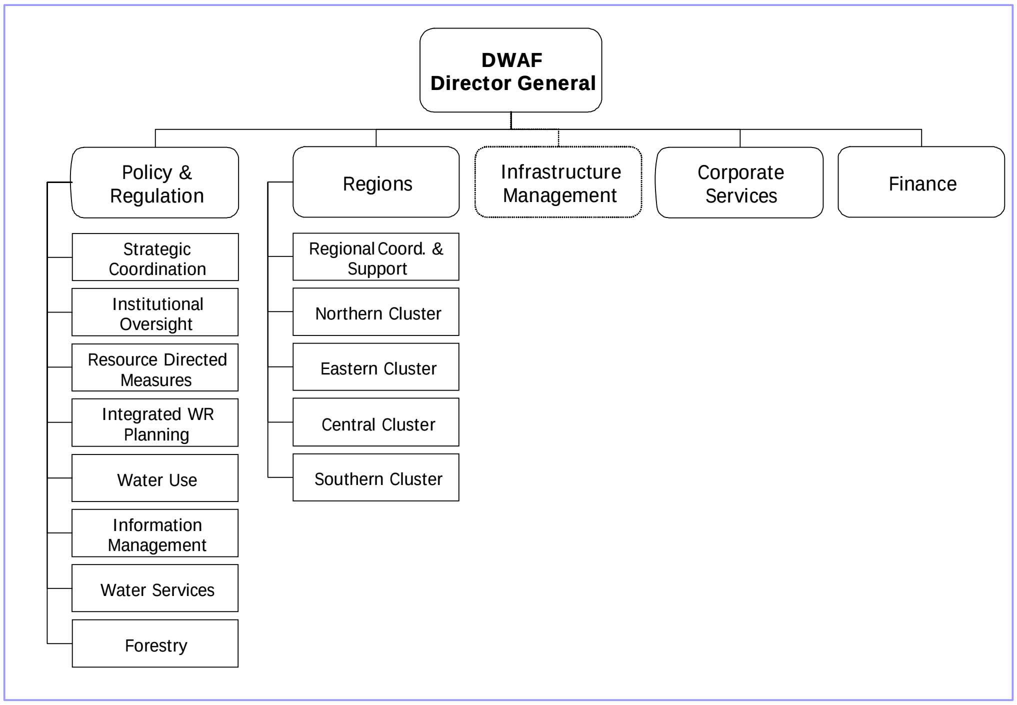

Figure 3.1: DWAF High Level Organisational Structure.

3.3 Process of Institutional Decentralisation

Introduction

The process of institutional change and decentralisation in WRM can be viewed as having four generic phases, from the current situation to fully functional CMAs, as described below. While the phases imply a sequential process, in certain instances the DWAF decentralisation process may only occur once the CMA has already been established. This would indicate the need to adopt a "fast-track" approach from the current situation to an established CMA in these circumstances.

Phase 1: Current Situation / Status Quo

Phase 1 follows the reorganisation of DWAF. The P&R Branch maintains control over authorisation decision making, as well as the initial implementation of new processes while systems are being developed, such as classification and compulsory licensing. Proto-CMAs are being established in the Regions, distinct from the ongoing WRM Regulation and Support components. The intensive period of policy and methodology development can be expected to continue for the next 3 years.

The principal challenge during this phase is the establishment of stable systems and the piloting or testing of these systems. This involves an iterative process during which early systems are tested through targeted regional implementation, with increasing stabilisation through adaptation and consultation with stakeholders.

Phase 2: Decentralisation to the Clusters

As systems and approaches become more stable, implementation and decision making responsibility will be decentralised to the Regions at the lowest level possible. This would include RDM, compulsory licensing and water use authorisation (responsible authority) to be established in the Regions, though not necessarily the proto-CMAs.

The DWAF P&R Branch will retain the overall planning and regulatory functions and responsibilities. This process should take place over the next 2 to 5 years for most WRM functions in all Regions.

As the transfer of roles and responsibilities is initiated during this Phase, the key challenges to be overcome during Phase 2 are related to issues of capacity, coordination and management. Some Regions and the recently established proto-CMAs may not have sufficient capacity, and the institutional structures and arrangements may not be fully developed or sufficiently established to deliver on their new functions. Accordingly, institutional strengthening and capacity building within the fledgling subsidiary components becomes a key role of P&R. In this process, institutional cooperation and coordination are being developed and strengthened. Successful establishment becomes a key challenge as these systems and relationships will determine the success of decentralisation and the establishment of stable systems of information transfer and cooperation.

Phase 3: Establishment of CMAs

A CMA (with an appointed Governing Board) will be established in each of the 19 water management areas (WMA), to which the proto-CMA functions (and staff) would be transferred within the first 2 years. The Cluster would continue to perform WRM implementation functions that have not been delegated to the CMA. At least 5 CMAs will be established in the next 12 months, but the last CMAs are only expected to be established in about 5 years, implying an uneven process of decentralisation and institutional development.

During Phase 3, the changing institutional arrangements and shifting roles and responsibilities result in a range of difficulties and challenges centred on coordination. Owing to their complex institutional arrangements during this Phase, strategy development and water use management can be ineffective and inefficient, and are particularly vulnerable to problems of coordination. The resulting gaps and overlaps, and the general complexity of institutional arrangements during this phase, are clearly demonstrated in the development of the CMS process and the water use management/ authorisation process.

An initial function of the CMA, as stipulated by the Act, is the development of the CMS, which is a consultative and participatory process (driven through the visioning process). Developing the CMS involves the incorporation and expansion of the original Internal Strategic Perspective (ISP) for the WMA. These were developed by Integrated WR Planning (P&R) during Phase 1 or 2, also involving a consultative, participatory and “consensus-seeking” process (also through a visioning process). Particular attention still needs to be given to improving the water quality content of the different ISPs.

The roles and responsibilities of water use management are similarly widely distributed. The application process, which was a proto-CMA function during Phase 1 and 2, is transferred to the CMA in Phase 3. However, evaluation of authorisations and the authorisation process itself (Responsible Authority functions) are seated outside the CMA. It is likely that both of these functions will be transferred from Water Use (P&R) in Phase 1 and 2 to the Regions by Phase 3. These shifting roles and responsibilities are the result of the need to transfer the functions of the Responsible Authority from P&R to the CMA (which must be complete by Phase 4).

During Phase 3, this transfer process is most stretched across the institutions (i.e. there is still significant involvement of P&R at the one end of the institutional spectrum, some delegation of responsibilities to the CMA at the other end of the spectrum, and the Regional Clusters with shifting roles and responsibilities in-between).

Phase 4: Fully functional CMAs

Over the 5 to 10 years following establishment, the remaining WRM implementation functions will be transferred to the CMA, culminating with the CMA becoming the responsible authority. Certain WRM implementation functions will remain with DWAF, including the classification and compulsory licensing of catchments / water resources of national importance. Following the uneven establishment process, the development to full functionality across the country will also be very uneven. Those CMAs in capacitated WMAs will be able to accelerate their institutional development, while CMAs in less capacitated WMAs may lag in their development and still require support from DWAF Regions.

The principal challenge during this Phase is building and maintaining capacity within the subsidiary institutions, as these institutions and their engagement mature over time. Of particular significance is the need to maintain consistency and the development of the information transfers, review and feedback systems under the changing circumstances.

3.4 Policy and Regulatory Framework Responsibilities

Overview

The responsibilities for developing the policy, regulations, guidelines, methodologies, auditing and review for the different parts of the catchment WRM cycle remains with the P&R Branch; the details of these responsibilities can be derived from the 2003 restructuring documents. These are broadly indicated in Figure 3.2, which distinguishes the setting of resources objectives (through class, Reserve and RQOs), from the resource management required to achieve these objectives (through catchment planning), from the management of water use (through source directed measures). All of these require water resources, water quality and related information, and involve an iterative process.

Concept of lead and cooperative development

It is quite apparent that, since these processes are fundamentally inter-dependent, the development of the regulatory frameworks associated with resource objectives, resource management, use management and information management must be developed in a cooperative manner. However, for pragmatic purposes, each must be led by a responsible component within the P&R Branch, which has overall organisation and financial accountability for the system.

Policy & Regulation responsibilities

The policy and regulatory responsibility (of the P&R Branch components) needs to be interpreted as a process of policy (and legislative regulations) development, strategy for national implementation (including prioritisation of catchments), capacity building and technical support for the implementation through Regions and CMAs, monitoring and evaluation of the implementation, and finally audit and review of the policies, strategies and/or systems. An organisational "champion" must drive each policy process, with input from a number of components in the spirit of IWRM. However, it is important to recognise that integration does not require all related functions to be combined in a single component.

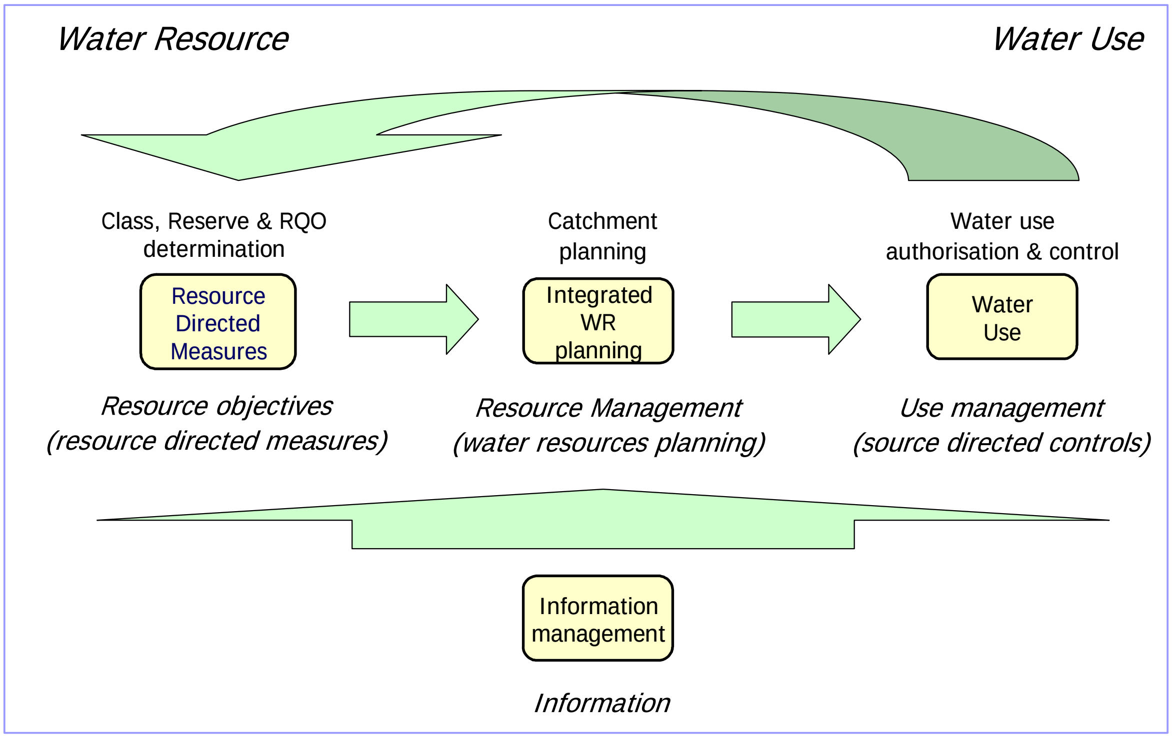

Figure 3.2: Broad Responsibilities for WRM Policy Development and Regulation.

Interim responsibilities

In the short to medium term, the P&R Branch components may also be involved in functions that are related to implementation, either around authorisation or to support the development of the systems (through initial implementation / piloting / testing).

Resource Directed Measures

The Chief Directorate: RDM has primary responsibility for the development of the classification system, as well as the policies and methodologies for Reserve determination and determining RQOs. From a WQM perspective, RDM particularly involves determining water quality related RQOs, including Reserve requirements, linking these with the quantity, habitat and biotic requirements. This requires close alignment with the approaches and methodologies for water resources / catchment planning and system management, because in determining a balance between resource protection and resource development / use, it is necessary to understand the management implications of different classification scenarios. While the systems are in development, the CD: RDM will also play a significant role in the early implementation of the systems (with the DWAF Regions and possibly CMAs). Finally, the Minister establishes the class of a water resource and therefore CD: RDM is also responsible for making a recommendation to the Minister on a specific class for the resource in question (in consultation with other P&R Branch components).

Water Resources / Catchment Planning

In this regard, the various CD: IWRP directorates play a significant role with regards to input to the RDM processes driven by the CD: RDM as far as the appropriateness and achievability of resource objectives is concerned, *inter alia* through foresight and scenario analysis.

In addition, the primary responsibility for developing and supporting the implementation of approaches and tools for catchment planning to meet RQO lies with the various directorates in CD: Integrated WRM Planning.

From a water quality management perspective, this involves the determination of appropriate catchment management approaches that will achieve the water quality related RQOs, considering possible load reductions through source directed measures, changes in system operation and/or resource remediation. This must also consider the flow and system implications of various management alternatives.

All of these approaches must therefore align with both the RDM and SDM, in order to create the 'bridge' between the resource objectives and the water use management options that are necessary to achieve them. In the interim, Integrated WR Planning plays a significant role in catchment planning, together with the Regions, but this should evolve to a national planning and supporting role as local planning capacity is built in the CMAs.

Source Directed Controls

The primary responsibility for developing source directed controls that focus on the management of water use and related land activities lies with the various directorates in CD: Water Use (and particularly Dir: Resources Protection and Waste). For water quality management purposes, this involves the development and auditing of discharge standards, management practices, license conditions, general authorisations, cleaner technology requirements, registration conditions, directives, compliance monitoring and enforcement requirements. These may be general (national / regionally based) or may be catchment based to meet the resource quality and/or catchment management / planning opportunities. Because they may require the management of land use activities that are not registered or licensed by DWAF, it is also necessary to foster cooperative arrangements with local government and other sectors, as well as self regulatory and awareness approaches to mitigating impacts. In the interim, the licensing of water use will remain with CD: Water Use, until this is delegated to the DWAF Regions or CMAs (as responsible authority), based on a stable and clear regulatory framework.

Monitoring and Evaluation

The responsibility for developing and maintaining the water resources monitoring networks and information systems required to support catchment level water resources management lies with CD: Information Management. The other components represent their clients, so there is a clear interaction with the other groups within the P&R Branch as well as the DWAF Regions.

3.5 Implementation Responsibilities

Institutional Split and Transition

Once policies, regulations, guidelines and methodologies are stable, their implementation is the responsibility of DWAF Regions and/or the CMAs. However, there are two complicating factors, namely (a) that not all functions will necessarily be delegated to a CMA (because some may remain with the Minister in the national interest as custodian of the resource), and (b) that delegation of some functions to a CMA will be phased to enable the CMA to build its capacity and legitimacy. Figure 3.3 presents the broad institutional responsibilities for the elements / functions of the catchment WRM process (from Figure 2.2), distinguishing those functions that will remain with DWAF, those "early" functions that the CMA will take responsibility for within the first 2 years, and those "later" functions that will be delegated to the CMA over the first 5 years.

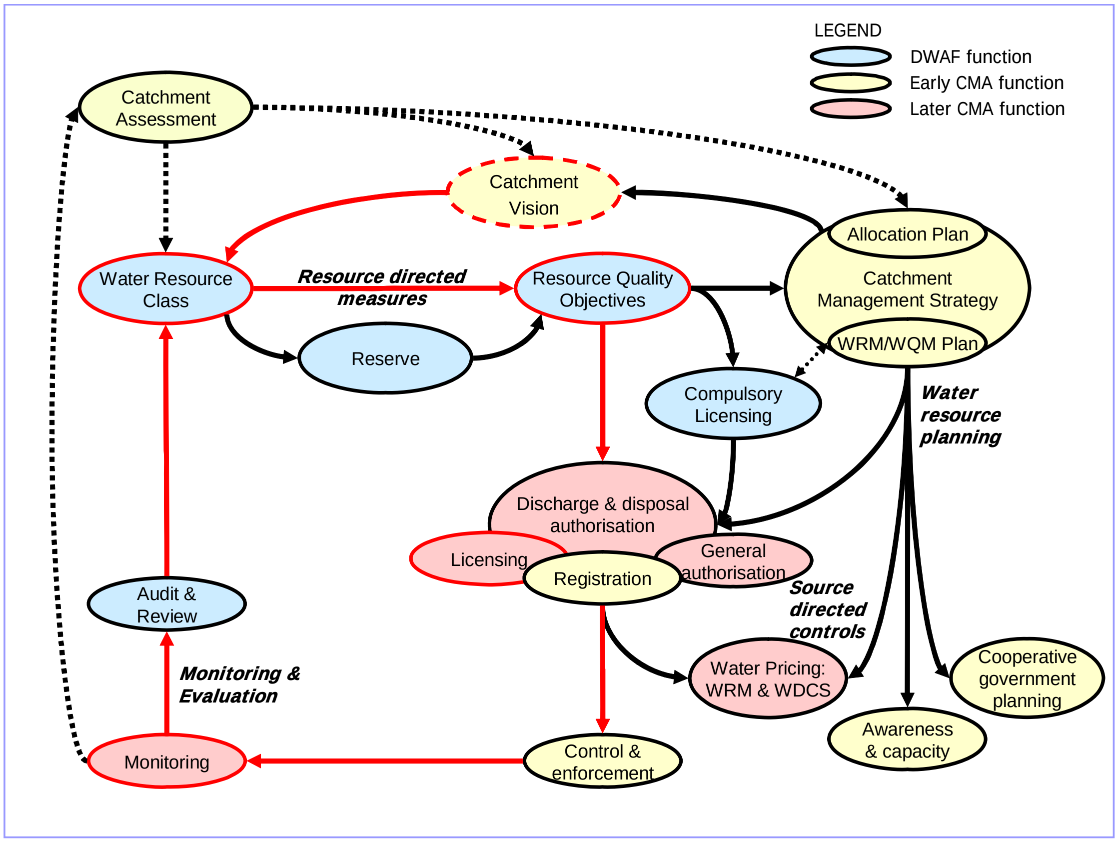

Figure 3.3: Broad Responsibilities for Catchment WRM Implementation.

Role of the CMA

Once established, the CMA has initial and early functions (taken up in the first 2 years) that include the CMS (and catchment visioning), institutional cooperation, stakeholder participation and empowerment (including awareness and capacity building), water use control and enforcement (including registration and initial processing of licence applications).

It is important to note that until the CMA is established, the proto-CMA in the DWAF Region already performs these functions; the functions and staff will be transferred to the CMA during this period. Over the following few years, the CMA will also take over the responsible authority (licensing, etc), water pricing and local water resource monitoring functions.

Role of DWAF

DWAF will continue to be primarily responsible for the classification of a water resource (together with the Reserve and RQO determination), compulsory licensing and reviewing the systems and their implementation. The CMA will support these processes and make recommendations, and may even completely drive the processes in those water resources that are not considered to be of national or strategic interest. However, the classification remains the Minister's responsibility as the trustee of the resource (but this will be achieved through a consultative "consensus seeking" process).

The compulsory licensing process will focus on redress and achieving the specified class (and Reserve), which is politically within the Minister's domain. These processes will be driven from the regions with endorsement/approval by the relevant P&R Branch components. Finally, the audit and review process must remain a DWAF responsibility as it is fundamental to the evaluation and maintenance of the relevant policies, regulatory frameworks and systems.

Transitional Management

Figure 3.4 indicates the shift in water quality management resources required by different institutions during the transition process. Initially, the required resources are relatively evenly spread between P&R, Clusters and the proto-CMA. However, there will be a progressive transfer of responsibilities from P&R to the Regional Clusters as systems are stabilised.

Following the establishment of the CMA, all roles and responsibilities of the proto-CMA are transferred to the CMA along with a continuing shift of roles and responsibilities from P&R to Clusters and from Clusters to the CMA. As this decentralisation occurs, P&R takes on new responsibilities centred on auditing, support and coordination between CMA, Clusters and P&R.

Once the CMA is fully functional, it is responsible for the majority of water quality management effort. The roles and responsibilities of the Clusters have shifted further (some to the CMA, with new responsibilities coming down from P&R), with the Clusters taking on an increasing responsibility and capacity in collaboration, information transfer, review and assessment. The functions of P&R have been further focussed and narrowed, with roles and responsibilities now centred on oversight and support.

Changing Responsibilities During Institutional Decentralisation

The preceding description has outlined the primary responsibilities for water resources management. Table 3.1 takes these broad areas and further disaggregates responsibilities for policy, regulation and implementation functions during the institutional decentralisation process.

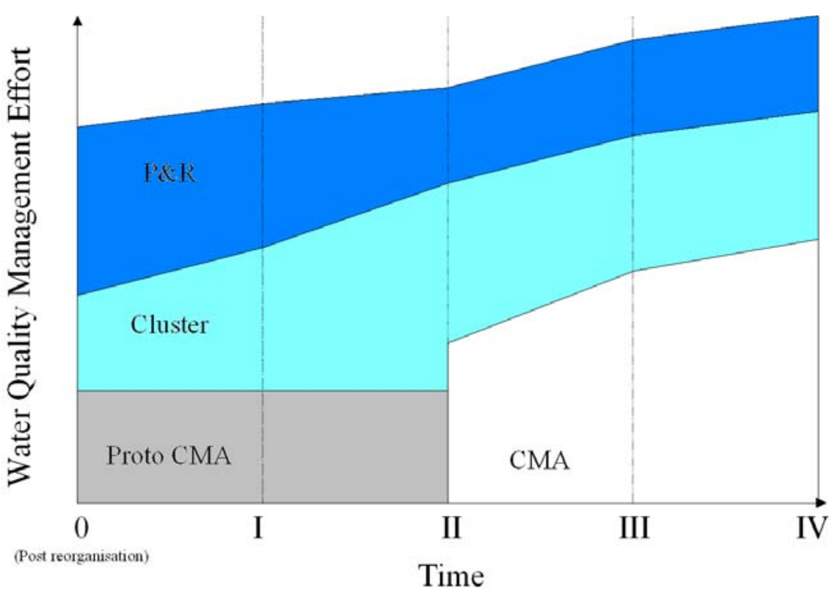

Figure 3.4: Evolving responsibilities and resources for catchment based water quality management.

Table 3.1: Summary of roles and responsibilities for WRM functions (focus on RDMWQ).

		PHASE			
Visioning		I	II	III	IV
	Developing visioning guidelines [Catchment visioning guideline]	P&R: P&SC	P&R: P&SC	P&R: P&SC	P&R: P&SC
	Catchment level visioning	P&R: IWRP / RO	P&R: IWRP / RO	CMA / RO	CMA
Resource Directed Measures		I	II	III	IV
	RDM system/ methodology [RWQO method]	P&R: RDM	P&R: RDM	P&R: RDM	P&R: RDM
	Developing catchment models [RWQO modelling]	P&R: RDM / WRPS	P&R: RDM / WRPS	P&R: RDM / WRPS	P&R: RDM / WRPS
	Classifying a water resource	P&R: RDM / RO	RO	RO	ROs/ CMA[1]
	Determining a Reserve	P&R: RDM / RO	RO	RO	CMA
	Assessing RQO	P&R: RDM / RO	RO	RO	RO/ CMA[1]
	Approving a Class, Reserve and RQO (Minister)	P&R: RDM	P&R: RDM	P&R: RDM	P&R: RDM
Water Resource Management Strategies		I	II	III	IV
	Developing planning and strategy guidelines / tools	P&R: IWRP	P&R: IWRP	P&R: IWRP	P&R: IWRP
	National Water Resource Strategy (NWRS)	P&R: P&SC (all)	P&R: P&SC (all)	P&R: P&SC (all)	P&R: P&SC (all)
	Developing the Internal Strategic Perspective	P&R: IWRP / RO	P&R: IWRP / RO	*replaced by CMS*	
	Developing Catchment Management Strategy (CMS)	*not developed yet*		CMA	CMA
	Water Resource / Quality Management Plan	P&R: IWRP/ RO	RO	CMA	CMA
Authorisation		I	II	III	IV
	Authorisation methodologies [ACWUA DSS tool]	P&R: Water Use	P&R: Water Use	P&R: Water Use	P&R: Water Use
	Application Process	RO: Proto-CMA	RO Proto-CMA	CMA	CMA
	Evaluation	P&R: Water Use	RO/ P&R: Water Use	RO/ P&R: Water Use	CMA
	Authorisation	P&R: Water Use	P&R: Water Use	RO	CMA
	Compulsory Licensing	P&R: WA / RO	P&R: WA / RO	RO	RO/ CMA[2]

[1] For resources that are not of national or strategic significance, implementation of the Class and the setting of the RQOs can be delegated to the CMA

		I	II	III	IV
Control and Enforcement	Control and Enforcement strategies and tools	P&R: WU / OPS	P&R: WU / OPS	P&R: WU / OPS	P&R: WU / OPS
	Control	RO: Proto-CMA	RO: Proto-CMA	CMA	CMA
	Enforcement	P&R: WU / RO	ROs	ROs	CMA
	Directives	P&R: Water Use	P&R: Water Use	RO	RO / CMA
	Self Regulation	P&R: WU / RO	RO / Proto-CMA	CMA	CMA
	Awareness creation	RO / Proto-CMA	Proto-CMA	CMA	CMA
		I	II	III	IV
Monitoring	Monitoring methodologies [Guideline for review and monitoring]	P&R: RDM / Info. Man.	P&R: RDM / Info. Man.	P&R: RDM / Info. Man.	P&R: RDM / Info. Man.
	Sustainable development monitoring	P&R: RDM Info. Man.	P&R: RDM, Info. Man. (with RO)	P&R: RDM, Info. Man. (with RO)	P&R: RDM, Info. Man. (with CMA)
	Water Resource monitoring	RO	RO	RO/ CMA	CMA
	Compliance monitoring	Self Reg./ RO	Self Reg./ RO	Self Reg./ CMA	Self Reg./ CMA
		I	II	III	IV
Review	Review and audit approaches [Guideline for review and monitoring]	P&R	P&R	P&R	P&R
	Authorisation and licensing	P&R/ RO	RO	RO/ CMA	CMA
	CMSs (ISP) and CMAs	P&R	P&R	RO	RO
	Classification	P&R: RDM	P&R: RDM	P&R: RDM	P&R: RDM
	Strategic review	P&R	P&R	P&R	P&R

[2] Compulsory licensing may be delegated to the CMA if resources are not deemed to be of national significance.

3.6 Responsibilities for RDMWQ Management Instruments

Responsibilities

Following the above allocation of responsibilities, the RDMWQ management instruments may be superimposed on the management process of water resources, as indicated in Figure 3.5. Ideally, the identified Directorates and/or Regional Offices, or in future the Catchment Management Agencies (CMAs), will be responsible for specific functions in either a lead or contributing role, and should take the responsibility of applying and implementing the relevant instruments.

Table 3.1 indicates (in red) the responsibilities for the policy process leading to the development of the different management instruments and then the implementation of those instruments, in accordance with the accepted DWAF structure, as approved by the Director General in 2003. While all of these instruments need to be developed and implemented jointly by a number of components within DWAF or the CMA, each process must have a lead individual or organisation that takes responsibility for ensuring cooperation and delivering the output.

While the lead responsibility may be clear, there are a number of subtle differences between the responsibilities and degree of involvement related to the development of RWQOs and the process of catchment planning to achieve them through water quality related source directed controls, particularly in terms of the interfaces between them. This further develops the lead responsibility discussion in Section 3.4 above, and addresses the implementation of the management instruments within this context.

RDM tools and implementation

While the lead responsibility for the development of methodologies for RDM (including the development of RWQOs) remains with D:RDM, the approaches, tools and models must be consistent with and interface with the tools and models that are used in catchment assessment and planning. This is because it is only through effective catchment planning and water use management that these objectives can be achieved. It is therefore appropriate for Integrated WR Planning (specifically WRPS) to work in partnership and support RDM through the development of relevant catchment planning models that may be used both to develop RQOs and to conduct catchment level water quality assessments.

While implementation of these tools should be through the DWAF Regional Offices or CMA, it is critical that P&R should provide adequate support for this process. Here, D:RDM should play a key role in supporting the implementation of the process, while D:WRPS should support the technical implementation of the models they have developed (in order to ensure organisational efficiency).

Catchment planning and authorisation

There is also an important interface between catchment level planning and the management of waste related water use (for both point and nonpoint sources). While the approaches and models for translation of RWQO into management objectives and acceptable loads at a catchment level should be led by Integrated WR Planning (WRPS), the development of discharge standards and best practice at a source level should be led by Water Use (RP&W).

There must however be clear alignment and consistency in the catchment water quality models (for catchment planning) and those used to evaluate local source related impacts (for authorisation purposes).

3.7 Challenges during the Institutional Decentralisation

Initial Phase

Initially, while the systems are being implemented and there are few CMAs, DWAF can effectively manage the implementation of RDMWQ. The management cycle involves RDM (classification system and implementation), Integrated Water Resource Planning (strategy development), Water Use (authorisation/ regulation) and Information Management (monitoring/ review), with Strategic Coordination assuming oversight of the process.

These P&R components that are responsible (supported by the Regions) are relatively well capacitated and resourced (generally supported by external service providers), and coordination is efficient.

Decentralisation with DWAF

As responsibilities shift to the DWAF Regions (including the proto-CMAs), problems may be introduced because capacity and expertise tends to be more limited at these levels. Although stable systems should have been established, detailed institutional processes and dynamics that are based on clear differentiation of roles and responsibilities may not yet have been fully developed.

The move from piloting to widespread implementation of policies, strategies and plans may therefore lead to some degree of institutional instability, unless this process is carefully phased and supported by broad institutional capacity building. However, as both the proto-CMA and the Regions are still contained within DWAF, collaboration, communication and capacity is more easily achieved.

CMA establishment

CMA establishment introduces a range of potential complications; for example, CMAs will be progressively established and will be taking on key planning responsibilities within the WMA linked to the CMS. In effect, the CMAs become the interface between the RDM and the high-level visioning process on the one hand, and authorisation on the other.

The CMAs will be new, young organisations with limited capacity and resources (although transfer of staff and resources from proto-CMA does strengthen the new CMAs). In addition, they will adopt a participative and cooperative approach to WRM, which needs to link into DWAF processes.

Particular challenges are related to: the establishment of capacity in, and the flow of resources to the new CMAs; the development of systems of mentoring, decision making and information flow between the CMAs and DWAF; and clarity on the roles and responsibilities of the CMA within DWAF’s WRM process.

Fully functional CMA

Once CMAs are fully established, the systems, capacity and resources should become relatively stable. The staff within the CMA should have grown as capacity is improved, and roles and responsibilities are more clearly defined. Capacity building of the CMA staff over 5 years should ensure that the institution evolves and the roles and responsibilities are refined according to the management needs and requirements of the WMA.

The problems of the transitional phases should have been addressed. The major challenge is developing the capacity of enough people in the water sector to support 19 CMAs.

SECTION 4: INSTITUTIONAL ROLES

Introduction

Water quality management inherently requires the collaborative management of activities and resources that are within the mandate of other government departments or are the property of private sector entities. Figure 4.1 indicates the key institutions that are relevant for WQM-RD, with the CMA / DWAF as the focus of this management attention. Institutional interactions around the main areas of RDMWQ are outlined below.

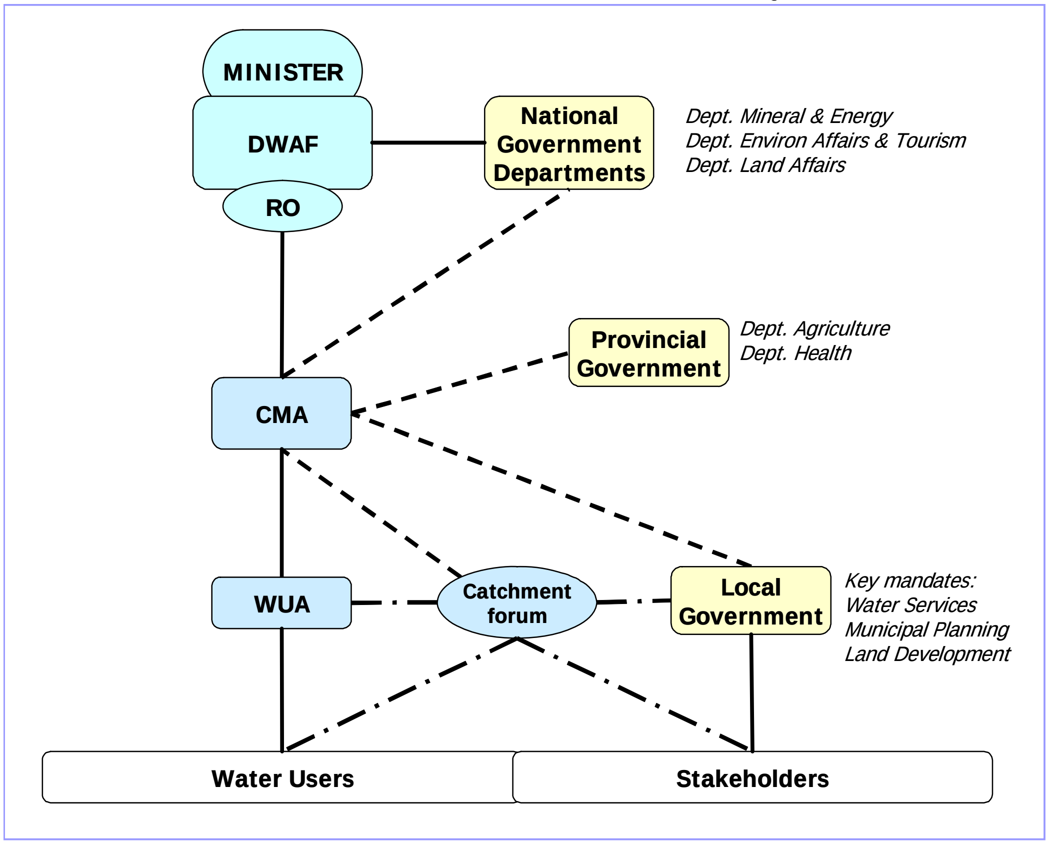

Figure 4.1: Primary institutional relationships related to RDMWQ.

Key external Stakeholders

In addition to water users and stakeholders, key institutional role players include:

- National government departments
- Provincial Government
- Local Government
- Water User Associations (WUA)
- Catchment Forums

The following discussion indicates how these entities need to be brought into the RD WQM environment.

Resource Directed Measures

The process of classification is consultative (a "consensus seeking process") and requires inputs from other national government departments and from interested and affected local and national agencies (e.g. WUA, Forums, national representative bodies). DWAF achieves this consultation through the CMA / proto-CMA, which functions as the locus for the consultation process.

Water Resources / Catchment Planning

The development of a CMS is a participatory process that is based on catchment visioning. There is a legal requirement within the NWA that the CMS must take account of any relevant national or regional plans that have been prepared in terms of any other law, including any development plan adopted in terms of the Water Services Act. This implies a requirement for them to be consistent with Integrated Development Plans, Water Services Development Plans, and Provincial Growth and Development Strategies/Plans.

Accordingly, the involvement of regional and national government, and local agencies (e.g. local government, Water User Associations and Forums) must be an integral component of the process. Engagement with Provincial Government also forms an important component of the review, assessment and harmonisation of the CMS. Facilitation of this relationship is principally undertaken by the CMA.

Source Directed Measures

The licence application process requires consultation at a local level with water users and dischargers (including local government). Similarly, license evaluation and authorisation functions require consultation and cooperation with local government, and with regional and national government departments. The authorisation process comments on, and is informed and influenced by, other processes such as the development of the Environmental Management Plan Reports within the mining sector as a requirement of the Department of Minerals and Energy (DME), or the requirements of the Environmental Conservation Act (ECA) of the Department of Environmental and Tourism (DEAT) for waste disposal (e.g. landfills).

In order to give effect to the water management directives of national / regional government, the enforcement and control functions of the CMA require the establishment of cooperative governance frameworks with the local agencies (local government, justice, law enforcement).

Establishment of the water management directives, and the harmonisation and consistency of these directives with other management and control instruments within the WMA requires close cooperation with the national and regional bodies responsible for development and implementing of management and control measures in the WMA (most commonly, these will consist of DEAT, Department of Agriculture (DoA), Local and Regional Government).

Monitoring

Sustainable development monitoring requires consistency with and input from DEAT and various levels of national strategy in sustainable development.

Water Resource Monitoring requires close cooperation with Local Government, WUAs, forums and individual users/ dischargers.

Compliance monitoring and monitoring of the water management institutions are largely internal functions conducted at varying levels within the water resource management institutions (CMAs, Regional Clusters, P&R).

Development of cooperative governance relationships are not a pre-requisite, although the involvement of local, provincial and national government and other agencies in the appropriate review process could be beneficial.

SECTION 5: IMPLEMENTING THESE RESPONSIBILITIES

5.1 Capacity Building

Interpretation of Capacity

Capacity is a complex issue that goes beyond simple human resources capacity, and includes both organisational capacity and institutional capacity. Institutional capacity includes:

- *Policy and legal capacity*. This capacity refers to the enabling framework of water related policy, legislation, regulations, and guidelines and tools flowing from these.
- *Planning and managerial capacity*. This is critical if proto-CMAs / CMAs are to make the right decisions and determine their own destiny. Planning has several dimensions including internal strategic planning and external service / functional delivery, planning and prioritisation.
- *Organisational and procedural capacity*. This capacity refers to the structure of an organisation and includes all of its internal processes. CMAs face the challenge of organizing themselves to perform the functions of the Responsible Authority and to harmonise, coordinate and ensure consistency of water management activities with Regional Clusters and P&R. These varying functions will require different structural responses, and different sets of procedures.
- *Financial capacity*. Without financial capacity, CMAs will be unable to act effectively on their plans, and will fail in the implementation of policy, with a consequent failure to deliver the services that are expected of them. Financial capacity refers to the processes that secure and manage funds, and the mobilization of the funds themselves to provide cost-effective services.
- *Human and infrastructural capacity*. Human capacity has to do with people filling posts, and having the correct mix of skills, abilities and experience to undertake their defined tasks effectively and efficiently. Infrastructural capacity refers to matters such as transport, offices, computers and IT services, telecommunications and security services. All of these are required to underpin the efficient and effective functioning of an organisation.
- *Networks and associations*. Very few organisations can operate in isolation, and CMAs are no exception to this rule. Networks provide support and coordination, information and experience, policy and mandate, and funds.
- *Stakeholders.* In the CMA case, stakeholders (users, effluent dischargers and affected parties) should take ownership of the resource through the catchment visioning process and the CMS. For CMAs, the users and dischargers are an important source of income, and hence sustainability. In effect they are the market for the services that the CMA provides. Importantly, this 'market' also helps to ensure that CMAs deliver the range of quality services that are needed by users.

Capacity Building and Institutional Change

As described above, a wide range of significant capacity challenges are associated with the changing institutional structures and arrangements, and the shifting roles and responsibilities during the decentralisation of WMA functions with the establishment of CMAs. These are primarily related to the following areas of capacity:

- Development of new institutions and the concomitant development of new structures, relationships, operating systems and processes,
- Introduction of new people with associated issues of appropriate levels of skills, expertise, experience and attitude or approach, and
- Limited resources.

In order to successfully address these challenges and surmount the associated hurdles, there will be a need for significant institutional and personnel capacity building and the establishment of stable operating systems. Accordingly, the institutional change process should include:

- A carefully structured and phased plan for decentralisation;
- Coherent process of decentralisation linked to the development of comprehensive and effective new operating systems;
- The establishment of stable systems and procedures; and
- Implementation of simple administrative systems, introducing as much routine as possible.

5.2 Key Institutional Considerations for Implementation

Institutionally Orientated Approach

Importantly, the implementation of RDMWQ should be informed by the available capacity and resources within the WMA (DWAF or CMA) and should strive to achieve maximum simplicity. In those situations where RQOs are being met, the approach should be to: a) adopt a routine process to meet effluent standards at minimum cost, b) discourage exceptions and relaxation of requirements, and c) base water management processes and decisions on the hierarchy of WQM.

Where RQOs are threatened or exceeded, the strategy that is chosen to address these issues must be based on a clear assessment of the problem and its associated issues, followed by appropriate actions and/or interventions that are best suited to rectify the problem promptly. It is important to ensure that the processes of problem-solving and decision-making are transparent, prompt and cost-effective. It is not acceptable to allow problems to linger for long time periods without adequate management attention.

Typical sets of actions / measures could include:

- Compulsory licensing;
- Ad hoc licensing;
- Rehabilitation or mitigation;
- WDCS; and
- Increasing levels of cooperation and awareness.

The choice of which measures should be employed depends on the specific problem and the nature of the associated issues, on the economic, social and environmental nature and dynamics of the WMA, and on the institutional requirements and constraints. A particular approach can therefore not be prescribed, but the list provided above contains the necessary tools to address the issues under most circumstances.

5.3 Mechanisms to Support Implementation

Institutional Cooperative Mechanisms

The entrenchment of an effective institutional approach to RDMWQ requires the development of key institutional mechanisms, both within DWAF and with other institutions. These may include issues of:

- Governance accountability and representation;
- Policy alignment;
- Coordinated strategy development;
- Institutional structures;
- Organisational design;
- Delegations and contracting;
- Financial arrangements;
- Consultation and comment processes;
- Information sharing and exchange; and
- Awareness capacity building and support.

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DOCUMENT INDEX

Reports as part of this project:

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1.1	Inception Report
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1.3	Glossary of terminology often used in the Resource Directed Management of Water Quality
1.4	Volume 1: *Policy Document Series*
1.4.1	Volume 1.1: Summary Policy
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Bold type indicates this report

APPROVAL

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EXECUTIVE SUMMARY

In many ways, natural resource sharing and management are reflective of the complexities, challenges and opportunities in contemporary South African society. In many cases, supplies of natural resources cannot be augmented or replaced as fast as they are used and society is under pressure to share them equitably and democratically. Tough decisions must be made because the costs and benefits of resource use must be reconciled in an equitable way. Further complexity is added through the changing nature of ecosystems, and as societal contexts and values shift over time. Thus, the sharing and reconciliations are never static, but an ever-moving target. Urgent and compelling development and economic growth needs must be balanced with the equally important need to protect the natural resources that provide the life support systems for society. Through these challenging deliberations, natural resource management becomes an important vehicle for nation building through participation, value-sharing, development of new shared understandings, improved tolerance, and co-operation. But these processes and changes cannot happen on their own. Society's diverse needs, preferences and values have to be aligned continually towards a common vision for the future.

This guideline provides the underpinning rationale and a process for developing a catchment-level vision. It also provides a structured process that should be used to disaggregate the vision to objectives, and which is designed to promote accountability in both management and the public who participate in the process. The management instrument takes account of the fact that public participation processes range from non-existent to robust and vibrant across the country, and therefore makes provision for setting up a catchment vision and management objectives regardless of the state of maturity of public engagement processes.

The tool focuses on the social process of sourcing shared values and bringing them into the same arena to develop a shared vision for the future. The dynamic social process (with technical and scientific support) is the one which can generate voluntary co-operation and support for the vision as well as the management objectives that flow from it.

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ACRONYMS

CAS	Catchment Assessment Study
CMAs	Catchment Management Agencies
DWAF	Department of Water Affairs & Forestry
IDP	Integrated Development Plan
IWRM	Integrated Water Resource Management
NWA (36:1998)	National Water Act
RDMs	Resource Directed Measures
RDWQM	Resource Directed Management of Water Quality
RQO	Resource Quality Objective
RQOs	Resource Quality Objectives
RWQO	Resource Water Quality Objective
RWQOs	Resource Water Quality Objectives
SEA	Strategic Environmental Assessment
WMA	Water Management Area
WQM	Water Quality Management

SECTION 1: INTRODUCTION

1.1 A 'vision' and 'visioning'

Visioning is a future-building process

It is widely acknowledged that a fundamental objective of integrated water resource management (IWRM) is to ensure that resource-based costs and benefits are appropriately distributed in society (Van Wyk *et al*., 2006a). Because of past inequities, there will be much emphasis on redistribution of benefits. A first step in this redistribution is to align the diverse and competing interests in the resource (where 'resource' refers to the entire aquatic ecosystem, not only the water component), and then to direct them towards achieving a collective desired future. Visioning is a process of articulating society's aspirations for the future – in this case, the 'basket' of benefits to be derived from aquatic ecosystem services and the costs associated with their use.

The visioning process begins with the generation of a vision statement and ends with the identification of focus areas that allow for the setting of management objectives. A vision statement must be converted into, and explicitly linked with, objectives that are useful at the operational level. Unless a vision is linked clearly to practical end-points (i.e. explicit objectives for management), it will not be supported by those who are involved in the water allocation and licensing process. Promoting these objectives will move society towards the attainment of the vision.

Balancing the costs and benefits of resource use must include both resource quality and quantity components. In this way, both are incorporated into the formulation of a statement of the desired future conditions of resource use and protection.

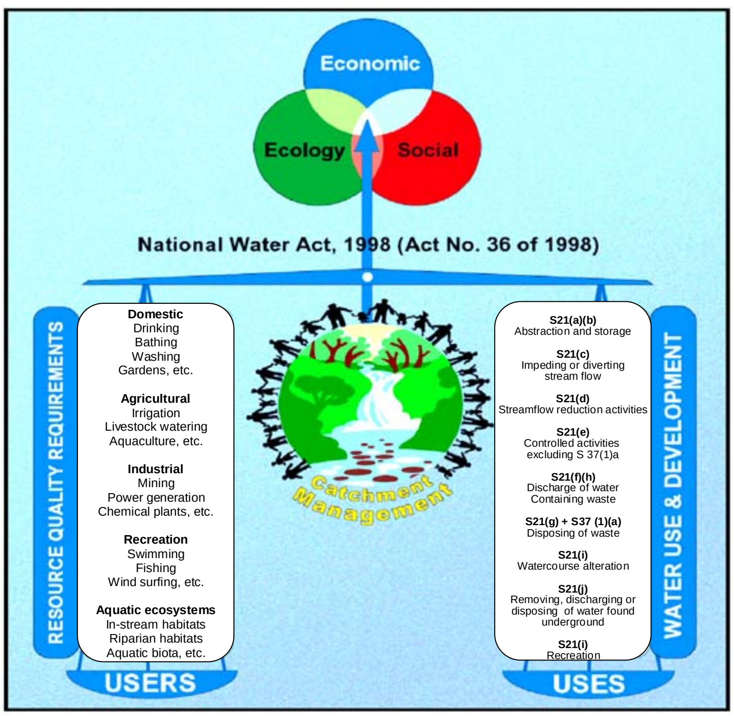
Aquatic ecosystems support human well-being

River ecosystem goods and services sustain human life by supporting basic human needs, social well-being and economic growth and development. Benefits include tangible products such as water, food, forage, building and craft material (e.g. timber, sand and reeds), natural pharmaceuticals and industrial products and their precursors. The harvest and trade of these goods represent an important and familiar part of the human economy. Ecosystem services include a range of processes that support human well-being, for example the maintenance of water quality through filtration and waste disposal, as well as benefits relating to recreational and spiritual needs. When people think of their future relationship with the water resource, they tend to think of it in terms of the goods and services they might benefit from, or those that are needed but may not be available to them.

People derive benefit from both on-site and off-site use of river ecosystem goods and services. For example they may engage in on-site consumptive processes such as watering and grazing livestock and harvesting animal and vegetable products. They may also engage in non-consumptive on-site activities, including recreation and religious ceremonies. Others, some of whom may never access rivers directly, derive benefit from off-site use of the resource. These include benefits accruing to people who use water abstracted from the rivers and aquifers to service domestic and industrial needs at remote locations.

Some of the off-site uses may be consumptive such as extracting water for irrigated agriculture, while others - such as waste disposal - may to a large extent be non-consumptive. Those who have direct association with rivers for enjoyment or survival tend to hold greater awareness of the diversity and value of ecosystem goods and services than those who depend on goods and services at locations remote from rivers, such as in urban environments. Both of these groups are linked to river ecosystems, but their awareness of the linkages is often quite different (Van Wyk *et al*., 2006a). This point has an important bearing on the visioning process, since these different levels of awareness of the 'basket' of water resource uses in a catchment will pose a challenge to aligning a catchment community's aspirations towards a common vision.

Several factors influence the nature of the relationship between people and the water resource over time. One is that the resource itself is variable over space and time, for example droughts and seasonal fluctuations in the supply of goods and services. Also, user needs may change in space and time. Perhaps a town expands and requires more domestic water, or a crop loses market value and the farmer chooses to convert to another crop that may use more or less water. Or a water-conservation technology such as drip-irrigation becomes available, which changes perhaps the magnitude and patterns of water use. These examples illustrate the dynamic nature of the factors that influence the condition of the resource. One of the functions of the visioning process (and public participation as part of the visioning process) is to bring this variation in the resource and dynamic changes in user needs (See Schematic 1) into the process of setting the desired future condition.



Schematic 1: Use and user needs, plus the state of the resource, are dynamic over space and time. The visioning process creates a space in which this dynamic variability can be aligned towards an agreed future. (Extract from Van Wyk *et al*., 2003).

The resource is more than water

In setting a vision it is important to understand how the law expects us to interpret 'the water resource', for which a vision is developed. The law acknowledges that the entire aquatic ecosystem, thus not only water, is a life support system. The 'water resource' is thus defined to include a watercourse, surface water, estuary or aquifer, on the understanding that a watercourse includes rivers and springs, the channels in which water flows regularly or intermittently, wetlands, lakes and dams into or from which water flows, and where releVant the bed and banks of the system. The quality of the resource (the 'resource' being the ecosystem providing services beneficial to people) is also defined broadly to include fluxes in flow; physical, chemical and biological characteristics of the water; the character and condition of the in-stream and riparian habitat; and composition, condition and distribution of the aquatic biota. The resource was thus seen by drafters of the law in a holistic sense, to include (1) the water, and (2) the ecosystem of which it is a part and through which it flows. It also recognises the diverse influences exerted by the quality and quantity of water on the ecological processes, which in turn regulate or direct the functioning of the resource.

Visioning promotes voluntary compliance

The visioning process must generate a dialogue that promotes ongoing shared awareness and understanding amongst resource users - of each others' diverse, dynamic and often competing water resource-related needs. A properly conducted visioning process will encourage people to adjust their individual demands on the resource in the broader interests of sustainability and co-operative management. People are more likely to support resource-related decisions (and processes) voluntarily if the visioning process promotes equity and shared understanding of the costs and benefits of different resource use options. It will be critical to foster a process that promotes the co-operative design of rules for water resource sharing and the voluntary compliance (i.e. self-regulation) to such rules. The alternative is a likely reversion to more centralised government regulation and policing process to ensure that the rules of water resource use are complied with.

1.2 Intent of the visioning process

Vision promotes accountable decision-making

The specific intent of catchment visioning is:

- To generate a sense of cohesion and common purpose amongst people with diverse interests in the water resource.
- To direct activities related to diverse interests towards that common purpose.
- To continuously improve water resource management practices and the state of the resource.
- To promote a culture of co-operation and consensus-building.
- To provide a chain of accountability that links the vision to management objectives and management actions, so that it is possible to track whether or not the actions contribute to achieving the overall vision.
- To provide clusters of objectives that allow operational managers to interpret licence applications and to formulate and recommend license conditions in a strategic fashion.

1.3 Purpose of this document

Public participation is an important part of designing a vision

This guideline describes a practical process for developing a catchment-level vision and for disaggregating this vision into component management objectives.

This process should ideally be conducted with the involvement of and input from, all interested parties. However, building inclusive participatory processes into natural resources management takes time, and is a new experience for South Africa. Resource managers currently find themselves in a transitional phase in terms of putting in place processes that underpin inclusive and transparent public engagement.

Visioning can be useful in the absence of full public participation

A number of instruments and guidelines are available to guide visioning and public participation for natural resource management in South Africa (e.g. Rogers and Bestbier, 1997; Carl Bro Int., 2001; DWAF, 2001; Motteux, 2001; Anderson, 2002 and Van Wilgen *et al*., 2003), but none have been fully implemented. A number of these processes may be legitimate, but only one is presented here in detail.

Water resource managers have relatively little experience in engaging the public in the resource management process and civil society is in many cases ill-prepared to participate in such processes. Water resource managers drive the resource management process within an environment of radical institutional change (restructuring in DWAF, the establishment of Catchment Management Agencies and related statutory and non-statutory organisations).

Bringing the public into a participatory process in this environment and sustaining the energy of the process can be complex, time-consuming and frustrating. In the meantime, resource allocation (and the resulting authorisation of water use) and resource use must continue. Resource-based businesses and livelihoods cannot wait for the "perfect" public participation process to be in place. The visioning process outlined here provides regional DWAF officials with a tool to articulate, relatively quickly, a desired future state on behalf of the catchment community and other interested parties, in order to set the adaptive management process in motion. The consequence of this is that, initially, there will most likely be little stakeholder buy-in to either the vision or the process of achieving it.

Regional staff will have to engage in a continuous process to incorporate an ever-increasing number of stakeholders and their views, and to facilitate vision-building so that the process is supported. This does not imply that the interim process should be regarded lightly. It must set a robust precedent and platform for subsequent, more inclusive stakeholder participation.

Visioning tool components

Visioning has three major components:

- A step-wise method to generate a vision.
- A method for translating the vision into objectives that drive operational management, and.
- An approach whereby the Regional Office or a CMAs can mobilise stakeholders over time to participate more intensively in the catchment visioning process.

1.4 Outcomes of a catchment visioning process

Visioning results in an objectives hierarchy that links management action to the vision.

The outcome of a catchment visioning process is a vision for the desired future condition of the resource and an 'objectives hierarchy'. The objectives hierarchy begins at its coarsest level with the vision and ends in a series of management objectives of increasing focus, rigour and practical achievability. The desired future state is set through the integration of diverse values, which can be categorised as social values, technical values, ecological values, and economic and political values.

Objectives in the hierarchy relate to both the management of the water resource (biophysical objectives) and to the institutional adjustments required to support more efficient and effective water resource management (Figure 1.1). The higher level vision and objectives serve upper management levels with statements of strategic intent, while the lower level objectives provide on-the-ground operational objectives that can be linked to specific targets with spatial and temporal limits. The lower level objectives represent the most detailed and most technical level of objectives. These are of particular interest to operational resource managers because these objectives inform the monitoring component of the resource management system.

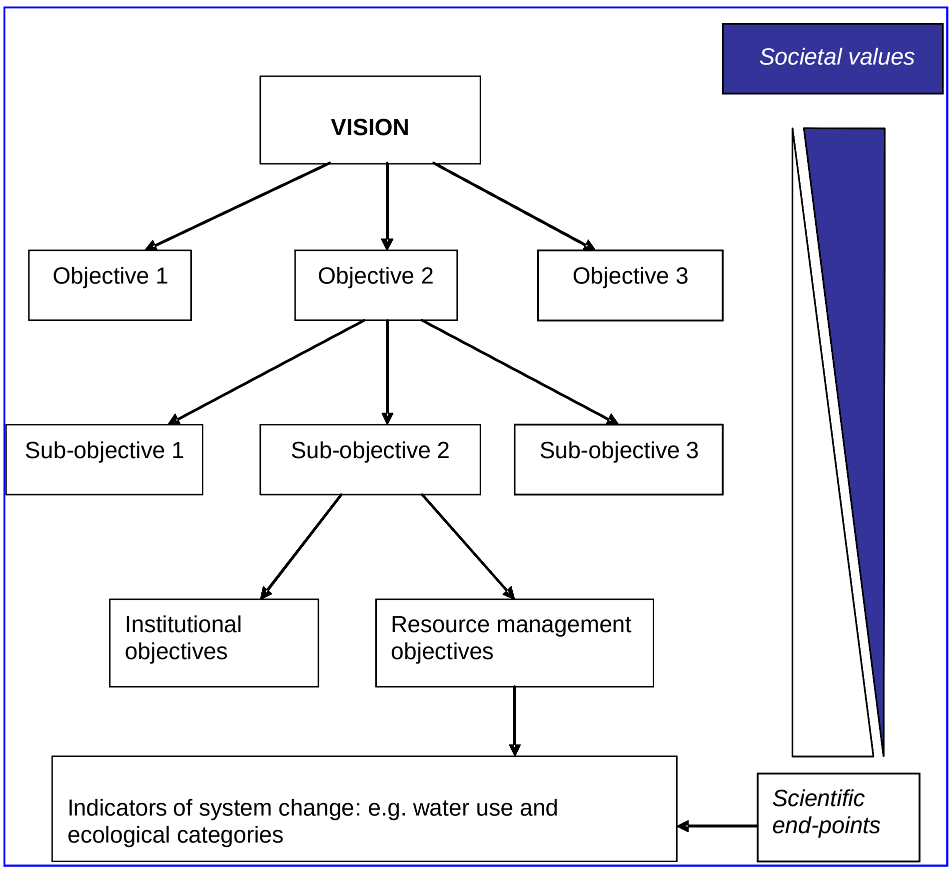


Figure 1.1: The objectives hierarchy process starts with the statement representing the desired future state (a societal / values-based statement) which is converted to scientific/technical endpoints. The technical endpoints are useful at the level of operational management but also link back to the vision explicitly through the objectives hierarchy.

Objectives explicitly linked to the vision

Near the higher level, objectives are more value-based, broad statements of society's aspirations for their relationship with the water resource. They are less technical in nature and cater for clusters of water resource users and functions. Towards the more detailed end of the hierarchy, the objectives are more technical and specific, but they can be related back explicitly to higher level objectives (Figure 1.2) to ensure accountability.

Objectives hierarchy and licensing

Figures 1.1 and 1.2 indicate that an objectives hierarchy provides higher level objective clusters that are able to clearly present the aspirations of broad, user, or interest groups. These will be convenient user clusters (e.g. irrigation agriculture and forestry) according to which allocation and licensing can be grouped and managed. At the more detailed level of the hierarchy, the finer-level objectives produce clusters that relate more to within-sector licence conditions at quite a fine geographic scale, for example at the scale of a river reach.

This is an especially useful feature of the objectives hierarchy because it allows the regional or operational manager to issue licences and decide on licence conditions within a broader strategic framework. In other words, it helps to prevent dealing with each licence as an isolated application by placing it within a broader picture of what is required to achieve the overall vision for any given catchment. To use an example from Figure 1.2, a resource manager may receive a water use application for consumptive use. The framework (Figure 1.2) helps the manager to place that application, according to its nature and magnitude, within the vision for consumptive use for that catchment. It also helps the manager to interpret the application in relation to how it might affect the objectives for non-consumptive use and resource protection.

Societal values and management objectives are linked

Figure 1.2 is a more detailed version of Figure 1.1. It shows that the process of vision disaggregation provides a direct link between the values in society (encapsulated by the vision statement and higher level objectives), higher level management objectives (suited to for example, strategic decisions at national and/or regional/WMA level), and lower level operational objectives. Not everyone need be involved in the entire process or at all levels. Higher level management and society representatives might want to be part of the top part of the process, below which the details can become very technical. From this point 'downwards', scientific/technical and operational-level management input is more appropriate. Even though different groups might provide more or less input at various stages of the process, the way it is structured and documented remains transparent and open for debate, contestation and request for accountable justification at any time.

Importantly, the visioning process should not be conducted to deliver water quality objectives alone. Instead, the process should deliver a vision and objectives as they relate to the whole water resource. Objectives that relate to water quality only will emerge as a subset of objectives that are nested within a wider resource management objectives framework. This approach gives effect to the underpinning philosophy that we should not manage water quality, or even water, in isolation, but rather the aquatic ecosystem in its widest possible sense, as required by the National Water Act (see Van Wyk *et al*., 2006a).

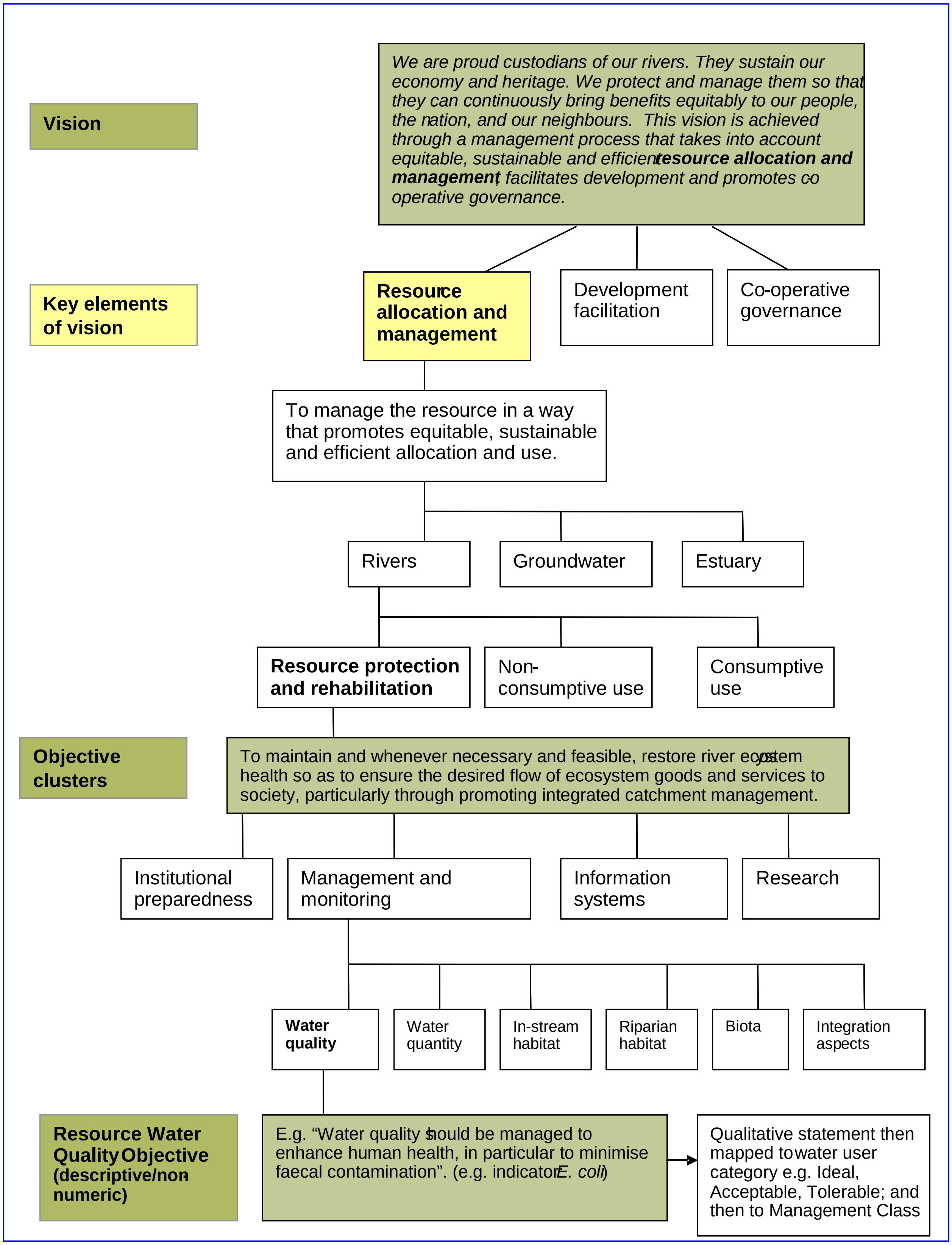


Figure 1.2: An example of a vision statement and its partial breakdown into an objectives hierarchy (adapted from Van Wilgen *et al*., 2003).

SECTION 2: VISIONING AND THE RESOURCE MANAGEMENT PROCESS

2.1 Catchment visioning and adaptive water resource management

Visioning drives the management process

New legislation makes provision for the use of an adaptive management process (Figure 2.1) to achieve the vision. Visioning sets this process into motion and provides a means of continuously cross-checking day-to-day operational decisions and actions against the vision and higher level objectives.

Visioning is not scenario planning

Note that scenario generation can help to inform the construction of a realistic vision, but should not be used as the primary process to derive a vision. Scenario planning attempts to predict a number of possible future options and encourages a choice between them. The 'designing the future' approach is more conducive to capturing aspirations and encouraging creative solutions from the water users themselves. The person constructing the scenarios (probably a technical specialist) has much control over the outcomes or options. Vision-building is based on a premise of articulating and integrating diverse values. Scenario-planning does not necessarily cater for inclusive value acknowledgement and integration. Inherent in this is the risk of low levels of stakeholder buy-in (i.e. overall poor support for the process) or buy-in by select groups whose interests happen to be captured by one or more scenario.

Adaptive management as an integrating framework

The adaptive management process is also useful in illustrating how instruments and products tie together, and reveals when and where they are used in relation to the catchment vision. For example, Catchment Assessment Studies will primarily be used to inform the 'current state' component in Figure 2.1. The vision (aided by possible scenarios for the future and their possible intended and unintended consequences) assists in defining a management class for a unit of the resource, the Reserve is, and resource quality objectives are determined to support the class.

Resource water quality objectives (RWQOs) costitute planning objective that specifically apply to the water qyality component of resource quality. The determination of RWQOs is inlfuenced by the socio-economic need to utilise the capacity of the said water resource in order to ensure a healthy functioning aquatic ecosystem together with water that is fit for use by the recognised water user sectors.

Apart from providing the basis for the water quality input, once determined, to the formal resource quality objectives (RQOs) detemination process, RWQOs are a pre-requisite whan planning for water quality. The determination of RWQOs provides the basis for conducting water quality reconciliation, water quality allocations, benchmarking during water quality foresight, and the detemination of water quality stress. In addition, RWQOs also allow for meaningful water quality scenario analysis and straetgy establishment; the above-mentioned all being central to water quality planning.

Allocations are made within the framework of the set objectives, while license conditions can then be formulated and licenses issued. These management actions lead to changes and the key variables representing change (for both use and the state of the resource) are monitored. The monitoring results drive perceptions of change (and its likely 'acceptability' to water users) and this in turn influences how we describe the 'new' current state.

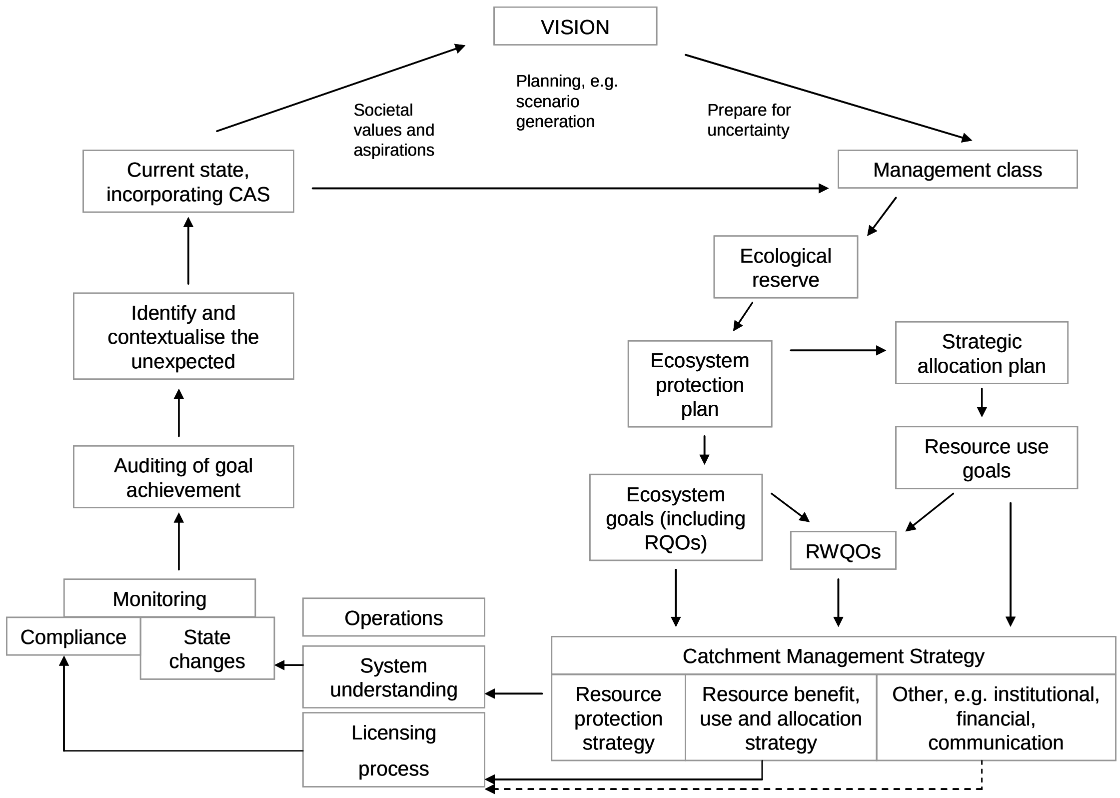


Figure 2.1: The vision relative to the whole strategic adaptive water resource management process.

SECTION 3: RATIONALE FOR CATCHMENT VISIONING

3.1 Why have a catchment vision?

What is the importance of a catchment vision to water resources management in South Africa? What does national executive policy say about it? Consider the following extracts (Table 3.1) from the National Water Act (Act No. 36 of 1998) and the White Paper on a National Water Policy for South Africa (DWAF, 1997).

Table 3.1: The National Water Act and the White Paper on a National Water Policy for South Africa spell out requirements for devolved, co-operative resource management and consensus-seeking approaches to achieve a common vision.

POLICY SOURCE	EXTRACT	MANAGEMENT IMPLICATIONS
NWA (36:1998) section 27	'water allocation must take into account 'the likely effect of the water use to be authorised on the water resource and on other water users;'	Requires consideration of the interdependencies between users and the impacts of their collective use on the resource's ability to sustain that suite of uses.
NWA (36:1998) Part 2 – Introduction	'In the process of developing the strategy, a catchment management agency must seek co-operation and agreement on water-related matters from various stakeholders and interested persons.	Requires co-ordination and communication between interest groups with diverse interests.
NWA (36:1998) Section 9 A (g)	'enable the public to participate in managing the water resources within its water management area'.	Facilitate public participation in a way that promotes consensus-decisions around resource use.
White Paper preceding the NWA (36:1998), principle 23	"Responsibility for the development, apportionment and management of available water resources shall, where possible and appropriate, be delegated to a catchment or regional level in such a manner as to enable interested parties to participate.	Devolved management. Societal participation at all levels required. Many more people and groups involved in decision-making. Needs and preferences expressed at various scales.
White paper preceding the NWA (36:1998), section 6.3.3	"Through a process of consensus-seeking among water users and other stakeholders, the level of protection for a resource will be decided by setting objectives	Consensus approach to negotiation rests on agreement on and commitment to building a common future (Rogers and Bestbier, 1997 and Sherwill and Rogers, in prep).
White Paper preceding the NWA (36:1998) – Integrated management	Integration is required between authorities and organisations, co-operatively within water use sectors, between water and other resources and the organisations and groups responsible for their management and across geographic boundaries.	The integration of diverse interest at various scales implies the need to learn and act in a co-operative manner towards a mutually agreed goal.
RDMs Integrated manual	The NWA (36:1998) makes provision for an adaptive management process and this is reflected in the way that the chapters are arranged. Adaptive management is iterative and requires that learning and experience be incorporated into each following round of management.	The adaptive management cycle relies on a vision, which provides the basis for collective action towards a common ideal (DWAF, 1999).
NWA (36:1998), Part 2 – catchment management strategies	Every catchment management agency must develop a catchment management strategy for the water resources within its water management area.	The requirement for a catchment strategy implies the need for a collective vision, since a strategy assumes movement from a current state to a defined future desired state.

Everyone contributes to resource decisions

Everyone affected by decisions must have the opportunity to influence resource-related decisions, regardless of their position in society. Within the water sector, the shift from centralised to decentralised, participatory management was driven by both growing water resource scarcity and the global and local trend of democratisation, the development of open societies, and the corresponding devolution of decision-making responsibilities.

The policy statements in Table 3.1 plus the South African Constitution (Act No. 108 of 1996), reflect this thinking and promote the paradigm shift by requiring devolved and democratic participatory decision-making with regard to the use and protection of water resources. In addition, the Department of Environmental Affairs and Tourism, through the National Environmental Management Act (Act. No. 107 of 1998) promotes co-operative governance (see Chapter 3), a right to healthy environment, and public participation in the allocation, use and management of the natural resources.

A vision aligns diverse interests

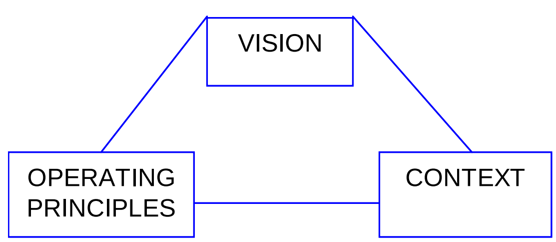
Devolved, demand-side management requires water resource managers to manage diverse interests in, and use of, the resource (i.e. demand) in such a way that the water resource is able to continue providing the desired services (i.e. supply) to society in the long-term. This is a radically different approach to managing aquatic resources from that which is currently practiced.

The vision fosters confidence in the new way of managing the water resource by providing an opportunity for needs and interests to be articulated. The needs and interests are used to construct the vision, which is in turn used as a point of departure and a point of reference throughout the process of adaptive change (MacKay *et al*., 2003).

Managing for the delivery of desired ecosystem services

Demand-side management of a scarce natural resource requires that decisions should be driven by a process that balances societal needs and preferences. Many diverse needs and preferences for our scarce and vital water resources can only be accommodated within a framework of a common vision. The vision is the first step in directing thoughts and action on how the water resource should best be shared. In this way, all types of water resource uses and their impacts are mutually agreed to be acceptable and compatible so that, together, they drive the change process towards achieving the vision.

The change process strives towards attainment of a desired future condition of the resource that reflects a more desirable balance between water resource protection and water resource use. The diagram below shows how context and operating principles can be used to guide the development of a vision. **Context** refers to relevant circumstances, and



operating principles refers to the values or ethical constraints we use to guide our aspirations. This shows that a realistic vision depends on circumstances and on the values which we choose to guide our actions.

Appropriate time frame for a catchment vision

The diagram also suggests that changes in society (changes in context and values) and the rate of change might affect the time frame across which a vision might be stable, but still acceptable. Since the stability of the vision depends on society's operating principles (i.e. 'rules' which are outflows of values) and the context (i.e. circumstances), the vision should be modified whenever principles and context change appreciably. For example, the move to a democratic government in South Africa has changed society's operating principles dramatically so as to achieve equity and sustainability. Thus a new vision for water resource management is important if society wishes to buy into the new operating principles.

A vision must therefore be sensitive to changes in operating principles and changing circumstances, but it should be stable enough to carry a community through one or more adaptive management cycles so that society has sufficient opportunity to do and to learn. It is difficult to put an exact time frame on when visions should change, but they should probably be revisited at least every five years if not more frequently. Ideally, revision of the catchment vision should happen in parrallel with the revision of the Catchment Management Strategy.

The vision, equity and sustainable development.

At the heart of sustainable development lies questions around what is to
At the heart of sustainable development lies questions around what is to
be sustained, over what temporal and spatial scales, what values (for example equity, efficiency and sustainability) society chooses to balance against one another, and by what process this should be done. This is dealt with in some detail in the Policy on the Resource Directed Management of Water Quality.

The debate on sustainable development has been largely around how to define sustainable development in general and to describe the general goals and biophysical thresholds by which it should be measured (Lele and Norgaard, 1996; Humphrey *et al*., 2002). The issue of the roles of policy and science within this debate has been contentious. This is not surprising, since it has been a popular assumption that scientists and policy-makers are equipped to design generalised statements about what sustainability is at various scales and to make appropriate decisions, on behalf of others, about how the users of natural resources value natural resources at the scale of their use.

In reality, the way people value their natural resources is highly specific to local context and conditions, though often influenced by impacts originating remotely, which means that the process of defining sustainability should be driven by a grounded, bottom-up approach in which society is assited in the process of eliciting and organising values. As Lele and Norgaard (1996, p. 363) put it: "Rather than impose their own perceptions of what should be sustained and for whom, for how long and with what certainty, it would be less destructive for science and more productive for the policy process if scientists allowed these value judgements to emanate from society". The visioning process is precisely designed to give effect to the notion of bottom-up value expression.

Although it is true that some values become less visible in the process of organising and aggregating values for management, the process should at any one time, reflect the perspectives of all those who are to be affected by the decision and its outcomes. This process holds much potential for conflict, since the water resource is in many cases over-utilised. It will for example require the balancing of competing needs and compromises over redistribution.

The vision-setting process strives to promote equity by incorporating all user aspirations for the resource. Visioning promotes equity by fostering good inter-stakeholder relationships and thereby respect, trust and legitimacy of (and therefore continued support for) the process. Once equity is reflected in the representation as well as in how the participatory process is run, stakeholder discussions about values such as optimal use (efficiency), equity and sustainability, and how these should be balanced, will be legitimised.

South African water policy intends for the water resource to be used to adVance social and economic development and to do this through an adequate balance between protection and use of the water resource (Sherwill *et al*., 2003). A vision is a consensus-derived statement of intent on how to balance water resource use and protection towards achieving sustainable development.

But, the term ‘sustainable development’ is too broad to be of practical use in most circumstances. On a practical level, society’s needs must be considered, resource limits of supply must be considered and these are dynamic over both space and time. If sustainability means achieving an acceptable balance between resource protection and resource use, then this complexity and variability must be dealt with at the local level first, in our efforts to promote sustainable development.

Our interpretation of sustainable development within the context of integrated water resource management in South Africa has yielded some useful pointers:

- It is the intention of policy that the balance between use and protection must be reached by participation and consensus. Stakeholders tend to think in terms of the benefits and costs of water resource use options to themselves and to their broader community. In other words, they will not think in technical terms such as the Reserve or water resource quality objectives, but rather in terms of goods and services provided by the water resource and the costs and benefits that are associated with those.
- It is useful to view water resource use and water resource protection within the same conceptual framework. The alternative (i.e. the uncoupling of protection and use) leads to a tendency to pitch development against protection, which is clearly not the intention of policy (Van Wyk *et al*., 2006a).

Making sustainability practical through the vioning process

The objectives hierarchy that stems from the vision, provides nodes or areas for detailed discussions around what might constitute an acceptable balance between protection and use.

A discussion around the meaning of sustainable development helps to contextualise sustainable development in terms of water resource use and management. In doing so, it helps us get down to some of the specific requirements (e.g. balancing water resource use and protection) of progressing towards sustainable use and development. It also places emphasis once again on the importance of public consensus around use patterns and use levels and the resource protection that is required to support the agreed upon uses. This approach agrees well with the principles of sustainability as put forward by the Rio Declaration on Environment and Development in 1992, namely equity, futurity, ecological integrity and participation.

Approval of a vision

Since the vision is an expression of values, it is not something that is 'right' or 'wrong' and therefore does not lend itself to formal approval. However, it can be deemed appropriate, but only by those who stand to gain or lose from it. As custodian of the resource, it will be the task of Department of Water Affairs and Forestry (DWAF) and the CMAs, not to 'approve' or 'sign off' on any one vision, but rather to approve of the quality and legitimacy of the process that underpins its development and implementation.

SECTION 4: CATCHMENT VISIONING AND RDMWQ

A licence must reflect consensus

It is important to ensure that the process of water resource allocation reflects a holistic catchment management philosophy. A holistic and integrated approach is important because the services society derives from aquatic resources are complex and integrated and are not easy to distribute fairly. Interest groups must define and agree on what constitutes an acceptable suite of water allocations given the overall requirement for equity, efficiency and sustainability.

Water allocations and the conditions associated with them (given effect through the authorisation of water use) must reflect society's collective decision about the appropriate level of water resource protection that will lead to the delivery of the desired set of water resource-based services. In other words, water allocations (and use) should give effect to the collective vision. If they do not, then resource protection and use will be disconnected from societal consensus and is therefore without context. In such circumstances, powerful groups will promote their own interests, leading to inequitable use and, in many cases, monopolising and over-utilisation of the services provided by aquatic ecosystems.

A licence is an administrative end-point of a social process

Water use authorisation (which includes licensing) is an administrative process, ultimately approved by the minister, to legitimise resource allocation. Water resource allocation, for reasons explained above, is a social process of ongoing dialogue and the balancing of levels and types of water use, in a constant effort to achieve an equitable, efficient and sustainable distribution of costs and benefits in society. Licence conditions, the resulting resource use patterns and the resulting state of the resource, must therefore collectively reflect the catchment stakeholders' consensus-decisions around allocation. However, these perspectives must be informed by visions and needs from other scales and other perspectives, notably that of the Department of Water Affairs and Forestry. Government is guided by minimum requirements for resource protection for example through the classification system. In this way, the Department's custodianship of the relationship between resource protection and use is supported through legal means.

A water quality vision supports a catchment vision

Although water quality managers are mainly concerned with the water quality aspects of water resource management, it would not be wise to set a water quality vision, before setting a catchment vision. The visioning process described here is a vision for society's relationship with the water resource in its entirety, i.e. the aquatic system, within a defined geographic space, and what it provides to society. It is not a vision specific to water quality management only, although the catchment vision, when disaggregated into management objectives, will expose water quality specific objectives.

Chain of accountability

The objectives hierarchy ensures that operational objectives descend directly from the vision and, in this way, provides a pathway of accountability for both the water resource manager as well as civil society, since everyone participates in the generation of, and agreement on, the vision. Water resource managers can hold resource users accountable to their vision and the actions supporting it. Water resource users can hold water resource managers accountable to operational actions in that they must contribute to the collective vision.

SECTION 5: APPROACH TO CATCHMENT VISIONING

The process must reflect its intent

The 'low confidence' visioning process suggested here mimics the full participatory process. The difference between a 'low confidence' and 'high confidence' or full process is not what is done, but rather the intensity and inclusiveness of the process. For example, a single person in a regional office can follow the process suggested here and come up with a catchment vision and an objectives hierarchy.

Similarly, a regional manager can engage a group of key stakeholders in the process or the same process can be followed with many stakeholders. The amount of and the level on confidence in catchment related information obtained through CASs may increase the confidence of the vision. The difference lies in the intensity and inclusiveness of the process, how confident people are in the validity of the process and how acceptable the outcomes are perceived to be. The aim of the visioning tool is partly to sensitise facilitators of the process (e.g. regional managers and Catchment Management Agencies), to the intent and principles of catchment visioning as a process that should ultimately attract full stakeholder participation.

Existing participatory fora in a new context

In many areas of the country, catchment fora and similar interest- and action-oriented groups have been in existence for several years prior to the promulgation of the 1998 National Water Act.

As a result, some areas may already have a fairly robust participatory process, perhaps requiring more inclusive participation, but already having a culture of articulating issues, discussing possible solutions and implementing actions. Such fora are in a good position to support the intent of water and environmental policy through the visioning process.

One of the shifts in thinking required would be for stakeholders to think and talk about, not only their issues and the solutions to these, but about how these issues affect and are affected by others that use the same resource. It requires participants to broaden the scope and context within which their issues and actions happen, thereby recognising that people are co-dependent on the resource.

But, it will be important to always use issues as a point of departure in the participatory process. People are much more motivated to talk about issues that affect them directly, compared to abstract aspects such as 'planning' or 'vision'. Imagine being invited to a meeting which aims to 'address your pressing issues' compared to an invitation to a meeting to 'plan a collective future'.

The latter generally does not excite people immediately – at least not until they can connect their particular issues to that future. Section 6 describes how issues are used to generate a collective context for formulating a vision.

A desired future condition

The process is based on an opportunity to define a desired future condition of the resource. Associated with this condition is the basket of goods and services that people need and want, and therefore also involves defining the appropriate levels of protection and use that will support the desired provision of resource goods and services. A future-focused approach prompts people to think about their collective future instead of being bogged down by past and current conflicts. This process is therefore concerned with creating a non-confrontational environment for defining a desired state and then identifying the operational steps that are required to promote progress towards this 'desired' future.

Visioning is iterative

The process provided here allows a regional office to start with a 'low confidence' vision and then to integrate the iterative visioning process with the continuous development of a stakeholder base (Figure 5.1). This approach recognises the time it takes to build a stakeholder base, against the current pressure and need to make decisions for water allocation. Initial decisions will then at least be informed by a low-confidence vision, that can be used in a systematic way and with an accountability pathway built into it.

Once a vision and associated goals are constructed, it should be taken to stakeholders who will be able to provide constructive comment on both the outcomes of the visioning process but also on the process itself. The vision can be revised following these inputs and used while the stakeholder base is built and empowered to provide inputs into the next round. With each round, confidence in the process and the acceptability of the outcome is enhanced. Confidence and acceptability will improve with an increasingly inclusive stakeholder base, improved information and a trusted process. Even though confidence and acceptability may be relatively low to start with, the process allows and promotes starting, despite imperfect knowledge and an incomplete stakeholder base. In this way, management can make the most informed decision possible at the time with a process that allows them to demonstrate accountability for the decision.

When a regional office takes a 'low confidence' vision, which was set without much public participation, to stakeholders, it will be important to encourage stakeholders to generate their own vision and for the regional office manager to use the 'low confidence' vision as a guide only. Do not try to make stakeholders accept the 'low confidence' version of a vision. The result will inevitably be one of conflict with stakeholders who will not buy into something they have not generated. Rather ask them to critique it according to what they perceive as the strengths and weaknesses of the vision (Figure 5.1).

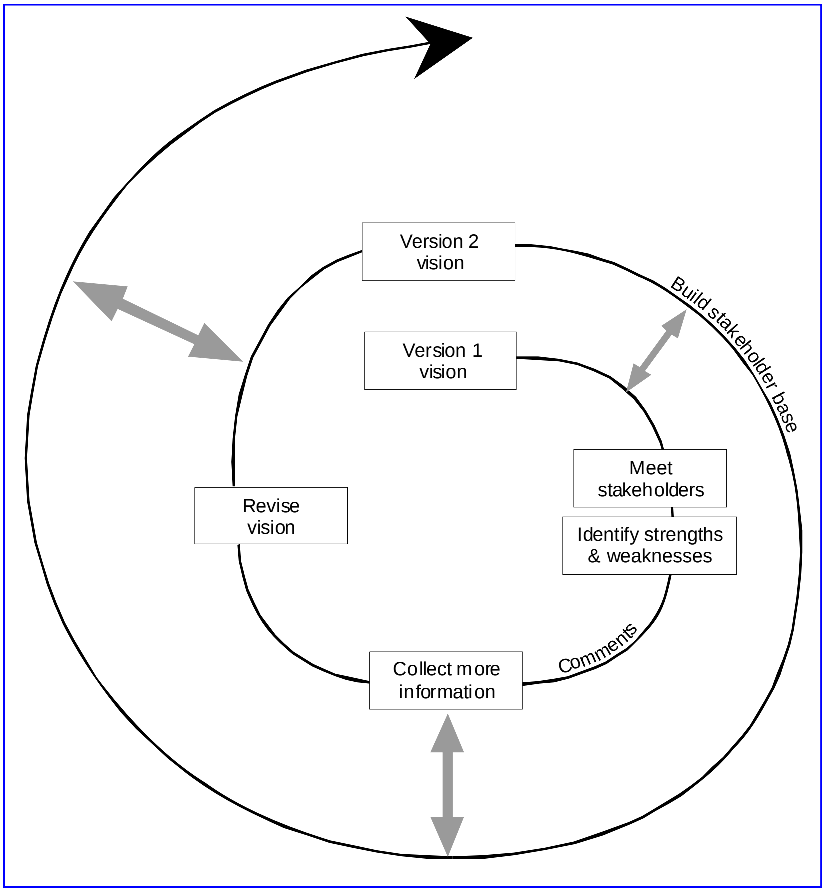


Figure 5.1: The relationship between a vision and the concurrent development of a stakeholder base. The thickness of the arrows represents degree of confidence in and acceptability of, the vision.

Importance of context

The vision is always situation- or context-specific. This means that the suggested process is strongly based on an understanding of the condition of the ecosystem (i.e. the water resource) and of society within a chosen area. A catchment vision that is not embedded within a specific context, will not reflect the social or resource circumstances of the area and thus will not promote buy-in or encourage the dialogue necessary to stimulate consensus-based agreements between different water resource users.

Baseline information to inform the context

Collect map/s, schematic or graphical representations of the catchment and information on the resource and social dynamics.

Describe the water resource template: major vegetation types, topography, etc.

Describe the water resources (major rivers, wetlands, groundwater and estuaries). Amongst others, consult Internal Strategic Perspectives, the catchment assessment study (CAS) report and National Water Resource Strategy, State-of-Rivers reports and Reserve determinations.

Describe how people are distributed and use the resource; identify land use types, e.g. use land cover and other types of maps. Use river conservation planning outputs to inform an assessment of the current state of the resource or as an indication of what the future conservation status should be. Generate familiarity around how each land use may affect integrated water resource management.

Describe interest groups that relate to the water resource – statutory and non-statutory organisations and also informal interest groups. Note that interest groups are not necessarily only resident in the catchment. Examples are academic institutions, trans-boundary / international neighbours. Take care to include interest groups that are not as well organised as other well-resourced sectors (i.e. the more visible and obvious ones). Sectors rarely encompass all interest groups, e.g. consider special interest groups e.g. fly-fishing clubs.

Describe the water resource goods and services of interest in the chosen area. Lists of existing lawful uses of the resource can be used as an input into this step. It may be useful to define these in terms of ecosystem services, as it is likely that this terminology will be widely understood by all users and interest groups. These uses should include not only water use, but use of all or any components of the aquatic ecosystem. Access the DWAF database of registered water and river users. This will help provide an indication of the types of goods and services currently used and valued by users.

Use Catchment assessment studies to create baseline context

In order to generate a vision, an idea of a preferred future, it is necessary to be somewhat confident in knowing what the current state of the water resource is. Because visioning is about a future to be shared by all water users, it is equally important to understand the current state in terms of user perspectives of the resource, and how they are organised and empowered (or not) to contribute to water resource sharing and management.

Catchment assessment studies are a good resource to help with the gathering of information about the current state for a catchment area and its people. Refer in particular to Part 2 of the Guide to Water Quality Catchment Assessment Studies. This document provides extensive guidelines to accessing information ranging from the biophysical attributes of a catchment and water resource to water quality patterns, administrative attributes, policy requirements, resource use and conservation, information about stakleholders and their affiliations, institutional arrangements and local, regional and national development plans and projections for future water use (DWAF, 2003).

Important caveats about information gathering

Caveat 1: A lot of information is available on various aspects of water resources and at various scales. The DWAF (2003) report on catchment assessment studies attests to this. It is not necessary to have all of that information in hand before starting a visioning process. In other words, do not wait until all information is in place before starting the visioning process. The adaptive approach espoused by the National Water Act acknowledges that management can and usually does proceed with imperfect and incomplete information (Rogers *et al*., 2000). An iterative, adaptive process allows for ongoing learning and for the incorporation of new information and new insights along the way. Waiting for a perfect and complete information base before starting, is likely to paralyse efforts to promote change.

Caveat 2: Most of the information that is available for catchments is technical information that has been compiled by engineers and biophysical scientists. While this information is important and necessary for the process, keep in mind that catchment and water resource allocation, sharing and management are social processes. Thus care should be taken to not allow technical inputs to dominate the process, simply because there is a lot of technical information available. Technical and scientific contributions must serve a social process of consensus-building around human preferences and values as they relate to the water resource (Van Wilgen *et al*., 2003). Integrated water resource management is intended to be a people-centered process. If facilitators of the process commit to this simple assumption, then caveat 2 is taken care of. Those who benefit by and / or bear the costs of resource use are the most valuable sources of information, knowledge and perceptions.

Interaction between visioning, class and RWQOs

The Department of Water Affairs and Forestry is responsible for a process for determining the Management Class (the classes being defined as Natural, Moderately used/impacted and Heavily used/impacted) A Management Class (a statutory requirement) represents a vision for a significant water resource, for example a river-reach. The water resource classification system provides for consistency in the description of management classes, or desired states. Each management class represents a permissible but different balance in the types and magnitude of water resource use and the mix of associated costs and benefits.

The Department is also tasked with ensuring that Resource Quality Objectives (RQOs) and Resource Water Quality Objectives (RWQOs) are derived from the Management Class. RWQOs refer to the water quality component of the Resource Quality Objectives, and they are thus a sub-component of Resource Quality Objectives. “RQOs are numerical or descriptive statements of the conditions which should be met in the receiving water resource in order to ensure that the water resource is protected” as referred to in the RWQO Guidelines. The Management Class, RQOs and RWQOs are derived via a systematic technical process.

How does visioning and the objectives hierarchy relate to these statutory instruments and objectives? How much weight should be attached to the technical instruments and their derivation compared to the participatory visioning process?

To make these decisions, there are two basic principles to follow:

- **Principle 1: visioning can work in the absence of technical instruments.** The power of the visioning process lies in being able to derive operational management objectives that can be drawn back directly to the catchment vision, thus making the objectives and their outcomes answer to the expressed human aspirations for the water resource. . Thus, even in the absence of a Reserve determination, Management Class, RQOs and RWQO, the visioning process and objectives hierarchy will still provide a means to articulate the objectives of stakeholders (Rogers and Bestbier, 1997).

- **Principle 2: Public participation is critical for designing objectives in highly contested resources, but a more technical derivation of objectives must assist where public participation is weak.** The way in which the outputs of the visioning process should be used in conjunction with the technically derived instruments depends on the level of confidence required for the water resource allocation, and the extent to which the articulation of objectives can lean on the participatory process for a defined area. If the confidence in, and acceptability of the vision and visioning process are low (i.e. an immature participatory process), the management class derived via the technical process will carry more weight. By the same token, the visioning process should have an increasing influence as stakeholder needs and values are required for decisions, especially in highly contested situations.

For a while to come, most areas in South Africa will have a situation where there will be some degree of public engagement plus some capability for supporting objective-setting via more technical means and instruments. This mix in capability will vary over time and space. Figure 4 and its related text addresses this relationship to some extent. Public engagement in the resource management process should strenthen over time. But in the meantime, how do we integrate the outcomes of the objectives hierarchy with the technical instruments available?

As mentioned, the Objectives Hierarchy can function in its own and deliver detailed objectives releVant to operations management. But for integration purposes here, the lower level descriptive objectives of the objectives hierarchy can be used to inform the setting of the Management Class. The objectives hierarchy will deliver many different kinds of objectives. In Figure 1.2 for example, the lower level objective there relates to an issue of human health (faecal contamination) that is dependent on water quality. Some objectives from the hierarchy will relate to improved institutional needs, some to enhanced co-operative governance, some to resource protection, some to resource use and the benefits derived from resource use. The objectives that relate to the state of the resource plus those that relate to user needs can be ‘extracted’ and inserted into the more technical categories and process described in the RWQOs Guideline. Resource quality categories plus user needs categories are then used to generate the Management Class.

SECTION 6: GENERATING A VISION

Figure 6.1 shows the steps for generating a vision and disaggregating it into component objectives.

Generating a vision

The function of a vision is to mobilise change from the current resource condition towards a desired future water resource condition. Because this process has implications for the goods and services provided and also for the associated costs and benefits, the process is as much about social change and negotiation around what people value, as it has to do with the condition of the water resource.

Thus, a vision provides a continuous 'pull' towards what is expressed as an improved water resource and societal conditions. But what does 'continuous improvement' mean? It means the continuous enhancement of societal well-being and economic development as supported by an ecosystem state that is continuously being enhanced in terms of its capability to support shifting/dynamic societal needs and preferences. Therefore a vision and its sub-components can be expressed in terms of what society demands of the water resource, and in terms of the ability of the ecosystem to supply goods and services to support the demand. A robust vision will therefore be based on the integration of values and preferences that are societal, technological, ecological, economic and political in nature. Coupled with this is the need for continuous improvement of the management systems and processes that move the resource management process forward.

The nature and legitimacy of the process are important

This guideline is based mainly on Rogers and Bestbier (1997) and Van Wilgen *et al*., (2003). The Rogers and Bestbier report provides a scientifically rigorous process for disaggregating a desired future state into component management objectives, while the Van Wilgen study shows the appropriate principles and processes to be followed in a multi-interest, multi-sectoral stakeholder environment. Both studies show that with a visioning process, **the nature of the process is as important as the outcome of that process**. If the process is fair and inclusive, allowing stakeholder views and interests to be respected and incorporated, support for the outcomes will tend to be a natural outflow of support for the process and the way it is conducted.

Visioning is like a journey

An analogy of a vacation journey describes the visioning process quite accurately. The journey has three important aspects, namely the vision (the vision is to have a good vacation), the road rules (i.e. the guiding principles) and the road map (i.e. the context). As we start out, we might discover picturesque and enjoyable side-routes. What this means is that our understanding of the context changes and grows as we travel and encounter real-world siuations and options; and we may adjust our route to achieving the vision as our understanding of the 'map' changes. Also note that the vision is not only only the way to get to destination x, but to have an enjoyable vacation. We may want to rethink the destination as we go along according to what we achieve along the route and based on our understanding of what we want and need, i.e. our understanding of the vision.

Golden rules of the process

Some so-called "rules of thumb" guide the entire process and, if ever a group or facilitator feels they are 'stuck', they should return to the following basics. Ideally, these aspects should be cross-checked at each step of the visioning process:

- As you begin to explore a new aspect of the process, get everyone to put their cards on the table **before** trying to promote agreement on **issues**. Ask each person to say what they think are priority issues and should be priority uses of the water resource in the catchment. Write each one down for everyone to see. Take care **not to debate** the issues as you get them, as this could lead to fights. **The point is to get all the issues out** visibly so that stakeholders can view them as a collection of catchment issues and to note that these issues are interdependent and collectively belong to the catchment community;

- Two golden rules for everyone to follow are: (1) no-one's perspective counts less than another. The facilitator may ask for clarification of what someone means but the most important point is to accept a stakeholder's perception of an issue; and (2) you are more likely to get what you need by helping others get what they need. People can only see each other's issues and realise interdependencies through a collective process. These two rules underpin a consensus-based approach to joint decision-making and reduce conflict;

- Discuss the collection of perceptions to ensure people understand them and their implications. Do not try to reach agreement on them;

- Synthesise the ideas by grouping like ideas into fewer statements and recognising conflicting ideas; and

- Do not prioritise, as the process is designed to filter out incompatibilities. In other words, less important things are filtered out automatically through the process because people begin to focus on the important few they can and are willing to deal with.

STEP 1: Select a geographical area for the vision.

Purpose

A vision must correspond with some defined geographical area. This defined area must make sense in that it should capture a sufficient diversity of interests in the resource to generate incentives for the interest groups in question to work together towards a common objective.

Process

Divide the WMA into components and sub-components that will make sensible units for visioning. A whole WMA may be too large for all users to relate to the same vision. On the other hand, a whole quaternary catchment might be occupied by one land use and say 3 landowners. It would also not make sense to create a vision for that group because they may not have any reason for collective action.

<u>Guiding selection criteria</u>:

- Catchment boundaries, especially secondary and tertiary. However, this is not prescriptive. It may make sense, for example, to expand the choice of area for a vision beyond a catchment boundary to capture one or more interest groups that has an impact on, or interest in the resource within the catchment in question.
- Try to capture within the geographical area for visioning, a diversity of users and interests. (Be careful to not focus only on consumptive use! - interests may be based on scenic benefit or recreation, i.e. non-consumptive use of the water resource is also a 'use' because it accrues to benefit).
- Try to capture as large a degree of interdependencies as possible, since interdependent use requires people to enter into conversations with one another. This is important because the conversations around use and balancing use types, once they gain momentum, tend to drive the decision-making process.

- <u>Prioritise which areas must be dealt with first</u>:

Guiding questions are:

- Which area has the biggest backlog in the water allocation process?
- Which area has the most important backlog in the allocation (licensing) process? For example, one area may not have many license applications waiting to be processed, but may have one or two users that are desperate for finalisation of allocation in terms of their livelihoods, or business processes.
- Identify the areas where the (societal) demand and (resource) supply situation is such that the resource is stressed, i.e. it is unable to supply the current demand of a suite of services in a sustainable way. Indicators of this may be the expression, by users, that they are unable to derive the services they require, and / or other signs of this, i.e. a state of the water resource that cannot satisfy even the current need for services. Instruments or information that can assist with this is for example information from the Internal Strategic Perspectives process. The National Water Resource Strategy will also provide information to support this decision.

Principles

The main principle here is to capture a diversity of interests and interdependencies within a sensible geographical area, so that the vision will be (1) relatable to the group of interested parties, and (2) combine a critical mass of diverse and competing interests to drive a need for co-operative behaviour around balancing use types and levels.

STEP 2: Prepare material

Purpose

To ensure that relevant materials for STEPS 6 to 11 are available. Much of this baseline material should be collected earlier (see section 5: Approach to visioning). This step serves to revisit that information and to identify gaps in information that may be addressed so that more relevant information is available in the following iteration of the visioning process.

Process

Collect material that is relevant to and that will support STEPS 6 to 11 of Figure 6.1. An example of a bundle of information for generating a catchment vision for a chosen area is given in Section 5. Note that while written information relevant to the catchment and its stakeholders will help to provide background, some of the most important information lies in people's expressions of their needs and preferences as they relate to the water resource.

For many catchments, a lot of technical information will be available, for example through Catchment Assessment Studies. Organising this information into a useful format for generating say, a managers' first pass perspective of what is currently happening or has historically happened in the catchment, may be a daunting task. There is also a need to link this catchment information to considerations for overall sustainability, including social and economic considerations together with ecosystem aspects. Structuring this information into useful categories of catchment observations and using sustainability indicators in conjunction with current state data to come up with scenarios and possible trajectories of change for the catchment and for the resource in the future, warrants another study and is beyond the scope of this guideline. However these sorts of syntheses of assessments will become increasingly important. They are needed not only to help make an educated guess as to possible visions and resource quality objectives, but also to assist in probing how the current state and possible trajectories of change might influence the future.

STEP 3: Set up workshop and facilitator

Purpose

To set up a workshop, identifying individuals to participate and to identify and involve an appropriate facilitator.

Process

- Organise a workshop with regional office staff. Also involve, wherever possible, regional folk from other releVant government departments and local government (in particular those who are involved in Integrated Development Planning) and knowledgable stakeholders.
- Select people who are likely to bring to the workshop diverse perspectives and experiences, i.e. people who work with different aspects of water resource management, operational managers and higher-level managers, people working at different scales. It will be important to involve key stakeholders because they have knowledge and experience of what happens on the ground.
- Be careful to avoid bias towards any one water user sector and to not only choose like-minded people, i.e. people who tend to agree with each other most of the time.

- Invite an appropriate facilitator. During this phase of growing an understanding of how a vision should be generated, it will be essential for the regional team to make use of a facilitator who has a good grounding in the intent and process of catchment visioning as it relates to integrated water resource management.
- Remove the team from the usual office environment for the duration of the workshop. Try to hold the workshop in a place that stimulates creative thinking.

Principles

The facilitator's role in the visioning process is critical, because he or she is not simply the driver and regulator of the process, but can also influence the spirit by which the process is conducted. (See Sherwill and Rogers, in prep., for more detail). It will be easy to follow a process as set out by the National Water Act and related policy documents, but this could fall far short of the intended outcome. The following principles of facilitation promote a workshop environment that is aligned with what we understand the intended outcome of the National Water Act to be.

- Facilitators must strive to create an environment that promotes new insights and shared understanding. This means that each perspective must be respected and given a fair chance of audience.
- It is the facilitator's responsibility to ensure that discussion is inclusive. Contributions must be heard from all participants and the discussion should promote a leveling of the playing field (i.e. promoting equity). This will only work well if the workshop team has done good homework around discovering the full suite of interest groups in question (See Annexure A for an example of a stakeholder list for a process aimed at the level of a tertiary catchment).
- Co-evolution of perspectives and interests toward consensus can only take place in an atmosphere of mutual trust and openness. This approach encourages disclosure of interests and agendas and this is critical, since the balancing of different types and magnitudes of water resource use between water resource users will only be sound if they incorporate and reflect the full suite of interests. This issue is probably more releVant to the full participation process, but the principle should be followed even with the initial process with fewer participants.
- The facilitator needs to keep interaction and dialogue between participants constructive. Strive to achieve consensual agreement (it requires that participants have a willingness to change their perceptions in response to hearing the perspectives of others) rather than promoting counter-arguments to produce a 'winner'.
- Facilitation must be aimed at keeping the attention of participants' focussed on the future. Looking to the future gives public participation positive purpose. Shared medium- and long-term objectives enable participants to find common ground in the presence of often conflicting perceptions about the present.
- The process must be given as long as it needs. An important aspect is for the facilitator to keep the process true to the guiding principles (see STEP 5) and to maintain a balance between getting the issues exposed but keeping within a reasonable time frame.

STEP 4: Find and consider an existing vision

Purpose

If any form of vision exists for the defined area, or for any sub-area, the team should make use of the vision and also of the material and knowledge that were gathered to derive that vision, as far as this is possible and appropriate. Not all forms of vision will have been developed with this particular process in mind, but there will be much value in drawing from the insights and knowledge of other visioning processes and products, in particular for the phase where the team develops a joint context (See STEP 6).

Source visions at levels other than for the catchment in question but which might have bearing on the catchment in question. Examples of this might be Integrated Development Plans (IDP), Spatial Development Initiatives and national level goals. National level goals will often be couched as overarching principles (see Section 3). Consider how such visions for the future may interact with the catchment vision and try to involve representatives of those visions in the catchment visioning process. Attempts to achieve synergy between different user and use type visions (i.e. individuals and sectors with diverse interests), different levels or scales of visions (e.g. nested catchments) and different types of visions (e.g. IDP and catchment visions) forms the basis for co-operative governance.

Process

Consult relevant people to find out if one or more visions exist for the area in question or for adjacent areas, or for areas that may be nested within the chosen area. Most often this will be DWAF regional (catchment forum visions) and national offices, but also consult the regional Department of Environmental Affairs and Tourism and conservation authorities.

Examples:
- Existing water resource planning processes: e.g. Plettenberg Bay Catchment Management Planning Process, Kruger National Park management plan
- Spatial Development Initiatives
- Strategic Environmental Assessments (SEAs) and plans
- Integrated Development Plans (IDPs) (source: local government)
- Visions generated by other catchment forums

If the process followed to derive other visions clearly had the same purpose and context as this process, and circumstances have not changed since it was developed, then make use of these vision/s. Sector-specific visions are typically not suitable to use because they will not encourage buy-in and ownership from catchment stakeholders and thus cannot provide a sound basis for collective action.

Principles

In order to ensure equity, use an existing vision if:
- It is based on diverse stakeholder/interest group input and is not biased toward any particular water user group;
- If the vision was generated recently enough to capture at least the majority of existing interests in the water resource;

Otherwise, generate a 'low confidence' vision according to STEPS 5 - 7.

STEP 5. Agree on guiding principles

Define principles

Identify the principles that will guide planning, decision making and management for the desired state. These principles describe the core values of the community involved and are used as the 'rules' to which everyone will adhere to while developing and moving towards the desired future. They should be used as checks and balances at each step of the objectives hierarchy development process. The box below provides examples of guiding principles chosen by a set of catchment stakeholders.

EXAMPLES OF GUIDING PRINCIPLES (from WRC project, see Van Wilgen *et al*., 2003)

Holistic/integrated: A shared resource requires a common vision and co-ordinated action

Co-operative governance: Working partnerships must be created both vertically and horizontally

Equity: There should be equity in access to the resource, and the distribution of costs and benefits; Revenue should be generated from all who benefit from management of the resource.

Efficiency: Management and administration processes should work towards speedy and efficient service delivery.

Empowering civil society: Civil society should be informed and active; the importance of a bottom-up approach must be recognised; a sense of shared ownership and responsibility must be created.

Adaptive: Policies and processes should be able to improve with experience; the CMA and all levels of stakeholder representation should be transparent, accountable and challengeable.

STEP 6: Generate collective catchment context.

Purpose

The purpose of STEP 6 is to generate a shared understanding of the current state of the area in question. This provides the context for envisioning the future. **Current state does not refer to the state of the water resource only, but also to the current state of societal issues and values affecting patterns of water resource use.**

This step builds common understanding, within the visioning team, of the current state of the water resource, and of the people whose well-being depend on it and what goods and services they value. It allows the catchment visioning team to adopt a perspective as though they were the collection of interest groups.

The information generated by this step relates strongly to the Catchment Assessment Study (DWAF, 2003), a process used by the Department of Water Affairs and Forestry to understand the current state of the catchment so that this knowledge adequately informs the desired future state.

Process

This step relates strongly to the 'golden rules' of this Section. When the meetings start to involve stakeholders, encourage them to descibe their water resource issues. This will provide a description of the context as stakeholders see it. Together with water users, develop a shared understanding of the context of the chosen area, its people and their water resource issues at local, regional, national and international levels and at ecological, technical, socio-economic, governance, policy and legal levels. This step requires considerable brainstorming, knowledge of the literature, local conditions and policies, governmental policies and international agreements. This step will lean on the baseline information collected in STEP 2.

- Help water resource users to express their issues. Good questions to start with are: why are you here? What are your water resource issues?
- Identify, if information is available, services provided by the water resource in the past. Stakeholders often want these restored.
- Identify interdependencies between interest groups. Water resource users are interdependent when the access to, and use patterns of, the water resource by one stakeholder affects another. The point is that users are often unaware of these. Part of the objective of discussing and building context is to make these interdependencies explicit (see Table 6.1).
- Identify, broadly, the strengths and weaknesses of the system. Develop a sense of trajectories of change. Typical questions may be: Does any aspect of the water resource or people's relationship with the water resource seem to be improving or deteriorating? Why? What was the water resource like and how has it changed over time?

Discussion about these aspects (without focusing too hard on the details) will prompt participants to place their perceptions of context on the table.

- These steps are simple, but an important outcome is the joint understanding that encourages the catchment visioning group to new insights of how other people view and use the water resource.

Table 6.1: Example of interdependencies for a hypothetical catchment.

Interest and beneficiaries	Aquatic ecosystem services	Impacts on other users/interested parties	Impacted on by other uses	Notes about interdependencies
Fly-fishing in river headwaters (Fly fishing club)	Trout fishing and scenic beauty	Access to certain parts of the main stem river headwaters restricted or blocked.	Harvesting activities of upstream forestry affecting TDS and trout survival. Sawmill settling ponds discharging into river – water quality impacts.	River water turbidity at times of timber harvesting seems to be the impact of greatest concern here.
Scenic beauty and safety of resource. Town inhabitants and tourists	Attractive riparian zone and close contact with this through picnic sights on river bank.	None	Upstream sewerage works not well managed and spills occur at times.	Spills are sporadic but safety issues (high *E. coli* levels) warrant high priority attention to this issue.
Irrigation water (adequate quality and assurance of supply) for subtropical fruit production.	Water provision.	Affects flow and quality of water use by downstream irrigators. Downstream protected area with RAMSAR wetland dependent on flows downstream of irrigation.	Affected by upstream water use by forest plantations. Some farms affected by upstream sewerage spills.	This is both a volume and quality issue. Flow levels noticeably higher during dry season since forestry removed plantation tress from riparian zone.
Informal agriculture – growing madumbi's in riparian zone.	Moisture in riparian zone soils; medicinal plants.	Unknown.	Probably all upstream water use.	Need better information on this use type to understand interdependencies.

Understanding interdependencies assists allocation decisions

A structure such as that shown in Table 6.1 will indicate which groups are directly dependent on the water resource for their livelihood, and which groups are more interested in the water resource from a purely economic or business perspective. It should highlight non-consumptive use of the water resource, an aspect of water resource use that is often overlooked when categorising use according to sectors. (These aspects relate to ensuring equity and, through equity, ensuring sustainability). The table encourages the team to start thinking about interdependencies. It will be these interdependencies (both their nature and their magnitude) that will most likely drive decisions around general authorisations, and license conditions.

How to ask questions

The way questions are posed to expose perceptions and issues is critically important to encourage responses that are meaningful to the facilitators but that will also build confidence in stakeholders that they are being heard. Avoid questions that require a 'yes' or 'no' response. Such answers will not help to develop insight.

Avoid a "if x, then y" situation in the visioning process. The visioning process is not supposed to yield predictive results to be fed into a technical system. Rather, the process should deepen understanding of how water users value the water resource in diverse ways, so that reconciliation between these values can happen. The technical part of the allocation process (i.e. licensing) then supports what has been socially agreed on.

Keep questions simple. Addendum 2 contains an example of a single question asked of river stakeholders in the Inkomati catchment. The question was simply: "Why are you here?" Water resource users responded eagerly and the facilitator then organised the responses into categories of issues, which laid the foundation for developing the vision statement. Once the vision statement was generated, stakeholders proposed elements of a strategy by responding to the simple question: "name two steps which you think are important to achieving the vision".

The responses to this are included in Annexure A. Be careful of too much technical terminology. If the facilitator has an interest in the type of water resource use, consider the difference between these two types of questions: "How do you use your river and what sorts of benefits are there for you?" compared to "What do you use the water resources in your management unit for"? Imagine you are a water resource user in rural eastern Cape. You may respond better to the type of terminology in the first question!

Principles for STEP 6.

Try to identify all interest groups, not just the ones that are well organised or highly visible. Identify interests groups that have not yet been represented and make provision for such groups in the conversation around needs and preferences and use impacts. Insufficiently resourced or disempowered interest groups may be missed. Failure to consider them from the 'low confidence' and subsequent catchment visioning process may lead to decisions that omit some needs and would lead to preferential allocation to established and more powerful groups.

Focus on a common language. Ecosystem services language is useful as it allows people to express water resource use and benefits in terms of human well-being. This will be especially important once the full stakeholder process is operational, since most water resource users will struggle to describe their needs and preferences in purely technical and/or scientific terms (Van Wyk *et al*., 2003). Common language promotes confidence and joint understanding and through this, encourages entry into conversation and decisions. Thus, equity through inclusiveness is promoted.

STEP 7: Formulate a vision

Purpose

Discussing and generating a joint perception around context and current state (STEP 6) leads the catchment visioning team to a joint understanding of current issues, problems and points of strength. These provide the starting point for catchment vision because it encourages a change in thinking towards an improved future. Usually a diversity of issues will emerge and it indicates that the current state is not desirable. This highlights the need for change and generates the momentum to drive it.

Process

The process relates to what was said in Section 6 of this report under the heading "Golden rules". Discussion of the context will produce issues. Group these issues to formulate a vision. For example, stakeholders in the Inkomati WMA came up with issues that were grouped according to **Land use, River use, Development, Equity and Sustainability:**

- *Land use*: healthy banks, no erosion
- *River use*: Healthy beautiful river, maintain biodiversity and uses that it benefits, maintain supply of indigenous fruits, crops and medicines, rehabilitation beyond conservation areas.
- *Development*: Provide employment that benefits local people, provide basic services, cultural and recreational tourism development, agricultural development.
- *Equity*: Equitable access to the water resource, equitable distribution of costs and benefits.

- *Sustainability*: Maintain health of water resource, and profitability of economic activities, protect our children's heritage, environmental capacity known and respected, future options not foreclosed, transparency and accountability to achieve a sustainable management system.

(Note: these issues were elicited using an ecosystem services terminology to which everyone could relate).

Tip: Record any reference to a better future, even if it is not necessarily connected to a particular issue. Often, people have a sense of what future benefits the aquatic ecosystem can offer, without this notion being fixed to a current problem or issue. It is important to capture these statements, because the approach to visioning given here makes provision for creating a generative future, as opposed to choosing between a limited number of options or scenarios.

Based on this, the facilitator can construct the vision as follows:

Inkomati stakeholders, July 2000

We are proud custodians of our rivers.

They sustain our economy and heritage.

We protect and manage them so that they can

Continuously bring benefits equitably to our people,

The nation, and our neighbours.

This vision was constructed for example from the bundle of issue statements expressed by Inkomati stakeholders. If a catchment forum is in place, bounce the vision off this group to test its acceptability to a diverse group.

Other examples of visions are:

Plettenberg Bay Catchment Community

Ensure the wise use of all water resources and maintain an adequate supply of acceptable quality to all users to sustain the prosperity and integrity of the natural environment of the catchment areas of the Piesang, Bitou, Keurbooms, Groot, Matjies and Sout Rivers.

Blesbokspruit Catchment Forum Charter

To promote a healthy, safe and sustainable environment that is fit for all uses through interactive stakeholder participation within the Blesbokspruit catchment.

Kruger National Park

To maintain biodiversity in all its natural facets and fluxes and to provide human benefits in keeping with the mission of the National Parks Board in a manner which detracts as little as possible from the wilderness qualities of the Kruger National Park.

Principles for STEP 7

Follow facilitation principles as in STEP 3.

SECTION 7: FROM A VISION TO OBJECTIVES

Achievable management objectives

A vision that correctly reflects societal needs and preferences can be disaggregated into management goals that serve the collective societal expression of a better future, as it relates to the resource.

An objectives hierarchy (See Rogers and Bestbier, 1997) provides a structured and rigorous way to do this. Importantly, this way of defining and using a desired future state provides an accountability pathway and focuses on taking small steps at a time while keeping the ultimate desired future state in mind. This is critical in terms of creating achievable objectives over various time scales so that participants have a sense of achievement and motivation (Roux, 2001).

Refer back to Figure 1.2. This is an example of a vision that is partially disaggragated into objetives to illustrate how the objectives hierarchy is constructed. Note that, starting from the broad vision, key elements of the vision statement are identified and pulled out. Higher-level objectives are then set for those key elements. Again, key elements of these higher-level objectives are identified and pulled out to produce sub-objectives and the process is repeated and a series of objectives of increasing detail and specificity is generated. **Each objective is set so as to maintain vital attributes and strengths and to overcome constraints and threats.**

The process of identifying key elements, and setting different levels of objectives that are sensitive to strengths and constraints, is thus iterative. Eventually, the objectives at the lower end of the hierarchy are so detailed that operational managers can start to regognise them as management objectives that relate to their day-to-day tasks. Refer to Rogers and Bestbier (1997) for an example of a fully disaggregated objectives hierarchy. STEPS 8 to 11 are extracts from the Rogers and Bestbier (1997) objectives hierarchy process to illustrate key components of the vision disaggregation process.

STEP 8: Define strengths of the system

Defining system strengths

A strength is a positive characteristic of the system to be managed and may be scientific, ecological, value judgements, legal, historic and socio-economic. Resource managers want to maintain system strengths and overcome constraints.

- List all the known and perceived, current and future strengths of the social-ecological system. Current strengths may be determined from lists of ecosystem characteristics and vital attributes, e.g. species diversity and landscape types, and other attributes that are releVant to IWRM. Scenario modelling may be useful for identifying possible future strengths.
- Discuss and evaluate the list of strengths to reduce it to the essential elements that are compatible with the vision. The strengths describe the fundamental purpose of integrated water resource management.

STEP 9: Evaluate strengths

System strengths expose opportunities to balance use.

Use a matrix to indicate compatible and incompatible strengths. (This may be the point at which balancing uses becomes critical, where compatible and apparently incompatible aspects of resource use become explicit). Strengths can be sifted, grouped together in logical groupings, and condensed. Thus, the end product of this step would be a concise list of strengths that would form the focus of management efforts.

Facilitation principle: Personal values play an important role in this step. Look for common ground opportunities to rationalise the list of strengths to ensure compatibility with the vision and guiding principles.

STEP 10: Determinants of and constraints and threats to strengths

Maintain system strengths and overcome constraints

A major purpose of management is to ensure the maintenance of the factors determining and maintaining the strengths of the system.

- List all the determinants of, and constraints and threats to, the condensed list of strengths. Several instruments can be helpful in doing this, such as matrices. An example of a matrix (see Table 7.1) from Rogers and Bestbier (1997) is provided here.

Table 7.1: An example of a matrix used in assigning determinants, threats and constraints to two of the strengths of Nylsvley Nature Reserve (from Rogers and Bestbier, 1997)

Strengths	Determinant	Threat	Constraint
A good information base.	History of involvement: academic, research & management.	Lack of support from funding agencies.	The nature reserve is a very small part of the floodplain and catchment; lack of understanding of the system as a whole. Information is not in a user-friendly format. Management does not have clear goals and therefore does not demonstrate their information requirements clearly.
It is an excellent breeding and staging site for nomadic aquatic birds.	Hydrological regime drives wetland processes, water quantity and quality. Grazing and fire regime on nature reserve influences breeding and other life history strategies.	Water resources development in catchment is a threat to the hydrological regime (water is scarce) – extraction is a high risk. Exotic plants in the catchment – alter water quantity (reduce runoff) and quality.	Management does not know how to, and have not, explicitly managed for birds.

STEP 11: Define objectives

Set objectives to enhance strengths and overcome constraints

Objectives are set to ensure the maintenance of identified strengths and vital attributes, and to overcome constraints and threats to achieving the vision. Examples are provided in Table 7.2.

A hierarchical approach should be adopted to formulate a set of nested objectives of increasing rigour and achievability. This is an iterative process involving identifying, structuring and analysing objectives, and understanding how they relate to each other.

Objectives at different levels of the objectives hierarchy can be used to direct operations at different levels in the management institution, or other institutions that form part of management.

Table 7.2: Examples of objectives emerging from the vision, taken from Rogers and Bestbier (1997), objectives for Riverine Biodiversity for the Kruger National Park.

OBJECTIVE TYPE	EXAMPLE OF OBJECTIVE
Research	Understand natural fluxes in key components of aquatic biodiversity with a view to servicing the establishment of Thresholds of Potential Concern (targets).
Management	Integrate the activities of alien species control officers into the river programme.
Monitoring	Catalogue riverine biodiversity and any trends of change.
Information systems	Provide guidelines for sharing of data and products.

From vision to RWQOs through the objectives hierachy

The management objectives derived from the objective hierarchy process will be descriptive of aspirations that relate to either ecological categories or to water user categories or to institutional or governance arrangements (Figure 1.2). Those that relate to ecological categories or to water use categories can be used in conjunction to derive the management class, as described by the RWQOs Guideline. RWQOss are then derived from the Class. See Section 5 for detail on how to integrate objectives from the onbjectives hierarchy with the more technical derivation of the Management Class as described in the RWQOss Guideline.

SECTION 8: CONCLUSION

Back to basics

A basic recommendation about the visioning process is to keep it simple and to commit and stick to the basic principles of the process. A good facilitator is key to start mobilising stakeholders – to provide a structured but generative process to get stakeholders excited about participation and new friendships they are forging in the process. Much work remains to be done and this guideline can be expanded on and developed further in many ways. However, the visioning process described here allows a robust and defendible start – albeit with imperfect information but built on the values and inspiration that make water resources management the perfect vehicle for rebuilding our nation.

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Annexure A:
List of Stakeholders

An example of a list (non-exhaustive) of water resource stakeholders in the Sabie-Sand catchment (as during November 2003). Adapted from Van Wyk *et a*l., (2006b).

Sector	Interest grouping	Organisation	Catchment
Regulators	Department of Water Affairs and Forestry	Nelspruit Regional Office	Sabie-Sand
	Irrigation Boards	Sabie River Irrigation Board	Sabie
		White Waters Major Irrigation Board	Sabie
	Local Government	Bohlabela District Council	Sabie-Sand
	Tribal Authority	Hoxane Tribal Authority	Sabie
Major resource users	Forestry	Global Forest Products	Sabie
	Agriculture	Mpumalanga Department of Agriculture, Environment & Conservation	Sabie
		Mpumalanga African Farmers Union	Sabie
		Individual small-scale irrigation farmer	Sabie
	Domestic use	Bushbuckridge Water Board	Sabie-Sand
		Belfast villagers doing laundry at river	Sabie
	Conservation	Kruger National Park	Sabie-Sand
		Mpumalanga Parks Board	Sabie
		Hazyview-Kiepersol ConserVancy	Sabie
	Tourism	Hazyview Tourism Authority	Sabie
		Induna Adventures	Sabie
Non-government organizations		Association for Water and Rural Development (AWARD)	Sand
Multi-sectoral fora		Sabie River Working Group	Sabie-Sand

Annexure B:
Extracts from a workshop synthesis

Extracts from a workshop synthesis: developing a process for stakeholder engagement for river management in the Inkomati Water Management Area (2002). Refer to Van Wilgen et al., (2003) for details of this Water Research Commission funded project.

OUTLINE FOR APPENDIX 2:

The example illustrates a possible process and interaction with stakeholders and how information and values were sourced and organised. This example only refers to what happens leading up to the formulation, in other words STEPS 5 to 7 in Figure 6 of the main text of this guideline. It does not deal with how the vision is disaggregated into sub-objectives (Rogers and Bestbier, 1997 provides much detail on that and an example).

The following example can be broken down into the following:

- **ISSUES**: what is wrong, why are we here?
- **GROUPING OF ISSUES**
- **WHAT DOES AN IMPROVED PICTURE LOOK LIKE?** (the 'more desirable future')
- **GROUPING OF ASPECTS THAT DESCRIBE A BETTER FUTURE**
- **THE VISION STATEMENT**

In this particular case, the stakeholders were engaging and confident to the extent that the facilitating team could assist them in producing a broad, local-level but structured strategy to move toward an improved future.

Flip chart summaries of participants' inputs:

Question: ***Why are we here?***

Note that this simple question helps stakeholders produce a lot of information about how they value the water resource, both currently and in the past, and what they think is wrong and how they think their future could improve. Note that stakeholder inputs are not deemed to be right or wrong. This is **their** context and issues, how they perceive and experience it.

Stakeholder 1:

- Water is scarce
- How will we manage our expectations?
- How will we jointly make decisions?

Stakeholder 2:

- Management system for our resource (democratic – *consensus/participation*)
- Grass roots Task Teams learn to protect resource (*x 2 = infrastructure and ecosystem)*
- Task Teams educate community
- Protect water users from violence*
- Management must be community-driven

Stakeholder 3:

- Equitable allocation
- Strategy to improve legislation
- Control illegal water use*
- Financing mechanisms for service delivery

Stakeholder 4:

- Correcting past inequities in access to water, land and finance
- Improve administrative and legal framework to better serve equity
- *Empower Task Teams*
- *COOPERATIVE GOVERNANCE AT ALL LEVELS*

Stakeholder 5:

- Equitable allocation
- Protect infrastructure

Stakeholder 6:

- Distribution to villages will also result in river protection
- Indigenous knowledge of water conservation (Consult elders)

Stakeholder 7:

- Change irrigation techniques (micro-systems)
- Better stock management to protect river → water points, grazing areas
- Dept. of Education → water care
- Better farming practice to reduce erosion
- More appropriate crops, and better timing (crop rotation) to conserve water
- Better distribution to reduce wastage
- Farmers to educate employees in water conservation
- *MATCH FARMING SYSTEM TO SOIL AND WATER and markets*

Stakeholder 8:

- How to get a common vision for the future
- Avoid conflict - "unity in diversity"
- Recognise variability is central issue

Stakeholder 9:

- Understand what we have: total resource and Reserve etc.
- Holistic (incl. population issues) catchment approach (across international boundaries)
- Reward/penalty system
- Across-the-board education

Stakeholder 10:

- Protect investment (historical financial obligations)
- Technical support in maintaining resource quality (pollution control) and infrastructure, legal advice
- Broad, equitable 'tax' base

Stakeholder 11:

- Improve river condition
- Co-operative governance
- Upstream users → improve land management
- Upstream users → pollution control (industry, mining, farming, domestic)

Stakeholder 12:

- Negotiate
- Technical and administrative support from DWAF/Agric

Stakeholder 13:

- Mechanism to stop destruction of resource
- Extension to improve irrigation practice and finance for infrastructure
- Government (Agric, DWAF, Education) educate youth on water and land use
- Holistic approach - treat causes not symptoms

Stakeholder 14:

- Skills development
- Access to admin. knowledge and technical/legal people
- Mutual support systems, structures/networks at grassroots level & financed
- Public awareness of CMAs role and functions in community

Stakeholder 15:

- Balance water use and protection
- Broad 'tax' base, reward/penalty system
- Long-term commitment
- Holistic and strategic catchment approach
- Market-driven better management

Issues presently affecting natural resource use within the catchment.

Stakeholders' responses to the question "why are we here?" were grouped and organised by the facilitator into **issues**.

Extract from the workshop synthesis:

> It is clear that stakeholders within the catchment are presently facing a wide range of problems in natural resource management. Some of these concerns result from the limitations of past political and management systems. Others have arisen with the transition to a new system. The issues raised are diverse and complex, and may be broadly grouped as follows:

Policy and legislation

- Lack of clarity about new legislation and conflicting interpretations of its implications.

e.g. Future government ownership of dams that were previously privately owned.

e.g. The implications of previous scheduling statuses of redistributed land, and the criteria for classification as an “existing water user” under the Act.

- Lack of clarity about interim procedures to be followed.

e.g. Rewarding of a temporary licence prior to the determination of the Reserve.

- Concern about the protection of historic investments under the new legislation.

e.g. Whether a future allocation will be able to provide sufficient returns on previous long-term investments in private infrastructure.

- Concern about future pricing strategies.

e.g. Whether agriculture and forestry will pay a greater proportion of total catchment management costs than is warranted by their use of catchment resources (water).

Resources

- The scarcity and finite nature of water resources and the variability of their supply.

e.g. A noticeable long-term decline in the level of rivers, and the severity of the effects of recent droughts on water users.

- Threats to rivers and ecosystems from pollution and poor land use.

e.g. Poor water quality due to industries upstream.

e.g. Increased erosion due to farming on river banks.

- Increasing demands for water, and the need for reallocation of the resource.

e.g. Growing populations, and a large number of emerging farmers who require access to water.

- The need for quantification of the total resource, the Reserve and the amount available for allocation.
- The urgency of a preliminary estimate of the allocatable amount to enable economic activity to continue.
- The need for a system to monitor the resource and manage its use.

e.g. Monitoring and controlling the amount of water pumped from the river.

- The need for long-term vision on a catchment scale to ensure sustainability and an optimal balance between use and protection of the resource.
- The need for a holistic approach to integrate the use of land and water, and social, economic and environmental goals.

e.g. Identifying appropriate combinations of soil type, water availability, crops, farming practices and markets, on a catchment scale.

- The need for strategic and informed decision-making.

Administration

- Delays in the transfer of land ownership.

e.g. Status of farmer must progress from 'permission to occupy' to title deed holder in order to obtain an allocation of water.

- The need for integrated and democratic management systems.

e.g. CMC members must have a mandate from the people they represent.

- The role and responsibilities of community-based/local organizations within the overall management system.

e.g. Local responsibility for management of recreational water use.

- The need for co-operative governance, both vertically – between the different levels of government, from local to national – and horizontally – between government departments (in particular DWAF, DALA, DEAT), between user sectors and geographical areas, and to involve the broader community.

e.g. Lack of co-operation between the departments of Water Affairs and Agriculture in allocating water to emerging farmers.

- Uncertainty about licensing procedures.

Capacity / Empowerment

- Researching and using indigenous knowledge.

e.g. Consulting tribal elders about water conservation methods.

- Inadequate extension services.

e.g. The need to advise emerging farmers about farming methods, and about administrative procedures involved in applying for a license to use water.

- Empowering and educating the community, especially through women and youth, about better resource use.

e.g. Schools should educate youth about the scarcity of water resources and how they can save water.

- The need for both mutual and professional support.
- Instilling a sense of 'ownership' of resources, and responsibility for their protection.

Technology

- Methods of saving water or using it more efficiently.

e.g. Micro-irrigation techniques .

- Improved farming practices.

e.g. Better stock management to prevent bank erosion.

e.g. More appropriate choice and timing of crops to conserve water.

Once people have expressed their issues and created a collective understanding of each others' and their collective context, they will be ready to start thinking about what a new, better situation may be like and what might be the properties of such a system.

Question: ***2 steps toward the new vision***

Stakeholder A:

1. Proper communication across ALL grass roots structures

   $\rightarrow$ one voice to government

   (Youth League, Women's League, ANC, SANCO, traditional leaders, farmers)

2. Co-operation between Land Affairs, DWAF, Agric. and Local Government, CPF in administration and financing (also DEAT)

Stakeholder B:

1. **Integrated** development planning and marketing to draw investment

   (*Central CMAs $\rightarrow$ local agent; CMAs should have commercial wing*)

2. Clear stepwise process for land acquisition and transfer

Stakeholder C:

1. Community awareness of water shortage

2. Education of youth about water (*Dept of Education)*

3. Both urban & rural areas need to be involved

Stakeholder D/E:

1. Devolve power to CMAs

   from national DWAF
   - Responsible leadership
   - To ensure everyone has (an organized) voice through appropriate forums (WUA's)
   - Effective lines of communication to and from national departments.

2. Active land stewardship

Stakeholder F:

1. CMAs to ensure active and organized local/sub-catchment groups, who understand each other, and develop pride in their resource.

Stakeholder G:

1. Responsibility to integrate land and water admin must be at CMAs level

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Stakeholder H:

1. Participation of civil society (esp. churches and women) in understanding water use and the CMAs
2. Government to deploy MEC's to conduct local water forums
3. CMC's to conduct public awareness workshops and education → next generation (*also education about nature conservation, and using radio and other media*)
4. Bottom-up involvement in policy development
5. Government to speed up land distribution & Land Care

Stakeholder I:

1. Over-all planning – S.E.A. using cost/benefit analyses to enable effective and informed decisions
2. Training for improved resource management
3. Long-term research, sustainability

Stakeholder J:

1. CMC and grass-roots (forum) have **common vision** (everyone's needs) → cascade from general to specific (operable)
2. Determine Reserve and its variability

Stakeholder K:

1. Peace and security for all through affirmative action
2. Root out corruption, nepotism and bribery regardless of who is involved
3. Responsibility for action now, and commitment to finding solutions
4. Share knowledge about how to do it right
5. Tangible benefits delivered to people

The following is a further extract from the workshop process:

A vision for a future system of catchment management

It is clear that we are all trying to find our way in a very complex, evolving and confusing system. The difficulties of trying to deal with this complexity may lead us to focus solely on our own sector's needs and problems. But the catchment and its water resources form one interrelated system and various sectors affect each other's ability to use the resource. We have to work together to avoid and resolve conflicts, and to share the resource in a way that benefits the whole catchment.

The diverse issues that were discussed have also shown that no one is satisfied with the present situation. We all recognize the need for change. In moving our focus from the present to the future we can use our experiences of past and present problems to build a vision for a new system that is better able to deal with these issues. Designing a new system frees us from the constraints of the old management system and the problems it creates.

We all agreed that one of the limitations of the previous management system was that it only made use of a 'top-down' approach – in the future a 'bottom-up' approach should also be followed. This transfer of power to lower levels will require that the 'bottom' takes responsibility for organizing itself so that it can direct higher levels and processes. The 'bottom-up' approach is impossible without organization and action – government can only help us if we are organized to help ourselves.

Discussion of the symptoms and causes of our present problems has helped us to envisage some of the properties of a new system of organization for both 'bottom-up' and 'top-down' management processes. These may be summarized as follows:

A more holistic approach

- All stakeholders need to strive for an understanding of each other's positions, and to co-ordinate their activities toward a common vision for their shared resource.

Greater integration

- Linkages between land and water, upstream and downstream resource use, and social, economic and environmental goals must be created.

Co-operative governance

- There is a need for co-operation between different levels – from individual users to forums, CMCs, the CMAs and DWAF, and from local to national government.
- There is a need for co-operation between different sectors, areas and communities, and between government departments – in particular DWAF, DALA and DEAT.

Equity

- There needs to be more equitable access to resources, and a more equitable distribution of the costs and benefits of resource management. This can only be achieved by a holistic, co-operative and integrated approach.

Efficiency

- The management and administrative process must be efficient in their use of human resources, finance and time.

More informed civil society

- Communities must be empowered to use the system to address their needs.

More adaptive policies and processes

- Management policy and processes must be able to adapt to changing needs, and to improve over time by learning from experience.

As part of the workshop process, stakeholders were taken to a nearby river to consider goods and services and costs and benefits associated with the use of the river resource.

This exercise identified the following areas over which agreement at the broad catchment scale could potentially be reached:

LAND USE

e.g.

- *Healthy banks.*
- *No erosion.*

RIVER USE

e.g.

- *Healthy, beautiful river.*
- *Maintain biodiversity, and use its benefits.*
- *Maintain supply of indigenous fruits, crops and medicines.*
- *Rehabilitation beyond conservation areas.*

DEVELOPMENT

e.g

- *Provide employment that benefits local people.*
- *Provide basic services.*
- *Cultural and recreational tourism development.*
- *Agricultural development.*
- *Using some of the resource's assimilative capacity to support development.*

EQUITY

e.g.

- *Equitable access to the resource.*
- *Equitable distribution of costs and benefits.*

SUSTAINABILITY

e.g.

- *Maintain health of resource, and profitability of economic activities.*
- *Protect our children's heritage.*
- *Environmental capacity known and respected.*
- *Future options not foreclosed.*
- *Transparency and accountability to achieve a sustainable management system.*

These aspects can be drawn together into a statement that reflects the aspirations we share for the future of our resource. A suggested vision or mission statement for our workshop group could thus be as follows:

We are proud custodians of our rivers.
They sustain our economy and heritage.
We protect and manage them so that they can continuously bring benefits equitably to our people, the nation, and our neighbours.

We recognise that such a statement functions mainly to inspire and unite us, rather than to provide the achievable goals that a strategy could be designed to address. A commitment by all stakeholders to a broad vision such as this is however a necessary starting point for building consensus on a more detailed vision or desired state that balances specific sectoral needs.
At these lower levels of detail, the compatibility of different stakeholders' needs and aspirations will become easier to discern and address. This may take place by a process of discussion and negotiation, as well as more technical inputs and processes to optimise overall resource use, and achieve an equitable distribution of costs and benefits.

Stakeholders were asked to identify ways in which they would want to see change in order to support the achievement of the vision. This discussion led to the design of a strategy for action, including the identification of responsibilities. The following is an extract from this exercise:

Strategies for achieving holistic, integrated and co-operative catchment management

It has been recognized that the importance of a 'bottom-up' approach was neglected in the past, resulting in ill-informed 'top-down' policies, which were not responsive to local needs. It is essential that in the future both 'bottom-up' and 'top-down' initiatives work together if effective water resource management is to be achieved.

The catchment has been identified as an important scale at which the future integration and coordination of stakeholder needs and activities must take place. The CMAs, as the 'top' level at this scale, has the important function of maintaining a catchment-wide perspective of resource management issues. This broad scale view is needed in order to develop 'top-down' policy that can ensure the co-ordination and compatibility of local policies and activities at both a catchment and national scale. This perspective must however be properly informed of local needs and activities through effective 'bottom-up' processes initiated at a local level.

There are thus two important levels at which strategies toward the achievement of effective resource management must be initiated:

1. The CMAs, including the CMCs for the various sub-catchments.
2. Local and community-based resource management structures and user forums.

The role of the CMAs

Ideas expressed by the group about the future role of the CMAs, and the principles by which it should operate, can be summarized and organized as follows: (Figure 1)

The CMAs should have clear strategies to address the following areas of concern:

1. Resource allocation and management.
2. Facilitation of development.
3. Ensuring co-operative governance.

Resource allocation and management

- There is a need to address the issue of allocation and re-allocation, in order to create more equitable access to resources, and at the same time protect stakeholders' livelihoods by allowing economic activity to continue.
- Separate strategies are required for the management of consumptive versus non-consumptive use, and the protection and rehabilitation of the resource.
- Incentives such as a system of rewards or penalties should be used to influence the way people use the resource. It should also be recognized that often education, or even disciplinary action, is not effective in discouraging poor resource use. For various socio-economic reasons, viable alternatives to such practices may not exist – management actions should not address symptoms, but causes.

Facilitation of development

- There is a need for long-term assessment (Strategic Environmental Assessment) of the development potential of the resource, in order to optimize future resource use.
- A starting strategy must identify opportunities to use water in facilitating development within the catchment, and employ a marketing strategy to attract investment. This responsibility is shared with lower levels where entrepreneurial activity is more likely to be initiated. The CMAs must provide a facilitatory framework to encourage such local activity.

Co-operative governance

- A commitment to the principle of co-operative governance is not enough. A strategy is needed to establish working links between the various levels and departments.

e.g. DWAF and DALA need to put in place structures and strategies to co-ordinate land and water use.

- There must be clarity on organizational and institutional arrangements at the various levels, eg. CMCs, WUAs, and community forums.
- A system is required for managing information, communicating and promoting co-operation between levels, and conducting appropriate research.
- There is an urgent need for capacity building at all levels.

e.g. Awareness and education campaigns are needed to empower stakeholders to use administrative processes and consult available sources of help.

The role of local and community-based resource management structures

Placing sole responsibility on the CMAs for all aspects of resource management, development facilitation and co-operative governance will merely entrench another 'top-down' approach, in a more localized system. If the voice from the 'bottom' is to be heard and understood it must communicate in a way that facilitates the work of the CMAs. Lower levels need to be organized, and to communicate to upper levels their local commitment and pride – they must create music not noise!

All 'bottom' groups must see themselves as facilitators of their joint work with the CMAs. Our strength is in the strength of others – all levels and groups need to provide each other with mutual support. In order for the overall management system to operate effectively the lower levels must work to the same pattern as higher levels.

The CMAs, and all the other levels of organization within the catchment, such as CMCs, WUAs, community forums, Water Boards, emerging farmers' groups, etc. must share a common understanding of:

- what needs to be done;
- how to approach it;
- who is responsible;
- where and when it should happen.

This will require local level strategies that match those outlined for the CMAs (Figure 1). If a 'bottom-up' approach is to be effective, all local structures must have their own strategic plans for resource allocation and management, facilitation of development and co-operative governance, as well as the more specific strategies by which these main strategies are to be achieved.

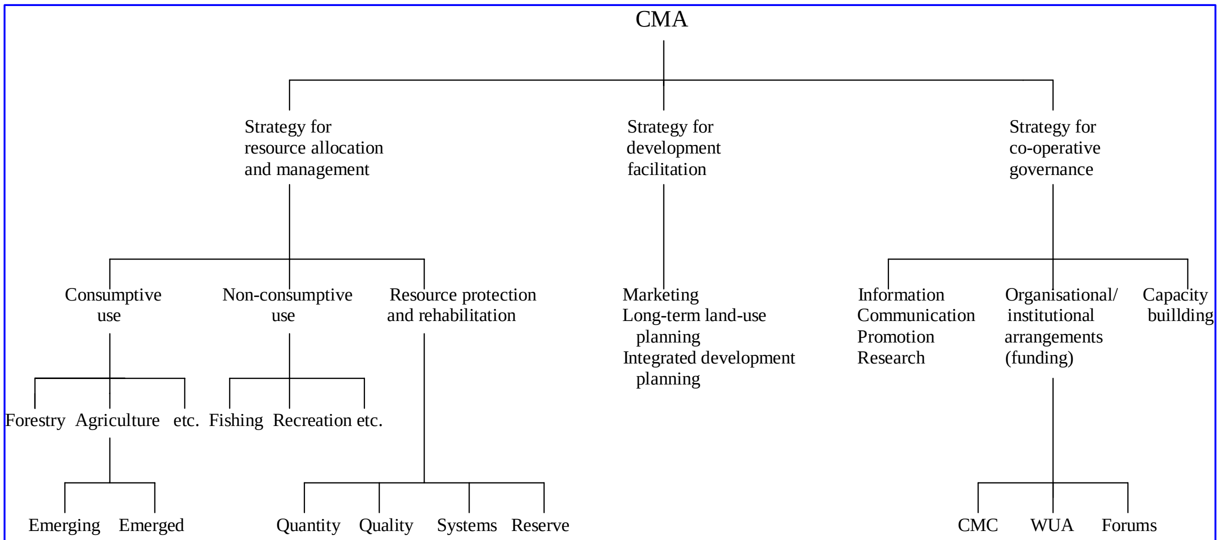

Figure 1: The role and responsibilities of the future Catchment Management Agency (CMA)

Operating principles for a new management system

The vision we generated in the first workshop for the attributes of a future management system can be seen as a set of operating principles to which a CMAs may be expected to commit. All other management levels would then also be required to adopt these principles in planning and carrying out their management activities.

These principles were summarised as follows:

HOLISTIC / INTEGRATED

- *A shared resource requires a common vision and co-ordinated action.*

COOPERATIVE GOVERNANCE

- *Working partnerships must be created both vertically and horizontally.*

EQUITY

- *There should be equity in access to the resource, and in the distribution of costs and benefits.*
- *Revenue should be generated from all who benefit from management of the resource (the river ecosystem) and not just water users. (See Appendix C.)*

EFFICIENCY

- *Management and administration processes should work towards speedy and efficient service delivery.*

EMPOWERING CIVIL SOCIETY

- *Civil society should be informed and active.*
- *The importance of a bottom-up approach, and grass-roots sourcing of issues, must be recognised.*
- *A sense of shared ownership and responsibility must be created.*

ADAPTIVE

- *Policies and process should be able to improve with experience.*
- *The CMAs and all levels of stakeholder representation should be transparent, accountable, and challengeable.*

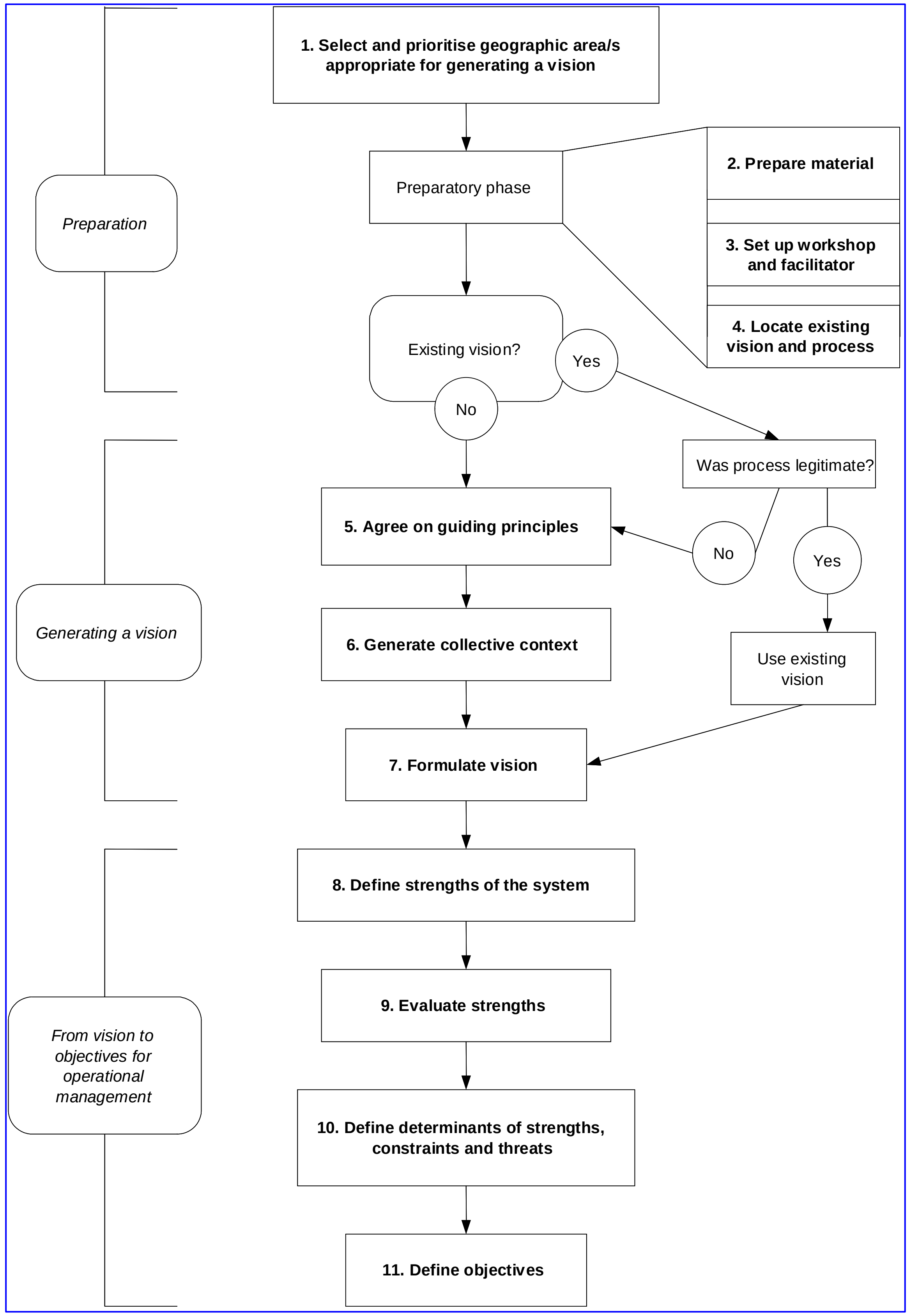

Figure 6.1: A summarised process diagram to show steps in generating a vision and breaking it down into component objectives.

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Resource Directed Management of Water Quality

MANAGEMENT INSTRUMENTS

Volume 4.2

Guideline for Determining Resource Water Quality Objectives (RWQOs), Allocatable Water Quality and the Stress of the Water Resource

August 2006

Edition 2

water & forestry

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Reports as part of this project:

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1.4	Volume 1: *Policy Document Series*
1.4.1	Volume 1.1: Summary Policy
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1.7.6	Introduction to the Resource Directed Management of Water Quality
1.8	Implementation Plan

Bold type indicates this report

APPROVAL

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EXECUTIVE SUMMARY

"Providing guidance for determining Resource Water Quality Objectives, Allocatable Water Quality and Stress of the Water Resource"

What are Resource Water Quality Objectives (RWQOs)

RWQOs are the water quality components of the Resource Quality Objectives (RQOs) which are defined by the National Water Act as "clear goals relating to the quality of the relevant water resources." In the document, "Policy on the Resource Directed Management of Water Quality", RWQOs are defined as numeric or descriptive in-stream (or in-aquifer) water quality objectives typically set at a finer resolution (spatial or temporal) than RQOs to provide greater detail upon which to base the management of water quality.

Purpose of the Guidelines

This Guideline provides an approach to the determination of the Resource Quality Objectives, as they relate specifically to water quality, for South African freshwater resources. It also describes an approach for determining the allocatable water quality and the water quality stress of a water resource.

Relation to other RDMs management instruments

The guideline also provides an approach to integrate catchment visioning, water resource classification and the Reserve process into the water resource management process, through the determination of RWQOs.

Guiding principles

The determination of RWQOs is underpinned by the principle of sustainable development and was informed by the principles which formed the foundation for the following instruments:

- The Precautionary Principle,
- The default rule described in the Resource Directed Measures documentation,
- The National Water Resource Strategy, and
- Environmental rights as described in the South African Constitution (Act No. 108 of 1996)

The implications of these principles are that:

- The Department may not accept a deterioration in water quality from the present state, at least when determining RWQOs using a low confidence method,
- In areas of deteriorated water quality, the quality should be improved to the minimum sustainable Ecological Category,
- The default rule for other users is that the minimum desired category should be 'Tolerable', and
- RWQOs should be determined to that of meeting the Ecological and Basic Human Need Reserve (or better).

Levels of RWOQ determination

Three levels of determining RWQOs are described:

- **Low confidence method** - RWQOs are based only on available data and information and there is limited possibility for new data collection to assess the present state. It is used to support individual licensing with small impacts in unstressed catchments or catchments of low ecological and user importance and sensitivity.

- **Medium confidence method** - RWQOs are based on specialist field studies and institutional stakeholders are involved in the process. It is used to support individual licensing with moderate impacts in relatively stressed catchments or catchments of high importance and sensitivity.
- **High confidence method** - RWQOs are based on extensive field data collection by specialists and characterised by intensive stakeholder involvement. It is used to support all compulsory licensing (in stressed catchments) or individual licensing having a large impact, or licences with small or large impacts in very important and/or sensitive catchments.

Methodology for determining RWQOs

The guideline describes the following steps for determining RWQOs:

- Determine the Ecological Water Quality Requirements (Reserve)
  - Delineate resource unit (spatial scale of RWQOs)
  - Determine present water quality state
  - Determine desired (attainable) water quality (ecological component of the catchment vision), and
  - Determine ecological specifications (water quality component of the Reserve)
- Determine User Water Quality Requirements
  - Identify water users
  - Assess present water quality with regards to water user requirements
  - Determine desired water quality (water user component of the catchment vision), and
  - Determine water user specifications
- Determine the Management Class for the water resource through integration.
- Establish RWQOs, through the integration of ecological and water user requirements for water quality.
- Establish time period of RWQOs, i.e. seasonal, short-term, or long-term water quality goals (RWQOs) for the resource unit.

Allocatable water quality

RWQOs provide the basis for determining the Allocatable Water Quality. This is defined as the maximum worsening change in any water quality attribute away from its present value that maintains it within a pre-determined range reflecting the desired future state (typically defined by a resource quality objective). If the present value is already at or outside the predetermined range, this indicates that none is allocatable and that (a) reduced pollution loads relating to the affected attribute(s) and/or (b) remediation of the resource may be necessary.

Determination of water quality stress

RWQOs also provide the basis for determining the water quality stress. Water quality stress is the difference between the present water quality and the RWQOs. The closer the present water quality is to the RWQOs, the higher is the degree of water quality stress of the water resource.

Annexures

The first annexure describes generic water quality limits for various water user categories (domestic, agricultural, recreational, etc.) in terms of Ideal, Acceptable, Tolerable and Unacceptable categories.

The last three annexures describe in detail the procedures for determining Resource Water Quality Objectives (RWQOs) at a Low, Medium and High levels of confidence.

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ACRONYMS

AEV	Acute Effect Value
CAS	Catchment Assessment Study
CEV	Chronic Effect Value
CMAs	Catchment Management Agencies
DEAT	Department of Environmental Affairs & Tourism
DWAF	Department of Water Affairs & Forestry
Ecospecs	Ecological Specifications
EI	Economic Importance
EIS	Ecological Importance and Sensitivity
EISC	Ecological Importance and Sensitivity Category
IWRM	Integrated Water Resource Management
NWA	National Water Act (36:1998)
PES	Present Ecological State
RDMs	Resource Directed Measures
RDMWQ	Resource Directed Management of Water Quality
REC	Recommended Ecological Category
RQOs	Resource Quality Objectives
RWQOs	Resource Water Quality Objectives
SASS	South African Scoring System
SAWQG	South African Water Quality Guidelines
SI	Social Importance
TWQR	Target Water Quality Range
WAP	Water Allocation Plan
WMA	Water Management Area
WMS	DWAF water quality database
WQM	Water Quality Management
WRC	Water Research Commission

PREFACE

National Water Act (Act 36 of 1998)

Part 2: Classification of water resources and resource quality objectives

"Under Part 2 (of the Act) *the Minister is required to use the classification system established in Part 1* (of the Act) *to determine the class and resource quality objectives of all or part of water resources considered to be significant. The purpose of the resource quality objectives is to establish clear goals relating to the quality of the relevant water resources. In determining resource quality objectives a balance must be sought between the need to protect and sustain water resources on the one hand, and the need to develop and use them on the other. Provision is made for preliminary determinations of the class and resource quality objectives of water resources before the formal classification system is established. Once the class of a water resource and the resource quality objectives have been determined they are binding on all authorities and institutions when exercising any power or performing any duty under this Act."*

This Guideline provides an approach to the determination of the Resource Quality Objectives, as they relate specifically to water quality, for South African freshwater resources. This Guideline does not address Resource Quality Objectives for water quantity, habitat integrity and biotic characteristics.

SECTION 1: INTRODUCTION

1.1 What is in the RWQOs Guideline?

1.1.1 General overview of contents

Purpose and use of the RWQOs Guideline

Section 1 provides:

- An overview of the contents of the Guideline (Section 1.1.1)
- A description of the purpose of the Guideline and how to determine Resource Water Quality Objectives (RWQOs) (Section 1.1.2), and
- An overview of how to use the Guideline in conjunction with other Resource Directed Measures (RDMs) documents (Section 1.2).

Assumptions and exclusions

The focus of this document is on the determination of RWQOs for surface water resources; however the approach is considered generic and as such was developed with the other water resources, i.e. groundwater, estuaries, wetlands, lakes and reservoirs in mind. However, until progress is made regarding the development of a classification system for groundwater, estuaries, wetlands and reservoirs, it is difficult to fully integrate the vision, classification and Reserve process for these resources.

The methodology presented here applies to freshwater resources only. A policy for quality objectives for marine resources has been developed by the Department (DWAF, 2004b.

The RWQOs apply only to water quality and do not consider quantity, habitat, biota, etc. Water quantity is, however, considered as far as constituent loads are concerned.

Guiding Principles

Section 1.3 provides an overview of the principles which guide the decision-making process in determining RWQOs.

Important components of the approach presented in this report, are the over-arching requirements to ensure sustainable and equitable use of the water resource for the "optimum social and economic benefit" of the country. Coupled with this is the need for a transparent and participative approach to water resources management. These policy principles must underlie the approach to water resource management on a catchment basis (DWAF, 2003b).

Levels of RWQOs determination

Section 2 briefly describes each of the three levels of RWQOs methodologies, each method relating to a specific level of confidence:

- Low confidence method
- Medium confidence method, and
- High confidence method.

Rules for the selection of the appropriate method for different water use licensing situations are provided (Table 1). The level of confidence required for determining the RWQOs depends on, for example, the ecological importance and sensitivity (EIS) of the water resource, the scale and degree of the impact of proposed water uses, the urgency for determining RWQOs and the degree of 'acceptable' risk.

The low confidence method is typically used in data sparse catchments.

However, it is important to stress that applying a low confidence method can produce very accurate RWQOs, when sufficient, accurate water quality data are available.

Acceptable risk

RWQOs for a water resource are determined on the basis of acceptable risk, i.e. the less risk that one is prepared to accept of damaging the water resource and possibly losing the goods and services provided by it, the more stringent would be the objectives. A higher risk to the water resource might be accepted, in return for greater short-term utilisation, in which case the RWQOs would be determined at less stringent levels, but not to a level where the long-term sustainable use of the resource is compromised.

Generic methodology for RWQOs

Section 3 contains the "roadmap" - a first introduction to the generic methodology for RWQOs determination. The generic methodology and its relationship to water quality management are shown in Figures 3.1 – 3.3.

Detailed descriptions of methods

Annexures C-E provide more detailed procedures for the determination of RWQOs using either low, medium or high confidence methods.

1.1.2 Purpose of the RWQOs Guideline

What are RWQOs

RWQOs are the water quality component of the Resource Quality Objectives (RQOs) defined by the National Water Act (NWA) (36:1998), “as clear goals relating to the quality of the relevant water resources.” The integrated RDMs manual (DWAF, 1999a) defines an RQOs as “a numerical or descriptive statement of the conditions which should be met in the receiving water resource… in order to ensure that the water resource is protected.” The RWQOs outline both water user needs with respect to water quality, as well as their needs with respect to the disposal of water containing waste to the resource (a water use need). The process of determining RWQOs is consultative, but requires strong technical support” (DWAF, 2003a).

In the document, “Policy on the Resource Directed Management of Water Quality”, RWQOs are defined as numeric or descriptive (narrative) in-stream (or in-aquifer) water quality objectives typically set at a finer resolution (spatial or temporal) than RQOs that provide greater detail upon which to base the management of water quality (DWAF, 2005).

RWQOs should be seen as one component of Resource Quality Objectives, as defined in the NWA (36:1998, Chapter 3). These RWQOs should not be mistaken for Resource Quality Objectives (RQOs) which encompass all four components of the resource quality, namely water quantity, water quality, habitat integrity and biotic characteristics.

It must be noted that the NWA (36:1998) allows for the determination of preliminary [(1)] RQOs of water resources before the formal classification system is established.

Once RQOs have been published in the Gazette, or preliminary RQOs have been determined, they must be given effect (Section 15 of the NWA).

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(1) ‘*Preliminary’* does not refer to the method or level of confidence used in determining the RQOs but rather their legal status as defined in the NWA (36:1998).

To do so, the Department or water management institutions (such as catchment management agencies) may also set narrative or quantitative "resource water quality objectives (RWQOs)". These may be set at a greater spatial resolution (i.e. closer together) and/or temporal resolution (i.e. more frequently monitored) than the RQOs (preliminary or otherwise) to which they may be linked. The purpose of these will be to provide greater detail upon which to base management of water quality aimed at achieving and sustaining compliance with resource quality objectives (DWAF, 2006).

RWQOs will not be gazetted as such but will provide the water quality input to the formal RQOs process. It would therefore be possible to have more RWQOs than RQOs if so desired.

Purpose of the Guideline

The aim of this Guideline is to provide a practical, consistent approach to the determination of RWQOs, by integrating the results of the Catchment Vision, and Resource Classification and Reserve, i.e. Resource Directed Measures (RDMs) (Figure 1.1), and to provide an approach to operationalising these RWQOs in the evaluation of licence applications through the allocatable resource.

Administrative Process

In the absence of Catchment Management Agencies (CMAs), RWQOs will typically be determined by the DWAF with the Regional Offices playing a prominent role.

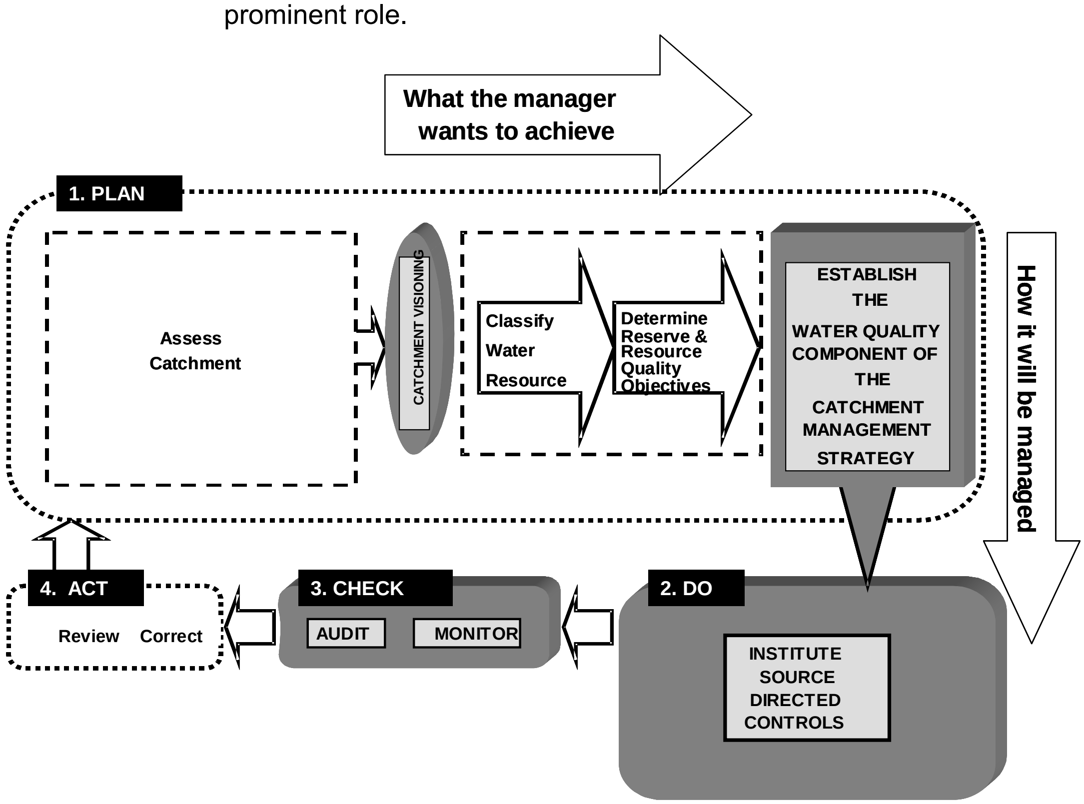

Figure 1.1: Water quality management business process (DWAF, 2003c)

1.2 Relation to other RDMs Management Instruments

1.2.1 Vision, Classification and Reserve

Resource Directed Measures

As mentioned in Section 1.1.2, this guideline provides an approach to the integration of visioning, classification and the Reserve process into the water resource management process, through the determination of RWQOs.

The following section provides a brief overview to each of these three components, highlighting some of the recent developments but, in particular, providing a reference to more detailed studies and manuals which will assist in the determination of RWQOs.

Catchment visioning

Society benefits immeasurably from rivers. In fact, human society exists only because water resources associated with water, and the goods and services that they provide are present and available in quantities that can support it (Karr, 1999). These goods and services include water supply; waste transport; processing and dilution; natural products (e.g. fish, reeds, medicinal plants); nature and biodiversity conservation; flood control; and places for rituals or spiritual needs.

The NWA (36:1998) acknowledges that water resources are ecosystems by providing for the protection of aquatic ecosystems. However, it is not necessary for a water resource to be left untouched to be functional. The intention of "environmentally sustainable water use" is one that balances water use with the protection of the resource in such a way that water resources are not degraded beyond recovery and to ensure that the aquatic ecosystems, if managed appropriately, continue to supply people with different goods and services into the future. Aquatic ecosystems cannot however offer the whole range of goods and services at the same time and in the same place. For example, if heavy use is made of water supply and waste disposal – then the ecosystem is unlikely to provide well for recreation, conservation or "a sense of place". Therefore people need to be able to choose which services they want from ecosystems in time and space (DWAF, 2002c).

Why is a catchment vision important?

South Africa's water resources are scarce and typically give rise to diverse and often competing interests. Within this management environment, a collective vision and co-operative spirit are needed to direct societal choice and action in a co-ordinated and peaceful fashion towards a notion of a better future.

What does catchment visioning offer?

Bringing the public into a participatory process and discovering how to sustain the energy of this process is complex and time-consuming. In the meantime, resource allocation and use must continue as resource-based businesses and livelihoods cannot wait for a perfect public participation process to be in place. The visioning process (DWAF, 2004a) provides a proxy for a process that incorporates the inputs of all interested parties. This enables the DWAF Regional Office to make an initial statement about a desired future state on behalf of the catchment community and other interested parties, in order to set the adaptive management process in motion.

What does catchment visioning offer?

The process has two main parts:

- Design a step-wise, low confidence method to generate a vision; and
- Indicate how the vision can be operationalised through a method known as Objectives Hierarchy. This method shows how the vision can be broken down into component management objectives.

The objectives hierarchy ensures that operational goals are developed in a way that demonstrates they are directly descended from the vision and, in this way, provides a pathway of accountability for both the water resource manager as well as civil society.

Visioning Approach

The approach to visioning/desired state setting, has elements that are important for Integrated Water Resource Management (IWRM) in South Africa:

- The catchment visioning process mimics the full participatory process. This approach sensitises users of the process to the intent and principles of visioning in a process involving full stakeholder participation and should streamline the transition from a low confidence to a more inclusive process.
- The vision must be context-specific. A vision embedded within context promotes buy-in and encourages the dialogue necessary to drive a consensus-based balance between different water resource users.
- The process is based on an opportunity to design the future. This approach is more conducive to capturing aspirations and prompting creative solutions.

Classification

In order to enable choices about the kinds and degrees of use of aquatic ecosystems, and therefore choices about the degree of ecosystem health and integrity, the NWA (36:1998, Section 12) makes provision for the development of a national classification system to classify all significant water resources. At present the national water resource classification system is still under development by the Department, with various interim approaches having been adopted since the implementation of the Act. The proposed approach to classifying a water resource is given below and in Figure 1.2.

In short, the classification system allows for the classification of a water resource in terms of aquatic ecosystem protection and water user requirements. These two components are summarised in a management class, for which the resource is managed.

Management Class The final management class of a water resource is a combination of the ecological requirements for the water resource and the requirements of other water users within the catchment. The ecological requirements are determined by assessing the present ecological state (PES) category (A-F) [(2)] and the recommended ecological category (REC) (A-D)

Ecological Categories:

- A – unmodified natural
- B – largely natural
- C – moderately modified
- D – largely modified
- E – seriously modified
- F – critically modified

Categories used to define the present ecological category (A-F) and the recommended ecological category (A-D), form the basis for assessing the ecological Reserve and associated ecological specifications for the Resource.

A classification that incorporates other water users within a catchment has not as yet been finalised by the Department. However, the categories of Ideal, Acceptable, Tolerable and Unacceptable have been widely used within the Department and are adopted in this document.

Based on the water resource protection requirements and the socio-economic goals of the water resource, the management class may be determined as a gradient in aquatic ecosystem health and other user requirements from Natural to Heavily used/impacted (DWAF, 2004d) (Figure 1.2).

- Natural - unimpacted,
- Moderately used/impacted - slightly to moderately impacted
- Heavily used/impacted - heavily impacted, and
- Unacceptable - unacceptably impacted.

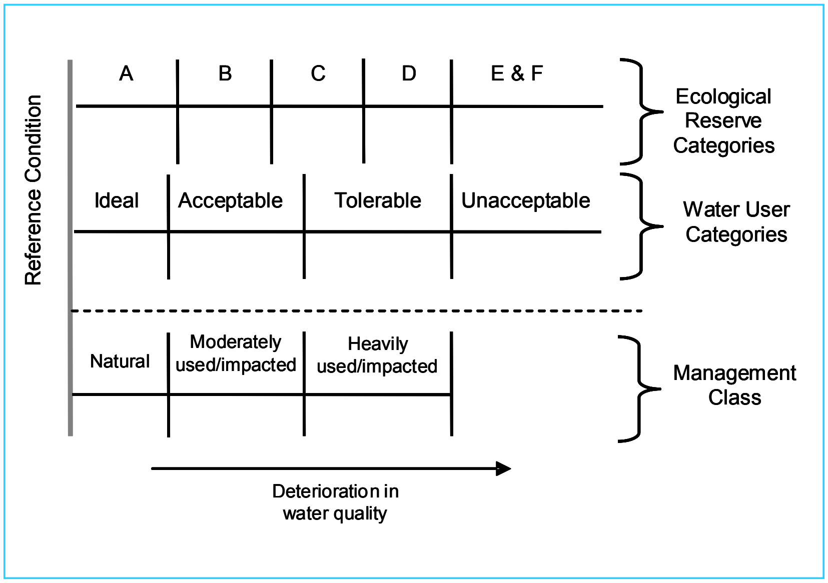

Figure 1.2: Mapping to a Management Class.

Note: The boundaries between Ideal, Acceptable, Tolerable and Unacceptable, as they relate to the ecological categories or management class have not been finalised and are only represented here schematically.

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(2) The revised water quality Reserve Methodology (Hughes, 2005) uses the terms "Natural", "Good", "Fair", and "Poor" to describe water quality categories. However, the Department prefers that the Categories A-F be applied to the ecological category (water quality) instead of Natural – Poor, to ensure consistency in integration of ecological components. Similarly the water user categorisation should allow for a similar six tier categories to allow for integration with the A-F ecological categories (water quality).

Rationale of classification

The rationale to base a classification system on ecological health and integrity principles is because biological communities reflect not only the influence of the prevailing quality of the water, but also the effect of pollution episodes that may not be detected by routine chemical sampling. The inclusion of biological information in river classification should therefore reduce the risk of placing a river reach in the wrong class (NRA, 1991)

The classification system also considers other water users. The NWA calls for the efficient, equitable and sustainable use of the nation's water resources. These economic, social and ecological goals respectively, are embodied in DWAF's official motto, 'ensuring some, for all, for ever, together'. The economic goal of efficiency relates to maximising economic returns from aquatic resources, or achieving the maximum net benefit. The social goal of equity seeks to allocate and distribute the costs and benefits of utilising the resource fairly, while the ecological goal of sustainability seeks to promote the use of resources in a way that meets the needs of current generations, but does not compromise the economic opportunities and social wellbeing of future generations.

However, these economic, social and ecological goals are potentially conflicting, and the Classification Process therefore requires trade-offs to be made in setting a management class (DWAF, 2006).

Classification framework

The framework for determining a preliminary class will be guided by the following requirements :

- Be consistent with the requirements of the NWA (36:1998);
- Be supported by key policies and principles adopted by DWAF;
- Aligned with the current philosophy and thinking around water resource classification;
- Based on available information and existing methods; and
- Be developed in such a way as to ensure that a seamless transition takes place once a water resource classification system is available for implementation.

Reserve process

It is not the intention of this document to repeat the considerable amount of work that has been undertaken by the Department in assessing the Reserve. The reader is referred to the Integrated and Specialist RDMs Manuals which have been prepared by DWAF.

RDMs Supporting Information

This guideline document should be used in conjunction with other guideline documents and manuals, such as:

- Water Quality Reserve Determination Methods (Hughes, 2005)
- Manual for Ecostatus Determination (Kleynhans et al., 2005)
- Catchment Assessment Study Guideline (DWAF, 2003a, b)
- Catchment Visioning Guideline (DWAF, 2006g)
- Integrated RDMs Manual (DWAF, 1999a)
- Reserve Determination Manuals (DWAF, 1999b)
- South African Water Quality Guidelines (DWAF, 1996)

1.3 Guiding Principles

Background

The determination of RWQOs incorporates ecological, social and economic interests across all components of water resources. Although this guideline provides a generic approach to the determination of objectives, with varying levels of detail and confidence, the approach is based upon a number of key principles adopted by the Department in numerous DWAF policy documents and in particular those described in the Resource Directed Management of Water Quality Policy (DWAF, 2006c). These principles are outlined below, together with the resultant implications of using these principles in the determination of the management class and the RWQOs.

Guiding Principles

The decision-making process used for the determination of preliminary RWQOs is driven by the principle of sustainable development, which is enabled by the principles of integration, equity between generations and dependence on aquatic ecosystems.

Environmental rights, South African Constitution (Act No. 108 of 1996), Section 24:

Everyone has the right :

a. To an environment that is not harmful to their health or well-being; and
b. To have the environment protected, for the benefit of present and future generations, through reasonable legislative and other measures that:
    - Prevent pollution and ecological degradation;
    - Promote conservation; and
    - Secure ecologically sustainable development and use of natural resources, while promoting justifiable economic and social development.

Precautionary Principle (DEAT, 1997):

A risk averse and cautious approach that recognizes the limits of current knowledge about the environmental consequences of decisions or actions.

Default Rule, DWAF (1999a) Resource Directed Measures:

The management class is determined in relation to the present state, but at a level which represents a goal of no further degradation for water resources which are slightly to largely modified, and at least a move toward improvement for water resources which are critically modified.

DWAF, National Water Resource Strategy (2002b:48)

Any water resource which demonstrates 'Unacceptable' conditions is deemed to be unsustainable. In these cases the management class will be determined as a minimum of 'Heavily used/impacted' (the lowest management class), and management will aim to rehabilitate the water resources to this state.

DWAF, National Water Resource Strategy (2002b:7)

Water required to meet basic human needs and to maintain environmental sustainability will be guaranteed as a right, whilst water use for all other purposes will be subject to a system of administrative authorisation.

Finding a balance between the needs of downstream water users and upstream water use and development

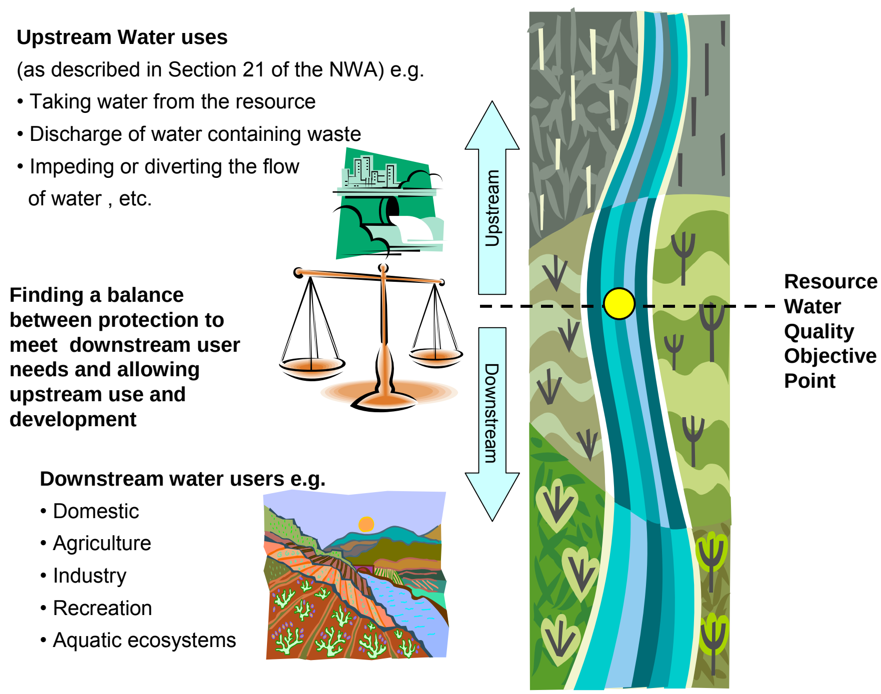


Figure 1.3: Illustration showing the difference between uses and users, as well as the RWQOs point (adapted from Van Wyk, 2006)

The site selected for setting RWQOs (Figure 1.3) affects both the upstream water ***uses*** and the downstream water ***users***. In setting RWQOs the Department strives to achieve a balance between protecting the water resource for the downstream users and allowing use and development of the water resource upstream of that point. For the downstream water users, the focus is on protecting the water quality in order to ensure a healthy functional aquatic ecosystem, while also meeting the water quality requirements of the other five recognised water user groups (domestic, agricultural, industrial and, recreation and aquatic ecosystems) downstream of the RWQOs point. However, the selected RWQO selected might also restrict the type and extent of water use upstream of the point. Water uses refer to those described in Section 21 of the NWA and includes uses such as the discharge of water containing waste (using some of the allocatable water quality) or taking water from a water resource (using some of the dilution capacity) (adapted from Van Wyk, 2006).

Implications of Principles to determining RWQOs

Based on the above principles, the following is implied:

- The Department may not accept deterioration in water quality from the present state, at least when determining RWQOs using the low confidence method, which due to the low level of confidence in the approach, by default adopts the Precautionary Principle.
- In areas of deteriorated water quality, the quality should be improved from an Ecological Category of 'E/F' to an ecological category of 'D' and a management class of 'Heavily used/impacted' (as a minimum).
- The default rule for other users is that the minimum desired category should be 'Tolerable'.
- RWQOs should be determined to (as a minimum) meet the Ecological and Basic Human Needs Reserve (or better).

SECTION 2: LEVELS OF RWQOS DETERMINATIONS

2.1 Levels of RWQOs determination methodologies

Descriptions of different levels

Descriptions of the three levels of confidence in determining RWQOs are shown in Table 2.1.

Rules for selection of appropriate level

The rules for selection of the appropriate level of RWQOs determination are summarized in Table 2.1 and Figure 2.1, and provided in more detail in Table 3.

Table 2.1: Levels of RWQOs determinations

Level	Characteristics	Use
Low confidence	Low confidence; based only on available data and information. Limited possibility of new data collection to assess present state	Individual licensing for small impacts in unstressed catchments or catchments of low ecological and user importance & sensitivity
Medium confidence	Medium confidence, specialist field studies, institutional stakeholder involvement	Individual licensing for low to moderate impacts in relatively stressed catchments or catchments of high importance and sensitivity
High confidence	Relatively high confidence, extensive field data collection by specialists, intensive stakeholder involvement	All compulsory licensing (stressed catchments). Individual licensing, for large impacts in any catchment. Small or large impacts in very important and/or sensitive catchments.

The following rationale (Figure 2.1) is applied in selecting the required level of RWQOs determination:-

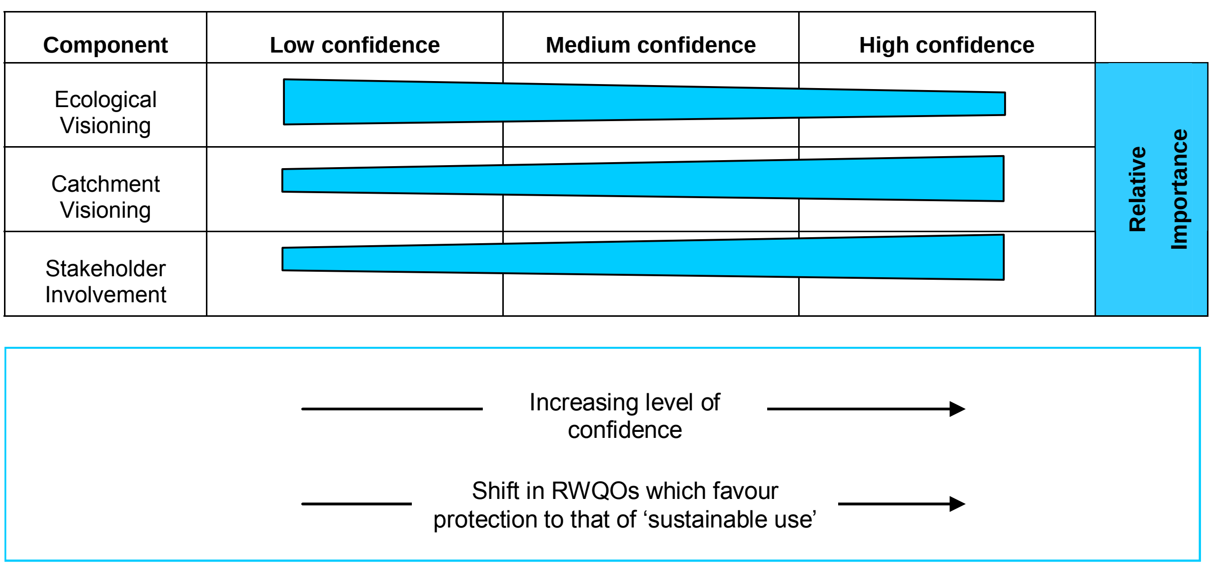


Figure 2.1: Varying level of importance of aspects in determining RWQOs.

Nature versus impact

The level of confidence required to determine RWQOs is seen to be based both on the nature of the catchment (ecological and user importance and sensitivity) and on the degree of impact (stress).

Stressed catchments

The level of confidence adopted (Low to High) in determining the RWQOs is based largely on the existing degree of stress of the water resource (See Section 5), i.e. RWQOs in low stressed catchments may be determined by a low confidence method, while RWQOs in a moderate to highly stressed catchment should be determined at a higher level of confidence using medium or high confidence methods.

However, the level of stress is often not known until the RWQOs are determined and the remaining allocatable resource assessed. As such, an assessment of the stress of a water resource should be seen as an iterative one, i.e. the level of confidence in determining RWQOs may be improved after an initial determination of the RWQOs.

Local expert knowledge and an understanding of the catchment are always important in assessing the initial degree of stress of a catchment, even when determining the RWQOs at a low confidence level.

Confidence

The assessment of confidence is a combination of the confidence in the data used in the RWQOs determination and in the process followed to determine the RWQOs.

- Assessment of the confidence in the data is based on an assessment of the datasets used (higher confidence allows for collecting data for variables of concern that are not monitored routinely - such as dissolved oxygen or toxic substances), specialist knowledge of how representative the data set is to characterise water quality in the whole water resource management unit, and statistical measures of central tendency, etc.
- Confidence is also a function of the process followed. The higher the level of confidence, the higher the level of stakeholder participation and consultation. For example, at a low level of confidence, the generic requirements of user sectors are considered while at a high level of confidence, the requirements of key individual users are considered. At a higher level of confidence, stakeholders participate actively in determining a vision for the catchment and agreement is sought on the RWQOs.

Assessing the degree of stress of a water resource is discussed in Section 5.

Methodology

The method used to derive RWQOs is described in Sections 3-5 with detailed descriptions in Annexures C - E.

SECTION 3: METHODOLOGY FOR RWQOS DETERMINATIONS

3.1 Road map of the RWQOs methodology

Description of each step

This section contains an overview of the methodology for determining RWQOs. A brief description is given of each step in the methodology, with indications of:

- The purpose of the step; and
- The differences between the different levels of RWQO determinations.

Approach

The following approach to the determination of RWQOs is proposed:

- Ecological Requirements (Reserve):
    - Delineate resource unit (spatial scale of the RWQOs)
    - Determine present water quality state
    - Determine desired (attainable) water quality (ecological component of the catchment vision)
    - Determine ecological specifications (water quality component of the Reserve)
- Water User Requirements
    - Identify water users
    - Assess present water quality with regards to water user requirements
    - Determine desired water quality (water user component of the catchment vision)
    - Determine water user specifications
- Determine the Management Class for the water resource through integration.
- Establish RWQOs, through the integration of ecological and water user requirements for water quality (Figure 3.3).
- Establish time period of RWQOs, i.e. seasonal, short-term, or long-term water quality goals for the resource unit.

The approach for determining RWQOs at a low confidence level, although incorporating ecological, social and economic considerations, may not involve intensive stakeholder participation. However, the Department must consider all permissible water uses when determining the RWQOs.

Parallel tasks

The two components for establishing the RWQOs, i.e. the ecological requirements and the water user requirements are indicated in Figure 3.1 and 3.2, and outlined above, as being two separate tasks. The subdivision of the process into two components is necessary due to the division in responsibilities in conducting the various components. The assessment of the ecological specifications is typically a function of the RDMs Directorate of the Department, while the assessment of water user specifications is a function of the Regional Office or, in the future, the Catchment Management Agency. These two components must however be seen as integrative, both contributing to the determination of the RWQOs. The process of developing a Catchment Vision addresses both the ecological and water user aspirations of stakeholders.

In this guideline document these two components of the vision supports the two parallel components of establishing the RWQOs. The ecological component of the Catchment Vision therefore informs the Ecological Requirements (Figure 3.1) and the water user component informs the Water User Requirements (Figure 3.2).

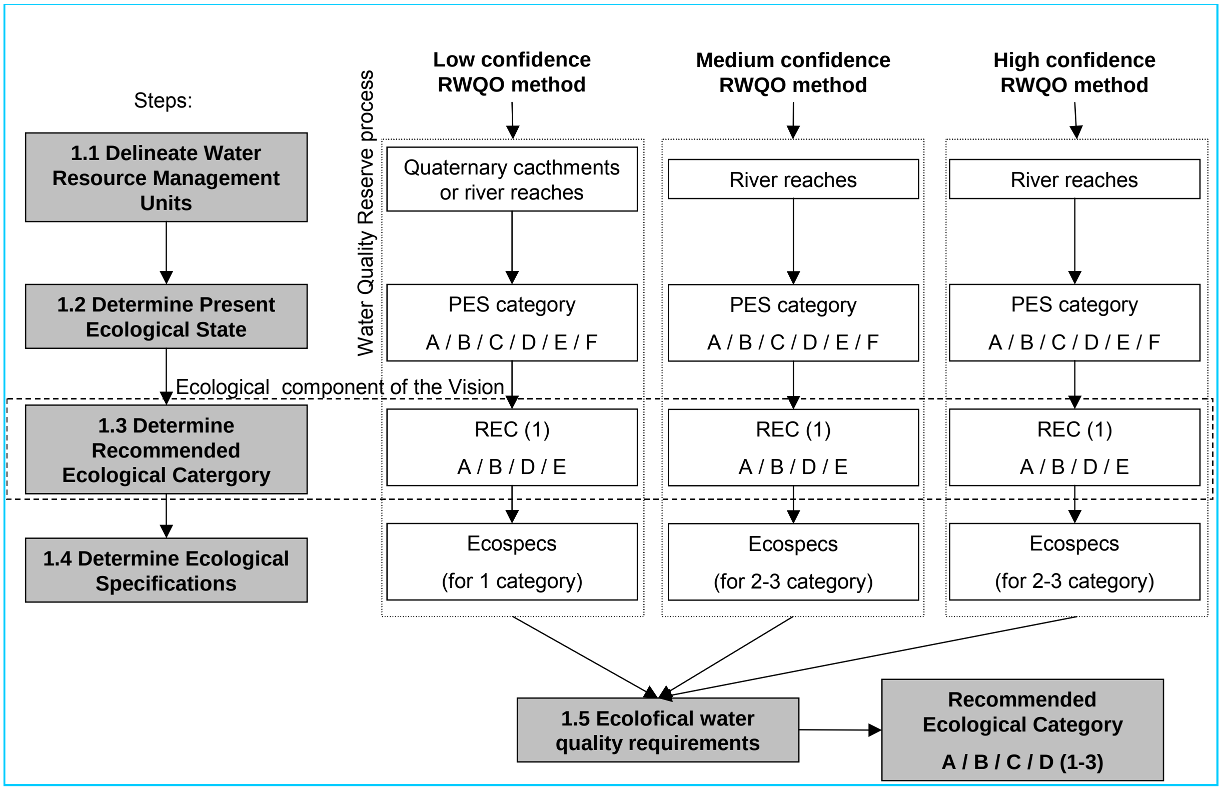
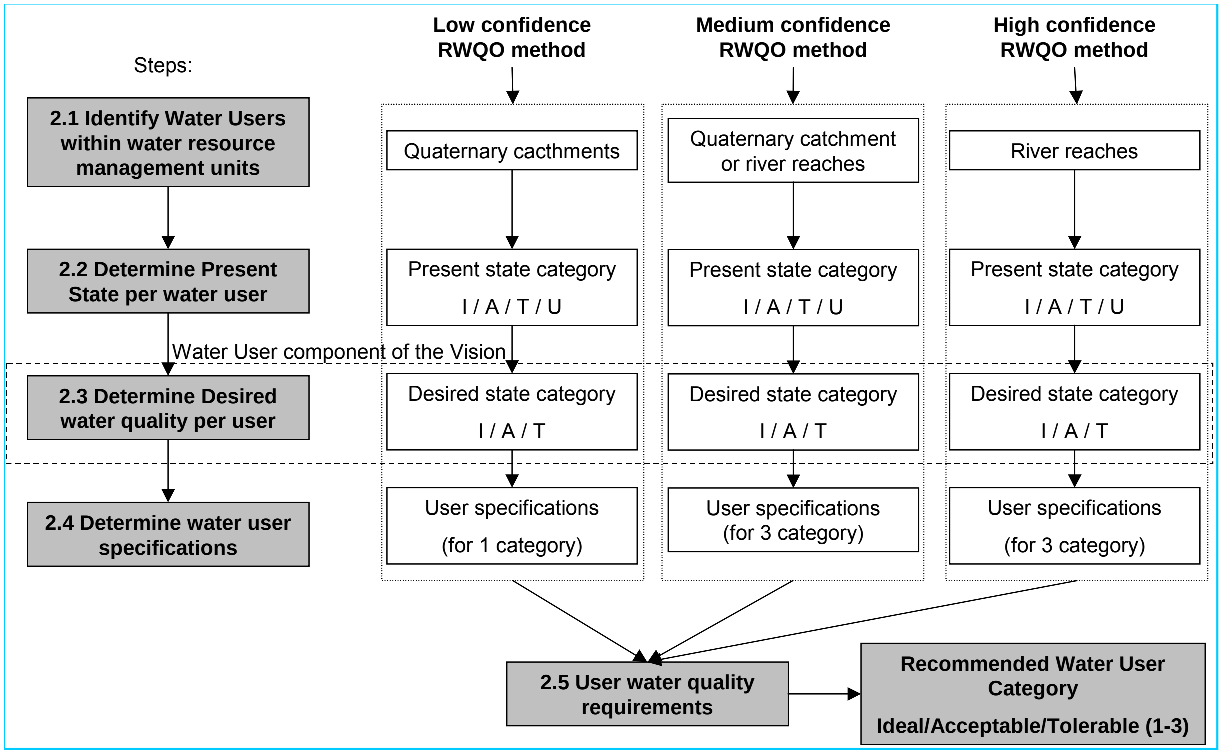


Figure 3.1: Generic procedure for determination of Ecological Requirements.



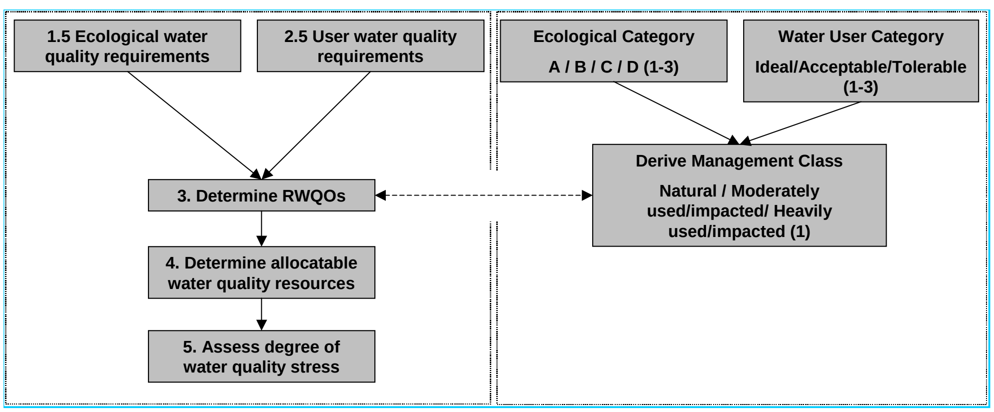


Figure 3.2: Generic procedure for determination of Water User Requirements.

Figure 3.3: Generic procedure for determination of RWQOs.

Note: (1-3) - Reflects the number of categories which may be selected during the Ecological Requirements process or the Water User Requirements process, based on the level of confidence adopted for determining RWQOs (i.e. low, medium or high confidence methods). See Annexures C-E for further details.

3.2 Ecological Requirements

Protection of water resources

The NWA (36:1998) makes provision for the protection of water resources through RDMs to ensure that the quality, quantity and assurance of water are protected, so as to meet basic human needs and to protect the structure and function of ecosystems, thereby securing ecologically sustainable development and utilisation.

The ecological requirements as outlined in steps 1.1-1.5 below are aimed at assessing the ecological component (water quality) of the Reserve. Only an overview is given here and it is not the authors' intention to repeat the Reserve Methodology. For more information the reader is referred to the Water Quality Reserve Determination Manual (DWAF, 1999b, DWAF, 2002c) and the RDMs Integrated Manual (DWAF, 1999a).

Step 1.1: Delineate water resource management units

Spatial scale

RWQOs must be determined for a defined spatial unit or water resource management unit whether it be a river reach, an eco-region, a quaternary catchment or a group of catchments.

The scale for which the RWQOs are determined is dependant upon:

- The level of confidence (low, medium or high)
- The required level of spatial detail
- The heterogeneity of the catchment, i.e. topography, land use, geology, ecology, etc.
- Spatial scale of available information, e.g. Reserve Determination, Catchment Vision, etc.
- Ecological similarity of the water resource with neighbouring catchments.

The Catchment Vision will be set at a catchment to sub-catchment level whereas RWQOs will be set at a sub-catchment to river reach level. Rapid (low confidence) Reserve determinations whether for surface or groundwater, are conducted at the level of a quaternary catchment, while Intermediate to Comprehensive (medium-high confidence) Reserve determinations can typically be conducted on smaller resource units, such as river reaches, eco-regions or geohydrological response units (DWAF, 2002c).

Ecoregions

The breakdown of a catchment into surface water resource management units for the purpose of determining ecological requirements, is done primarily on a biophysical basis, according to the occurrence of different ecological regions (ecoregions) within the catchment. The approach is based on delineating, on a biophysical or ecological basis, relatively homogenous units, within a larger resource which might require their own specification of RDMs (DWAF, 1999a). The geographic area used in generating the catchment vision (DWAF, 2006) is more related to serving the interests of a group of interested water users than on biophysical or ecological characteristics.

NWRCS - Network of significant resources

The procedure that is being developed for the National Water Resource Classification System (NWRCS) describes a comprehensive process and guiding rules to delineate a network of significant resources. If the water resources in a catchment have been classified as part of the NWRCS, then the network of significant resources should be used as the initial template for delineating water resource management units. These can then be subdivided into smaller water resource management units as required.

Geohydrological response units

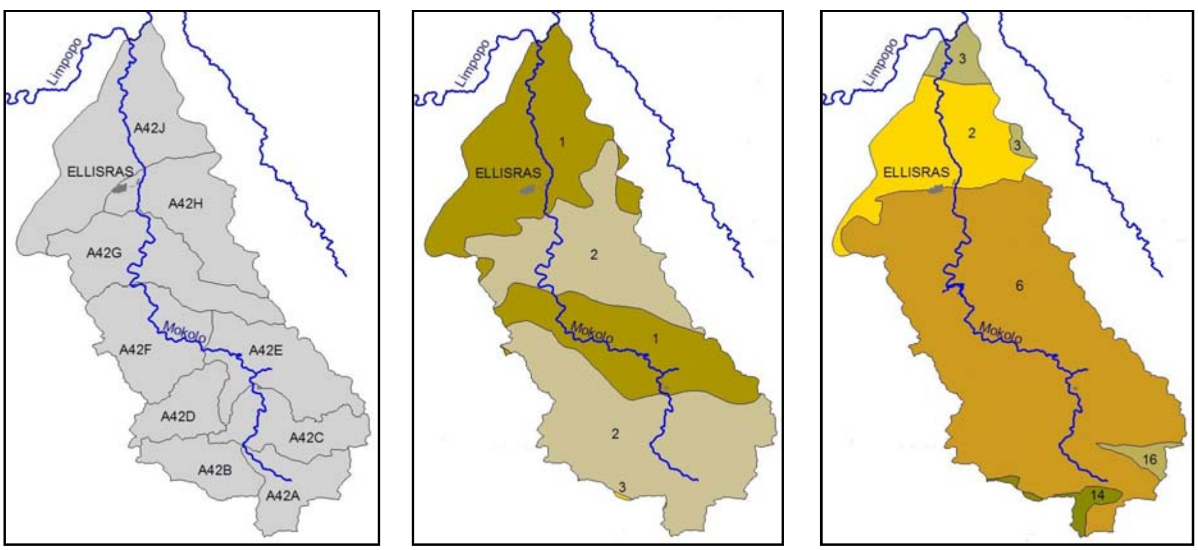
For groundwater, water resource units are initially defined on the basis of geohydrological response units, relatively homogenous aquifer units based on geological conditions.

Guide

The following guide may be applied to the selection of the spatial scale of the Resource unit.

- Low confidence RWQOs determination – quaternary catchment / river reach
- Medium confidence RWQOs determination – river reach
- High confidence RWQOs determination – river reach

The same Resource unit should be used when assessing the ecological and water user requirements (Figure 3.4).



Quaternary catchments | Ecoregions (Level 1) | Geohydrological regions

Figure 3.4: Defining water resource management units.

Step 1.2: Determine Reference and Present State

Reference conditions

Reference conditions describe the natural unimpacted characteristics of a water resource (DWAF 1999a), or the natural unimpacted conditions of the Water Resource Management Unit. The assessment of present state, the selection of the management class and the quantification of the Reserve and RWQOs, are all carried out relative to the reference conditions for that water resource (DWAF, 1999a).

Assessment of the state of the water resource

Step 1.2 entails a present state assessment of the resource water quality in terms of monitored water quality and the degree of modification of this quality from reference conditions.

Purpose of the present state assessment

The present state assessment is required for two purposes:

- Firstly to assess the **degree of modification**, (and hence the current degree of risk of irreversible damage), and if possible to identify whether the resource quality is stable within a particular assessment category, or the water resource is currently degrading due to past or present impacts;
- Secondly to identify what **may be achievable** in terms of the management class, in order to rule out unrealistic options when determining the Ecological Category in Step 1.5. Sometimes structural modifications to the water resource (such as dams or urban development), or short-term needs for economic development may be such that a higher class than the present one can not be practically achieved in the short- to medium-term. Hence the need for intermediate objectives as described in DWAF (2003a).

Ecological state

The ecological state provides a point from which the state of the water quality can be assessed. The ecological state considers, amongst others, the flow, inundation, water quality, stream bed condition, instream biota and riparian or stream bank condition.

The desktop model of Kleynhans (2000) provides an overview of the present ecological state category (PES) at a desktop level, established through local expert knowledge and by considering the above ecological attributes. Results for each quaternary catchment in the country are available from the Department.

Ambient water quality

An assessment of the present state or ambient water quality within the Water resource management unit should include:

i. Identifying water quality stations or monitoring points within the catchment. These may be DWAF stations, or belong to Water Boards, catchment forums, private companies or local authorities.
ii. Extract water quality data for these stations. This can be done either from the DWAF water quality database (WMS), from tools such as Water Quality on Disk (available from DWAF or the CSIR), or the water quality information systems of Water Boards, catchment forums, etc.
iii. Obtain water quality statistics for each of the monitored chemical parameters, e.g. pH, EC, TDS, Ca, Mg, K, Na, TAL, Cl, F, Si, SO_4, NH_4, NOx, KN, PO_4, TP
    a. Min – Max (range)
    b. 5^{th} – 95^{th} percentiles
    c. Median, mean

Ecological Assessment Categories

Based on an assessment of the present state, a present ecological state category can be assigned to the water resource management unit. The six ecological present state categories are identified simply as categories A-F, and are described in more detail in the Reserve Manuals (DWAF, 1999b).

Step 1.3: Determine the Recommended Ecological Category

Ecological visioning

To contextualise the present state of a water resource, it is important to have an idea of what is desirable for the water resource management unit. An understanding of what the ecological state of a river should be can provide water resource managers with direction for making decisions and implementing management actions.

Factors to consider

Many factors can be considered in determining the recommended ecological category for a particular water resource management unit, including:

- The ecological importance (in maintaining ecological diversity and functioning at local and wider scales) and sensitivity (ability to tolerate disturbances) of the system. The ecological importance and sensitivity of the water resource considers biodiversity, rarity, uniqueness, and fragility, from habitat, species and community perspectives.
- What can be achieved towards improvement of the resource water quality, given that some prior impacts or modifications may not be practically reversible due to technical, social or economic constraints.
- The strategic importance of the water resource for social and economic development.

Ecological Importance and Sensitivity

Ecological importance of a river is an expression of its importance to the maintenance of ecological diversity and functioning on local and wider spatial scales. Ecological sensitivity (or fragility) refers to the system's ability to tolerate disturbance and its capacity to recover from disturbance once this has occurred (resilience).

In determination of RDM, the following ecological aspects are considered as the basis for the estimation of ecological importance and sensitivity:

- The presence of rare and endangered species, unique species (i.e. endemic or isolated populations) and communities, intolerant species and species diversity.
- Habitat diversity, including specific habitat types such as reaches with a high diversity of habitat types, i.e. pools, riffles, runs, rapids, waterfalls, riparian forests, etc.
- The importance of the particular water resource management unit (e.g. river or reach of river) in providing connectivity between different sections of the whole water resource, i.e. whether it provides a migration route or corridor for species.
- The presence of conservation areas or relatively natural areas along the river section.
- The sensitivity (or fragility) of the system and its resilience (i.e. the ability to recover following disturbance) of the system to environmental changes are also considered. Consideration of both the biotic and abiotic components is included here.

Procedures for rating ecological importance and sensitivity are given in detail in each specialist manual (DWAF, 1999a, 1999b).

Ecological Assessment Categories

Based on an assessment of the desired state, a recommended ecological category (REC) can be assigned to the water resource management unit. The four recommended ecological categories are identified simply as categories A-D, and are described in more detail in the Reserve Manuals (DWAF, 1999b). Categories E and F are not considered as desired ecological states since they are significantly modified and are considered ecologically unsustainable in their present state.

Step 1.4: Determine Ecological Specifications

Ecological Specifications

The ecological specifications (so-called 'ecospecs') determined here are numeric descriptions of the ecological component (water quality) [3] of the RWQOs and define the output of a Reserve determination process.

The ecospecs describe the upper and lower boundaries of the selected ecological category (A-D), in terms of water quality. Typical chemical parameters for which ecospecs are described in a Reserve determination, include:

- Total dissolved solids (TDS) or Electrical Conductivity (EC)
- pH
- Dissolved oxygen
- Temperature
- Total suspended solids (TSS)
- Major ions – sodium, magnesium, calcium, potassium, chloride, sulphate, carbonate-bicarbonate
- Salts – $MgSO_4$, Na_2SO_4, $MgCl_2$, $CaCl_2$, $NaCl$, $CaSO_4$
- Nutrients – ammonia, total inorganic nitrogen, ortho-phosphate, total phosphorus
- Toxic substances
- Biological indicator water quality
- Chlorophyll *a* as an indicator of algal abundance

At a low confidence level, ecological specifications only need to be given for the recommended category. At a medium to high confidence level, ecological specifications are typically given for the recommended ecological category plus for one category up (unless recommended category is an 'A') and one category down. The implications of one category up and one down, on the water resource, are also given. The intention is to give the Department or CMA the opportunity to adequately integrate the ecological and water user components while being fully aware of the implications of their choice.

Step 1.5: Ecological Requirements

Output

The output of the ecological requirements is the ecological Reserve (water quality) or a proxy for the ecological Reserve, which defines the recommended ecological category with corresponding water quality ecological specifications. The ecological requirements will establish the:

- Present ecological category (A-F)
- Recommended ecological category (A-D), and
- Associated ecological specifications for specific water quality variables

Mapping Categories to Classes

Ecological categories may, in combination with the water user category, be mapped to a management class. The mapping route from the four ecological categories (A, B, C, D) system to the three class system (Natural, Moderately used/impacted, Heavily used/impacted) is as follows:

- A = Natural
- A/B, B, B/C = Moderately used/impacted
- C, C/D, D = Heavily used/impacted

The Reserve considers both the Ecological Requirements and Basic Human Needs. In this guideline document, the water quality requirements for Basic Human Needs are dealt with under domestic user requirements in Section 3.3.

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[3] Ecospecs may also include numeric descriptions of flow, habitat, biota etc. and are not only defined for water quality.

3.3 Water User Requirements

Water User Requirements

Water user requirements, as outlined in Steps 2.1-2.5, aim to assess the Basic Human Needs Reserve (water quality), and to assess the other water quality requirements of other water users.

Step 2.1: Identify Water Users

Identify water users

All water users within the catchment must be identified, whether they are seen as an existing permissible water-use or not [4]. Water users may be grouped into the following categories (WRC, 1998, DWAF, 1996):

- Domestic
  - Drinking (health)
  - Food preparation
  - Bathing
  - Laundry
- Agriculture
  - Live stock watering
  - Irrigation
  - Aquaculture
- Industry
  - Category 1 (High water quality requirement)
  - Category 2 (Intermediate water quality requirement)
  - Category 3 (At least domestic water quality requirement)
  - Category 4 (Low water quality requirement)
- Recreation
  - Full contact
  - Intermediate contact
  - Non contact

It must be noted that only the major water user sectors are presented here. More detailed information may be collected on the user sector, e.g. under agriculture: irrigation - maize, tobacco, vegetables etc. Certain water users may have specific water quality requirements, e.g. tobacco is sensitive to elevated chloride concentrations.

Sources of information

Water users who are exercising existing lawful use within the Water resource management unit should be identified from the following sources:

- Registered water users – DWAF WARMS database
- Water Users Association
- Local knowledge of the catchment
- Site visit and/or field investigations
- Maps – orthophotos, satellite imagery, aerial photographs
- Land use database (1996) – currently being updated
- State of Rivers Reports

Catchment Assessment Study

If the Water resource management unit falls within an area where a catchment assessment study has been undertaken, this will provide valuable information as to the state of the catchment, existing water users and the desired water quality within the catchment. The reader is referred to the Water Quality Catchment Assessment Study Guideline (DWAF, 2003b).

[4] Note: RWQOs should take into account both permissible water uses and possible future water uses, however they may need to take cognisance of unlawful water uses, which may place additional stress on the water resource.

Step 2.2: Assess Present State per water user

Variables of concern

Based on the present water quality, identified water users and the permissible water uses within the catchment, the variables of concern must then be identified. The variables of concern are based on water user requirements and known sources of pollution within the Water resource management unit which may impact upon water quality. The variables of concern therefore provide key indicators to monitor changes in the water quality which would render the water unfit for a specified use.

For example, in areas of gold mining, turbidity, pH and sulphate (SO_4) may be high due to pollution of water resources – these would then be considered as variables of concern.

Tobacco farmers are known to require water quality with low chloride (Cl) concentrations. Accordingly, Cl would be a variable of concern in a catchment where tobacco farming takes place.

Key water quality constituents will fall into one of the following groups:

- Physical properties – pH, conductivity, suspended solids
- Cations – Na, K, Mg, Ca, NH_4
- Anions – Cl, SO_4, HCO_3, CO_3, NO_3, PO_4, OH
- Salts – $MgSO_4$, Na_2SO_4, $MgCl_2$, $CaCl_2$, NaCl, CaSO4
- Metals – e.g. Fe, Mn, Al, Zn, Cu, Ni, Cr, Co, Pb, Se
- Other inorganic constituents – e.g. B, Si, F, As
- Organic constituents

The Guideline for Monitoring and Auditing for RDMWQ (DWAF, 2006) also provides guidance on the selection of variables of concern and recommends an “essential” list of variables that are critical for the affected water users.

Water quality state

An assessment of the water quality within the water resource management unit should be compared to the South African Water Quality Guidelines, per water user sector, to identify the present state of the water quality.

Fitness for use categories

Water quality may be categorised as follows (Van Wyk, Moodley & Viljoen, 2002):

- Ideal
- Acceptable
- Tolerable
- Unacceptable

At present the DWAF Water Quality Guidelines (DWAF, 1996) only reflect the Target Water Quality Range (TWQR), which may be considered as Ideal water quality. The Water Quality Guidelines have been used as a basis for establishing generic water quality limits for each of the water user categories. The method used to covert the guidelines to categories is discussed in Annexure A.

Step 2.3: Determine Desired Quality per water user sector

Catchment Visioning

A catchment vision should be established to identify the current and future water user requirements and the desired state of the catchment through agreement with key stakeholders. The reader is referred to the Department's Catchment Visioning guideline (DWAF, 2004a) for details of how to go about establishing a catchment vision.

The requirements for catchment visioning depend on the level of detail adopted in determining the RWQOs.

- The low confidence determination, although considering existing, permissible uses, also considers future water uses through catchment visioning, but it does not consider a relaxation in water quality at the expense of socio-economic development.
- At a medium to high confidence level, catchment visioning and stakeholder participation in determining RWQOs is vital. A compromised (lower) water quality may be considered to ensure economic and social development while still ensuring sustainable utilisation of the water resource, i.e. relaxation in the fitness-for-use category from Ideal to Acceptable or Tolerable.

Relationship of visioning and objectives hierarchy with other RDMs-related management instruments

The interim version of the classification and RWQOs makes provision for a dual approach to defining objectives. The 'low confidence' option refers to a low confidence option where little or no information about the aquatic system is available for decision-making. For this approach, the precautionary principle is used to guide decisions. The medium to high confidence approach options are based on better (or more complete) information about the aquatic system.

The outputs from both of these options can be used as a compatibility cross-check against the outcomes of the objectives hierarchy process, i.e. the management objectives that stem from the vision.

The power of the process provided here lies in being able to derive technical operational management objectives that can be drawn back directly to the catchment vision, thus making the objectives and their outcomes answer to the 'heart and soul' of human aspirations with regard to the water resource.

About this approach

The reader should consult the Catchment Visioning document (DWAF, 2006f) for more detailed information on establishing a catchment vision.

Water user categories

At a low confidence level, the desired water user category, by default, is conservatively set to the present state provided the present state is better than the Tolerable category. If the present state is poorer than Tolerable, then the desired water user category is set (i.e. raised) to the Tolerable category.

The method does, however allow for some flexibility with regards to determining the water user category. At a low confidence level, *in the absence of data*, it is recommended that the desired water user category be conservatively set to the present state.

At a low confidence level, *with the availability of catchment specific water quality data* the water user category may be moved up or down from the present category provided the change can be justified and the reasons for the change are properly documented. At medium or high confidence levels, the desired water user category is set through stakeholder participation and may be moved up or down from the present category to Ideal, Acceptable or Tolerable.

It is important to stress that when a water user category is moved up or down from the present state, i.e. allowing for an improvement or deterioration in the water quality of the water resource management unit, the implications of such a change, on both the water resource and the water users, must be adequately known, understood and accepted.

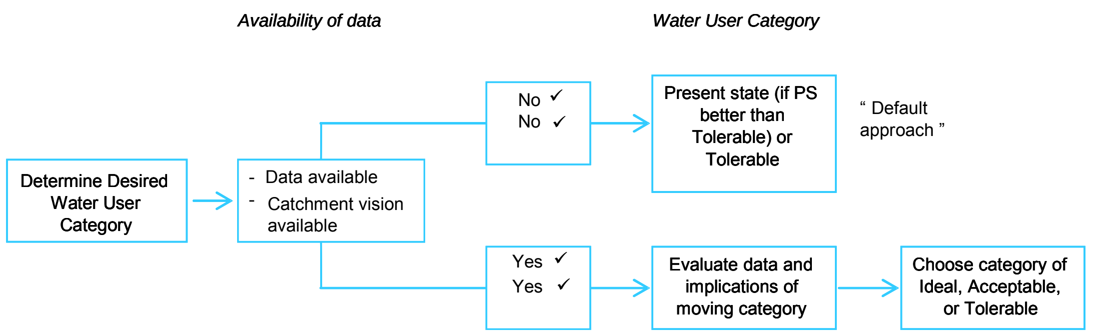

Figure 3.5: Flow diagram for selecting the desired water user category (low confidence method).

Step 2.4: Determine Water User Specifications

Water User specifications

The water user specifications are a numeric description of the water user requirements.

At a low confidence level these water user specifications are determined from the desired water user category (Step 2.3) and the associated generic water quality limits for that category (Annexure A). With increasing levels of confidence, the water user specifications for the selected water user category must be based on site specific water quality data and site specific water user requirements.

Since the ecological water quality requirements (Reserve) will provide details for one class up and one class from the present state, at a medium to high confidence method, the ecological specifications are available to assess the resultant implications of relaxed water quality requirements on the ecological component.

Water Quality Guidelines

The water quality requirements (Ideal, Acceptable, Tolerable) of the water users (at a low confidence level) is based upon the generic RWQOs determined from the South African Water Quality Guidelines for Domestic, Recreational, Agriculture, and Industry (DWAF, 1996).

The Basic Human Needs Reserve is currently determined for a Class 1 (Good) resource, based on the WRC Guidelines for Domestic Water Supplies (WRC, 1998). This water quality is less stringent than the TWQR (Ideal) for domestic use given in the South African Water Quality Guidelines (DWAF, 1996).

Target Water Quality Range

As a matter of policy, the Department strives to maintain the quality of South Africa's water resources in such a way that they remain within the No Effect Range (DWAF, 1996). The No Effect Range in the South African Water Quality Guidelines is referred to as the TWQR, categorised as the Ideal Water User Category.

Users of the South African Water Quality Guidelines should note that an important implication of setting the TWQR equal to the No Effect Range is that it specifies good or ideal water quality, instead of water quality that is merely acceptable to users.

Which users are considered

At a low confidence level, it is likely that all existing permissible water uses within the water resource management unit will be considered. However, with increasing levels of confidence and stakeholder participation, certain uses may be excluded, e.g. due to particularly stringent requirements that are not aligned with the catchment vision, or certain users may accept a poorer water quality than that specified for the water user category.

Step 2.5: User Requirements

Output

The output of the water user requirements is the Basic Human Needs Reserve (water quality), an assessment of the present water quality with regards to water user requirements and a statement of the desired water quality with corresponding water quality limits.

Water User Category

The water user category for domestic, agriculture, industry and recreation can be classified as :

- Ideal,
- Acceptable,
- Tolerable.

User category 'unacceptable' is not considered as a management category.

3.4 Resource Water Quality Objectives

Step 3: Determine RWQOs

Integration

The RWQOs are determined through the integration of the ecological and water user requirements, with the most stringent water quality or most sensitive water user, defining the RWQOs within the desired category or management class. The water use must be beneficial, in the public interest and promote the values described in Section 3(2) of the NWA (36:1998).

Time Frame

The temporal scale for the determination of RWQOs must always be defined. The temporal aspect in the determination of RWQOs plays a number of roles, as outlined below.

Duration of RWQO:
RWQOs must be determined for a specific time period, i.e. the duration over which RWQOs apply:

- Short-term – 2 years
- Medium-term – 2-5 years
- Long-term – > 5 years

For example, in instances where a water resource is significantly impacted, resulting in non-compliance with the determined RWQOs, the present water quality may be set as a short-term RWQOs ensuring no further deterioration in water quality, while the determined RWQOs are set as the medium- or long-term objective.

Compliance of water quality with the RWQO:

It is unlikely, and not expected, that in-stream water quality will comply with the RWQOs for 100% of the time. As such, a target of 95% compliance is recommended.

Period for which RWQO are determined:

RWQOs may be determined for the following periods:

- Annual – i.e. RWQOs apply for a complete hydrological year.
- Seasonal – i.e. RWQOs apply for a particular season within the year. Here the most sensitive season, e.g. dry season may apply.
- Monthly – i.e. RWQOs are determined for each month of the year.

Spatial scale

The spatial area or water resource management unit (i.e. river reach, quaternary catchment etc.) for which the RWQOs are determined must be clearly stated. The point where compliance to the RWQOs is measured is situated at the downstream end of the water resource management unit.

Classification

Based on the determined ecological and water user categories, a final management class can be determined. Management classes described in ecological and water user terms have been identified as Natural, Moderately used/impacted and Heavily used/impacted.

Mapping Categories to Management Classes

The mapping route from the four ecological categories (A, B, C, D) to the three water user categories and the management class is provided in Table 3.1.

Table 3.1: Mapping ecological and water user categories to management class (illustrated in Figure 1.2).

Ecological Category	Water User Category	Management Class
A	Ideal	Natural
B/C	Acceptable	Moderately used/impacted
C/D	Tolerable	Heavily used/impacted

* (approach to be finalised through the national classification system)

Review

The RWQOs once selected, should be reviewed against the following criteria to ensure their relevance and applicability within the water resource management unit:

- Present water quality – are RWQOs achievable against the present state or will it require considerable management intervention or re-engineering.
- Upstream and downstream water quality requirements.

Acceptance of the RWQOs

It is recommended that the final RWQOs should be signed off at a water management area (WMA) level to provide a formal record of decision.

The final RWQOs report should properly document:

- the level of confidence selected,
- the reasons for delineating the water resource management units,
- the variable of concern that were selected, the RWQOs that were developed, and
- the level of stakeholder participation in the process, etc.

The output of the Resource Water Quality Objectives Model (WQM 1.7.2.1) can be used to summarise the determined RWQOs.

Fate of RWQOs in the RQOs process

Although RWQOs are not formally gazetted, they provide essential input to the process of setting RQOs which are officially gazetted as part of the classification process.

SECTION 4: ALLOCATABLE WATER QUALITY

Background

The RWQOs provide the numeric or descriptive goals, within which the water resource must be managed. However, these water quality 'limits' can also assist the Department in assessing the extent of the remaining allocatable water quality within a water resource management unit, and how a possible licence application may impact upon this allocatable resource.

Allocatable water quality defined

In the RDMWQ Policy document, "Allocatable water quality" is defined as the maximum worsening change in any water quality attribute away from its present value, which maintains it within a pre-determined range that reflects the desired future state (typically defined by a resource quality objective). If the present value is already at or outside the predetermined range, this indicates that none is allocatable, and that (a) reduced pollution loads relating to the affected attribute(s), and/or (b) remediation of the resource, may be necessary.

It is also stated that it is the Department's policy to only use "Assimilative capacity" as a routine management instrument in the particular context of dilution capacity. The term "assimilative capacity" refers to the capacity of a water resource to assimilate disposed waste, through processes such as dilution, dispersion, and chemical and biological degradation, without water quality changing to the extent that fitness for use or ecosystem health is impaired (DWAF, 1995). Assimilative capacity depends on many factors and it is evident that quantifying assimilative capacity to the extent that this can translate into useful management instruments could be extremely complicated. It is therefore the Department's policy to use this as a routine management instrument only in the particular context of dilution capacity.

Approach

The accompanying RWQOs Model (WQM. 1.7.2.4) can be used to determine the RWQOs and the corresponding allocatable water quality for the water resource management unit. The allocatable water quality is calculated as the RWQOs minus the present state, i.e. RWQOs – present state. In this way, the allocatable water quality can be determined for each parameter of concern.

Allocatable = RWQOs – Present State

The 'Allocatable water quality' may be expressed in terms of the units in which the respective variables are measured, or as 'Allocatable loads', which are derived from the 'target flow'. The statistical confidence level in determining the allocatable water quality is based on the percentiles provided for the present state. The confidence in the allocatable loads is a function of the percentiles provided in the present state and the 'flow assurance'.

Allocatable water quality may in future be included in a water allocation plan as described in section 9(e) and section 45 of the National Water Act.

Selecting a 'target flow'

There are a number of options for selecting a 'target flow'. These include:

- Select the maintenance low flow that was determined as part of a Reserve study. The maintenance low flow is generally regarded as the flow that would occur for about 70% of the time, or
- If the present flow is more than the maintenance low flow then use the present flow (measured or use simulated present day flows), or
- In regulated rivers where capping flows have been specified as part of a Reserve study, the capping flows can be used.

The choice of the target flow is dependant on the specific flow conditions in the system where the RQOs are determined.

The target flow may also differ for different variables. This is done by identifying the critical condition or "reasonable worst case scenario" for a specific variable. For example, in the USA the critical condition for dissolved oxygen is taken as low flow summertime condition (typically the 7Q10 flow which is the lowest 7-day duration mean flow with a 10 year recurrence interval).

Salinity RWQOs may be specified for the low flow season/month.

Setting RWQOs at present state

In those instances where a water resource is significantly impacted, resulting in non-compliance with the determined RWQOs, the present water quality may be set as short-term RWQO. This would ensure that no further deterioration in water quality occurs, while the determined RWQOs are set as the medium- or long-term objective.

The implications of setting the RWQOs equal to the present water quality is that by default, no water quality is available for allocation. This may be the exact intention of the Department's or a CMA's Water Allocation Plan (WAP), that no further water quality be allocated and/or no new water use licences approved that would require a water quality allocation, until the RWQOs can be determined at a higher level of confidence, or new water quality data obtained for the water resource management unit.

Total allocatable water quality

The method determines the total allocatable water quality per variable. The Department needs to decide on how much (i.e. which portion) and to whom the allocatable water quality resource can be allocated to.

The total allocatable water quality can be allocated to one strategic user or it can be allocated proportionally to various users.

End-of-pipe discharge standards

General and/or special effluent standards are not always stringent enough to achieve the RWQO for a specific variable within a river reach or stream. It is therefore necessary to convert the RWQOs to an end-of-pipe discharge target concentration, to determine if imposing the general or special effluent standard will achieve the RWQO or not. If imposing the general or special effluent standard will not achieve the RWQO, a more stringent standard needs to be imposed in the licence condition, to ensure short- to long-term achievement of the RWQOs. If the general or special standards are stringent enough to ensure achieving the RWQOs, they should be imposed.

The guideline for converting RWQOs into end of pipe discharge standards, included as Annexure B, provides a standard method of converting the RWQOs into end-of-pipe discharge standards. The method is digitised as part of the RWQO Model (WQM 1.7.2.1).

SECTION 5: WATER QUALITY STRESS

What is water quality stress

Water quality stress is the difference between the present water quality and the determined RWQOs.

The European Environmental Agency (2003) defines 'water stress' as that which *"occurs when the demand for water exceeds the available amount during a certain period or when poor quality restricts its use. Water stress causes deterioration of fresh water resources in terms of quantity (aquifer over-exploitation, dry rivers, etc.) and quality (eutrophication, organic matter pollution, saline intrusion, etc.)".*

Degree of stress

The closer the present water quality is to the RWQOs that have been set, the higher is the degree of water quality stress of the water resource.

- If the present state is less than the RWQO for a specific chemical parameter, the water resource is considered *unstressed* for that parameter (Figure 5.1a).
- If the present state is equal to or exceeds the RWQO for a specific chemical parameter, there is, in effect, no remaining allocatable water quality, and the water resource is considered *stressed* for that parameter (Figure 5.1b).

In the accompanying RWQO Model (WQM. 1.7.2.1), a proximity of the present state to within 10% of the RWQO, or in exceedance of the RWQO, is considered *stressed*.

As such, the degree of water quality stress includes all three components of water resource management, i.e. the ecological, social and economic aspects, thereby achieving a balance between socio-economic development and environmental protection.

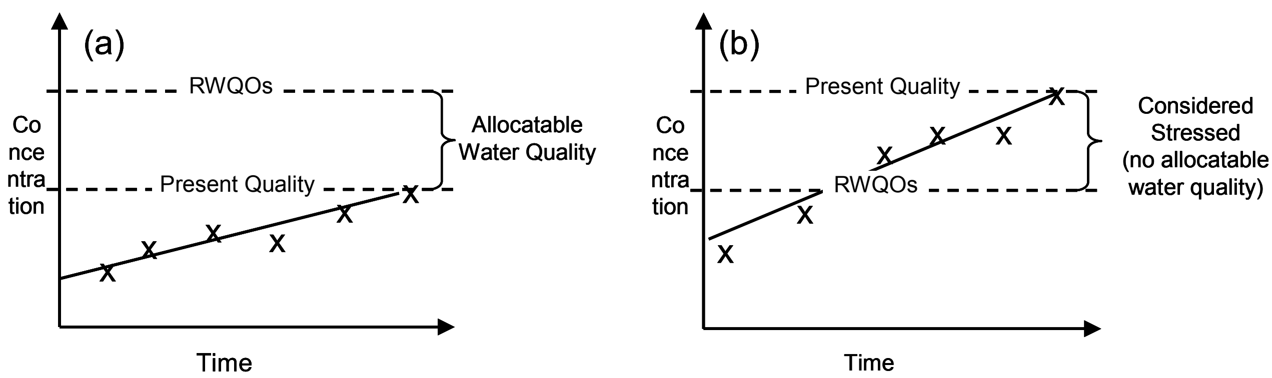

Figure 5.1: Schematic illustration of allocatable water quality in an unstressed and stressed resource.

Why is an assessment of water stress important

The degree of water quality stress of a water resource informs the Department as to:

- What level of detail is required in determining the RWQOs.
- Whether or not a licence can be issued, or a general authorisation considered, for an activity which may impact upon the water quality within the water resource management unit, without compromising the Reserve and existing permissible water uses.
- Whether or not compulsory licensing may be required within a water resource management unit, as per Chapter 4, Part 8 of the NWA (36:1998), to ensure equitable, sustainable and efficient use of water.
- Whether general or special effluent discharge standards will suffice as licence conditions for discharge.
- Other conditions for issue of general authorisations or licences which may be required for discharge or abstraction, as per Section 29 of the NWA (36:1998).

SECTION 6: SUMMARY OF RWQOS DETERMINATION METHODOLOGIES

Table 6.1: Master table of differences/similarities between RWQOs levels by steps

Step	Low Confidence Determination	Medium Confidence Determination	High Confidence Determination
1. Delineate water resource management units	Quaternary, Ecoregion Level II (hydrological ecoregions only)	Ecoregion Level II + stream classification	Ecoregion Level II + stream classification
2. Reference conditions	Default tables (water quality reserve), qualitative or semi-quantitative description	Qualitative or semi-quantitative description	Quantitative description
3. Present state	Historical water quality data, local experts	Historical water quality data plus water quality samples taken over one season	Historical water quality data plus water quality samples taken over one season, extensive literature and field work
4. Importance + sensitivity	Desktop EISC	EIS + field check Social Importance (limited survey)	EIS + field survey SI (extensive survey) Economic importance (extensive survey)
5. Assess desired state	"Default rule" i.e. no degradation from present state.	Consultative process, scenario evaluation	Consultative process, scenario evaluation
6. Determine ecological specifications	Default water quality tables	Intermediate water quality Reserve method	Comprehensive water quality Reserve
7. Determine user requirements	Present state provides point of departure from which to assess user requirements	Present state provides point of departure from which to assess user requirements	Present state provides point of departure from which to assess user requirements
8. Catchment Visioning	RWQOs process informs catchment visioning, no stakeholder involvement	Catchment visioning informs RWQOs process, stakeholder involvement important	Catchment visioning informs RWQOs process, stakeholder involvement essential
9. Determine management class	Ecological category and water user category mapped to management class	Ecological category and water user category mapped to management class	Ecological category and water user category mapped to management class
10. Determine RWQOs	Default rule, consider existing lawful users, strategic and international obligations, plus future user requirements. Most sensitive water user determines RWQOs.	Consider existing lawful users, strategic and international obligations, plus future user requirements. Relaxation in water quality considered.	Consider existing lawful users, strategic and international obligations, plus future user requirements. Relaxation in water quality considered.

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Annexure A:

Generic water quality limits for various water user categories

A.1. Conversion of South African Water Quality Guidelines to Fitness for Use Categories

Context

In South Africa, the South African Water Quality Guidelines (SAWQGs) have been developed as discrete values that depict the change from one category of fitness for use to another (DWAF, 1996). However, the SAWQGs recognise only one management category, namely the Target Water Quality Range (TWQR). Above this value / range, the categories describe an ever increasing negative impact with respect to the use of the water. Thus, for any resource it is necessary to determine whether or not the effect is acceptable to the user.

Assessment of water quality should be linked to management actions to enable managers of water resources to know where to focus the limited resources at their disposal. Van Veelen (2002) developed a protocol to derive and quantify water quality objectives for surface water resources such that it can be measured, which in turn represents the RQO. Aspects of this protocol were used to convert the SAWQGs to fitness for use categories for use in the RWQO model.

Brief overview of approach for setting the RWQOs

The water quality guidelines describe the “fitness for use” of a water resource, while the water quality objectives define “what management action is required” for a water resource. The fitness for use of water is a judgement as to how suitable the quality of water is for its intended use. The following fitness for use categories were linked to the SAWQGs:

- Ideal
- Acceptable
- Tolerable
- Unacceptable

Water quality state

Van Veelen (2002) suggested the development of a range of criteria that describe the change in water quality in terms of fitness for use, and not in terms of an effect on the water user. The fitness for use of water can range from being completely unfit for use to being 100% or ideally fit for a specific use (DWAF, 1996; WRC, 1998; Van Veelen, 2002). According to the SAWQGs (DWAF, 1996) and Van Veelen (2002), the fitness for use of a water resource can be expressed as:

- Ideal – the use of water is not affected in any way; 100% fit for use by all users at all times; desirable water quality; TWQR
- Acceptable – slight to moderate problems encountered on a few occasions or for short periods of time.
- Tolerable – moderate to severe problems are encountered; usually for a limited period only.
- Unacceptable – water cannot be used for its intended use under normal circumstances at any time.

Development of water quality guidelines linked to fitness for use categories

The Department of Water Affairs and Forestry (DWAF) strives to maintain the quality of water of South Africa's water resources such that it remains within the No Effect Range, also referred to as the TWQR in the SAWQGs. The TWQR is a management objective that is used to specify the ideal concentration range and / or water quality requirements for a particular constituent. This is the range of concentrations or levels within which no measurable adverse effects are expected on the health of the user, and should therefore ensure their protection.

As the fitness for use terms may have different meanings or interpretations for different water users, Van Veelen (2002) produced a set of colour-coded "rules" that can be used to derive fitness for use categories from the SAWQGs. The rules have been adapted to include the methodology for converting the SAWQGs to fitness for use categories.

Table A1.1: Rules for setting cut-off values for fitness for use ranges (adapted from Van Veelen, 2002)

USER CATEGORY AND EFFECT				FITNESS FOR USE CATEGORY
DOMESTIC	RECREATION	AGRICULTURE	ECOSYSTEM	(COLOUR)
Upper limit of TWQR. No health risk. No aesthetic effect.	Upper limit of TWQR. No health risk. No aesthetic effect.	Upper limit of TWQR. No reduction in yield. No special management practices.	Upper limit of TWQR. No impact.	Ideal (Blue)
Average of TWQR and Tolerable level. Slight health risk for sensitive individuals. Noticeable aesthetic effect but not objectionable.	Average of TWQR and Tolerable level. Slight health risk for sensitive individuals. Noticeable aesthetic effect, but acceptable.	Average of TWQR and Tolerable level. Only sensitive crops are affected, but no special management practices are required.	Average of TWQR and Chronic Effect Value (CEV). Some chronic effects may occur in sensitive species.	Acceptable (Green)
At Tolerable level / minimal health risk. Slight health risk for most individuals. Objectionable aesthetic effect to sensitive persons.	At Tolerable level / minimal health risk. Slight health risk for most individuals. Objectionable aesthetic effect to sensitive persons.	At Tolerable level / minimal health risk. Some yield loss is experienced or special management practices are required.	Upper limit of CEV. Some acute effects may occur in sensitive species.	Tolerable (Yellow)
Above Tolerable level. Significant health risk with short-term exposure. Aesthetically un-acceptable.	Above Tolerable level. Severe health risk. Aesthetically unacceptable.	Above Tolerable level. The economic viability of irrigation is questionable.	Above the CEV. Species diversity is significantly reduced and community as a whole is com- promised.	Unacceptable (Red)
Gross pollution or deviation from the norm.				Totally unfit for use

Conversion of the SAWQG to Fitness for Use of the Water Resource Categories

The TWQR has been used to define the Ideal category, while the upper limit of where negative effects are seen has been defined as the tolerable category. Assuming that a linear distribution in the data was used to derive the TWQRs (DWAF, 1996), the acceptable category was interpolated to be the average of the Ideal category (i.e. TWQR) and the tolerable level. The unacceptable category is regarded as any concentration / level above the upper limit (i.e. Tolerable).

The water quality limits for the following water uses are presented in Tables A1.2 - A1.12 of this Appendix:

- Domestic
- Agriculture (Livestock watering; Irrigation, Aquaculture)
- Recreation (Full contact, Intermediate contact, Non-contact)
- Industrial (Category 1, Category 2, Category 3, Category 4)

Link to the Reserve and Water Resource Classification for Aquatic Ecosystems

The RWQOs have to take into account the Reserve, which depends on the class of the water resource. The categories are:

A – unmodified natural

B – largely natural

C – moderately modified

D – largely modified

E – seriously modified

F – critically modified

The ecological classification system makes provision for six categories, A, B, C, D, E and F, of which categories A to D fall within the sustainable level, while categories E and F represent unsustainable conditions. The following relationship can be used to link the above ecological categories to the fitness for use categories (water quality assessment categories) (adapted from Van Veelen, 2002).

<table>
<tr><th>FITNESS FOR USE CATEGORY</th><th>COLOUR CODE</th><th>ECOLOGICAL CATEGORIES</th></tr>
<tr><td>Ideal</td><td>Blue</td><td>A</td></tr>
<tr><td rowspan="2">Acceptable</td><td rowspan="2">Green</td><td>B</td></tr>
<tr><td rowspan="2">C</td></tr>
<tr><td rowspan="2">Tolerable</td><td rowspan="2">Yellow</td></tr>
<tr><td>D</td></tr>
<tr><td>Unacceptable</td><td>Red</td><td>EF</td></tr>
</table>

Motivation for approach

The motivation for using the fitness for use ranges in association with the ecological categories (adapted from Van Veelen, 2002) is as follows:

- Category A: This category requires undisturbed conditions and an almost zero risk to the ecosystem. This means that not even short term excursions into the acceptable range can be tolerated.
- Category B: This category allows only a small risk of modification to the ecosystem. In essence, there may be no loss of species diversity, although the numbers of some sensitive species may be reduced. The acceptable level may result in chronic effects in sensitive species but will not cause acute effects. As long as there is a recovery period (at least 50% of the time in the ideal range) and the acceptable range is not exceeded, the requirements for Category B will most probably be met.
- Category C: This category allows a moderate risk of modification to the ecosystem. Some very sensitive species may be compromised from time-to-time, but survival should be possible in refugia. Short-duration excursions into the tolerable range may therefore be allowed, but on the whole the water quality should fall in the acceptable range.
- Category D: A large risk is accepted, but in general the ecosystem should not be modified excessively. Some sensitive species may be absent, but the ecosystem should still function adequately. The water quality will therefore mostly fall in the tolerable range, but no excursions into the unacceptable range are allowed.

References

Department of Water Affairs and Forestry (DWAF) 1996. *South African Water Quality Guidelines for Fresh Water. Edition 2. Volumes 1-7*. Department of Water Affairs and Forestry, Pretoria, Republic of South Africa.

Van Veelen, M. 2002. *The Development of Principles and Procedures for the Establishment of Water Quality Objectives for Aquatic Systems and Their Application on the Jukskei River System, Gauteng*. Ph.D. Thesis. Rand Afrikaans University.

Water Research Commission (WRC), 1998. *Quality of Domestic Water Supplies, Volume 1: Assessment Guide*. No. TT 101/98, Second Edition.

Generic water quality limits for various water user categories - as used in the Resource Water Quality Objectives Model

Table A1.2: Generic water quality limits for Domestic Use.

WATER QUALITY GUIDELINES FOR DOMESTIC USE					
VARIABLE	UNITS	IDEAL	ACCEPTABLE	TOLERABLE	UNACCEPTABLE
PHYSICAL REQUIREMENTS					
Hardness	mg $CaCO_3$	200	300	600	>600
Turbidity	NTU	0.1	1	20	>20
CHEMICAL REQUIREMENTS					
Calcium	mg/l	10	150	300	>300
Chloride	mg/l	100	200	600	>600
Chlorine (upper)	mg/l	0.6	0.8	1.0	>1.0
Chlorine (lower)	mg/l	0.3	0.2	0.1	<0.1
Electrical Conductivity	mS/m	70	150	370	>370
Fluoride	mg/l	0.7	1.0	1.5	>1.5
Magnesium	mg/l	70	100	200	>200
Nitrate + Nitrite	mg N/l	6.0	10.0	20.0	>20.0
PH (upper)		9.5	10.0	10.5	>10.5
PH (lower)		5.0	4.5	4.0	<4.0
Potassium	mg/l	25	50	100	>100
Sodium	mg/l	100	200	400	>400
Sulphate	mg/l	200	400	600	>600
Total Dissolved Solids (TDS)	mg/l	450	1000	2400	>2400
Arsenic	mg/l	0.01	0.05	0.2	>0.2
Cadmium	mg/l	0	0.01	0.02	>0.02
Copper	mg/l	1.0	1.3	2.0	>2.0
Iron	mg/l	0.5	1.0	5.0	>5.0
Manganese	mg/l	0.1	0.4	4	>4
Zinc	mg/l	20	20	20	>20
BIOLOGICAL					
Total coli forms	per 100ml	0	10	100	>100
Faecal coli forms	per 100ml	0	1	10	>10

Reference: Quality of Domestic Water Supplies, Volume 1: Assessment Guide. (Water Research Commission, 1998).
* The 'Ideal' water quality is equated to the Target Water Quality Range (TWQR) provided in the Water Quality Guidelines.
** The above generic water quality guidelines are recommended for use in determining the present and desired water user category at a low confidence desktop and rapid approach.
*** The limits presented above do not take into account site specific conditions.

Table A1.3: Generic water quality limits for Agricultural Use: Livestock Watering

WATER QUALITY GUIDELINES FOR AGRICULTURAL USE: LIVESTOCK WATERING					
VARIABLE	UNITS	IDEAL	ACCEPTABLE	TOLERABLE	UNACCEPTABLE
CHEMICAL REQUIREMENTS					
Calcium	mg/l	1000	1500	2000	>2000
Chloride	mg/l	1000	1750	2000	>2000
Fluoride	mg/l	2.0	4.0	6.0	>6.0
Magnesium	mg/l	500	700	1000	>1000
Nitrate	mg/l	100	250	400	>400
Nitrite		100	150	200	>200
Sodium	mg/l	2000	2250	2500	>2500
Sulphate	mg/l	1000	1250	1500	>1500
Total Dissolved Solids (TDS)	mg/l	1000	2000	3000	>3000
Aluminium	mg/l	5.0	7.5	10.0	>10.0
Arsenic	mg/l	1.0	1.25	1.5	>1.5
Boron	mg/l	5.0	27.5	50.0	>50.0
Cadmium	mg/l	0.01	0.02	0.02	>0.02
Chromium VI	mg/l	1.0	1.5	2.0	>2.0
Cobalt	mg/l	1.0	1.5	3.0	>3.0
Copper	mg/l	0.5	0.75	1.0	>1.0
Iron	mg/l	10.0	30.0	50.0	>50.0
Lead	mg/l	0.1	0.15	0.2	>0.2
Manganese	mg/l	10.0	30.0	50.0	>50.0
Mercury	ug/l	1.0	3.5	6.0	>6.0
Molybdenum	mg/l	0.01	0.015	0.02	>0.02
Nickel	mg/l	1.0	3.0	5.0	>5.0
Selenium	mg/l	0.05	0.063	0.075	>0.075
Vanadium	mg/l	1.0	2.0	2.0	>2.0
Zinc	mg/l	20	30	40	>40
BIOLOGICAL					
Faecal coliforms	per 100ml	200	600	1000	>1000

Reference: South African Water Quality Guidelines, Volume 5, Agricultural Water Use - Livestock watering (DWAF, 1996)
* The 'Ideal' water quality is equated to the Target Water Quality Range (TWQR) provided in the Water Quality Guidelines.
** The above generic water quality guidelines are recommended for use in determining the present and desired water user category at a low confidence desktop and rapid approach.
*** The limits presented above do not take into account site specific conditions.

Table A1.4: Generic water quality limits for Agricultural Use: Irrigation.

WATER QUALITY GUIDELINES FOR AGRICULTURAL USE: Irrigation					
VARIABLE	UNITS	IDEAL	ACCEPTABLE	TOLERABLE	UNACCEPTABLE
CHEMICAL REQUIREMENTS					
Calcium	mg/l	1000	1500	2000	>2000
Chloride	mg/l	1000	1750	2000	>2000
Fluoride	mg/l	2.0	4.0	6.0	>6.0
Magnesium	mg/l	500	700	1000	>1000
Nitrate	mg/l	100	250	400	>400
Nitrite		100	150	200	>200
Sodium	mg/l	2000	2250	2500	>2500
Sulphate	mg/l	1000	1250	1500	>1500
Total Dissolved Solids (TDS)	mg/l	1000	2000	3000	>3000
Aluminium	mg/l	5.0	7.5	10.0	>10.0
Arsenic	mg/l	1.0	1.25	1.5	>1.5
Boron	mg/l	5.0	27.5	50.0	>50.0
Cadmium	mg/l	0.01	0.02	0.02	>0.02
Chromium VI	mg/l	0.1	0.55	1.0	>1.0
Cobalt	mg/l	1.0	1.5	3.0	>3.0
Copper	mg/l	0.5	0.75	1.0	>1.0
Iron	mg/l	10.0	30.0	50.0	>50.0
Lead	mg/l	0.1	0.15	0.2	>0.2
Manganese	mg/l	10.0	30.0	50.0	>50.0
Mercury	ug/l	1.0	3.5	6.0	>6.0
Molybdenum	mg/l	0.01	0.015	0.02	>0.02
Nickel	mg/l	1.0	3.0	5.0	>5.0
Selenium	mg/l	0.05	0.063	0.075	>0.075
Vanadium	mg/l	1.0	2.0	2.0	>2.0
Zinc	mg/l	1.0	3.0	5.0	>5.0
BIOLOGICAL					
Faecal coliforms	per 100ml	200	600	1000	>1000

Reference: South African Water Quality Guidelines, Volume 4, Agricultural Water Use - Irrigation (DWAF, 1996)

* The 'Ideal' water quality is equated to the Target Water Quality Range (TWQR) provided in the Water Quality Guidelines.

** The above generic water quality guidelines are recommended for use in determining the present and desired water user category at a low confidence desktop and rapid approach.

*** The limits presented above do not take into account site specific conditions.

TableA1.5: Generic water quality limits for Agricultural Use: Aquaculture.

WATER QUALITY GUIDELINES FOR AGRICULTURAL USE: AQUACULTURE					
VARIABLE	UNITS	IDEAL	ACCEPTABLE	TOLERABLE	UNACCEPTABLE
PHYSICAL REQUIREMENTS					
Hardness	mg/l $CaCO_3$	50	175	300	>300
CHEMICAL REQUIREMENTS					
Alkalinity	mg/l $CaCO_3$	20	97.5	175	>175
Ammonia	Mg N/l (NH3)	0.03	0.3	1.0	>1.0
Chloride	mg/l	2	6	10	>10
Nitrate	mg/l	300	650	1000	>1000
Nitrite	mg/l	0.05	70.03	140.2	>140.2
pH (upper)		9.0	9.0	9.0	>9.0
pH (lower)		6.5	5.25	4.0	<4.0
Ortho-phosphate	mg/l	0.08	0.34	0.6	>0.6
Sulphide	mg/l	0	0	0.01	>0.01
Aluminium	Mg/l	0.03	0.07	0.1	>0.1
Chromium VI	mg/l	0.02	0.02	0.02	>0.02
Copper	mg/l	0	0.3	0.6	>0.6
Cyanide	Mg/l	0.02	0.11	0.2	>0.2
Iron	mg/l	0.01	0.88	1.75	>1.75
Lead	mg/l	0.01	1.08	2.15	>2.15
Manganese	mg/l	0.1	0.3	0.5	>0.5
Mercury	µg/l	1	140.5	280	>280
Selenium	mg/l	0.3	19	35	>35
ORGANIC AND GENERAL CHEMICAL REQUIREMENTS					
Dissolved oxygen (upper)	mg/l	8	16	20	>20
Dissolved oxygen (lower)	mg/l	6	5	4	<4
Total dissolved gas	mg/l	100	115	130	>130
Phenol	mg/l	1	13	25	>25

Reference: South African Water Quality Guidelines, Volume 6, Agricultural Water Use - Aquaculture (DWAF, 1996)
* The 'Ideal' water quality is equated to the Target Water Quality Range (TWQR) provided in the Water Quality Guidelines.
** The above generic water quality guidelines are recommended for use in determining the present and desired water user category at a low confidence desktop and rapid approach.
*** The limits presented above do not take into account site specific conditions.

Table A1.6: Generic water quality limits for Industrial Use: Category 1.

WATER QUALITY GUIDELINES FOR INDUSTRIAL USE: CATEGORY 1					
VARIABLE	UNITS	IDEAL	ACCEPTABLE	TOLERABLE	UNACCEPTABLE
PHYSICAL REQUIREMENTS					
Hardness	mg/l $CaCO_3$	50	75	100	>100
Total Suspended Solids	mg/l	3	10	25	>25
CHEMICAL REQUIREMENTS					
Alkalinity	mg/l $CaCO_3$	50	175	300	>300
Chloride	mg/l	20	70	120	>120
Electrical Conductivity	mS/m	15	30	70	>70
PH (upper)		8.0	8.75	9.5	>9.5
PH (lower)		7	6.5	6	<6
Sulphate	mg/l	30	80	90	>90
Total dissolved salts	mg/l	100	200	450	>450
Iron	mg/l	0.1	0.56	1.0	>1.0
Manganese	mg/l	0.05	0.525	1.0	>1.0
Silicon	mg/l	5	12.5	20	>20
ORGANIC AND GENERAL CHEMICAL REQUIREMENTS					
COD	mg/l	10	30	50	>50

Reference: South African Water Quality Guidelines, Volume 3, Industrial Water Use (DWAF, 1996)

* The 'Ideal' water quality is equated to the Target Water Quality Range (TWQR) provided in the Water Quality Guidelines.

** The above generic water quality guidelines are recommended for use in determining the present and desired water user category at a low confidence desktop and rapid approach.

*** The limits presented above do not take into account site specific conditions.

Table A1.7: Generic water quality limits for Industrial Use: Category 2.

WATER QUALITY GUIDELINES FOR INDUSTRIAL USE: CATEGORY 2					
VARIABLE	UNITS	IDEAL	ACCEPTABLE	TOLERABLE	UNACCEPTABLE
PHYSICAL REQUIREMENTS					
Hardness	mg/l $CaCO_3$	100	300	500	>500
Total Suspended Solids	mg/l	5	15	40	>40
CHEMICAL REQUIREMENTS					
Alkalinity	mg/l $CaCO_3$	120	360	600	>600
Chloride	mg/l	40	120	200	>200
Electrical Conductivity	mS/m	30	50	120	>120
PH (upper)		8	9	10	>10
PH (lower)		6.5	5.75	5	<5
Sulphate	mg/l	80	165	250	>250
Total dissolved salts	mg/l	200	350	800	>800
Iron	mg/l	0.2	1.1	2	>2
Manganese	mg/l	0.1	1.05	2	>2
Silicon	mg/l	10	25	40	>40
ORGANIC AND GENERAL CHEMICAL REQUIREMENTS					
COD	mg/l	15	40	70	>70

Reference: South African Water Quality Guidelines, Volume 3, Industrial Water Use (DWAF, 1996)

* The 'Ideal' water quality is equated to the Target Water Quality Range (TWQR) provided in the Water Quality Guidelines.

** The above generic water quality guidelines are recommended for use in determining the present and desired water user category at a low confidence desktop and rapid approach.

*** The limits presented above do not take into account site specific conditions.

Table A1.8: Generic water quality limits for Industrial Use: Category 3.

WATER QUALITY GUIDELINES FOR INDUSTRIAL USE: CATEGORY 3					
VARIABLE	UNITS	IDEAL	ACCEPTABLE	TOLERABLE	UNACCEPTABLE
PHYSICAL REQUIREMENTS					
Hardness	mg/l $CaCO_3$	250	375	500	>500
Total Suspended Solids	mg/l	5	20	50	>50
CHEMICAL REQUIREMENTS					
Alkalinity	mg/l $CaCO_3$	300	450	600	>600
Chloride	mg/l	100	150	200	>200
Electrical Conductivity	mS/m	70	120	250	>250
PH (upper)		8	9	10	>10
PH (lower)		6.5	5.75	5	<5
Sulphate	mg/l	200	250	300	>300
Total dissolved salts	mg/l	450	800	1600	>1600
Iron	mg/l	0.3	6.5	10	>10
Manganese	mg/l	0.2	6	10	>10
Silicon	mg/l	20	85	150	>150
ORGANIC AND GENERAL CHEMICAL REQUIREMENTS					
COD	mg/l	30	50	100	>100

Reference: South African Water Quality Guidelines, Volume 3, Industrial Water Use (DWAF, 1996)

* The 'Ideal' water quality is equated to the Target Water Quality Range (TWQR) provided in the Water Quality Guidelines.

** The above generic water quality guidelines are recommended for use in determining the present and desired water user category at a low confidence desktop and rapid approach.

*** The limits presented above do not take into account site specific conditions.

Table A1.9: Generic water quality limits for Industrial Use: Category 4

WATER QUALITY GUIDELINES FOR INDUSTRIAL USE: CATEGORY 4					
VARIABLE	UNITS	IDEAL	ACCEPTABLE	TOLERABLE	UNACCEPTABLE
PHYSICAL REQUIREMENTS					
Hardness	mg/l $CaCO_3$	1000	1000	1000	
Total Suspended Solids	mg/l	25	100	100	
CHEMICAL REQUIREMENTS					
Alkalinity	mg/l $CaCO_3$	1200	1200	1200	
Chloride	mg/l	500	500	500	
Electrical Conductivity	mS/m	250	250	250	
PH (upper)		10	10	10	
PH (lower)		5	5	5	
Sulphate	mg/l	500	500	500	
Total dissolved salts	mg/l	1600	1600	1600	
Iron	mg/l	10	10	10	
Manganese	mg/l	10	10	10	
Silicon	mg/l	150	150	150	
ORGANIC AND GENERAL CHEMICAL REQUIREMENTS					
COD	mg/l	75	75	75	

Reference: South African Water Quality Guidelines, Volume 3, Industrial Water Use (DWAF, 1996)
* The 'Ideal' water quality is equated to the Target Water Quality Range (TWQR) provided in the Water Quality Guidelines.
** The above generic water quality guidelines are recommended for use in determining the present and desired water user category at a low confidence desktop and rapid approach.
*** The limits presented above do not take into account site specific conditions.

Table A1.10: Generic water quality limits for Recreational Use: Full Contact.

WATER QUALITY GUIDELINES FOR RECREATIONAL USE: FULL CONTACT					
VARIABLE	UNITS	IDEAL	ACCEPTABLE	TOLERABLE	UNACCEPTABLE
PHYSICAL REQUIREMENTS					
Clarity	Secchi disk (m)	3	2	1	<1
CHEMICAL REQUIREMENTS					
PH (upper)		8.5	8.75	9.0	>9.0
PH (lower)		6.5	5.75	5	<5
BIOLOGICAL					
Faecal coliforms	per 100ml	130	1065	200	>200
F. streptococci	per 100ml	30	65	100	>100
Coliphages	per 100ml	20	60	100	>100
Enteric virusses	per 100ml	0	5	10	>10
Algae	µg/l Chl-a	15	22.5	30	>30
Algae	Units	6	6	6	>6

Reference: South African Water Quality Guidelines, Volume 2, Recreational Water Use (DWAF, 1996)
* The 'Ideal' water quality is equated to the Target Water Quality Range (TWQR) provided in the Water Quality Guidelines.
** The above generic water quality guidelines are recommended for use in determining the present and desired water user category at a low confidence desktop and rapid approach.
*** The limits presented above do not take into account site specific conditions.

Table A1/11: Generic water quality limits for Recreational Use: Intermediate Contact.

WATER QUALITY GUIDELINES FOR RECREATIONAL USE: INTERMEDIATE CONTACT					
VARIABLE	UNITS	IDEAL	ACCEPTABLE	TOLERABLE	UNACCEPTABLE
PHYSICAL REQUIREMENTS					
Clarity	Secchi disk (m)	3	2	1	<1
BIOLOGICAL					
Faecal coliforms	per 100ml	1000	2500	4000	>4000
F. streptococci	per 100ml	230	485	700	>700
Algae	µg/l Chl-a	15	22.5	30	>30

Reference: South African Water Quality Guidelines, Volume 2, Recreational Water Use (DWAF, 1996)

* The 'Ideal' water quality is equated to the Target Water Quality Range (TWQR) provided in the Water Quality Guidelines.

** The above generic water quality guidelines are recommended for use in determining the present and desired water user category at a low confidence desktop and rapid approach.

*** The limits presented above do not take into account site specific conditions.

Table A1.12: Generic water quality limits for Recreational Use: Non-Contact.

WATER QUALITY GUIDELINES FOR RECREATIONAL USE: NON-CONTACT					
VARIABLE	UNITS	IDEAL	ACCEPTABLE	TOLERABLE	UNACCEPTABLE
BIOLOGICAL					
Algae	µg/l Chl-a	20	25	30	>30

Reference: South African Water Quality Guidelines, Volume 2, Recreational Water Use (DWAF, 1996)

* The 'Ideal' water quality is equated to the Target Water Quality Range (TWQR) provided in the Water Quality Guidelines.

** The above generic water quality guidelines are recommended for use in determining the present and desired water user category at a low confidence desktop and rapid approach.

*** The limits presented above do not take into account site specific conditions.

Annexure B:

Guideline for Converting RWQOs into End of Pipe Discharge Standards

B1.1 Definitions

Mixing Ratio (MR)	The mixing ratio (MR) is the rate of discharge (Q_w) divided by the rate of stream flow (Q_s). MR = Q_w/Q_s
Recommended Resource Directed Value (RRDV)	The recommended resource directed value (RRDV) is the individual end of pipe discharge standard protecting the resource for a specific MR and Class.
Maximum Allowable Resource Directed Value (MARDV)	The maximum allowable resource directed value (MARDV) it the individual end of pipe discharge standard protecting the resource for a specific MR and one class lower than the Class for the RRDV.
Source Directed Value (SDV)	The source directed value (SDV) represents the individual end of pipe discharge value that is achievable by using recognised treatment processes on a predominantly domestic (household) effluent. The SDVs were empirically determined by investigating discharge records from a large number of treatment facilities and it represents the 25^{th} percentile value of the 25^{th} percentile waste water treatment works (WWTW). In other words, the chosen plant performed better for 75% of the time, while 75% of the plants performed better than the chosen plant.
Existing General Standard (EGS)	The existing general standard (EGS) is the existing end of pipe discharge standard applicable in unlisted areas.
Existing Special Standard (ESS)	The existing special standard (ESS) is the existing end of pipe discharge standard applicable in all listed areas, including the special standard for phosphate.
TWQR	Target water quality range.
CEV	Chronic effect value
AEV	Acute effect value

B2: Calculations

Basic Formula

$$C_W = \frac{C_R(MR+1) - Cs}{MR}$$

where C_W = End of pipe discharge standard (RRDV or MARDV)

C_R = Desired maximum in stream concentration (RQOs)

MR = Mixing ratio

C_S = Receiving stream concentration

B2.1 Toxic substances

Mixing Ratio (MR)

Use the 5th percentile flow for the driest month of the year (Q_s) and the design capacity of the facility (Q_w) to determine the mixing ratio.

Receiving stream concentration (C_s)

Use the recommended standard provided in the table below as the background concentration, or zero (0) for all toxic substances, to determine C_s.

All figures to the nearest 0,001mg/ℓ, unless the value is less than 0,001mg/ℓ

							RECOMMENDED STANDARD	
Constituents	Unit	EGS	ESS	SDV	RRDV	MARDV	Short Term	Long Term
Aluminium	mg/ℓ	-	-	0,045	0,281	0,315	0,28	0,28
Arsenic	mg/ℓ	0,5	0,1	0,05	0,244	0,273	0,24	0,24
Cadmium	mg/ℓ	0,05	0,05	0,01	0,011	0,013	0,01	0,01
Chlorine	mg/ℓ	0,1	0	-	0,056	0,063	0,063	0,056
Chrome III	mg/ℓ	0,5	0,05	0,005	1,913	2,142	0,5	0,5
Chrome VI	mg/ℓ	0,05		0,005	0,375	0,420	0,05	0,05
Copper	mg/ℓ	1,0	0,02	0,01	0,009	0,010	0,01	0,01
Cyanide	mg/ℓ	0,5	0,5	0,03	0,206	0,231	0,21	0,2
Fluoride	mg/ℓ	1,0	1,0	0,1	1,350*	1,500*	1,0	1,0
Lead	mg/ℓ	0,1	0,1	0,05	0,013	0,015	0,015	0,013
Manganese	mg/ℓ	0,4	0,1	0,261	0,580*	4000*	0,4	0,4
Mercury	mg/ℓ	0,02	0,02	0,01	0,003	0,004	0,004	0,003
Phenol	mg/ℓ	0,1	0,01	-	0,938	1,050	0,1	0,1
Selenium	mg/ℓ	0,05	0,05	0,1	0,169	0,189	0,05	0,05
Zinc	mg/ℓ	5,0	0,3	0,098	0,068	0,076	0,076	0,068
Iron	mg/ℓ	-	0,3	0,187	-	-	0,3	0,3
Boron	mg/ℓ	1,0	0,5	0,288	-	-	1,0	1,0
Sulphides	mg/ℓS	1,0	0,05	-	-	-	1,0	1,0
COD	mg/ℓ	75	30	50	94	122	75	75
Susp Solids	mg/ℓ	25	10	15	33	37	25	25
pH		5,5-9,5	5,5-7,5	7,5 – 8,0	6,0 – 9,0	6,0 – 9,0	6,0 – 9,0	6,0 – 9,0
Temperature	° C	35	25	-	35	39	35	35
Orthophosphate	mg/ℓ	-	1,0	0,8	0,60	0,90	0,8	0,6
TDS	mS/m above intake	75	15%	-	90	190	75	75
Nitrate/Nitrate	mg/ℓ	-	1,5	7,0	15*	20*	15	20
Ammonia	mg/ℓ	10,0	1,0	2,0	11,6	27	10	10

*Domestic use determines value

Desired maximum in-stream concentration (C_R)

Use the following (refer to SA Water Quality Guidelines for Aquatic Ecosystem) to determine C_R:

Category A : 1,25 TWQR
Category B : 1,0 CEV
Category C : 1,25 AEV
Category D : 1,40 AEV (Jooste, 1999)

B2.2 System variables

Mixing Ratio (MR)

Use the average daily flow of the 5th percentile year (Q_s) (i.e. the total flow for the driest year on record ÷ 365), and the design capacity of the facility to (Q_w) determine the MR.

Receiving stream concentration (C_s)

Use the reference condition for the receiving water body to determine C_s. This should be determined from long-term records, and calculated as the median value for low flow periods (winter in the summer rainfall area, and summer in the winter rainfall area).

Desired maximum in-stream concentration (C_R)

Use the reference condition plus the maximum allowable variation for the chosen class, as given in the latest RDMs documentation to determine C_R.

Example

Total Suspended Solids (values in mg/ℓ)

Category	Reference condition (C_s)	Maximum allowable in-stream value (C_R)
A	20	22 (+10%)
B	20	23 (+15%)
C	20	24 (+20%)
D	20	25 (+25%)

B3: Setting Individual End-of-Pipe Discharge Standards

Possible outcomes

There are three possible outcomes from the calculation of the RRDV and the MARDV, considering the SDV. For each of these a different end of pipe discharge standard is set as shown below:

Outcome	End of pipe discharge standard
SDV ≤ RRDV	RRDV
RRDV < SDV ≤ MARDV	SDV
MARDV < SDV	MARDV

In all cases where the end of pipe discharge standard is set as higher than the RRDV, this standard is a short-term standard, and the RRDV is the long-term standard that should be strived for.

Irrespective of what the outcome of the above is, if the end of pipe discharge standard exceeds the existing general effluent standard or the special effluent standard (in unlisted or listed areas), the existing effluent standard is set as the end of pipe discharge standard.

Receiving stream concentration (C_s)	Use the reference condition for the receiving water body to determine C_s. This should be determined from long-term records, and calculated as the median value for low flow periods (winter in the summer rainfall area, and summer in the winter rainfall area).
Desired maximum in-stream concentration (C_R)	Use the reference condition plus the maximum allowable variation for the chosen class, as given in the latest RDMs documentation to determine C_R.

B4: Default Standards

Mixing Ratio (MR) < 2	When the MR is less than 2, the values for the short-term and long-term individual end of pipe discharge standards in the default tables should be used.
Insufficient data	When enough data are not available for a catchment to perform the calculations, the values for class B in the default tables should be used to set individual end of pipe discharge standards.

Annexure C:

Procedure for the Low confidence DETERMINATION of RWQOs

Introduction

A low confidence RWQO determination is undertaken when there are no or very limited water quality data available for the water resource management unit. The scope for collecting new data to assess the present state is generally very limited. The low confidence method is used in the consideration of individual licences likely to have a small impact in an unstressed catchment or a catchment with low importance and sensitivity. Stakeholder involvement is not a requirement and is limited to consultation with institutions normally involved in the water use licensing process.

When to use

This approach is to be used when no data are available, or only a minimal ecological data set (present state) (Section 2) is available, and assumes data for water quality, SASS and in-stream habitat, and/or fish and/or riparian habitat are available at the level of:

- a Rapid Ecological Reserve determination; or
- State of Rivers Report.

If no data are available, then a low confidence ecological present state assessment can be based on expert opinion and environmental clues (Kleynhans *et al*., 2005).

A water quality Reserve may not be available. If a Reserve determination has been undertaken for the Water resource management unit, then these results should be used instead of repeating section C.1.1.

A catchment assessment study (CAS) may not be available. However, if a desktop or more comprehensive CAS has been undertaken for the Resource unit, then these results should be used instead of repeating section C.1.2.

C.1 Method

C.1.1 Ecological Requirements

Delineate Resource unit

At a low confidence level, the determination of preliminary RWQOs can be done for a quaternary catchment subject to the availability of water quality data.

Refer to the five-step water quality reserve determination methodology for rivers described in Hughes (2005) and the Spatsim help files (Hughes, 2005).

Determine reference conditions

The reference, or natural, condition provides the site-specific benchmark against which the default "Natural" category boundary is assessed. The default benchmark tables (Hughes, 2005) were based on literature and available database information. For a low confidence water quality assessment the default "Natural" or A category boundary is used without modification as the reference condition.

Determine Present State

If no water quality data are available, then a low confidence present water quality state can be estimated using expert knowledge of the resource unit and environmental clues. The Physico-Chemical Driver Assessment Index (PAI) (Kleynhans *et al*., 2005) describes the use of environmental clues to assess the present water quality state in the absence of measured water quality data.

If limited water quality data are available (but less than the minimum number of observations required for a medium confidence assessment as described in Hughes (2005)), then an initial assessment of the present state of the water quality within the Resource unit should be made based on available water quality data. Water quality data should be selected for identified DWAF Water Quality Stations, and may be obtained from the DWAF Water Quality Database (WMS) or Water Quality on Disk.

The water quality data for the area should be analysed statistically to indicate for example the 5^{th} and 95^{th} percentiles, average and median values for each chemical parameter. The statistics required for each constituent are described in Hughes (2005).

The water quality results should then be compared against the water quality default tables in Hughes (2005) to determine the appropriate ecological category (A-F) for the water resource management unit. The selected ecological category, if required, may be evaluated against the desktop results of Kleynhans (2000).

Ecological Importance and Sensitivity (EIS)

The ecological importance of a river is an expression of its importance to the maintenance of biological diversity and ecological functioning on local and wider scales. Ecological sensitivity (or fragility) refers to the system's ability to resist disturbance and its capability to recover from disturbance once it has occurred (resilience). Both abiotic and biotic components of the system are taken into consideration in the assessment of ecological importance and sensitivity. For a low confidence RWQOs determination, the EISC determined by Kleynhans (2000) should be used.

Determine Desired (Attainable) State

To determine the desired ecological category, the following steps are proposed:

- Determine the EISC
- Determine whether the present state should be improved (and if so, by how much) or maintained (which could still require restoration management, depending on the trajectory of change.
- Determine what would be necessary to address the causes.
- Determine how difficult it would be to address the causes (restoration/ reversibility potential).
- Determine the attainable ecological category for each component considering the ecological aims, and the difficulty of achieving the aims (DWAF, 2002c).
- The output resulting from the above should be two ecological categories, one ecological category attainable in the short-term (up to 5 years) and a second ecological category attainable in the medium- to long-term (between 5 to 10 years).

Describe Ecological Specifications

Each of the ecological categories is associated with a level of ecosystem health and integrity and the potential to offer a particular range of goods and services. The task of the ecological Reserve assessment is to provide quantified and descriptive information about the concentrations of water quality variables which:

- Describe the desired ecological category (A to D) of the system, and
- Provide numeric input into quantifying the management class.

The quantified and descriptive information is provided in the form of ecological specifications, termed “Ecospecs” (DWAF, 2002c)

Mapping Categories to Classes

Ecological categories may, in combination with the water user category, be mapped to a management class, i.e. Natural, Moderately used/impacted, Heavily used/impacted. The mapping route from the four categories (A, B, C, D) system to the three class system (Natural, Moderately used/impacted, Heavily used/impacted) is as follows:

- A = Natural
- A/B, B, B/C = Moderately used/impacted
- C, C/D, D = Heavily used/impacted

C.1.2 Other (Human) Water User Requirements

Identify Water Users

All water users within the Resource unit should be identified, e.g. domestic, agriculture, industry, recreation etc. At a low confidence level this may be as detailed as simply identifying the water user sector, e.g. Industry – Category 3. This may be carried out as part of a desktop Catchment Assessment Study (CAS).

Determine the parameters of concern

Identify the physical, chemical and/or biological parameters of concern within the Resource unit, based on the identified user sectors, e.g. for contact recreation microbiological parameters such as faecal coli forms are important. As such, RWQOs in such a Resource unit must include levels for *E. coli*.

Determine Present State

From the available water quality data, an assessment must be made as to the present state of the water quality with regards to all permissible water uses within the Resource unit. Such uses include:

- Basic Human Needs
- Permissible water uses
- Strategic Water Use
- International water use
- At a low confidence level, future water users can be considered in the RWQOs Model. As such, the relative role of catchment visioning in setting RWQOs at a desktop level is small.

Based on the default water quality guideline tables (Annexure A), a corresponding water user category can be assigned to the present water quality within the Resource unit. At a low confidence level this simply entails a comparison of present water quality against the default water quality guideline tables for Ideal, Acceptable, Tolerable, Unacceptable (Annexure A).

Determine Desired Water Quality

An assessment must be made as to what category of water quality is desired for use within the Resource unit, i.e. (Ideal, Acceptable, Tolerable). Note: Category 'Unacceptable' is not considered a desired category

In assessing the desired water quality at a low confidence level only existing water users could be considered, i.e. water user requirements which drive the determination of RWQOs and the corresponding Management Class, must include:

- Basic human needs (Reserve)
- Strategic water use requirements
- International water use requirements
- Existing lawful water use requirements.

In the absence of actual water quality data for the resource unit, the precautionary principle must be applied. Therefore, at a low confidence level the desired water user category may be set conservatively to the present state (provided it is better than Tolerable) or Tolerable. Alternatively, if sufficient information is available, the Department may motivate a better or poorer category than present state, e.g. in line with the catchment vision, from e.g. a present water quality category of 'Tolerable' to a desired water quality category of 'Acceptable'.

Water User Specifications

The desired water user category (Ideal, Acceptable, Tolerable) can be described by quantitative and descriptive information goals, provided in the form of water user sector specifications. These generic water user sector RWQOs are based on the DWAF Water Quality Guidelines (Annexure A).

C.1.3 RWQOs

Integration

The ecological specifications derived in Section C.1.1 must be compared against the water user specifications determined in Section C.1.2, i.e. the Water Quality Guidelines for each of the identified users, i.e.

- Ecological requirements (Reserve)
- Basic Human Needs (Reserve)
- Permissible water uses
- Strategic Water Use
- International water use
- Future use

By default, at a low confidence level, the most stringent water quality requirements or most sensitive user, defines the RWQOs.

Derive Management Class

The management class is determined for the Resource unit. In the absence of the national classification system, the management class can be given for both the ecological and water use categories, e.g.

- Ecological – Good
- Water Use – Ideal

Or mapped to a single management class (See Table 2, Section 3.4) of:

- Natural
- Moderately used/impacted
- Heavily used/impacted

Annexure D:

Procedure for the Medium Confidence DETERMINATION of RWQOs

Introduction

The medium confidence method is a determination that is undertaken when there are sufficient water quality data available for the resource unit to assess the present water quality status (refer to “number of data points” below). There is generally scope for collecting additional data for those variables of concern that are not routinely monitored in the Water resource management unit. The medium confidence method is used in the consideration of individual licences that could possibly have moderate impacts in relatively stressed catchments or in catchments with medium to high importance and sensitivity.

When to use

This approach is to be used when there are sufficient water quality data to assess the present water quality status. Data for water quality, SASS and in-stream habitat, and/or fish and/or riparian habitat are available at the level of:

- An Intermediate Reserve determination (medium confidence water quality reserve determination); or
- State of Rivers Report.

If a CAS has been undertaken at a scale that is compatible with the water resource management unit, then these results should be used instead of repeating section D.1.2.

D.1 Method

D.1.1 Ecological Requirements

Delineate Resource unit

At medium confidence level, the determination of preliminary RWQOs can be done for a river reach subject to the availability of water quality data for that reach. The delineation of the resource units is based on Ecoregion Level II boundaries and stream classification. The locations of significant point and non-point sources, dams and tributaries are also considered when delineating resource units because these can substantially modify the water quality in a resource unit.

Refer to the five-step water quality Reserve determination methodology for rivers described in Hughes (2005) and the Spatsim help files (Hughes, 2005).

Water quality data required for assessment of the ecological

The water quality data requirements to undertake the water quality component of an ecological water reserve assessment are the following (Hughes, 2005).

(*indicates that the variable is optional)

WATER QUALITY VARIABLES	REFERENCE CONDITION	PRESENT ECOLOGICAL STATE
Inorganic salts:		
Data: Ca, Mg, K, Na, Cl, SO_4 **Calculate inorganic salt concentrations:** $MgSO_4$, Na_2SO_4, MgCl, $CaCl_2$, NaCl, $CaSO_4$ **Data analysis:** $MgSO_4$, Na_2SO_4, MgCl, $CaCl_2$, NaCl, $CaSO_4$	Calculate 95% of reference data.	Calculate 95% of present state data.
	Compare to default boundary table.	Compare to relevant boundary table.
	Recalibrate boundary table if necessary.	Assign category. Calculate confidence level.
Nutrients:		
Data: NH_4, NO_2+NO_3, PO_4 **Calculate TIN** (NH_4+NO_2+NO_3) **Data analysis:** TIN and SRP	Calculate 50% of reference data	Calculate 50% of present state data
	Compare to default boundary values	Compare to relevant boundary table
	Recalibrate boundary table if necessary	Assign category. Adjust accordingly using Chl-*a* data. Calculate confidence level.
System variables:		
DO	Calculate 5% of reference data	Calculate 5% of present state data
	Compare to default boundary values.	Compare to relevant boundary table.
	Recalibrate boundary table if necessary.	Assign category. Calculate confidence level.
pH	Calculate 5% and 95% of reference data.	Calculate 5% and 95% of present state data.
	Compare to default boundary values.	Compare to relevant boundary table.
	Recalibrate boundary table if necessary.	Assign category. Calculate confidence level.
Turbidity*	Method not yet developed.	Method not yet developed.
Temperature* **Data:** If no water temperature data are available, calculate daily water temperature from air temperature	Calculate monthly 10% and 90% of reference data.	Calculate monthly 10% and 90% of present state data.
	Calculate the upper and lower boundaries of the categories.	Compare to boundaries obtained for reference condition.
	Summarize results in benchmark table.	Assign category. Calculate confidence level.
TDS / EC	Method under development.	Method under development.

Toxic substances:		
Data: NH_3 (calculate from NH_4 data), Al, As, Atrazine, Cd, Cr, Cu, Cyanide, Endosulfan, F, Pb, Phenol, Hg	Calculate 95% of reference data.	Calculate 95% of present state data.
	Compare to default boundary table.	Compare to relevant boundary table.
	Recalibrate boundary table if necessary.	Assign category. Calculate confidence level.
Biological response variables:		
SASS **Data:** SASS scores and ASPT scores	Assess whether ASPT score from Reference site is >5% different to default Natural boundary.	Compare ASPT scores from resource unit with relevant boundary table.
	Recalibrate boundary if necessary.	Assign category.
CHL-*a** **Data:** Phytoplankton (µg/ℓ) and periphyton (mg/m^2)	Calculate 50% of reference data	Calculate 50% of periphyton data and mean of phytoplankton data.
	Compare to default boundary table.	Compare to relevant boundary table.
	Recalibrate boundary table if necessary.	Assign category. Calculate confidence level.
Toxicity	Method not yet developed.	Method not yet developed.

Number of data points

Use a minimum of 25 samples collected over a 1-3 year period at the present state site and the reference site, including wet and dry seasons, to calculate the relevant percentile concentrations (Hughes, 2005).

Determine reference conditions

The reference, or natural, condition provides the site-specific benchmark against which the default "Natural" category boundary is assessed. The default benchmark tables presented in Hughes (2005) were based on literature and available database information. For a medium confidence ecological water quality assessment the default "Natural" or A category boundary values should be reviewed and modified using observed water quality data and qualitative descriptions.

The relevance of the default benchmark tables is determined by the presence of water quality data for a reference site. If the relevant statistics at the reference site fall within the default "Natural" or A category then the default benchmark table is accepted for the present status assessment. If the reference site statistics fall outside the "Natural" range, then the benchmark table is modified to account for the new "Natural" or A category range. Rules for modifying the default benchmark tables for the different water quality variables, are given in Hughes, 2005.

If an data are not available for an unimpacted site, then:

- Pre-impact data from the present state site can be used, provided data can be extrapolated from present day data and there is evidence of a trajectory of change, or
- Based on expert judgement of natural conditions.

In many resource units, and particularly in the lower reaches of rivers, there are no unimpacted sites, and reference conditions are difficult to infer. Data can be used from neighbouring catchments within the same ecoregion or any acceptable approximation of the natural condition.

Determine Present State

The present ecological state (PES) is the measured, current water quality for each water resource management unit and in many cases provides the point of departure for the development of any management objectives.

Hughes (2005) provides methods for linking chemical and biotic response data to a present ecological state category - Natural, Good, Fair, or Poor. Only data from 1-3 years prior to the assessment of the present status should be used. If the data record is poor (less than a monthly sampling frequency), then data from up to, but no longer than, 5 years prior to the assessment can be used.

The water quality data at the present state site should be analysed statistically to indicate for example the 5th and 95th percentiles, average and median values for each chemical parameter. The statistics required for each constituent are described in Hughes (2005). Refer to the different constituents for the rules to determine the present state category using the default benchmark tables, or the modified benchmark tables if they were adjusted for reference conditions.

Ecological Importance and Sensitivity (EIS)

The ecological importance of a river is an expression of its importance to the maintenance of biological diversity and ecological functioning on local and wider scales. Ecological sensitivity (or fragility) refers to the system's ability to resist disturbance and its capability to recover from disturbance once it has occurred (resilience). Both abiotic and biotic components of the system are taken into consideration in the assessment of ecological importance and sensitivity. For a medium confidence RWQO determination, the EIS must be determined by an aquatic ecologist with knowledge of the area using the methods developed by Kleynhans (2000). The EIS should be checked against field data.

Recommended Ecological Category (REC)

The generic steps required to determine the Recommended Ecological Category (REC) include:

1. Determine reference water quality conditions.
2. Determine the present water quality status (PES).
3. Determine the trajectory of change in water quality, and whether these changes are short- or long-term.
4. Determine critical causes for the present water quality status and/or the trajectory of change, and the sources of these changes.
5. Determine the ecological importance and sensitivity categories (low, moderate, high, very high) in terms of water quality and state the confidence in the evaluations.

6. Determine whether the present water quality state can be improved (if so, by how much), or maintained (which could still require restoration management, depending on the trajectory of change).
7. Determine what would be required to address the causes.
8. Determine how difficult it would be to address the source (restoration/reversibility potential).
9. Determine the Recommended Ecological Category (REC) for water quality and the other ecosystem components considering the ecological aims, and the difficulty of achieving these aims.

The above steps are generally conducted in collaboration with a small team of aquatic specialists where key components of the ecosystem (e.g. water quality, water quantity, biota, etc.) are considered. The output resulting from the above should be two recommended ecological categories, one ecological category attainable in the short-term (up to 5 years) and a second ecological category attainable in the medium- to long-term (between 5 to 10 years).

Describe Ecological Specifications

Each of the ecological categories is associated with a level of ecosystem health and integrity and the potential to offer a particular range of goods and services. The task of the ecological Reserve assessment is to provide quantified and descriptive information about the concentrations of water quality variables which:

- Describe the recommended ecological category (A to D or Natural to Fair) of the system, and
- Provide numeric input into quantifying the management class.

The quantified and descriptive information is provided in the form of ecological specifications, termed “Ecospecs” (Hughes, 2005) and is specified for the recommended ecological category as well as for the categories above and below the REC.

Mapping Categories to Classes

Ecological categories may, in combination with the water user category, be mapped to a management class, i.e. Natural, Moderately used/impacted or Heavily used/impacted. The mapping route from the four categories (A, B, C, D) system to the three tiered management class system (is as follows:

- A = Natural
- A/B, B, B/C = Moderately used/impacted
- C, C/D, D = Heavily impacted

If the Natural/Good/Fair/Poor categories were used in a historical ecological water quality requirements determination, then the ecological categories can be mapped to the management class as follows:

- Natural = Natural
- Good = Moderately used/impacted
- Fair = Heavily impacted

D.1.2 Water User Requirements

Identify Water Users

Within the water resource management unit, all water user sectors and water uses within each sector should be identified, e.g. domestic, agriculture (e.g. irrigation of tobacco, aquaculture of warm water fish species, etc.) industry (power generation, canning industry, etc.), recreation (e.g. swimming, canoeing, hiking, etc.). At a medium confidence level, this may be as a detailed listing of the generic water uses within each water user sector present in the water resource management unit, and providing an estimate of the amount of water used by the different sectors. This information should be available from a Catchment Assessment Study (CAS).

Determine the parameters of concern

Identify the physical, chemical and/or biological parameters of concern within the water resource management unit, based on the identified user sectors and the user categories, e.g. tobacco farming in the irrigation water user sector is sensitive to Chloride (Cl). Therefore, RWQOs in that water resource management unit must include an assessment of Cl.

The water user sectors, user categories with the sectors and the parameters of concern should be confirmed through a limited, but effective stakeholder consultation process. At a medium confidence level, stakeholder consultation can be limited to key stakeholder groupings such as organised agriculture, chambers of commerce, industry associations, government departments, local authorities, etc.

Determine Present State

From the available water quality data, as derived in Section D.1.1 an assessment must be made of the present state of the water quality with regards to all permissible water uses within the Resource unit. Such uses include:

- Basic Human Needs
- Permissible water uses
- Strategic Water Use
- International water use
- Future water uses. As such it is necessary for the Region to have considered the types of water users required in the catchment in the future through a catchment visioning exercise.

At a medium confidence level, additional water quality data can be collected over one season for:

- Key parameters for which no or very limited data exist (e.g. E. coli); or
- At sites where key impacts occur (large abstractions or discharges).

In some cases it may not be practical to collect additional data (e.g. due to budget or time constraints). Under these circumstances, simple mass balance models can be used to estimate the present water quality state using known inputs and flow patterns in the water resource management unit.

Determination of the present state at a medium confidence level entails a comparison of present water quality against the water quality requirements of user sectors and their user categories (Annexure A).

Based on the user water quality requirements, a corresponding water user category can be assigned to the present water quality within the water resource management unit.

Social Importance (SI)

The social importance of a river is an expression of its importance in a social context for the local and wider communities. The Social Importance should be determined by a domain specialist using data collected from a limited social survey of the local and wider communities and available information.

Catchment Visioning

Catchment Visioning plays an important role in the medium confidence level because it informs the RWQOs process. The effective involvement of institutional stakeholders is important for the process.

Determine Desired Water Quality

An assessment must be made as to what category of water quality is desired for use within the water resource management unit, i.e. (Ideal, Acceptable, Tolerable). Note: Category 'Unacceptable' is not considered a desired category

In assessing the desired water quality at a medium confidence level, existing and future water users should also be considered, i.e. water user requirements which drive the determination of RWQO and the corresponding Management Class, must include:

- Basic human needs (Reserve);
- Strategic water quality requirements (if these exist);
- International water quality requirements;
- Existing lawful use water quality requirements; and
- Future user water quality requirements.

At a medium confidence level, the precautionary principle can be used to set the desired water user category equal to the present status provided that the present status is equal to a Tolerable category or better. Alternatively, if sufficient information is available, the Department may motivate for a better, or poorer, water quality category, e.g. in line with the catchment vision, from e.g. a present water quality category of 'Tolerable' to a desired water quality category of 'Acceptable'. Determination of the desired water quality is carried out in collaboration with key institutional stakeholders.

Assessing the desired state also involves the evaluation of alternative scenarios where the upstream and downstream water quality and classification are taken into account. At a medium confidence level, scenario analysis can be undertaken using simple modelling tools and professional judgement.

Water User Specifications

The desired water user category (Ideal, Acceptable, Tolerable) can be described in terms of quantitative and descriptive information goals, and the information provided in the form of water user category specifications. These water user category RWQOs are based on the DWAF Water Quality Guidelines (Annexure A) and WRC Water Quality Guidelines for Domestic water supply (Annexure A), and any modifications to these resulting from specifying site specific user requirements.

D.1.3 RWQOs

Integration

The ecological specifications derived in Section D.1.1 must be compared against the water user specifications determined in Section D.1.2, i.e. the Water Quality Guidelines for each of the identified users, i.e.

- Ecological requirements (Reserve);
- Basic Human Needs (Reserve);
- Permissible water uses;
- Strategic Water Use;
- International water use; and
- Future use.

By default, at a high confidence level, the most stringent water quality requirements or most sensitive user may not necessarily define the RWQO.

Due to the high level of confidence and stakeholder participation, certain uses may be excluded, e.g. due to particularly stringent requirements that are not aligned with the catchment vision, or certain individual users may accept a poorer water quality than specified for the water user category.

Derive Management Class

The management class is determined for the water resource management unit. In the absence of the national classification system, the management class can be given for both the ecological and water use categories, e.g.

- Ecological – Good
- Water Use – Ideal

Or mapped to a single management class (See Table 3.1, Section 3.4) of:

- Natural
- Moderately used/impacted
- Heavily used/impacted

Annexure E:

Procedure for the High Confidence Determination of RWQOs

Introduction

The high confidence method is a determination that is undertaken when there is a good set of water quality data available for the water resource management unit on which to base an assessment of the present water quality status for ecosystems and other water users. There is scope for collecting additional data for those variables of concern that are not routinely monitored in the water resource management unit and there is an extensive process of stakeholder involvement in developing a catchment vision and user water quality requirements. The high confidence method is used in the consideration of individual licences that have the potential to cause a high impact in a stressed catchment, or in a catchment with a high importance and sensitivity.

When to use

This approach is to be used when there is a good water quality data set available to assess the present water quality status. Data for water quality, SASS and in-stream habitat, and/or fish and/or riparian habitat are available at the level of:

- A Comprehensive Reserve determination (high confidence water quality reserve determination);
- Comprehensive Catchment Assessment Study; and/or
- State of Rivers Report.

A high confidence water quality Reserve may not be available in which case the steps described in section E.1.1 need to be followed. If a water quality Reserve has been undertaken for the water resource management unit, then these results should be used instead of repeating section E.1.1.

A comprehensive catchment assessment study (CAS) may not be available in which case the steps described in section E.1.2 need to be followed. If a CAS has been undertaken at a scale that is compatible with the water resource management unit and a high level of detail, then these results should be used instead of repeating section E.1.2.

E.1 Method

E.1.1 Ecological Requirements

Delineate Resource unit

At a high confidence level the determination of preliminary RWQOs can be conducted for a river reach, subject to the availability of water quality data for that reach. The delineation of the resource units is based on Ecoregion Level II boundaries and stream classification. The locations of significant point and non-point sources, dams and tributaries are also considered when delineating resource units because these can substantially modify the water quality in a resource unit.

Refer to the five-step water quality reserve determination methodology for rivers described in Hughes (2005) and the Spatsim help files (Hughes, 2005).

Water quality data required for assessment of the ecological requirements

The water quality data requirements to undertake the water quality component of an ecological water reserve assessment are the following (Hughes, 2005). (*indicates that the variable is optional)

WATER QUALITY VARIABLES	REFERENCE CONDITION	PRESENT ECOLOGICAL STATE
Inorganic salts:		
Data: Ca, Mg, K, Na, Cl, SO_4 **Calculate inorganic salt concentrations:** $MgSO_4$, Na_2SO_4, MgCl, $CaCl_2$, NaCl, $CaSO_4$ **Data analysis:** $MgSO_4$, Na_2SO_4, MgCl, $CaCl_2$, NaCl, $CaSO_4$	Calculate 95% of reference data.	Calculate 95% of present state data.
	Compare to default boundary table.	Compare to relevant boundary table.
	Recalibrate boundary table if necessary.	Assign category. Calculate confidence level.
Nutrients:		
Data: NH_4, NO_2+NO_3, PO_4 **Calculate TIN** (NH_4+NO_2+NO_3) **Data analysis:** TIN and SRP	Calculate 50% of reference data	Calculate 50% of present state data
	Compare to default boundary values	Compare to relevant boundary table
	Recalibrate boundary table if necessary	Assign category. Adjust accordingly using Chl-*a* data. Calculate confidence level.
System variables:		
DO	Calculate 5% of reference data	Calculate 5% of present state data
	Compare to default boundary values.	Compare to relevant boundary table.
	Recalibrate boundary table if necessary.	Assign category. Calculate confidence level.
pH	Calculate 5% and 95% of reference data.	Calculate 5% and 95% of present state data.
	Compare to default boundary values.	Compare to relevant boundary table.
	Recalibrate boundary table if necessary.	Assign category. Calculate confidence level.
Turbidity*	Method not yet developed.	Method not yet developed.
Temperature* **Data:** If no water temperature are available, calculate daily water temperature from air temperature	Calculate monthly 10% and 90% of reference data.	Calculate monthly 10% and 90% of present state data.
	Calculate the upper and lower boundaries of the categories.	Compare to boundaries obtained for reference condition.
	Summarize results in benchmark table.	Assign category. Calculate confidence level.
TDS / EC	Method under development.	Method under development.

WATER QUALITY VARIABLES	REFERENCE CONDITION	PRESENT ECOLOGICAL STATE
Toxic substances:		
Data: NH_3 (calculate from NH_4 data), Al, As, Atrazine, Cd, Cr, Cu, Cyanide, Endosulfan, F, Pb, Phenol, Hg	Calculate 95% of reference data.	Calculate 95% of present state data.
	Compare to default boundary table.	Compare to relevant boundary table.
	Recalibrate boundary table if necessary.	Assign category. Calculate confidence level.
Biological response variables:		
SASS **Data:** SASS scores and ASPT scores	Assess whether ASPT score from Reference site is >5% different to default Natural boundary.	Compare ASPT scores from resource unit with relevant boundary table.
	Recalibrate boundary if necessary.	Assign category.
CHL-*a** **Data:** Phytoplankton (µg/ℓ) and periphyton (mg/m^2)	Calculate 50% of reference data	Calculate 50% of periphyton data and mean of phytoplankton data.
	Compare to default boundary table.	Compare to relevant boundary table.
	Recalibrate boundary table if necessary.	Assign category. Calculate confidence level.
Toxicity	Method not yet developed.	Method not yet developed.

Number of data points

Use a minimum of 60 samples collected over a 3 year period at the present state site and the reference site, including wet and dry seasons, to calculate the relevant percentile concentrations.

Determine reference conditions

The reference, or natural, condition provides the site-specific benchmark against which the default “Natural” category boundary is assessed. The default benchmark tables presented in Hughes (2005) were based on literature and available database information. For a high confidence ecological water quality assessment the default “Natural” or A category boundary values should be reviewed and modified using observed water quality data from a reference site.

The relevance of the default benchmark tables is determined by the presence of water quality data for a reference site. If the relevant statistics at the reference site fall within the default “Natural” or A category then the default benchmark table is accepted for the present status assessment. If the reference site statistics fall outside the “Natural” range, then the benchmark table is modified to account for the new “Natural” or A category range. Rules for modifying the default benchmark tables for the different water quality variables are described in Hughes (2005).

If data are not available for an unimpacted site, then:

- Pre-impact data from the present state site can be used, provided data can be extrapolated from present day data, and there is evidence of a trajectory of change; or
- Based on expert judgement of natural conditions.

In many water resource management units, and particularly in the lower reaches of rivers, there are no unimpacted sites, and reference conditions are difficult to infer. Data can be used from neighbouring catchments within the same ecoregion or any acceptable approximation of the natural condition.

Determine Present State

The present ecological state (PES) is the measured, current water quality for each water resource management unit and, in many cases, provides the point of departure for the development of any management objectives.

Hughes (2005) provides methods for linking chemical and biotic response data to a present ecological state category - Natural, Good, Fair, or Poor. Only data from 1-3 years prior to the assessment of the present status should be used. If the data record is poor (less than a monthly sampling frequency), then data from up to, but no longer than, 5 years prior to the assessment can be used.

The water quality data at the present state site should be analysed statistically to calculate for example the 5^{th} and 95^{th} percentiles, average and median values for each chemical parameter. The statistics required for each constituent are described in Hughes (2005). Refer to the different water quality constituents for the rules to determine the present state category using the default benchmark tables, or the modified benchmark tables if they were adjusted for reference conditions.

At a high confidence level, additional water quality data monitoring can be undertaken to collect data for variables that are not routinely monitored. The water quality database can be supplemented with additional data that monitors the response of the ecosystem to changes in water quality. Present state categories based on observed water quality should then be verified against the response of the ecosystem (Hughes, 2005). The RWQO process should be supported with an extensive review of the literature relating to water quality in the water resource management unit.

Ecological Importance and Sensitivity (EIS)

The ecological importance of a river is an expression of its importance to the maintenance of biological diversity and ecological functioning on local and wider scales. Ecological sensitivity (or fragility) refers to the system's ability to resist disturbance and its capability to recover from disturbance once it has occurred (resilience). Both abiotic and biotic components of the system are taken into consideration in the assessment of ecological importance and sensitivity. For a high confidence RWQOs determination, the EIS must be determined using data collected during an extensive field survey by domain specialists (e.g. invertebrate, geomorphological, riparian vegetation specialists) and using the methods developed by Kleynhans (2000).

Recommended Ecological Category (REC)

The generic steps required to determine the Recommended Ecological Category (REC) include:

1. Determine reference water quality conditions.
2. Determine the present water quality status (PES).
3. Determine the trajectory of change in water quality, and whether these changes are short- or long-term in character.
4. Determine critical causes for the present water quality status, and/or the trajectory of change, and the sources of these changes.
5. Determine the ecological importance and sensitivity categories (low, moderate, high, very high) in terms of water quality, and state the level of confidence in the evaluations (see description above).

6. Determine whether the present water quality state can be improved (if so, by how much), or maintained (which could still require restoration management, depending on the trajectory of change).
7. Determine what would be required to address the causes.
8. Determine how difficult it would be to address the source (restoration/reversibility potential).
9. Determine the Recommended Ecological Category (REC) for water quality and the other ecosystem components considering the ecological aims, and the difficulty of achieving these aims.

The above steps are generally conducted in a workshop situation where each component of the ecosystem (e.g. water quality, water quantity, biota, etc.) is considered by their respective specialist teams. The output resulting from the above should be two ecological categories; one ecological category that is attainable in the short-term (up to 5 years), and a second ecological category that is attainable in the medium- to long-term (between 5 to 10 years).

Assessing the desired state also involves the evaluation of alternative scenarios where the upstream and downstream water quality and classification are taken into account. At a high confidence level, scenario analysis can be undertaken using catchment and river scale modelling tools and professional judgement.

Describe Ecological Specifications

Each of the ecological categories is associated with a level of ecosystem health and integrity and the potential to offer a particular range of goods and services. The task of the ecological water quality Reserve assessment is to provide quantified and descriptive information about the concentrations of water quality variables which:

- Describe the recommended ecological category (A to D or Natural to Fair) of the system, and
- Provide numeric input into quantifying the management class.

The quantified and descriptive information is provided in the form of ecological specifications, termed “Ecospecs” (Hughes, 2005) and is specified for the recommended ecological category as well as for the categories above and below the REC.

Mapping Categories to Classes

Ecological categories may, in combination with the water user category, be mapped to a management class, i.e. Natural, Moderately used/impacted or Heavily used/impacted. The mapping route from the four categories (A, B, C, D) system to the three tiered management class system (is as follows:

- A = Natural
- A/B, B, B/C = Moderately used/impacted
- C, C/D, D = Heavily used/impacted

If the Natural/Good/Fair/Poor categories were used in the ecological water quality requirements determination, then the ecological categories can be mapped to the management class as follows:

- Natural = Natural
- Good = Moderately used/impacted
- Fair = Heavily impacted

E.1.2 Water User Requirements

Identify Water Users

Within the water resource management unit, all water user sectors and water uses within each sector should be identified, e.g. domestic, agriculture (e.g. irrigation of tobacco, aquaculture of warm water fish species, etc.) industry (power generation, canning industry, etc.), recreation (e.g. swimming, canoeing, hiking, etc.). At a high confidence level, this should be as detailed as possible, listing the individual water users, grouped by water user sector, in the water resource management unit, and providing an estimate of the amount of water used by each user. This information should be available from a comprehensive Catchment Assessment Study (CAS).

Determine the parameters of concern

Identify the physical, chemical and/or biological parameters of concern within the water resource management unit, based on the identified user sectors, the user categories, and key individual water users, whether these users are considered to be exercising an existing lawful use or not.

The parameters of concern for the water user sectors, user categories within the sectors, and key individual users, should be confirmed through a comprehensive stakeholder consultation process. At a high confidence level, stakeholder consultation should include key stakeholder groupings such as organised agriculture, chambers of commerce, industry associations, government departments, local authorities, etc., as well as key individual water users.

Determine Present State

From the available water quality data, as derived in Section E.1.1 an assessment must be made of the present state of the water quality with regards to all permissible water uses within the Resource unit. Such uses include:

- Basic Human Needs
- Permissible water uses
- Strategic Water Use
- International water use
- Future water uses. As such it is necessary for the Region to have considered the types of water users required in the catchment in the future through a catchment visioning exercise.

At a high confidence level, additional water quality data should be collected over at least one hydrological year for:

- Key parameters for which no or very limited data exist (e.g. E. coli, toxic substances); or
- At sites where key impacts occur (large abstractions or discharges).

In some cases it may not be practical to collect additional data (e.g. due to budget or time constraints). Under these circumstances river water quality models can be used to estimate the present water quality state using known inputs and flow patterns in the water resource management unit.

Determination of the present state at a high confidence level entails a comparison of the present water quality against the water quality requirements of user sectors, their user categories and, where appropriate, key individual water users.

Based on the user water quality requirements, a corresponding water user category can be assigned to the present water quality within the water resource management unit.

Social Importance (SI) and Economic Importance (EI)

The social importance of a river is an expression of its importance in a social context for the local and wider communities. The Social Importance should be determined by a domain specialist using data collected from an extensive social survey of local and wider communities and their association with the river.

The Economic Importance of a river is an expression of its importance to support local and wider scale economic activities and growth in the region. A domain specialist using accepted methods and data collected during an extensive economic survey of the river and region must determine the Economic Importance.

Catchment Visioning

Catchment Visioning plays an important role in the high confidence level because it informs the RWQOs process. The effective involvement of institutional and other key individual stakeholders is critical to the process.

Determine Desired Water Quality

An assessment must be made as to what category of water quality is desired for use within the water resource management unit, i.e. Ideal, Acceptable, Tolerable. Note: Category 'Unacceptable' is not considered a desired category

In assessing the desired water quality at a high confidence level, both existing and future water users should be considered, i.e. water user requirements that drive the determination of RWQOs and the corresponding Management Class, must include:

- Basic human needs (Reserve);
- Strategic water quality requirements (if these exist);
- International water quality requirements;
- Existing lawful use water quality requirements; and
- Future user water quality requirements.

At a high confidence level, an extensive stakeholder consultation process is followed to set the desired water user category and to determine the consequences of this decision. In this process, different scenarios are evaluated using decision support tools such as catchment and river scale water quality models.

Water User Specifications

The desired water user category (Ideal, Acceptable, Tolerable) can be described in terms of quantitative and descriptive information goals, and the information provided in the form of water user category specifications. These water user category RWQOs are based on the DWAF Water Quality Guidelines (Annexure A) and WRC Water Quality Guidelines for Domestic water supply, and any modifications to these that might result from specifying site-specific user requirements as described below.

The boundary values in Annexure A should be reviewed during the stakeholder participation process to determine if these need to be adjusted for site-specific conditions or specific user requirements. The boundary values can be adjusted to be more stringent or less stringent provided that stakeholders can provide compelling reasons for the adjustment, and there is acceptance by the stakeholders of the potential impacts of adjusting the boundary values.

E.1.3 RWQOs

Integration

The ecological specifications derived in Section E.1.1 must be compared against the water user specifications determined in Section E.1.2, i.e. the Water Quality Guidelines for each of the identified users, i.e.

- Ecological requirements (Reserve)
- Basic Human Needs (Reserve)
- Permissible water uses
- Strategic Water Use
- International water use, and
- Future use

By default, at a high confidence level, the most stringent water quality requirements or most sensitive user may not necessarily define the RWQOs. Due to the high level of confidence and stakeholder participation, certain uses may be excluded, e.g. due to particularly stringent requirements which are not aligned with the catchment vision, or certain individual users may accept a poorer water quality than specified for the water user category.

Derive Management Class

The management class is determined for the water resource management unit. In the absence of the national classification system, the management class can be given for both the ecological and water use categories, e.g.

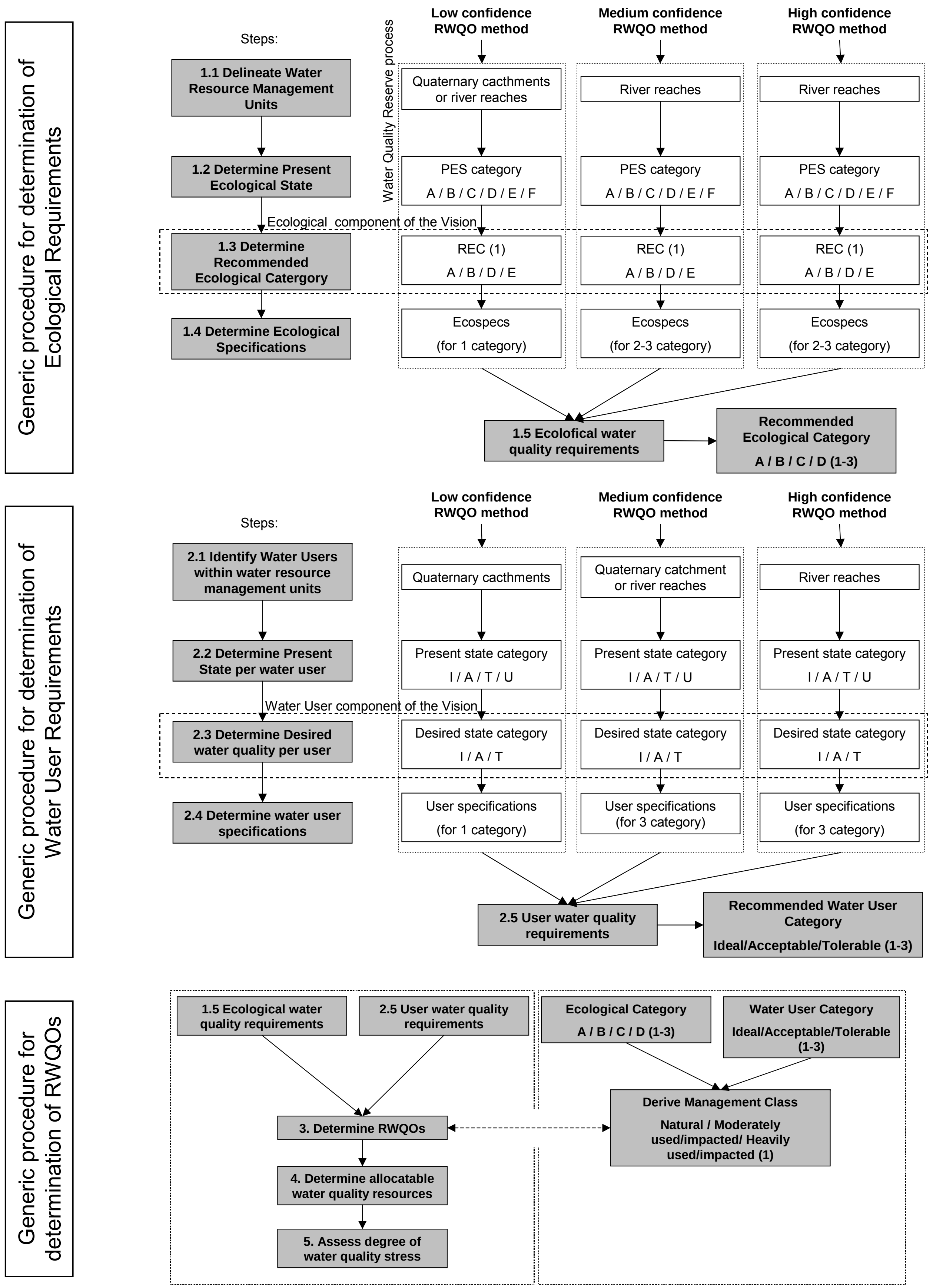
- Ecological – Good
- Water Use – Ideal

Or mapped to a single management class (See Table 3.1, Section 3.4) of:

- Natural
- Moderately used/impacted
- Highly used/impacted

FOLD OUT

Generic procedures for determination of Ecological Requirements, Water User Requirements and RWQOs



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Volume 4.2.1

Users' Guide

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DOCUMENT INDEX

Reports as part of this project:

REPORT NUMBER	REPORT TITLE
1.1	Inception Report
1.2	National and International Literature Survey and Contextual Review
1.3	Glossary of terminology often used in the Resource Directed Management of Water Quality
1.4	Volume 1: *Policy Document Series*
1.4.1	Volume 1.1: Summary Policy
1.4.2	Volume 1.2: Policy on the Resource Directed Management of Water Quality
1.5	*Strategy Document Series*
1.5.1	Volume 2.1: Summary Strategy
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1.5.3	Volume 3: Institutional arrangements for Resource Directed Management of Water Quality
1.6	*1st Edition Management Instruments Series (Prototype Protocol)*
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1.8	Implementation Plan

Bold type indicates this report

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TABLE OF CONTENTS

ACRONYMS

DWAF	Department of Water Affairs & Forestry
Ecospecs	Ecological Specifications
IWRM	Integrated Water Resource Management
RDM	Resource Directed Measures
RDMWQ	Resource Directed Management of Water Quality
REC	Recommended Ecological Category
RWQOs	Resource Water Quality Objectives
WQM	Water Quality Management

SUPPORT

For enquiries please contact the:
Department of Water Affairs and Forestry,
Tel (012) 336-7500 or Fax (012) 336-7044

Further supporting documentation may be obtained from
http://www.dwaf.gov.za/

Developed for the Department of Water Affairs and Forestry by the

1. System

This guide provides assistance to users of the software package (RWQO Model vs. 2.0) for the determination of Resource Water Quality Objectives (RWQOs) for surface water resources. For detail on the methodology behind this system, the user is referred to the "Guideline for determining Resource Water Quality Objectives (RWQOs) , Allocatable Water Quality and the Stress of the Water Resource" (DWAF, 2006), accessible from within the Model or on the enclosed CD. The software is freely available from the Department of Water Affairs and Forestry.

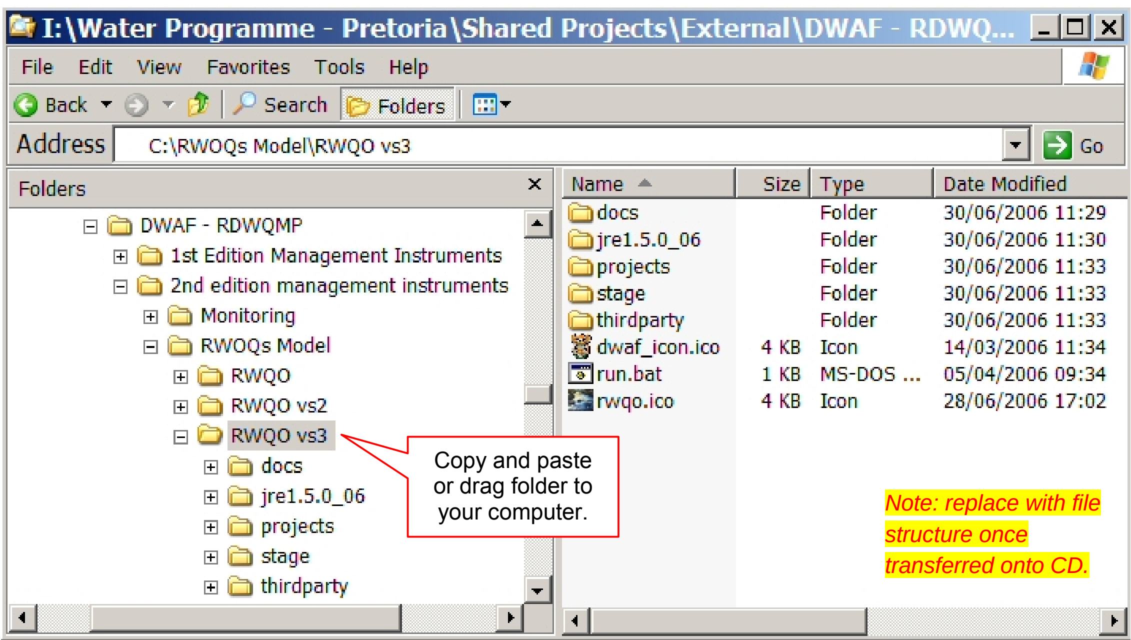
2. Setup

Software Version

This Users Guide is applicable to version 2.0 of the RWQOs Model, developed by the CSIR for the Department of Water Affairs and Forestry (DWAF).

Setting Up

The RWQOs Model is a computer-based application which can be run either from the setup CD or from a computer. To run the Model from the CD locate and open the file run.bat. To run the Model from the computer, the user should copy the relevant folder and associated files from the CD and paste them into a folder created for the application.



The Model is a standalone application and requires no additional software to run. Should users wish to open any of the available documents within the Model [See Functions], they will need Acrobat Reader. The setup file for Acrobat Reader is enclosed on the attached CD or can be downloaded from www.adobe.com.

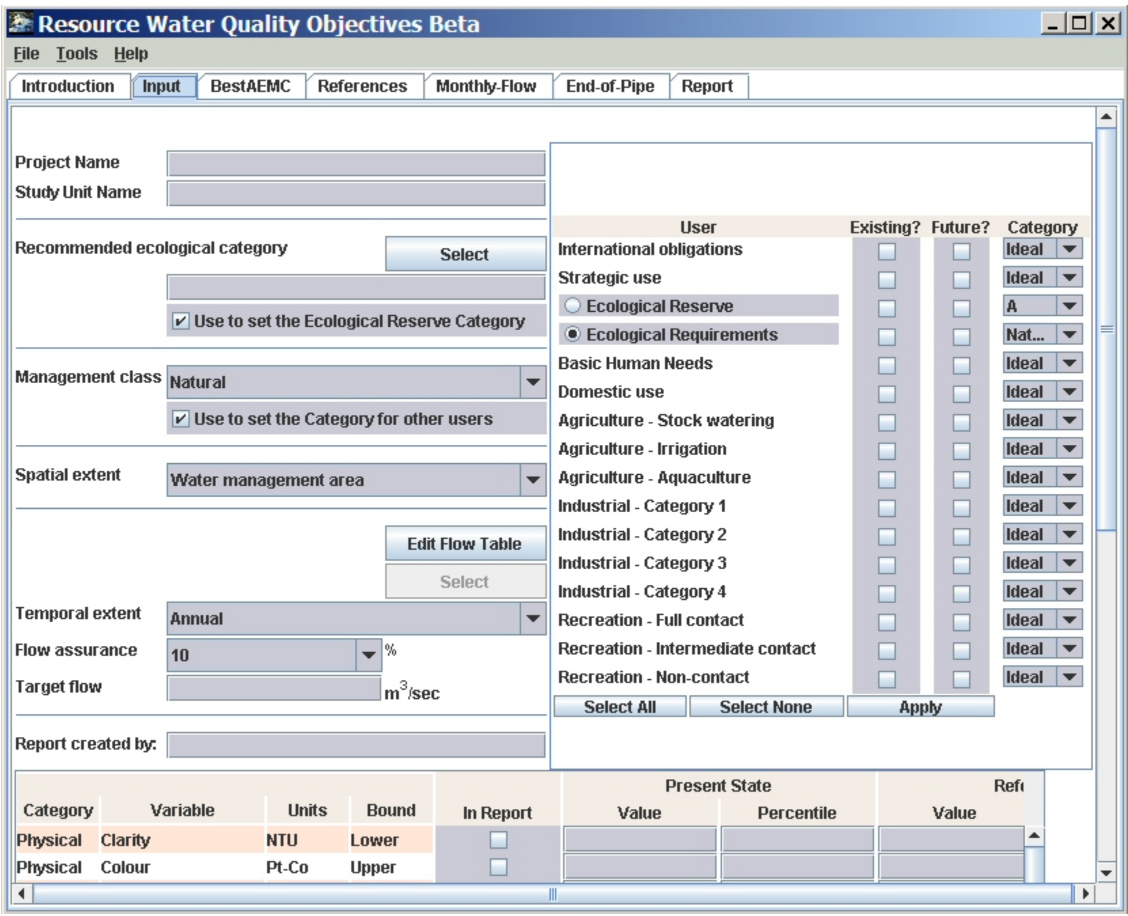
3. System Requirements

There are no specific system requirements to operate the RWQOs Model.

4. Quick Start

What you need to know and do to get started:

1. Copy the folder from the CD to your computer
2. Locate and Open the file run.bat
3. You are now ready to begin a new project, or an existing saved project.



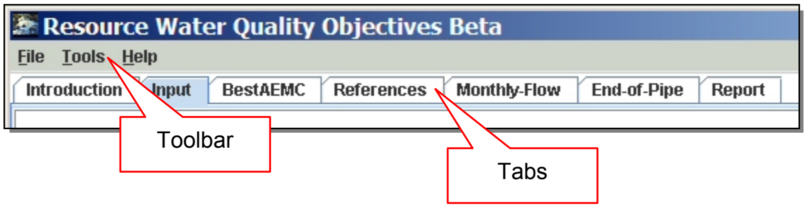
5. Overview

The RWQOs Model (vs 2.0) provides users with a standard approach to consistently setting Resource Water Quality Objectives (RWQOs) for surface water resources in South Africa. By selecting the water resource and user requirements, the Model generates RWQOs that are based on a database of provided and entered water quality parameters.

The Model provides a quick approach to setting RWQOs based on the guidelines for determining Resource Water Quality Objectives (RWQOs), Allocatable Water Quality and the Stress of the Water Resource (DWAF, 2006).

6. Functions

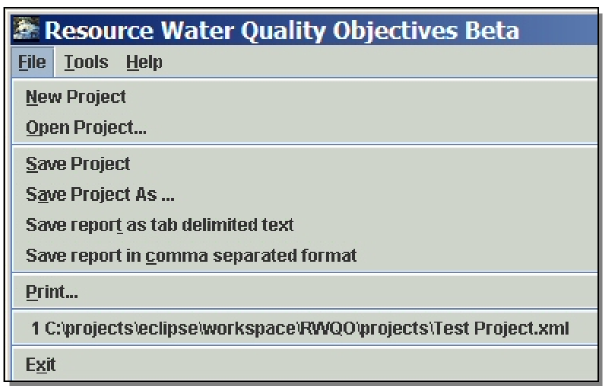
The Model provides two levels of functions; these are accessible through the Toolbar and through the Tabs.



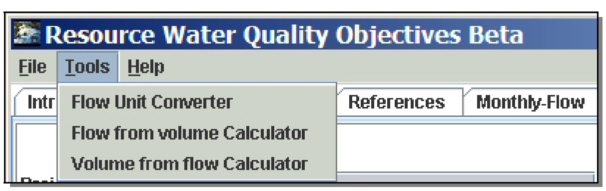
Toolbar

Toolbar options include:

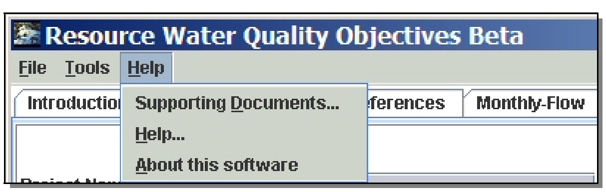
- File
- Tools
- Help



The 'File' dropdown menu on the toolbar, allows users to create a new project, open an already saved project, save a project, save a report, or print a report.



The 'Tools' dropdown menu on the toolbar, allows users to easily convert a number of flow units into the required flow format of m^3/s and vice versa.



The 'Help' dropdown menu on the toolbar, allows users to access supporting documents, e.g. guidelines, legislation; access to on-line help; and information about the software version.

Tabs

The 'Tabs' provide an overview of each of the working screens in the Model, namely:

- Introduction
- Input
- Best AEMC
- References
- Monthly-Flow
- End-of-Pipe
- Report

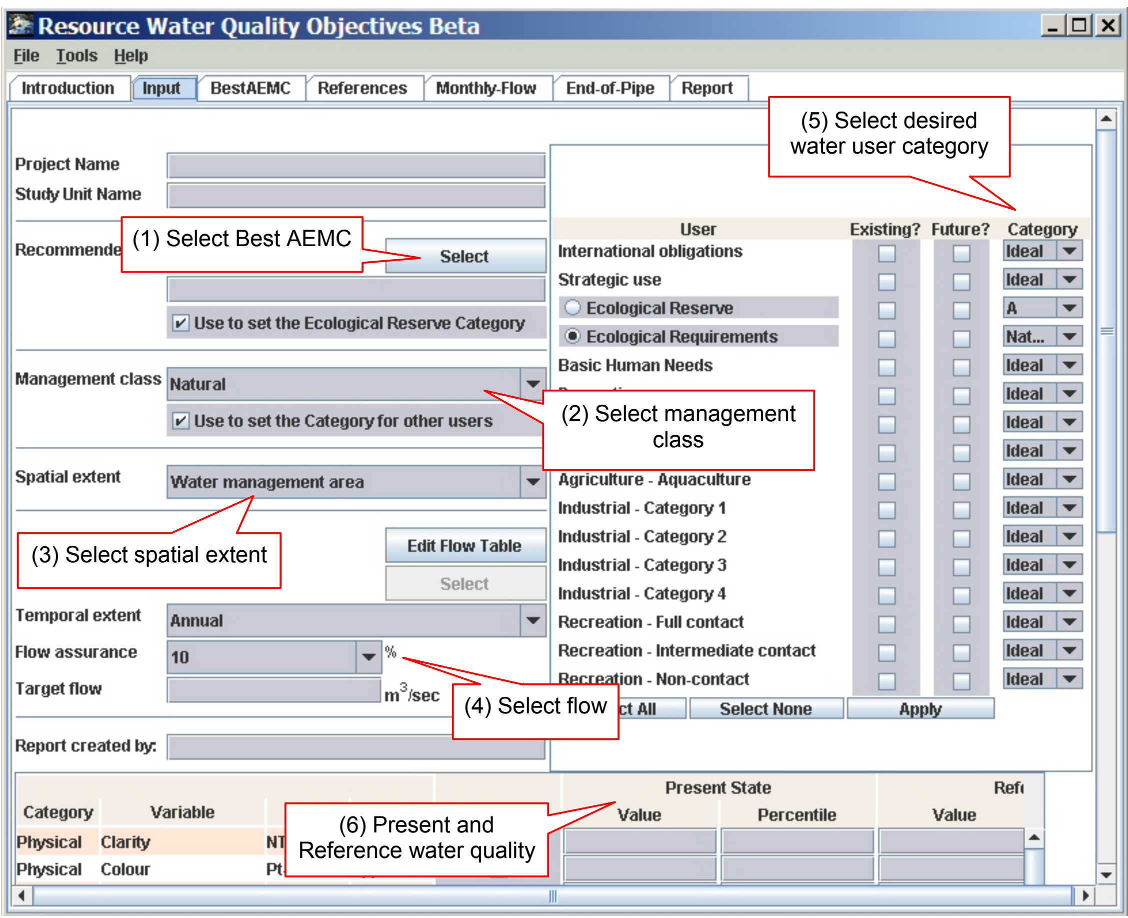
Introduction

The 'Introduction' tab provides users with a brief overview and background to the Model.

Input

The 'Input' tab is the main input screen in the Model. Here users are required to:

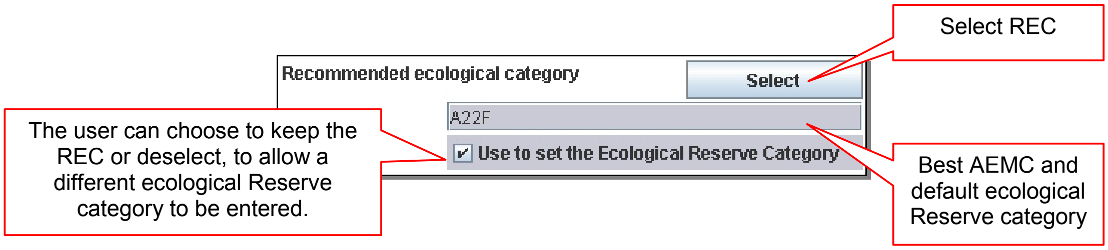
1) Select (or enter) the Recommended Ecological Category (Best AEMC) for the water resource management unit;
2) Select the desired management class for the water resource management unit;
3) Set the spatial extent of the water resource management unit;
4) Select the desired target flows to support the determination of loads;
5) Select the desired water user categories (current and future); and
6) Enter present and reference water quality for selected parameters of concern.



Each of these steps is briefly unpacked below and in more detail in the worked example in Annexure A.

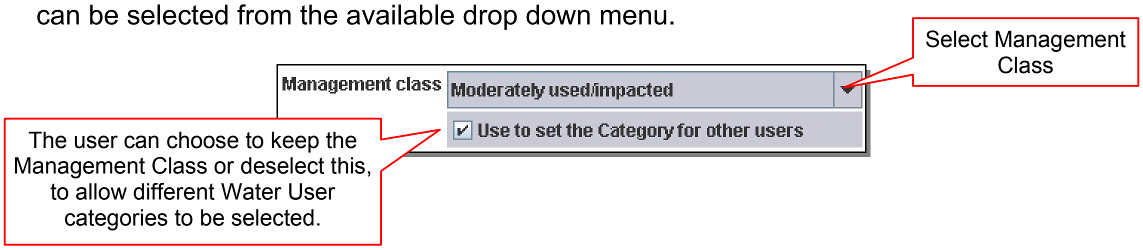
❖ Recommended ecological category

The Recommended ecological category (REC) (sourced from the Best AEMC) provides the starting default category for the ecological Reserve category [*under Users*]. To select the REC the user should go to the BestAEMC tab and select the appropriate quaternary catchment. By doing so, the Best AEMC will automatically be filled into the Input screen.



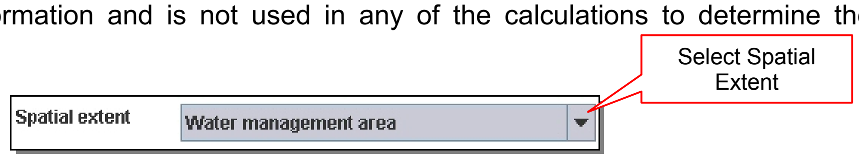
❖ Desired management class

The Management Class, for the water resource management unit, provides the starting or default category for the other Water Users [*under Users*] - [Natural=Ideal; Moderately used/impacted=Acceptable; Heavily used/impacted=Tolerable]. The Management Class can be selected from the available drop down menu.



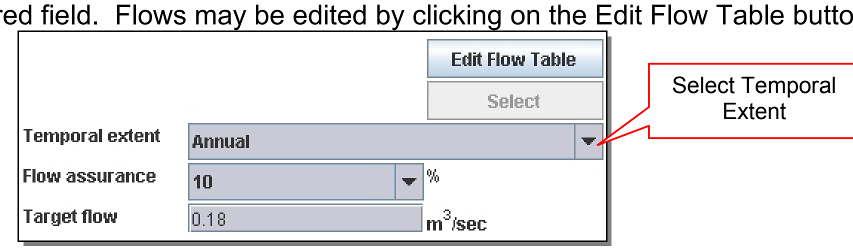
❖ Spatial extent of the water resource management unit

The spatial extent defines the water resource management unit for the study. This is used for supporting information and is not used in any of the calculations to determine the RWQOs.



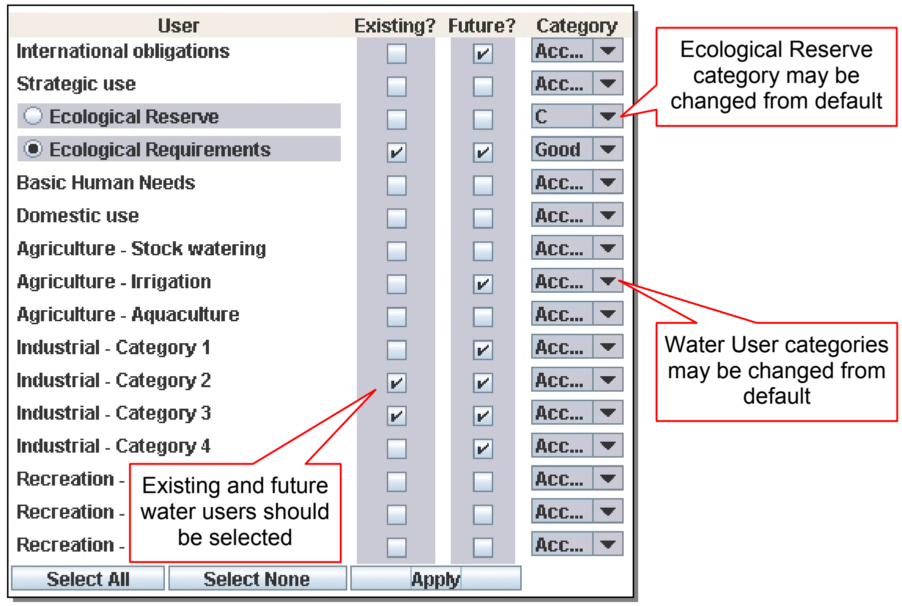
❖ Target flows and flow assurance

The flow is used in the Model to determine the allocatable load and the end-of-pipe discharges. Once flows have been entered in the Monthly-Flow tab, the desired temporal extent and flow assurance should be selected. This will automatically insert the target flow into the required field. Flows may be edited by clicking on the Edit Flow Table button.



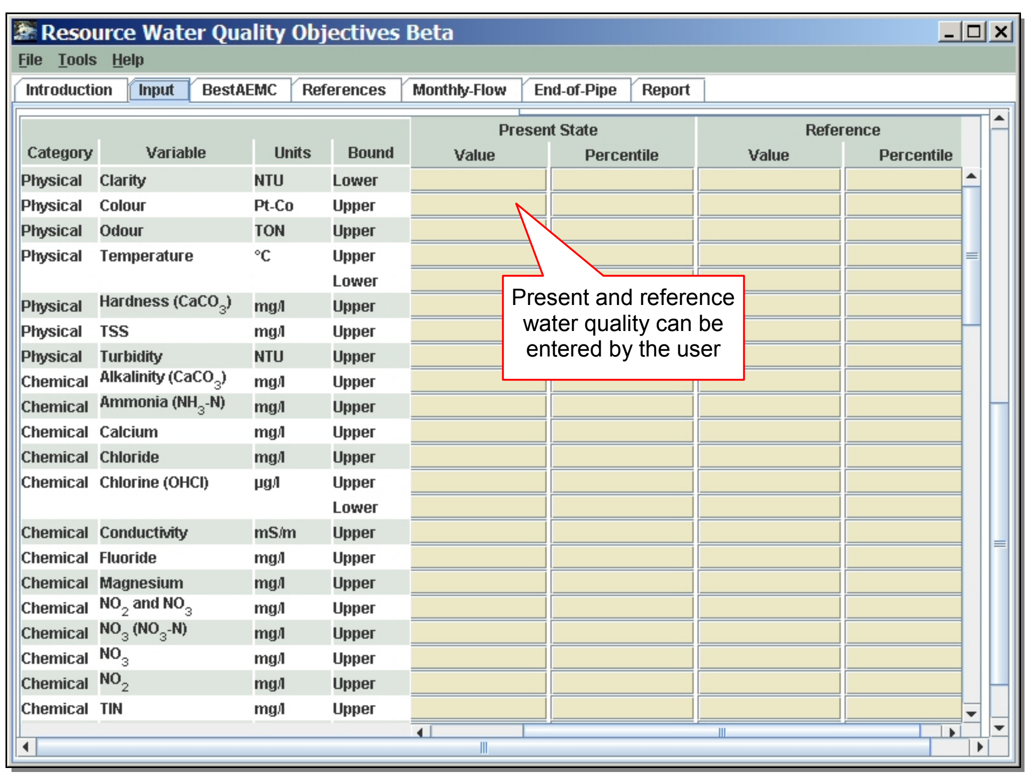
❖ Desired water user categories (current and future)

The desired water user categories, both existing and future are fundamental to determining the RWQOs.



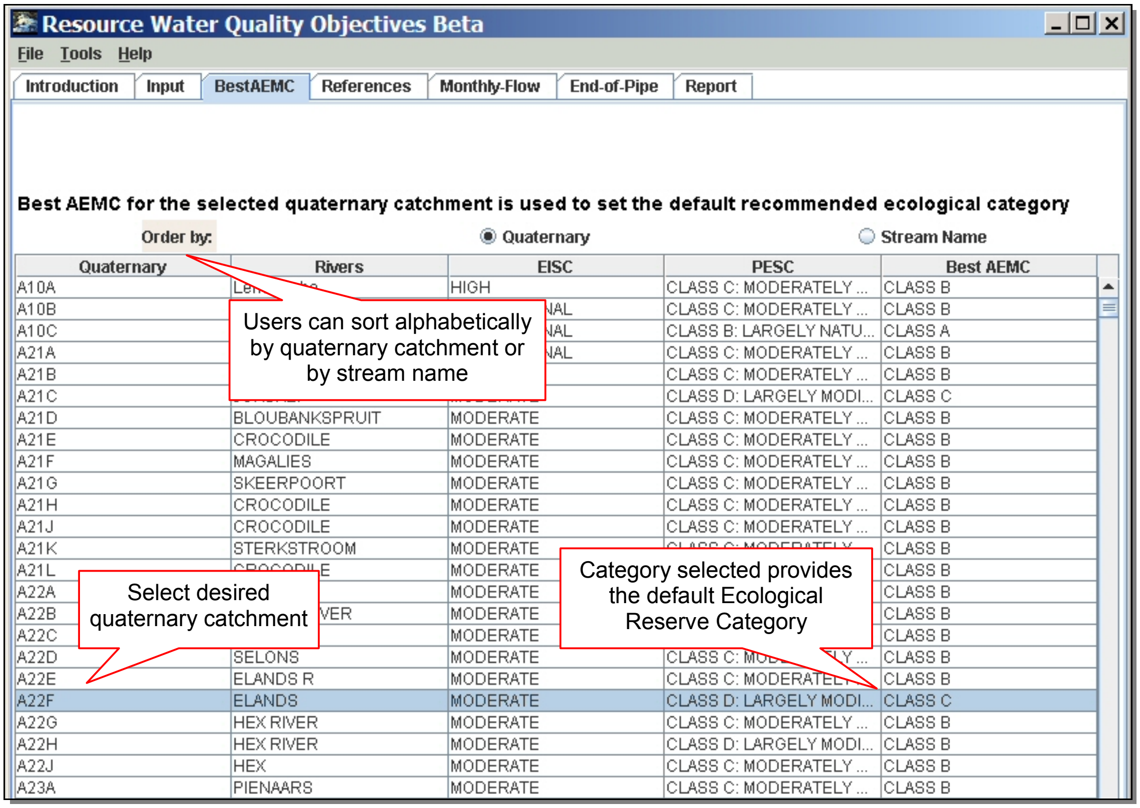
❖ Present and reference water quality for selected parameters of concern

The present water quality is used to determine the water resource stress [*See Reports*], while the reference water quality provides data to assess the feasibility of the determined RWQOs.



Best AEMC

The 'Best Achievable Ecological Management Category (Best AEMC)' tab allows users to automatically select the *Recommended Ecological Category* for a given quaternary catchment. The Best AEMC was determined by specialists with local knowledge of the various catchments (Kleynhans, 1999).

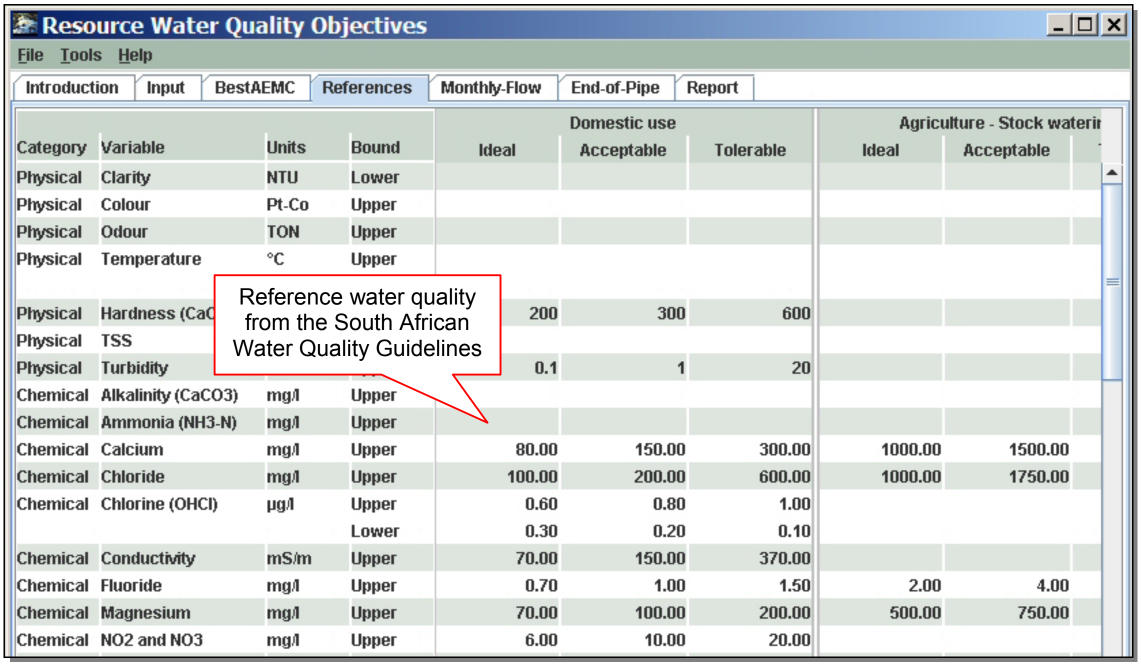


References

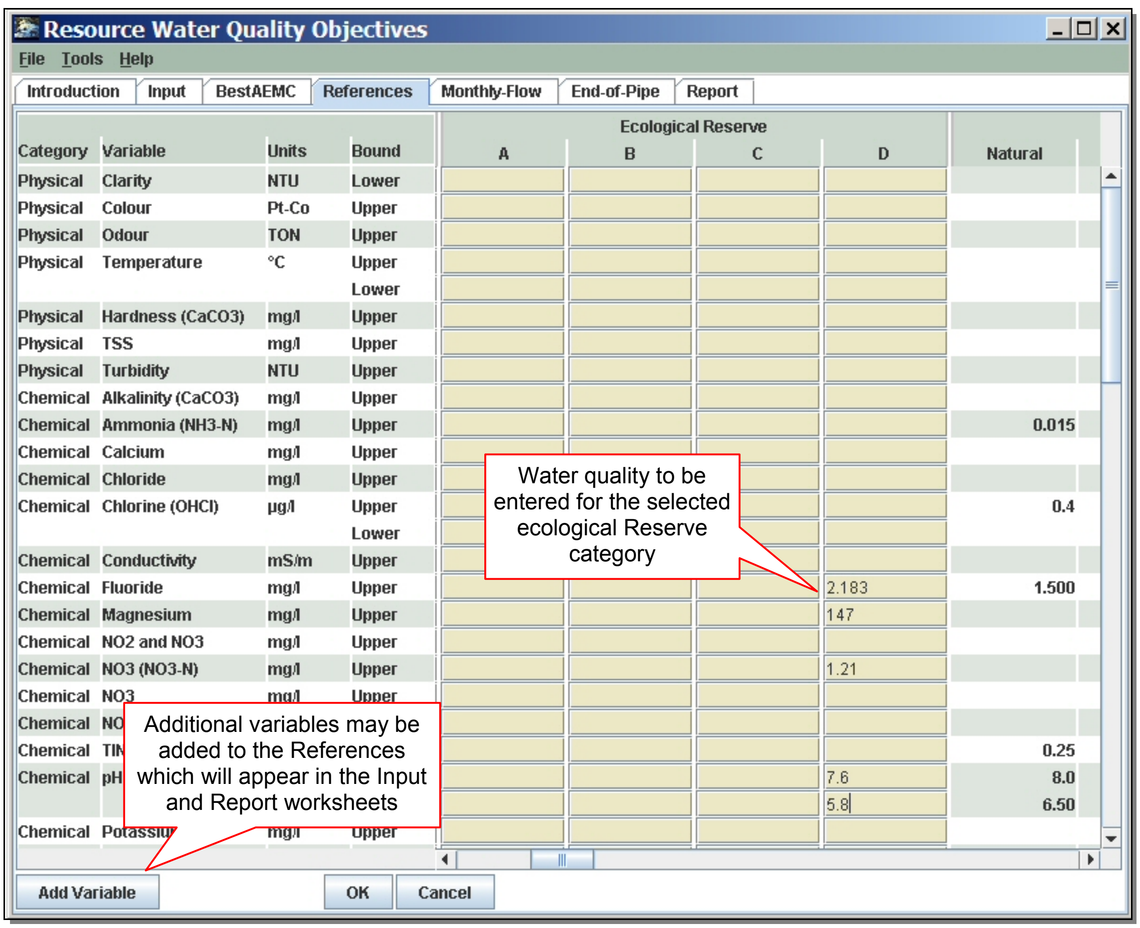
The 'Reference tab' provides the input water quality data for various water user types, and is used to determine the RWQOs. For certain water users, the water quality data are automatically provided in the Model [Reference tab], based on the South African Water Quality Guidelines (DWAF, 1996) (e.g. Domestic Use, Agriculture, Industrial, and Recreation) – these are accessible under Help > Supporting Documents. In addition, default water quality data are provided for Ecological Requirements (in the absence of an ecological reserve) (Palmer *et al.*, 2005) and Basic Human Needs (Class 1) (WRC, 1998).

If applicable to the catchment, users are required to enter the water quality in the 'Reference' tab for:

- International obligations;
- Strategic use; and
- Ecological Reserve.



The ecological Reserve water quality data are entered for the selected ecological Reserve category, as determined from the Reserve process.



There is no ecological Reserve?

If an Ecological Reserve has not been set for the water resource management unit, the Model will automatically use the 'Ecological Requirements' (Palmer *et al*., 2005) for the default Ecological Reserve Category, as determined from the Best AEMC.

Monthly Flow

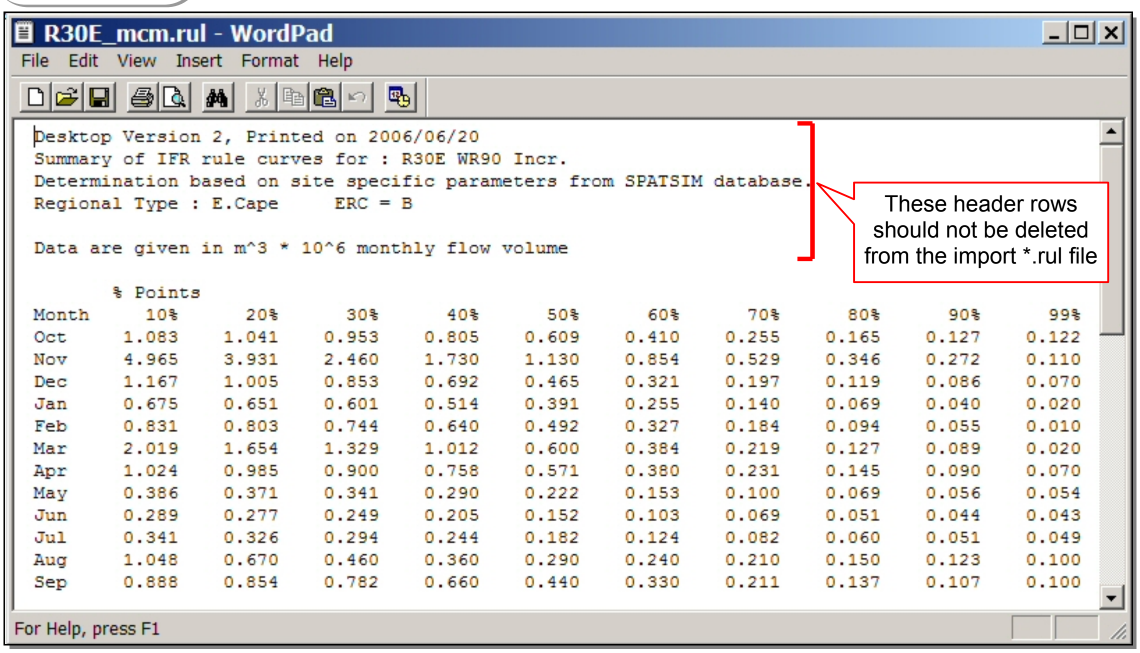
Target flows and flow assurances are used to set the 'Allocatable Load', i.e. the water quality over and above that required for the RWQOs, i.e. that which can be allocated for use.

The flows are entered into the 'Monthly Flow' tab. This can be done in two possible ways, either by:

- Typing the monthly flows into a given flow assurance column, e.g. 10%, or
- Importing the monthly flows as derived from the SPATSIM database (*.rul file), i.e. the output of the Reserve process.

What units should the flows be in?

The monthly flows can be imported as either m^3/s or $Mm^3/month$. If the SPATSIM *.rul file is being imported, it is important that the header rows remain in the file. The Model will read these lines, to determine the import flow units.


R30E_mcm.rul - WordPad
File Edit View Insert Format Help

Desktop Version 2, Printed on 2006/06/20
Summary of IFR rule curves for : R30E WR90 Incr.
Determination based on site specific parameters from SPATSIM database.
Regional Type : E.Cape ERC = B

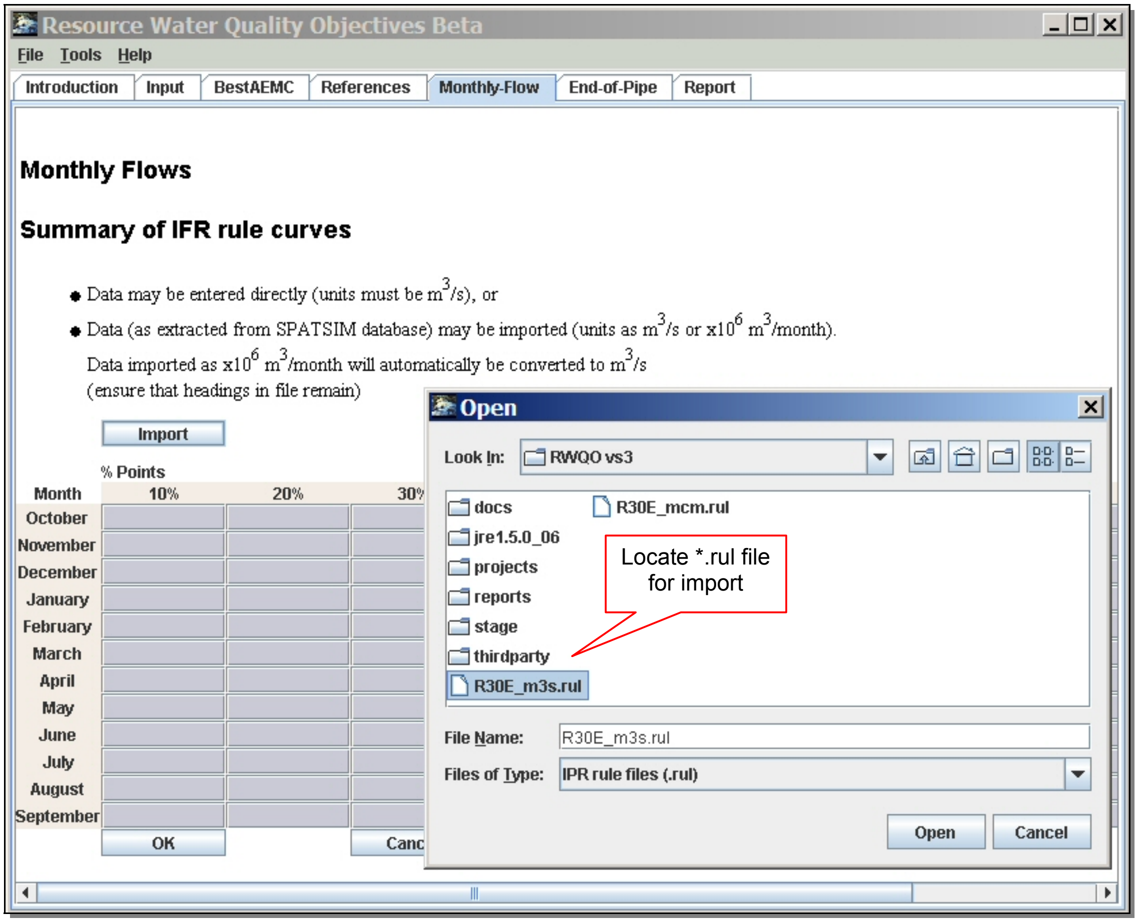
Data are given in m^3 * 10^6 monthly flow volume

% Points

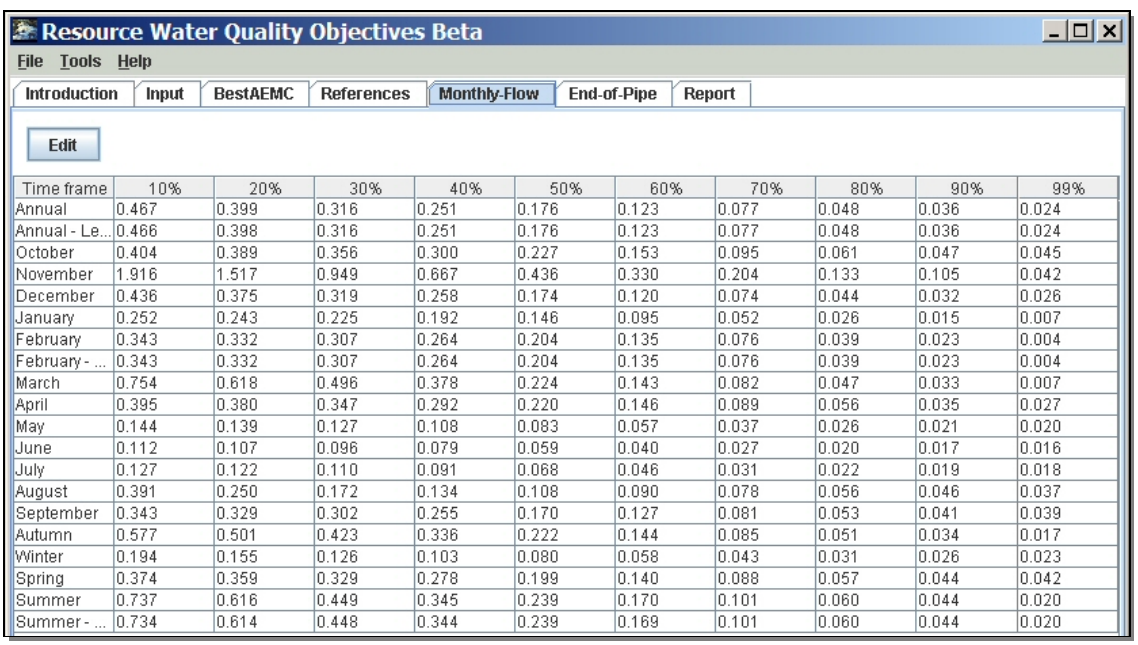
Month	10%	20%	30%	40%	50%	60%	70%	80%	90%	99%
Oct	1.083	1.041	0.953	0.805	0.609	0.410	0.255	0.165	0.127	0.122
Nov	4.965	3.931	2.460	1.730	1.130	0.854	0.529	0.346	0.272	0.110
Dec	1.167	1.005	0.853	0.692	0.465	0.321	0.197	0.119	0.086	0.070
Jan	0.675	0.651	0.601	0.514	0.391	0.255	0.140	0.069	0.040	0.020
Feb	0.831	0.803	0.744	0.640	0.492	0.327	0.184	0.094	0.055	0.010
Mar	2.019	1.654	1.329	1.012	0.600	0.384	0.219	0.127	0.089	0.020
Apr	1.024	0.985	0.900	0.758	0.571	0.380	0.231	0.145	0.090	0.070
May	0.386	0.371	0.341	0.290	0.222	0.153	0.100	0.069	0.056	0.054
Jun	0.289	0.277	0.249	0.205	0.152	0.103	0.069	0.051	0.044	0.043
Jul	0.341	0.326	0.294	0.244	0.182	0.124	0.082	0.060	0.051	0.049
Aug	1.048	0.670	0.460	0.360	0.290	0.240	0.210	0.150	0.123	0.100
Sep	0.888	0.854	0.782	0.660	0.440	0.330	0.211	0.137	0.107	0.100

For Help, press F1

To import flow data, click the Import Monthly-Flow' tab. This will take users to an 'Open' screen where you can locate the file for import.



Once imported, the 'Monthly-Flow' tab will be populated with flow assurance values to be used in the Input Tab.



Time frame	10%	20%	30%	40%	50%	60%	70%	80%	90%	99%
Annual	0.467	0.399	0.316	0.251	0.176	0.123	0.077	0.048	0.036	0.024
Annual - Le...	0.466	0.398	0.316	0.251	0.176	0.123	0.077	0.048	0.036	0.024
October	0.404	0.389	0.356	0.300	0.227	0.153	0.095	0.061	0.047	0.045
November	1.916	1.517	0.949	0.667	0.436	0.330	0.204	0.133	0.105	0.042
December	0.436	0.375	0.319	0.258	0.174	0.120	0.074	0.044	0.032	0.026
January	0.252	0.243	0.225	0.192	0.146	0.095	0.052	0.026	0.015	0.007
February	0.343	0.332	0.307	0.264	0.204	0.135	0.076	0.039	0.023	0.004
February - ...	0.343	0.332	0.307	0.264	0.204	0.135	0.076	0.039	0.023	0.004
March	0.754	0.618	0.496	0.378	0.224	0.143	0.082	0.047	0.033	0.007
April	0.395	0.380	0.347	0.292	0.220	0.146	0.089	0.056	0.035	0.027
May	0.144	0.139	0.127	0.108	0.083	0.057	0.037	0.026	0.021	0.020
June	0.112	0.107	0.096	0.079	0.059	0.040	0.027	0.020	0.017	0.016
July	0.127	0.122	0.110	0.091	0.068	0.046	0.031	0.022	0.019	0.018
August	0.391	0.250	0.172	0.134	0.108	0.090	0.078	0.056	0.046	0.037
September	0.343	0.329	0.302	0.255	0.170	0.127	0.081	0.053	0.041	0.039
Autumn	0.577	0.501	0.423	0.336	0.222	0.144	0.085	0.051	0.034	0.017
Winter	0.194	0.155	0.126	0.103	0.080	0.058	0.043	0.031	0.026	0.023
Spring	0.374	0.359	0.329	0.278	0.199	0.140	0.088	0.057	0.044	0.042
Summer	0.737	0.616	0.449	0.345	0.239	0.170	0.101	0.060	0.044	0.020
Summer - ...	0.734	0.614	0.448	0.344	0.239	0.169	0.101	0.060	0.044	0.020

Where do I get monthly flows?

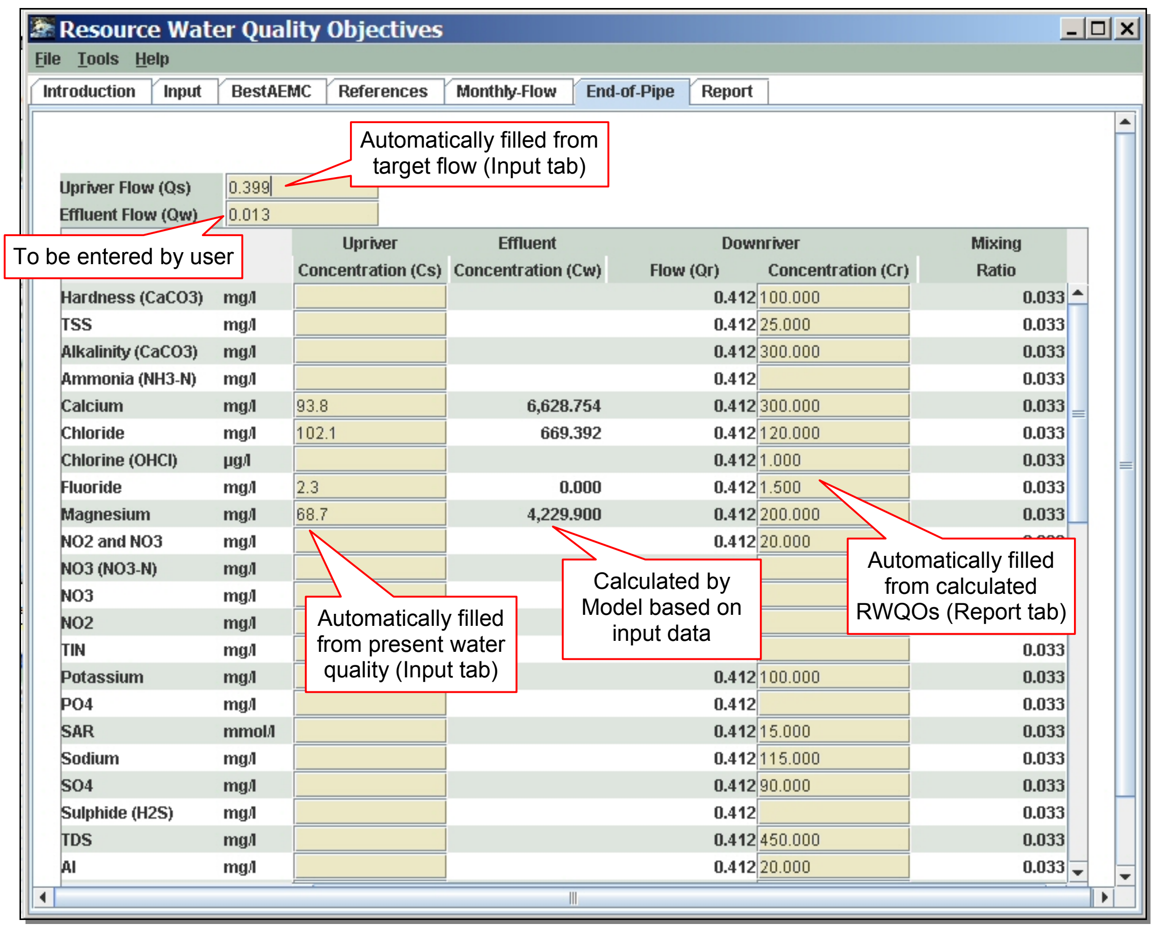
Monthly flow data are sourced from the SPATSIM database, obtainable from the Directorate RDM. Flows should be requested for the point or catchment for which the RWQOs are being set.

How do I edit flows after I have imported them?

If you need to edit the monthly flows after having imported the *.rul file, you can do this by clicking on the Edit Flow Table button in the 'Input' tab or b Edit e button in the Monthly-Flow tab.

End-of-pipe

The 'End-of-Pipe' tab, allows users to work back to point source effluent discharges, to determine the end-of-pipe discharge(s) that may be allowed in order to achieve the RWQOss. The 'End-of-Pipe' tab makes use largely of data that have already been entered within the other tabs. The only data to be entered in the 'End-of-Pipe' tab are the data for 'Effluent Flow'.



> ⚠ *Effluent Concentration (Cw)*
>
> The Effluent Concentration (Cw) calculated in the Model is the total allocatable effluent quality – this may be assigned to a single user or to multiple users. It is up to the user to determine how the effluent concentration will be assigned within a catchment or river reach.

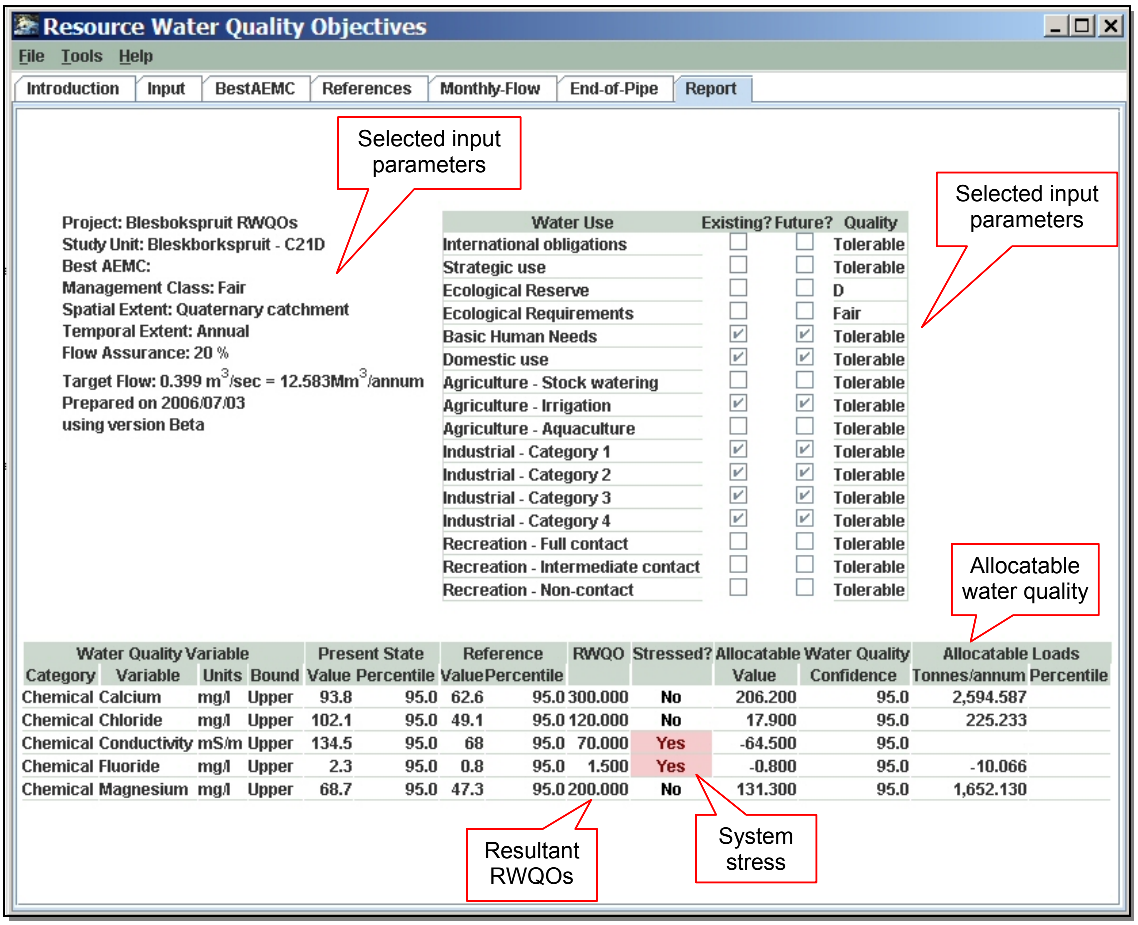
■ Report

Having entered all of the necessary data into the input screen, the user may view the results in the 'Report' tab. The report provides a:

(1) review of the present and reference water quality, and

(2) results of:

- RWQOs;,
- Resource stress;,
- The allocatable water quality and associated confidence; and
- The allocatable loads.



Water Use	Existing?	Future?	Quality
International obligations	☐	☐	Tolerable
Strategic use	☐	☐	Tolerable
Ecological Reserve	☐	☐	D
Ecological Requirements	☐	☐	Fair
Basic Human Needs	☑	☑	Tolerable
Domestic use	☑	☑	Tolerable
Agriculture - Stock watering	☐	☐	Tolerable
Agriculture - Irrigation	☑	☑	Tolerable
Agriculture - Aquaculture	☐	☐	Tolerable
Industrial - Category 1	☑	☑	Tolerable
Industrial - Category 2	☑	☑	Tolerable
Industrial - Category 3	☑	☑	Tolerable
Industrial - Category 4	☑	☑	Tolerable
Recreation - Full contact	☐	☐	Tolerable
Recreation - Intermediate contact	☐	☐	Tolerable
Recreation - Non-contact	☐	☐	Tolerable

Water Quality Variable				Present State		Reference		RWQO	Stressed?	Allocatable Water Quality		Allocatable Loads	
Category	Variable	Units	Bound	Value	Percentile	Value	Percentile			Value	Confidence	Tonnes/annum	Percentile
Chemical	Calcium	mg/l	Upper	93.8	95.0	62.6	95.0	300.000	No	206.200	95.0	2,594.587	
Chemical	Chloride	mg/l	Upper	102.1	95.0	49.1	95.0	120.000	No	17.900	95.0	225.233	
Chemical	Conductivity	mS/m	Upper	134.5	95.0	68	95.0	70.000	Yes	-64.500	95.0		
Chemical	Fluoride	mg/l	Upper	2.3	95.0	0.8	95.0	1.500	Yes	-0.800	95.0	-10.066	
Chemical	Magnesium	mg/l	Upper	68.7	95.0	47.3	95.0	200.000	No	131.300	95.0	1,652.130	

Parameters of Concern

For the RWQOs of a particular variable to appear in the 'Report' tab, that variable must have been selected in the 'Input' tab as a parameter of concern. This should be done by the required variable.

How are the RWQO determined by the Model?

The Model determines the RWQOs by selecting the lowest or most sensitive water quality, for each variable of concern, for each selected water user (existing and future). The water quality requirements are extracted from entered water quality data (Reserve, International Obligations, Strategic Use) and default SA Water Quality Guideline data.

How is Stress determined by the Model?

The stress of the resource is the difference between the proposed RWQOs and the present water quality.

RWQOs > Present = unstressed (water quality available for allocation)

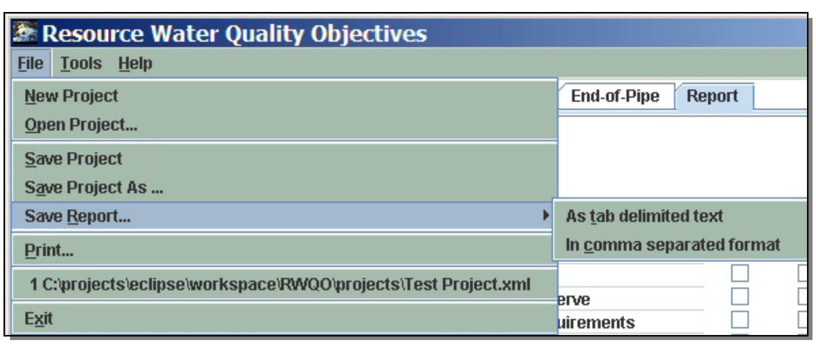
RWQOs < Present = stressed (no water quality available for allocation)

Saving and Exporting the results

Reports that have been generated for a project can be saved or printed, allowing users to modify input criteria and assess the impact of these changes on the resultant RWQOs.

The results can be exported as either '*tab delimited text*' or in '*comma separated format*'. The '*tab delimited text*' option allows users to open the report in e.g. Notepad, MS Word, WordPerfect, while the '*comma separated format*' allows users to open the report in e.g. MS Excel.

To export or save the report, go to >> File >> Save Report. Select either 'As tab delimited text' or 'In comma separated format'.



7. Data requirements

To determine RWQOs, the Model requires the following input data:

- Ecological category – from a Reserve or Best AEMC
- Management Class – from a catchment visioning exercise
- Target flows – from Reserve output - *.rul files
- Existing and future water users within the water resource management unit
- Present water quality – 5^{th} and 95^{th} percentiles
- Reference water quality – 5^{th} and 95^{th} percentiles

8. References

Department of Water Affairs and Forestry, 1996. *South African Water Quality Guidelines. Volumes 1-7*. Department of Water Affairs and Forestry, Pretoria, South Africa.

Department of Water Affairs and Forestry, 2006. *Guideline for determining Resource Water Quality Objectives (RWQOs), Allocatable Water Quality and the Stress of the Water Resource*. Water Resource Planning Systems Series, Sub-Series No. WQP 1.7.2, 2^{nd} Edition.

Kleynhans, C.J. 1999(b). *Desktop Level Estimate of Ecological Management Classes for the Quantity Component of the Ecological Reserve for use in the National Water Balance Model*. Unpublished Report.

Palmer, C.G., Rossouw, N., Muller, W.J. and Scherman, P-A. 2005. *The development of water quality methods within ecological Reserve assessments, and links to environmental flows*. *Water SA*, **31** (2): 161-170.

Water Research Commission (WRC). 1998. *Quality of Domestic Water Supplies, Volume 1: Assessment Guide, 2nd Ed.* Water Research Commission Report No: TT 101/98. Pretoria, South Africa.

9. Index by Keyword

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Systems Series

SUB-SERIES NO. WQP 1.7.3

Resource Directed Management of Water Quality

MANAGEMENT INSTRUMENTS

Volume 4.3

Guideline on Monitoring & Auditing for Resource Directed Management of Water Quality

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Co-ordinated by:

CSIR, Natural Resources and the Environment (NRE)
PO Box 395
Pretoria
0001

DOCUMENT INDEX

Reports as part of this project:

REPORT NUMBER	REPORT TITLE
1.1	Inception Report
1.2	National and International Literature Survey and Contextual Review
1.3	Glossary of terminology often used in the Resource Directed Management of Water Quality
1.4	Volume 1: *Policy Document Series*
1.4.1	Volume 1.1: Summary Policy
1.4.2	Volume 1.2: Policy on the Resource Directed Management of Water Quality
1.5	*Strategy Document Series*
1.5.1	Volume 2.1: Summary Strategy
1.5.2	Volume 2.2: Strategy for the Resource Directed Management of Water Quality
1.5.3	Volume 3: Institutional arrangements for Resource Directed Management of Water Quality
1.6	*1st Edition Management Instruments Series (Prototype Protocol)*
1.6.1	Conceptual Review of water use licence applications in the context of the Resource Directed Management of Water Quality
1.6.2	Guidelines on Catchment Visioning for the Resource Directed Management of Water Quality
1.6.3.1	Guideline for determining Resource Water Quality Objectives (RWQOs), water quality stress & allocatable water quality
1.6.3.2	Guideline on the conversion of the SA Water Quality Guidelines to fitness-for-use categories
1.6.3.3	Guideline for converting RWQOs to individual end-of-pipe standards
1.6.3.4	Decision-support instrument for the determination of RWQOs, water quality stress, allocatable water quality & end-of-pipe standards
1.6.4	Decision-support instrument for the Assessment of Considerations for Water Use Applications (ACWUA)
1.6.5	Guideline on pro-forma licence conditions for the Resource Directed Management of Water Quality
1.7	*Volume 4: 2nd Edition Management Instruments Series*
1.7.1	Volume 4.1: Guidelines on Catchment Visioning for the Resource Directed Management of Water Quality
1.7.2	Volume 4.2: Guideline for determining Resource Water Quality Objectives (RWQOs), water quality stress & allocatable water quality
1.7.2.1	RWQOs Model and User Guide
1.7.3	**Volume 4.3: Guideline on Monitoring and for the Resource Directed Management of Water Quality**
1.7.4	Project Document: Resource Directed Management of Water Quality: Philosophy of Sustainable Development
1.7.5	Project Document: Guidelines for Setting Licence Conditions for Resource Directed Management of Water Quality
1.7.6	Introduction to the Resource Directed Management of Water Quality
1.8	Implementation Plan

Bold indicates this report

APPROVAL

TITLE:	Resource Directed Management of Water Quality: Management Instruments. Volume 4.3: Guideline on Monitoring & Auditing for Resource Directed Management of Water Quality.
DATE:	August 2006
AUTHORS:	Kevin Murray, Michelle Binedell and Martella du Preez
PEER REVIEWER:	Peter Ashton
TECHNICAL REVIEW:	Pieter Viljoen, Jurgo van Wyk and Retha Stassen
EDITORS:	Hanlie Hattingh, Retha Stassen and Jurgo van Wyk
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CSIR Project Leader and Manager

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PROLOGUE

MAKING MONITORING WORK FOR YOU

The core problem

In casual conversation, most managers readily agree that water resource monitoring is important. However, when faced with real human or financial resource constraints, some of those managers will all too readily sacrifice monitoring in favour of some other activity, at least to some extent.

It would appear that some managers think they are supposed to say that monitoring is important (perhaps because they have been told it often enough). However, the evidence suggests that, deep down, they are unconvinced. Apparently, the advantages just don't seem that advantageous.

Why monitoring gets a raw deal

Some honest reflection on what is generally important to managers (and perhaps politicians, who managers need to be seen to be aligned with) suggests the following factors may play a role (not in any particular order). An assessment is also made as to whether they work for or against water resource monitoring.

- **Legislation and policy**. Not aligning oneself to existing legislation and/or policy can often boil down to, at least, not following due process or, at worst, simply breaking the law. Managers cannot afford this. Their jobs are at stake. The National Water Act (36:1998) requires monitoring of water resources. It has to be done. This is definitely "for monitoring". However, the real issue is the extent of monitoring required to satisfy the requirements of the Act. The Act is not clear on this. So while "legislation and policy" are perceived as important, the lack of clarity does not focus monitoring practices. (*The Act is for, but the vagueness is against, monitoring*.)
- **The need for simple rules and procedures**. When much of your time is spent "fire fighting", it seems unfair that you are expected to think as well. Simple rules and procedures are great once a monitoring programme is up and running. But designing is simply not simple. It often requires specialist input to really get it right. (*On balance, against monitoring*).
- **Affordability**. Nobody doubts that, in the end, information has to be paid for. When budgets are tight, compromises are inevitable. And monitoring can be expensive. "Value for money" is often low compared with many of the other kinds of information that are important to managers (political, social, economic, legal, administrative, and so on). (*Against monitoring*.)
- **Avoiding "egg on face"**. Nobody, especially managers and politicians, can afford to look inadequate. Can monitoring help to avoid "egg on face"? In some circumstances, yes (like preventing you confronting a water user about high fluoride or nitrate in the water when it is actually naturally high because of the local geology). In others, it may cause it (like when it exposes your own inadequate water resource management). (*For or against monitoring*.)
- **Having sound scientific/technical information**. Such information is useful. For example, managers and politicians can quote impressive facts that convey powerful messages ("quotable information"). But data assessments must not only be done soundly, they must communicate effectively. If they do not, the monitoring will be perceived to be useless. (*Largely for monitoring, if communicated effectively*.)

In summary, water resource monitoring can be difficult to design, and, even if you get it right, can expose inadequate management (i.e. cause "egg on face"), is almost always relatively expensive, and can sometimes be difficult to interpret. And, no matter what monitoring you are doing, it is easy to justify as implementing the Act.

It is not surprising that monitoring often gets a "raw deal" and doesn't achieve its full potential.

The positive perspective: Knowledge is power

One can turn the above factors around and use monitoring to one's advantage. The following are some examples.

- What you want to achieve in your water resources should intimately determine how water users are managed. Some water users have a very sophisticated knowledge of water quality. Managers have to negotiate face-to-face with such water users. Monitoring can provide both parties with a sound understanding of the current status and trends of the resource. The manager will be seen to be competent. He/she can negotiate more effectively from this position of knowledge.

> *"Knowledge itself is power"*
> Francis Bacon (1561-1626)

- As an aside, it may be tempting to use the precautionary principle when knowledge of the behaviour of a resource is lacking (*e.g.* because you haven't done enough monitoring). However, applying it is usually subjective and therefore prone to debate and dispute. This is not a position of power. It can also place unnecessary and sometimes unfair demands on water users. Monitoring could avoid this.
- On the other hand, the vast majority of water users will not be sophisticated. In a spirit of transparent governance, the Department or CMA has a responsibility to ensure that such users are suitably informed. To do this, managers must understand the behaviour of the water resource themselves. This can be achieved through effective monitoring.

> *"Honesty is the best policy"*
> R Whately (1787-1863)

- Some might argue that, in the long-term, the single most important principle of good governance is transparency. Being seen to be transferring knowledge (based on sound monitoring) in an honest and open manner could be a powerful positive basis for participatory water resource management. Specifically, this can lay the groundwork for the establishment of catchment management agencies.
- The current political climate demands implementation and service delivery. Prominent government officials are being held more accountable for their actions (or inaction, as the case may be). Monitoring is one powerful way of quantitatively demonstrating effective service delivery.

> *"Knowledge may give weight, but accomplishments give lustre,*
> *and many more people see than weigh"*
> PD Stanhope (1694-1773)

- Conscientious managers can use monitoring to quantify and prioritise the real problems. Annual budgeting will be more focused, be seen to be more cost-effective, and therefore more powerfully motivated.
- The greater the depth of knowledge about what lies behind a monitoring report (even an individual datum point), the more sensibly a manager can use that report (or datum). Getting into the field is not only good fun and stimulating. Seeing the samples being taken, experiencing the difficulties first hand, as well as understanding laboratory quality control and statistical analysis (and its flaws and assumptions), all provide powerful insights into monitoring that cannot be obtained in any other way.

- Much pressure is being placed on the Department and CMA to indicate whether or not they are "moving towards sustainable development". To many, these requests remain vague and difficult to answer and can therefore be ignored as futile wish-lists. However, monitoring specific variables (or indicators) can provide an insightful way of understanding how a resource is changing over time or beyond its limits – ultimately providing a clearer picture of its sustainability into the future.

But don't ignore the problems

More detailed guidance is necessary on precisely what monitoring should be achieving in South Africa. High-level thinking is going on in the Department (5-year resource quality monitoring plans and strategic frameworks). These need to link clearly with detailed monitoring designs, the individual needs of managers and water users, and more especially, a sound supporting institutional environment.

With a little careful thought, the costs of monitoring can be minimised:

- Designers should (a) be as clear as possible about what the managers really need, and (b) think creatively to maximise information while minimising costs.
- Monitoring results do not always need to be reported with very high certainty. Compromising certainty can often greatly reduce costs. Situations in which this is acceptable should be identified and the uncertainty reported. As long as the manager (a) understands that there is uncertainty, and (b) knows (preferably quantitatively) what this uncertainty is, the manager is able to make informed decisions.
- Sampling costs (of visiting monitoring sites on a regular basis) often contribute significantly to overall costs. Making sure that, where appropriate, sampling costs are shared with other programmes that sample at the same monitoring site can significantly reduce costs. However, be careful that sharing such resources does not compromise, in any significant way, the ability of the programme to achieve its own objectives.

Acquiring the data is only half the battle. Assessing it so that it addresses real needs is usually not trivial. In essence, data assessment and reporting must:

Keep it simple. Keep it sound. Keep it significant.

Conclusion

Some (though not all) perceive that monitoring does not give value for money. This has worked against monitoring. However, when properly implemented, monitoring provides tremendous power. This power can be brought to bear in:

- Negotiations (inside and outside the Department);
- Facilitating effective stakeholder engagement (transparency, in particular, being a significant "force for good");
- Demonstrating successes (service delivery); and
- Motivating budgets.

But it will not all be plain sailing. There are problems and they must be addressed explicitly. If any one issue stands out - it is that designers must focus explicitly on minimising costs, paying particular attention to the relationship between costs and uncertainty.

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ACRONYMS

CMA	Catchment Management Agencies
DEAT	Department of Environmental Affairs & Tourism
DPSIR	Driving force-Pressure-State-Impact-Response
DWAF	Department of Water Affairs & Forestry
ISO	International Standards Organisation
NEMP	National Eutrophication Monitoring Programme
NWA (36:1998)	National Water Act
POPs	Persistent Organic Pollutants
PSIR	Pressure-State-Impact-Response
PSPs	Professional Service Providers
RDM	Resource Directed Measure
RDMWQ	Resource Directed Management of Water Quality
RQO	Resource Quality Objective
RWQO	Resource Water Quality Objective
SDC	Source Directed Control
SoE	State of Environment
WARMS	Water Authorisation and Registration Management System
WMA	Water Management Area
WMS	Water Management System
WRC	Water Research Commission

SECTION 1: INTRODUCTION

PHOTO: K MURRAY

The purpose of this document is to provide general guidance for designing monitoring programmes related to resource water quality which collectively ensure useful statements can be made about the water quality in water resources and sustainable development.

1.1 Goal and objectives

Target audience

This document is aimed at the following people:

- Managers who are responsible for national planning related to water quality monitoring (so that they may understand just what it takes to do it effectively);
- Regional managers who are directly responsible for water quality monitoring (so that they may better understand how to make the most of the information derived from monitoring); and

Those who actually do the monitoring (so that they may better understand the bigger picture).

Management tool

This document provides guidelines for the monitoring that is required for resource directed management of water quality. It is one of many essential management tools required to implement the resource directed management of water quality strategy (DWAF, 2005a). The strategy, in turn, is aimed primarily at implementing the resource directed management of water quality policy ("the Policy") (DWAF, 2005b).

Regional perspective

Although there are top-down Departmental initiatives (described below), there is also a desperate need for better direction, standardisation and integration at a regional level. This document deliberately takes a regional bottom-up perspective with the intention that this will constructively feed into the top-down initiatives.

Policy vision

In its simplest sense, monitoring should be seen as measuring progress in order to provide useful management information. In the current context of resource directed management of water quality, this specifically means measuring the progress towards the ultimate vision of effective water quality management. The vision of the Policy is to ensure that "*the water quality in South African water resources enables an equitable and sustainable balance to be achieved between its use by society and its protection as a critical component of a natural system so that the quality of life of all South Africans is improved and sustained in the long-term*". Since the current context is "resource directed", the focus is on how this can be done through giving effect to resource directed measures (RDM).

Objectives

The monitoring related to resource directed management of water quality is focussed primarily on the spatial scale of water management areas. The objectives are as follows:

Objectives of monitoring for
Resource Directed Management of Water Quality

To measure, assess and report on a regular basis the status and trends broadly relating to water quality in water resources, and their management, in a manner that will support balanced decision-making and planning in the contexts of fitness for use and aquatic ecosystem integrity, in the Catchment Management Agency's quest to promote sustainable development.

1.2 Sustainable development

Sustainable development

Sustainable development is defined in the resource directed management of water quality policy ("the Policy") (DWAF, 2005b) as follows:

"*Sustainable development endeavours to ensure that future generations can meet their own basic water needs while promoting socio-economic development and improved quality of life for all in the current generation. This should be done in a manner that uses water resources in general, and water quality in particular, within the ability of the ecosystems to satisfy such needs now and in the future.*"

The Policy also notes six enabling principles:

- Protection of water resources.
- Optimal water use.
- Equity between generations.
- Current equitable access.
- Environmental integration.
- Good governance.

Resource management class

In specific situations there may be some degree of tension (if not conflict) between the principles (typically between protection of water resources and optimal water use or current equitable access). One of the tasks of a water resource manager is to balance these in an equitable way. First and foremost, this is done by designating, attaining and then sustaining a resource management class. This class is intended to reflect the optimum balance between the above principles.

The resource management class is the "first line of defence" against development that is not sustainable. In particular, it balances the way that a water resource is used with an appropriate degree of protection of that resource.

Need for more than resource quality objectives

Resource quality objectives (RQOs) and Resource Water Quality Objectives (RWQOs) are the most important management objectives against which monitoring data will be assessed. This will indicate whether the management class is being maintained. In general, RQOs will be the most important sustainability indicators for water resource management. **However, they will not necessarily provide all the information required for holistic management.** For example, on what should water resource management and the associated source management (including corrective actions) be based if the RQOs are not being achieved? They can only be based on a broader knowledge of the water resource, including the following (neither of which is addressed by RQOs):

- Information on what might be causing the problems. This helps focus source directed controls.
- Information on the nature and extent of the impacts of inadequate water quality (not only on other components of the water resource, like biota, but also on socio-economic enhancement). This facilitates cost-effectiveness by enabling sensible priorities to be set.

Managers will need more holistic information than just resource quality to properly manage (a) the resource, (b) those impacting on the resource, and (c) those impacted by the resource.

Environmental integration

This will also demonstrate the application of the "environmental integration" principle enabling sustainable development.

Besides these more practical management objectives, in order for the Department to demonstrate it is striving for sustainable development, it is important that the principle of "environmental integration" be applied. In the current water quality context, this requires consideration of all possible interactions with, and within, ecosystems and water quality in particular. Achieving the above objectives will therefore necessarily include monitoring, or at least an understanding, of:

- Causes of inadequate water quality.
- Actual water quality.
- Impacts of inadequate water quality.
- Decisive societal responses to inadequate water quality.
- Water quality management performance.

RDM and SDC

This is well aligned with the concept that the resource directed measures (RDM) determine the most appropriate source directed controls (SDC). Monitoring the water quality and the impacts of water quality on the water resource provide information on the most appropriate RDM. These determine the best SDC that relate to the causes of deteriorating water quality.

Monitoring in the even broader context of impacts on social and economic development, and associated societal responses, completes the "environmental integration" necessary to facilitate sustainable development.

1.3 Guiding principles for monitoring

The Policy

The principles that guide the manner in which monitoring is carried out are described in the Policy (DWAF, 2005b). They are listed here for convenience. Readers are particularly encouraged to examine all the enabling principles of sustainable development in the Policy. The monitoring described herein is intended ultimately to facilitate sustainable development. The long-term vision is to include elements of the biophysical, social and economic systems.

Relevant principles

- Sustainable development (enabled by protection of water resources, optimal water use, equity between generations, current equitable access, environmental integration and good governance);
- Adaptive management;
- Sound financial management;
- Prudent pragmatism; and
- General legislative alignment.

1.4 Document guide

Table 1.1: Quick reference guide to using this document.

If you want to …	Then …
Concentrate on water quality monitoring that is **relevant now and in the immediate future**	*Go to* Section 3: *Designing a water quality monitoring programme.*
See a **future vision** for monitoring	*Go to* Section 4: *A monitoring vision: Beyond water quality.*
Understand the necessary **supporting environment** for successful regional monitoring	*Go to* Section 2: *Institutional environment.*
See the **overall process** for designing a water quality monitoring programme	*Go to* Section 3.2.1: *Overall design process*.
Understand what **design documentation** is important (and see a suggested structure)	*Go to* Section 3.2.2: *Documentation*.
Get general advice on **how to monitor effectively** (no matter what specific water quality programme you may be designing)	*Go to* Section 3.2: *How to be effective*.
See some **suggested designs** for regional water quality monitoring	*Go to* Section 3.3: *Designing for the immediate future.*
Understand how this all connects with **sustainable development**	*Go to* Section 1.2: *Sustainable development, and* *Go to* Section 4.2: *The PSIR framework and sustainable development.*
See the overall **implementation strategy** once a programme is designed.	*Go to* Section 3.2.7: *Implementation strategy (making the plan reality)*.
See **definitions** of some technical terms	*Go to* Section 6: *Glossary*.

SECTION 2: INSTITUTIONAL ENVIRONMENT

2.1 Introduction

Crippling constraints

Without an institutional environment that is appropriately focused on supporting regional monitoring, effective monitoring is impossible. No degree of wishful thinking or careful scientific design can overcome the crippling constraints of inadequate human capacity and lack of a common vision of the future. The following sections briefly examine the Department's top-down vision and how this might be constructively influenced from the bottom-up.

An effective institutional environment that truly supports water quality monitoring is essential.

It is the most important current priority.

2.2 Important Departmental initiatives

2.2.1 5-year water resources quality monitoring plan

Goal and objectives

A document exists that is intended to inform management within the Department of a 5-year plan for resource quality monitoring (DWAF, 2004a). The overall goal is to achieve "an effective and efficient national information service". This entails achieving:

- User focus and value for money.
- Ease of access for users (one point of entry).
- One version of the truth (no duplication).
- Sharing of data acquisition and management.
- Integrated information systems (as far as is realistically possible).
- Appropriate capacity (expanded and multi-skilled capacity).

Key interventions

The following interventions have been identified to achieve the overall goal:

- *Umbrella programme*. Probably based on the objectives of the "US Water Information Co-ordination Programme".
- *Monitoring governance model*. There is a pressing need for clear governance structures and processes.
- *Integrated monitoring plans for each water management area (WMA)*.
- *Business plans for individual programmes*. A business approach to monitoring has become essential.
- *Water use monitoring feasibility study*. If feasible, this should be followed by a business plan.
- *Aquatic ecosystem health monitoring business plan*. This should also address how it can contribute to ecological Reserve monitoring.

- *Guidelines and standards for all levels*. Chapter 14 of the National Water Act mandates the development of guidelines and standards needs to be formalised and coordinated. This can form the basis of sharing of monitoring actions and outsourcing.
- *Development of auditing responsibility*. Water resources monitoring will be a major business process. This will require auditing. It has been suggested that ISO 9002 quality control system may suffice.
- *Scoping of technology for monitoring*. This is important given the growing importance of monitoring and the number of stakeholders.
- *Cost-benefit analysis for monitoring*. This should address the uncertainty that exists regarding the overall investment required by monitoring, including the degree of delegation and outsourcing.
- *Convergence of Information Technology systems*. These include HYDSTRA (surface water), NGA/REGIS (groundwater), WMS (water quality), GIS (spatial) and WARMS (Water Authorisation and Registration Management System).
- *Capacity building for monitoring*. Capacity creation required to meet the overall goal is seen as the most significant bottleneck, particularly in the Regions. The FETWATER programme could play an important role.
- *Pilot implementation*. To test the practicality of the overall 5-year plan, full rollout in one pilot area is seen as important.

2.2.2 National reporting system

Formalised national reporting system

A critically important aspect of effective monitoring is information generation and dissemination. The dissemination (*e.g.* reporting) explicitly exposes the target users to the results of the monitoring. The very wide variety of monitoring that currently occurs, and that will occur in South Africa in future, and the fact that the Department produces over 70 reports annually, has prompted the development of guidelines for reporting on the status of the South African water sector (DWAF, 2004c). The slogan of the Water Sector Report is proposed to be "*ensuring sustainable water use and water resource protection*".

Considerations

Work on a conceptual design for a national reporting system to facilitate the production of such a report has started and has been based on the following considerations:

- A regularly updated inventory of required reports.
- An agreed framework for each report.
- An agreed set of indicators for each report.
- Identified line functionaries who are responsible for policy, key performance areas, etc., and for ensuring appropriate monitoring is taking place, which measures performance of their functional area against the set indicator.
- Regular contributions by a water sector "think tank" or strategic planning team, with representation from relevant line functions and sector role players (e.g. agriculture, health, energy, environment, local government).
- A depository for standardised inputs that can be shared by various reports.

Indicator development

The following framework has been suggested for choosing monitoring indicators:

- *Factual indicators.* These describe the current status.
- *Policy and strategy objectives indicators*. These address the situation described by the factual indicators.
- *Policy and strategy implementation indicators*. These are associated with licensing, meeting of targets for compliance, resources allocated and performance.
- *Outcome indicators.* These address how policy, strategy or programmes address identified issues.

2.3 Resource quality monitoring strategic framework

Strategic framework

A strategic framework has been compiled specifically for national resource quality monitoring programmes (DWAF, 2004b). The framework emphasises the necessity for monitoring programmes to deliver useful information to water resource managers, planners and other stakeholders.

Hierarchy of information requirements

Information requirements can vary considerably. They depend on, among other factors, the spatial scale of interest (*e.g.* as illustrated in Figure 2.1).

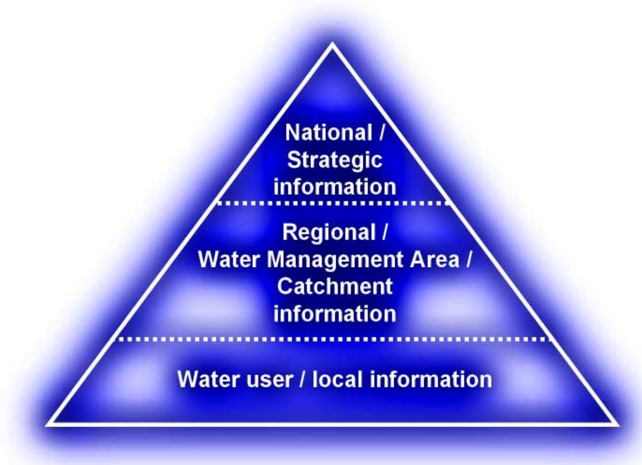

Figure 2.1: Hierarchy of information requirements for water resource management.

Principle components

The strategic framework identifies three principle functional components of a monitoring programme:

- Data acquisition.
- Data storage and management.
- Information generation and dissemination.

These should be seen as the more technical aspects, all of which fall within an overall management component that is required for successful implementation.

Portfolios of programmes

The framework also identifies a number of portfolios of programmes based on the responsible institution:

- Department of Water Affairs and Forestry (DWAF): DWAF Policy and Regulation will typically take responsibility for "national" programmes with strategic objectives.
- Catchment Management Agency (CMA): CMAs will implement programmes focussed on water resource management within their water management areas.
- Local water users: These are typically compliance or impact assessment monitoring programmes, and relate to source directed controls.

2.4 A supporting environment: a regional perspective

2.4.1 Introduction

Bottom-up

The above 5-year plan, reporting framework and strategic framework comprise the current top-down perspective. Although admirable, regional offices are not currently operating in an institutional environment that is adequately supportive for sound water quality monitoring. Even with a perfectly scientifically designed monitoring programme, it is doomed to failure if adequate institutional support is not provided. The following are some of the critical issues required to facilitate the creation of an appropriate supporting environment.

2.4.2 Financial support

Communicate clear objectives

Regional monitoring budget proposals should keep the following in mind:

- Ensure monitoring objectives are clear and relevant.
- Understand and communicate the "value for money" of monitoring.
- Ensure the most cost-effective budget is proposed.

2.4.3 Cost-effectiveness

Optimum use of resources

Optimising the use of resources is easy to say, but is often difficult to achieve. It requires careful thought about all aspects of the resources being used and exactly how these help to achieve monitoring objectives.

- Examine previous budgets and identify those tasks that were most expensive. Look for ways in which these can be made more cost-effective.
- Use local knowledge. Rely heavily on local people, inside and outside the Department, for advice on how best to optimise activities.
- Integrate with other existing monitoring programmes (as long as your own objectives are not compromised). Consider especially linking up with the national monitoring programmes that have, because of their national scale, been designed with cost-effectiveness in mind.
- Consider carefully the degree of confidence you require in your monitoring assessments. Compromising on confidence may often be quite acceptable and result in enormous savings.

2.4.4 Human resource management

Career building

Career building among those involved in monitoring addresses a critical requirement of all monitoring, namely continuity. Lack of continuity can lead to, at least, inconsistencies in procedures and, at worst, missing data. These play havoc with data assessments and obviously can seriously compromise achieving the monitoring objectives. Staff turnover also places enormous pressures on more experienced staff and others who are responsible for training.

Dedicated posts

Dedicated posts concentrating on monitoring can also greatly increase overall effectiveness. This provides for depth rather than breadth.

Incentives and rewards

One aspect of career building can be provision of rewards for outstanding work. People with pride in their work are likely to go that extra mile (for themselves and the Department/CMA). For some further thoughts on a rewards system see the Chapter: The Business of Monitoring in the National Eutrophication Monitoring Programme Implementation Manual (DWAF, 2002).

Mentorship

Continuity in monitoring can be significantly affected when an experienced person leaves. Mentorship programmes for new staff can greatly mitigate this, and generally facilitate sound knowledge transfer.

Training of local service providers

Training should go beyond Departmental/CMA staff to include appropriate local professional service providers (PSPs). All of these PSPs should be accredited and then used effectively so that they maintain a sufficiently high standard.

Analytical continuity

Continuity in the analytical laboratories used can be important. Besides the administrative demands of tendering and appointing new laboratories, changes in analytical methods (and quality control) that may result can cause step changes in the measured data that can confuse and confound data assessments.

2.4.5 Data management

Water Management System

The Water Management System (WMS) is the Department's designated central database for water quality data. The existence of a centralised user-friendly data management system is a critically important supporting function for effective water quality monitoring. For it to be effective, it must be remotely accessible both for data capture and retrieval (for assessment and reporting). The resources required for these two tasks should not be underestimated. Specialist posts should be created for these purposes.

Every effort should be made to increase the pace at which convenient access to WMS is achieved. If this is not achieved, data management will remain fragmented, non-standard and inefficient, and water quality monitoring will never reach its full potential.

SECTION 3: DESIGNING A WATER QUALITY MONITORING PROGRAMME

3.1 Introduction

Assumption that supporting environment exists

This and subsequent sections address the technical and scientific aspects of water quality monitoring design. It is assumed that the institutional supporting environment is in place. As noted above, if this is not the case, then these sections will be rather academic.

These sections assume that a reasonable institutional supporting environment is in place.

Effective monitoring is not easy

Monitoring "effectively" (*i.e.* producing the greatest amount of information that is genuinely useful to water resource managers for minimum cost) is not easy. Some might argue that even doing ineffective monitoring is difficult.

Careful design

Monitoring requires careful upfront thinking ("design"). This must focus attention primarily on what water resource managers really need. It must then focus on the most cost-effective way to provide that information.

The following sub-sections make a series of recommendations that aim to ensure that water quality monitoring is effective.

3.2 How to be effective

3.2.1 Overall design process

Need for holistic thinking

Figure 3.1 shows the steps of the ideal process for designing a water quality monitoring programme. Note that although the process is indicated as a series of sequential steps, at each step one must simultaneously consider all subsequent steps as well. For example, when deciding on the monitoring variables, also think about the frequency of monitoring, where samples will be taken, through to how the results will best be reported (graphically, in tables, etc.).

Design first and then, only if appropriate, integrate with other existing monitoring programmes later. This ensures that your design and implementation remains focused on your objectives. (Other programmes may not be implemented in the best way for your objectives.)

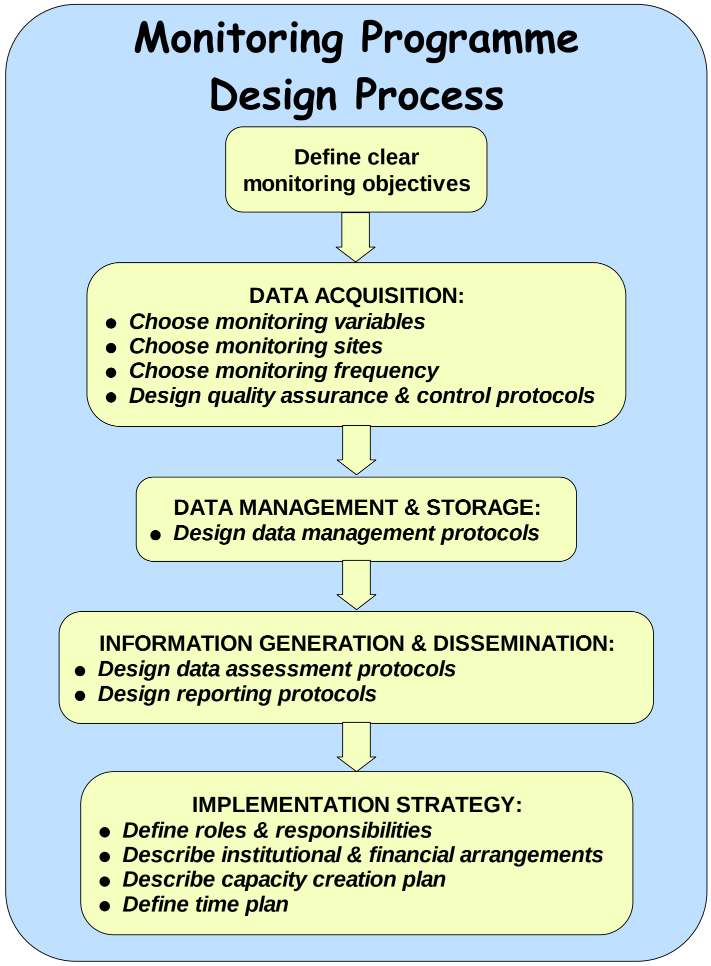

Figure 3.1: Generic monitoring programme design process.

Guidelines

The Departmental document on monitoring (DWAF, 2004d) should be consulted for some more detailed recommendations on monitoring design (including sampling procedures).

3.2.2 Documentation

Accountability

A wide variety of people is likely to be involved in a programme for monitoring water quality. These vary from samplers, analytical staff, data management staff, through to the managers that receive the monitoring reports. The roles and responsibilities of each need to be defined and well coordinated to ensure cost-effectiveness. Documenting the design of the programme helps to ensure that everyone is (a) working towards a common purpose, and (b) knows what he/she is accountable for (*i.e.* what needs to be done).

Thinking ahead

The effectiveness of any initial design needs to be assessed at periodic intervals so that improvements can be imposed. Under these circumstances, it is important to have on record why the particular initial design was chosen in the first place.

How to do it versus why to do it

The design of a monitoring programme should deliver two reports:

- *Implementation manual.* This should describe how the programme will be implemented.
- *"Record of decision" report*. This records why certain monitoring design decisions were taken. For example, why the chosen variables were selected, why the monitoring sites were selected in the way they were, and why the chosen monitoring frequency was selected.

The structure of the record of decision report will depend on the nature of the decisions taken. However, sections could simply correspond to those in the implementation manual, a possible structure for which is given below. The section on monitoring objectives should include a thorough analysis of information requirements of those for whom the monitoring reports are intended. (In certain circumstances some of the proposed sections may not be relevant).

Excessive detail is not necessary.

Simply record the most important factors.

Manual title

For water quality programmes the following general title could be used:

WATER QUALITY MONITORING PROGRAMME:
IMPLEMENTATION MANUAL
(UPPER VAAL WATER MANAGEMENT AREA)

Proposed structure

INTRODUCTION
- Need for monitoring
- Stakeholders
- Monitoring objectives

MONITORING FRAMEWORK
- Monitoring variables/indicators
- Monitoring site selection
- Monitoring frequency
- Sampling procedures
  - Equipment
  - Sampling protocol
  - Sample preparation
  - Sample delivery and analysis
- Data management
- Data assessment and reporting
- Quality assurance and quality control

IMPLEMENTATION STRATEGY
- Roles and responsibilities
  - Monitoring Coordinator
  - External stakeholders
  - Analysts
  - Samplers
- Institutional and financial arrangements
- Capacity creation plan
- Implementation time plan
- Review

3.2.3 Monitoring objectives

Objectives = why (not how)

Objectives of a monitoring programme should be summarised in one or two sentences. Objectives should describe why (not how) the monitoring will be done. For example:

***<u>Objectives of impact & licence compliance monitoring</u>:* To measure, assess and report on a regular basis the degree to which individual water users are (a) complying with the "end-of-pipe" conditions defined in their water use licence (if any), and (b) impacting on the local water resource water quality.**

> ***The objectives must be considered explicitly at every step in the design process.***

Monitoring is usually expensive. Sampling and laboratory analysis will often account for the greatest costs. Well-defined objectives maximise cost-effectiveness.

> ***Generic objectives are proposed below for various kinds of regional monitoring (section 1.3.3).***

3.2.4 Data acquisition (collecting the data)

Water quality variables

The water quality variables are those attributes that change over time and space, and whose measurement provides some of the raw data upon which the assessment and reporting of the monitoring programme is based.

Importantly, the monitoring variables chosen must be genuinely useful to managers. As a simple test answer the following question (truthfully):

"Why do I want to know what value that variable has (or how that variable is changing)?"

This forces one to consider how one might interpret monitoring data and, in particular, assess the benefits of monitoring against the costs. See Figure G3 for lists of some of the factors that should be considered.

The following are some particular points:

- *Be relevant.* Choose variables that are relevant to the local or regional situation and the monitoring objectives. For example, choose variables that are being impacted on by water users (e.g. sulphate or pH in the case of coal mines). If there are important ecosystems that need protection, choose variables upon which that ecosystem's integrity depends (e.g. dissolved oxygen).
- *Think beyond chemical variables*. Remember that chemical variables are not the only variables of importance. If human health is an issue (e.g. water may be used directly from the resource for domestic use), then include microbiological variables (such as *E. coli*, which is an internationally used indicator of faecal pollution).
- *Consider toxicity tests.* In certain special circumstances where toxic substances are suspected or known to be discharged into a resource, consider using toxicity tests on organisms like fish, Daphnia (an invertebrate) or even algae. Get advice from an aquatic toxicologist.

- *Make sure there are guidelines.* There must be guidelines or criteria (such as the South African Water Quality Guidelines (DWAF, 2001), RQOs or RWQOs, effluent targets, standards, etc.) available against which measurements can be assessed. If this is not the case, it will be difficult to know how "good" or "bad" a measurement is.

Complex ecological systems are usually driven by only a handful of factors. Water users are also typically heavily dependent on only a few critical parameters.
The challenge is to find out what these are.
For water quality, do your best to identify those variables.
These should be your "essential" list.

***Further reading*:** Roux DJ, PL Kempster, CJ Kleynhans, HR van Vliet and HH du Preez 1999. Integrating stressor and response monitoring into a resource-based water quality assessment framework. *Environmental Management*, **23**(1): 15-30.

Monitoring sites

When selecting monitoring sites, there are macro considerations (large spatial scale) and micro considerations (local scale) (see Figure 3.2). The macro factors depend heavily on the chosen objectives of the programme. The micro considerations refer to precisely where the sample will be taken:

- *Health and safety.* Sites must be chosen that ensure that samplers are safe from any danger, such as wild animals and even hijackings.
- *Accessibility.* Inaccessible monitoring sites (e.g. chosen from a map without on-site inspection of accessibility) may not only be dangerous or impossible to reach, but they may make the sampling round very time-consuming and expensive.
- *Spatial correlation.* Ensure that monitoring sites are not located so close to each other that the way in which water quality changes at one site is closely related to how it changes at an adjacent site. If this happens, the water quality at the two sites is "correlated" and, as such, can waste valuable resources and compromise the quality of the data for statistical analyses.
- *Mixing zone.* Samples must be taken well beyond the mixing zone that is located immediately downstream of a known or suspected pollution source, to ensure that samples are representative of the water resource. For a practical procedure to establish the extent of the mixing zone in a river see USEPA (1991).
- *Existing monitoring sites*. Sites at which sampling already takes place (for other monitoring programmes) may allow sharing of sampling resources and hence greater cost-effectiveness. However, these sites must be situated in locations that enable the objective of the current monitoring programme to be achieved.

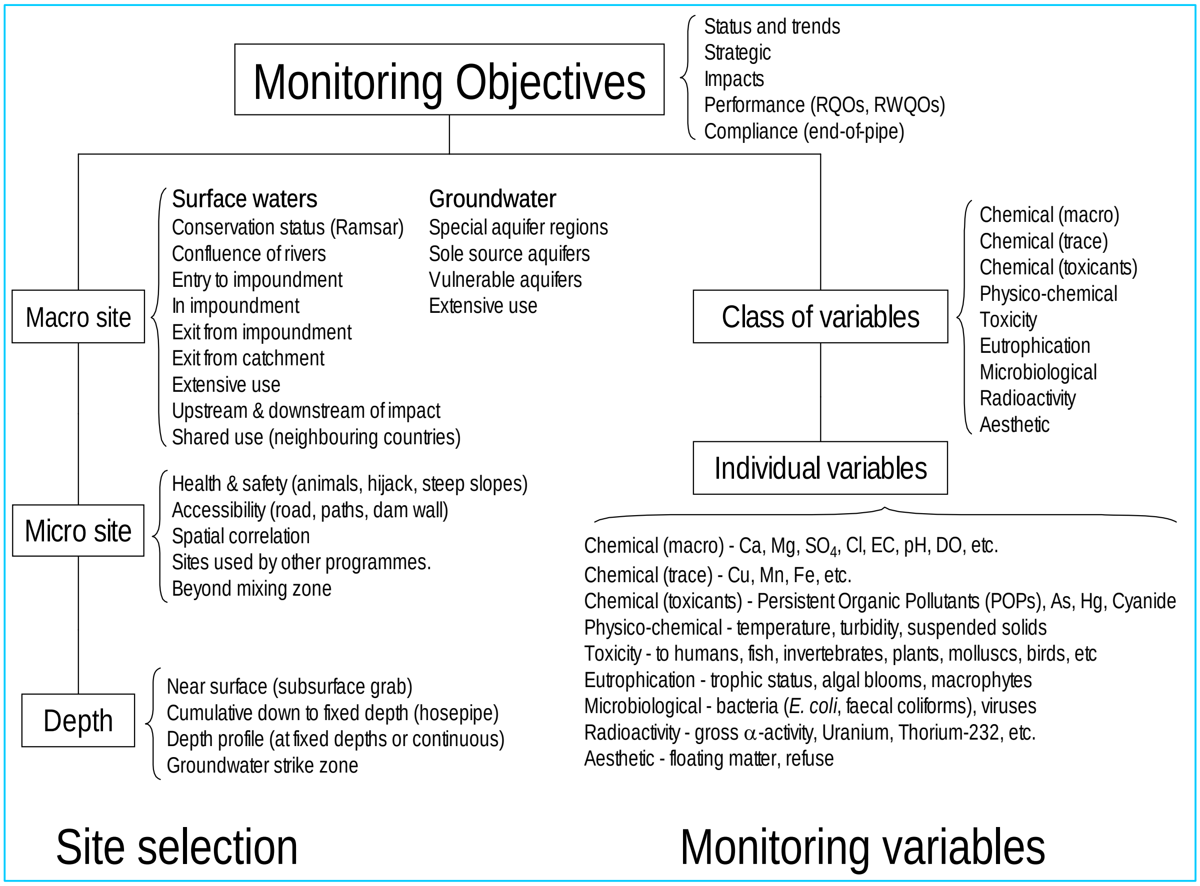

Figure 3.2: Some site selection and monitoring variable factors to be considered.

Monitoring frequency

The following tend to increase the monitoring frequency (*i.e.* decrease the time between successive sampling trips):

- *High random experimental variability.* The greater the random (unavoidable) variability in the experimental techniques (from sampling to analysis), the higher the frequency may need to be.
- *High natural variability.* Natural changes in the water quality attribute being monitored also result in variability. If this is high, and such changes as seasonality cannot be removed from the data, increased frequencies are also likely. Water quality changes in groundwater usually occur relatively slowly so less frequent monitoring is acceptable.

The following factors tend to decrease the monitoring frequency (*i.e.* increase the time between sampling trips):

- *Available resources.* The frequency of sampling is a major factor in determining the overall costs of a monitoring programme. For this reason the sampling frequency should be kept as low as possible.
- *Temporal correlation.* Samples that are collected on successive sampling trips should be independent of each other (because sufficient time has lapsed between sampling trips). If this is not the case, resources are being wasted and the quality of the data may be compromised if subsequent statistical analyses are intended. (See Table 3.2. for typical frequencies.)

Overall a balance needs to be achieved between the factors that increase the frequency and those that decrease it. If possible, consult a statistician.

Statistical methods are very useful; some would say essential. Be wary of drawing conclusions from a visual assessment of graphically presented data. It is often not easy to draw sound scientific conclusions on this basis. Monitoring frequency is a particularly important design decision that affects this.

Sampling and analytical methods

Sampling and analytical methods must be carefully chosen. They must ideally be well established and straightforward to implement in order to minimise:

- Initial capital and capacity creation costs; and
- The chances of inconsistent application (by different samplers in the field or by different laboratories).

See WRC (2000) for more detail on sampling techniques.

Choose laboratories that are accredited for the selected methods. If necessary, ask these laboratories for advice on the detailed sampling and sample preservation procedures. Be particularly careful to avoid sample contamination (*e.g.* by unclean hands) when sampling for microbial analysis.

Quality assurance and control

Quality assurance and quality control (see Glossary) are contentious, and often ignored, components of water quality monitoring in South Africa. This is particularly so because the management climate is one in which (a) the fundamental usefulness of monitoring is sometimes questioned and in which (b) lack of financial and human resources are frequently used to justify monitoring cutbacks or lack of progress. ("Basic monitoring is expensive enough without further strain being put on limited resources by invoking formal quality assurance and quality control protocols".)

The critical question that managers should ask is:

"How much confidence do I need to have in the monitoring data, and their assessment, to be able to make the decisions I need to make?"

The Department places considerable emphasis on the concept of "confidence" in visioning, determining the Reserve, the management class and resource quality objectives. Although the question is seldom easy to answer, managers are encouraged to answer the question to the best of their abilities in the current context. (Also, if possible, consider consulting a statistician and focus clearly on the objectives of the programme.

Unfortunately, statisticians often bear the brunt of inadequate data quality reflected in an inability to draw firm conclusions.

Furthermore, if a formal documented design is not available for the overall monitoring programme, it is impossible to specify a design for effective quality assurance and quality control.

Quality management

The standard SANS 9001 / SABS ISO 9001:2000 should be used to establish an overall management system that ensures that target readers of monitoring reports can have confidence that documented methods were followed. This is a general standard and each of the principles to which it ascribes should be carefully considered when setting up the overall quality management system.

These principles are:

- *Customer focus*. This will refer to the target readers of the monitoring reports.
- *Leadership*. This will refer at least to the coordinator of each programme but also refer to those to whom he/she reports.
- *Involvement of people*. All people associated with the monitoring should be fully committed.
- *Process approach*. Activities and related resources should be managed as a process.
- *System approach to management*. Managing interrelated processes well contributes to overall efficiency and effectiveness.
- *Continual improvement*. This should be a permanent objective.
- *Factual approach to decision making*. This acknowledges that effective decisions are soundly based on the analysis of data and information.
- *Mutually beneficial supplier relationships*. This emphasises the importance of the relationship between those involved in the actual monitoring and the target readers of the final reports.

Laboratory quality control

Although quality control goes beyond laboratory practices, it must be ensured that the laboratories that are chosen to perform certain analyses are properly accredited for those methods. The ISO 17025 system is particularly rigorous in this respect.

3.2.5 Data management and storage (handling the data)

Data capture

Primary data capture can potentially occur in at least two conceivable circumstances:

- Capture of experimental results in the laboratory; and
- Capture of these laboratory results on a centralised database.

In either case, ensure that the probability of human error is minimised by automating such actions as far as possible, including data transmission mechanisms.

Use software that automatically performs simple checks on the entered data to confirm that they are reasonable. For example, a pH value must be between 0 and 14.

Data management

Make sure that clear and robust protocols exist to ensure the data, once captured on a centralised database, are stored in such a way as to facilitate subsequent efficient access and processing. In particular, ensure that all data are stored so they can be made available under at least the following circumstances:

- A reasonable request for data is received from any stakeholder or interested party. The data should be provided, at reasonable charge if necessary, in line with the Access to Information Act (Act No. 2 of 2000) and the National Water Act (Act No. 36 of 1998).
- For the production of reports that constitute the formal and regular information dissemination mechanism of the programme.

3.2.6 Information generation and dissemination (reporting)

Data assessment do's and don'ts

Data assessments should:

- Be appropriate for the target readers of the report.
- Add (scientifically sound) value to the raw monitoring data.
- Be relatively straightforward to perform.
- Be understandable by all readers.
- Ensure misinterpretation is avoided.

Assessment criteria

A raw datum (such as the measured value of any water quality variable) is useless unless it can be compared with criteria that put it into context. This kind of assessment of data is the simplest way of adding value to produce "information". Two important kinds of criteria exist:

- *Regulatory criteria*: These are sometimes called "standards" and are often based on widely accepted guidelines. They have a legal status that facilitates their enforcement. Resource quality objectives will be regulatory criteria.
- *Guidelines*: These are usually widely (sometimes internationally) accepted threshold levels or ranges associated with certain effects relevant to the fitness for use of the water. National guidelines are usually generic (*i.e.* do not take into account site-specific situations). However, they are often a very useful starting point that gives an approximate indication of the possibility of effects occurring.

The following are some specific sources of water quality guidelines.

- DWAF, 2001. *South African Water Quality Guidelines for Fresh Water (2nd edition, 1996) and Coastal Marine Waters (1st edition, 1995).* Compact Disk. Water Quality Management Series. Department of Water Affairs and Forestry, Pretoria, South Africa.
- WRC, 1998. *Quality of Domestic Water Supplies. Vol. 1 Assessment Guide.* Department of Water Affairs and Forestry, Department of Health, Water Research Commission Report No. TT 101/98. Pretoria, South Africa.
- WHO, 2004. *Guidelines for Drinking-Water Quality. 3rd edition.* World Health Organisation, Geneva.

Statistical methods

DWAF (2003b) can be consulted for more information on some statistical methods that can be used. However, these must necessarily be consistent with the statistical methods used in the initial design (*e.g.* the choice of monitoring frequency).

False negatives and false positives

Be aware of the issues associated with reporting so-called "false negative" and "false positive" results. Let a "positive" result mean "there is a water quality problem" (whatever it might be). Then:

- A false negative result reports that there is NOT a problem when there actually is a problem with the water quality.
- A false positive result reports that there IS a problem when there is actually not a problem with the water quality.

The following table shows some causes and consequences of these errors.

In essence, an excessive number of false negative results can impact negatively on the achievement of sustainable development. An excessive number of false positive results impact negatively on the cost-effectiveness of the monitoring programme.

Table 3.1: Summary of some causes and consequences of false negative and false positive errors (adapted from DWAF, 2005f).

	FALSE NEGATIVES	FALSE POSITIVES
CAUSES		
Sampling method	Snapshot water sampling that may miss peaks	
Sensitivity	Toxicity test organism is less sensitive to stressor than organisms in the water resource	Toxicity test organism is more sensitive to stressor than organisms in the water resource
Bias	Guideline value very lenient	Guideline value highly precautionary
CONSEQUENCES		
Ecosystem integrity	Inadequate protection of water resources	Decreased cost-effectiveness of monitoring programme
Fitness for use	Increased likelihood of negative impacts on water users (and socio-economic enhancement and optimal water use)	

Reporting frequency

Distribute monitoring reports to target readers at a frequency that suits them. Annual reports will often suffice. However, it may be necessary in some circumstances to introduce more frequent reporting to provide feedback to some local stakeholders on a more regular basis (possibly with only limited data assessment). Reporting to selected stakeholders when certain "thresholds of concern" are reached should also be considered. This may be necessary in order to prompt a specific management response (like warning water users of potential problems when water quality deteriorates to a particularly unacceptable level).

Reporting format

The following are some general suggestions:

- *Targeted but easy to produce.* The format of the monitoring report should try to satisfy the requirements of the target readers. However, try to keep the resources required to produce such a report as limited as possible. For example, use facilities built into the database software (being used to store the data) as far as possible.
- *Be visual when possible.* Use visual presentations (like maps and graphs) whenever possible. However, use icons with care. In particular, ensure that they cannot be misinterpreted.
- *Watch your units.* Pay very careful attention to the units of monitoring variables. It is easy to make mistakes with units and cause considerable confusion as a result.

Reports can also highlight corrective and other management actions if appropriate.

3.2.7 Implementation strategy (making it happen)

The business of monitoring

Once the design decisions have been taken and documented, the actual monitoring programme must be initialised, implemented and carefully managed. It is useful to think about running a monitoring programme as you would about running any business. The following are some simple generic management reminders (Manning, 2004):

Management reminders

- Apply yourself to the right things.
- Keep things simple.
- Communicate.
- If you don't make a difference, you don't matter.
- Focus on the right stakeholders, improve their perception of the value you offer and drive down your costs.
- Think about the 7Ps: Purpose, Philosophies, Positioning, Partners, Processes, People, and Products.
- All businesses depend on social interaction to get things done.
- Embrace paradoxes by identifying opportunities.
- Provide good leadership.
- Give teams clear direction, simple rules and intense conversation.
- Facilitate creative thinking.

Tony Manning's Management Toolkit (Manning 2004)

Roles & responsibilities

Identify the various roles that are required to initialise and sustain the monitoring programme. These are likely to include the following:

- *Monitoring Coordinator*. A single person should be assigned the primary responsibility to coordinate all of the activities required to initialise the programme and ensure its continuity.
- *External stakeholders*. Identify those parties that may have a vested interest in the monitoring results. Ensure that their roles and responsibilities are clear defined and understood.
- *Analyst*. Identify appropriate laboratories that are accredited for the kinds of analyses required, and that are able to handle the number of samples likely to be delivered to them.
- *Samplers*. Identify organisations or individuals that have the capacity to perform the necessary sampling, sample preservation and sample delivery.
- *Reporter*. Identify who will be responsible for preparation and dissemination of final reports.

Institutional arrangements

Ensure that all necessary institutional arrangements are appropriate to the identified roles and responsibilities. For example:

- *Update job descriptions*. Ensure Departmental/CMA job descriptions are clear and formal.
- *Request tenders for, and then appoint, samplers and laboratories*. It is advisable to enter into formal contracts with analytical laboratories and samplers (following prescribed Departmental tendering procedures) to ensure that neither side can unilaterally change agreed protocols. This can be an important factor in ensuring continuity and standardisation of methods.

Financial arrangements

Clarify financial arrangements with all parties so that everyone involved understands and agrees to what they are likely to receive, and are likely to need to contribute, to ensure the success of the programme.

Tools: Two related costing spreadsheets are available from the Department (Resource Quality Services). These were developed for national status and trends monitoring. These can be used for any scale of monitoring programme as a relatively simple template for (a) identifying associated costs, and (b) developing detailed 5-year projected annual implementation costs. One spreadsheet is available for costing a single local programme (multiple monitoring sites in one local area). The other allows an overall regional (*e.g.* water management area) costing to be developed, based on a specified annual increase in the number of such local programmes over five years.

Capacity creation

The broadest goal of capacity building is to inform and improve decision-making in support of sustainable development of water resources (DWAF, 2004b). It focuses on enhancing the quality of the outcomes of monitoring programmes and hence the resultant decision-making. It covers all aspects of monitoring, including fostering collaboration between institutions and building human and social capital (DWAF, 2004b). As such it is the overarching quality assurance initiative. Creating capacity is more than just training samplers and analysts. It is ensuring that the entire institutional environment is geared towards maximising the effectiveness of the monitoring. (See Section: Institutional Environment above.)

Accordingly, carefully consider all activities and functions that will affect achieving the objectives of the monitoring and ensure that all are appropriately aligned.

Further reading: DWAF, 2004b. *Strategic Framework for National Water Resource Quality Monitoring Programmes.* [Compiledby DC Grobler and M Ntsaba]. Report No. N/0000/REQ0204. ISBN 0-621-35069-9. Resource Quality Services, Department of Water Affairs and Forestry, Pretoria, South Africa.

Time plan

Define an achievable timetable that implements the planned monitoring in a phased manner. For large-scale (*e.g.* strategic status and trends) programmes, initialise the programme in those areas in which:

- Monitoring data is most urgently needed; and
- Obvious problems (*e.g.* logistical and capacity-related) are minimal.

Then, in subsequent phases, when experience has increased through implementation in pilot areas, tackle the other areas that are less urgent or that are likely to be more challenging.

Review

Specifically state a reasonable period after which the overall effectiveness of the monitoring programme will be reviewed. This should not be longer than five years, though it may be much shorter initially (say three years). This auditing function should examine (a) the appropriateness of the programme's objectives, and (b) whether or not they are being achieved.

This should result in corrective actions if necessary to improve the programme's cost-effectiveness and focus on objectives.

3.3 Designing for the immediate future

3.3.1 What the future holds

Transition

The Department remains in a state of transition. Two particularly important aspects are relevant:

- *Decentralisation to catchment management agencies (CMA).* Although this process has started, it will be many years before the CMAs are firmly established. In the interim, this affects accountability for monitoring, clarity of mandate and resources available.
- *Introduction of the resource classification system.* Technically, this will be the most important initiative determining resource management by the Department and CMAs.

Management class

The management class is a resource directed measure (RDM) that will entail important water resources being assigned a "desired future state", typically encapsulated in the catchment vision. This will specifically be defined by resource quality objectives (RQOs) that define limits for specified characteristics of the resource, including water quality. Once designated, the management class will enable one to determine whether the resource is currently stressed (i.e. the RQOs are not being met) or unstressed (i.e. the current state falls within the limits defined by the RQOs). The degree to which RQOs are being complied with will therefore determine the nature of the management of current water users.

The degree to which the management class is being attained or maintained provides one important perspective on the degree to which sustainability goals are being achieved.

All monitoring will eventually need to provide information in direct support of water resource and water user management in the context of attaining or maintaining the management class (i.e. complying with RQOs) and complying with the Reserve.

Regional perspective

From a regional perspective, resource directed water quality monitoring should comprise a series of programmes with distinct objectives. Monitoring related to General Authorisations is not considered here because this typically does not involve monitoring of the water resource. Levels 1-4 refer to how the Upper Vaal catchment management agency categorises their current monitoring (Figure 3.3).

- ***Impact & licence compliance monitoring.*** This typically entails (a) upstream and downstream monitoring of sources of impact ("Level 3"), and (b) monitoring of effluent discharges to monitor compliance with authorisation conditions relating to "end-of-pipe" ("Level 4").
- ***Strategic status and trends monitoring.*** This can include major watercourses ("Level 1") and major tributaries of those watercourses ("Level 2"). This kind of monitoring is conceptually aligned with the objectives of the existing national water quality monitoring programmes. However, on a regional and local scale this should ultimately be aligned with the management class and RQO.
- ***Reserve monitoring.*** This monitors whether or not water quality meets the requirements of the Reserve.
- ***Performance monitoring (RQO and RWQO***). When RQOs and RWQOs become established, it will be the CMA's responsibility to comply with these objectives (conceptually, this is in the same way that water users have to comply with licence conditions).

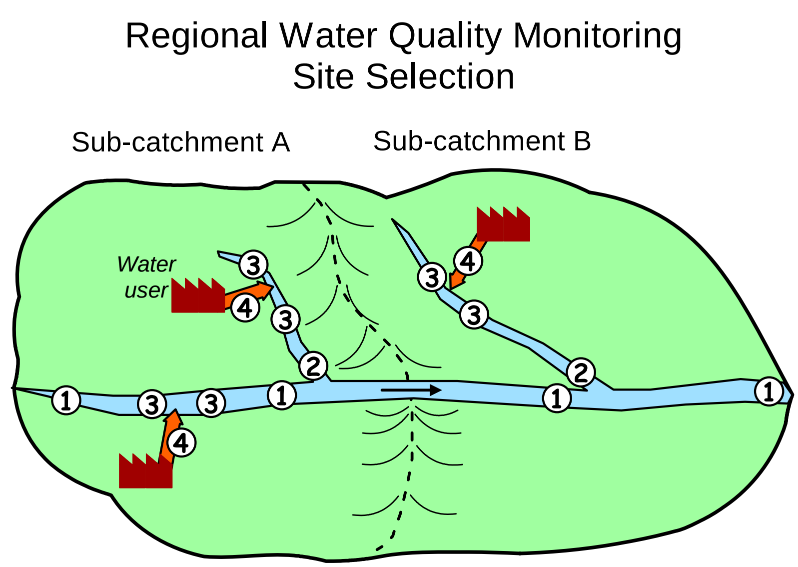

Figure 3.3: Illustration of four levels of regional water quality monitoring.

National perspective

A series of national water quality monitoring programmes exist, and others that are intended to be implemented, that have a strategic national (and international) perspective in their objectives. Strategic regional monitoring programmes can benefit considerably from these monitoring programmes. A typical design framework for national programmes is given below so that their perspective can be better understood.

Design frameworks

The following sub-sections suggest design frameworks for specific contexts. These expand on some of the issues noted above in the generic design process, interpreting them within the specific contexts.

3.3.2 Impact & licence compliance monitoring

3.3.2.1 Introduction

Generic objectives

To measure, assess and report on a regular basis the degree to which individual water users are (a) complying with the "end-of-pipe" conditions defined in their water use licence (if any), and (b) impacting on the local water resource water quality.

(Although monitoring end-of-pipe conditions is not directly resource directed, this monitoring has been included here for completeness).

Target users

The primary users of the monitoring information include the following:

- *The water user*. The information will indicate to the water user the extent to which adequate measures have been taken to limit and control the likely impacts on the water quality of the local water resource. Non-compliance can indicate the need for pro-active corrective actions by the water user.
- *The relevant authority*. The information will indicate whether or not the water user is complying with the conditions of the water licence. Non-compliance may lead to a number of possible actions in order to ensure compliance.

Management responsibility

There are two perspectives:

- *The water user*. The primary responsibility for licence compliance monitoring lies with the individuals or organisations whose water use is being monitored. Licence conditions typically stipulate upstream and downstream monitoring and monitoring of any discharge of water containing waste (if any).
- *The relevant authority*. The authority has the responsibility to audit these results by performing their own sampling and analysis.

3.3.2.2 Data acquisition

Water quality variables

- *The water user*. For an overview of the choice of monitoring variables see Section 6.2. In the interim, variables should be chosen that are (a) significantly affected by the particular water use, and (b) important to downstream water users and ecosystems (including the Reserve). Once RQOs are in place, these should give explicit guidance on what variables are important.
- *The relevant authority*. The authority should use the same variables for auditing.

Monitoring site selection

- *The water user*. For an overview of the monitoring site selection see Section 6.3.
- *The relevant authority*. The authority should monitor at the same sites for auditing.

Monitoring frequency

- *The water user.* The frequency of monitoring carried out by the water user should depend on available resources, how consistent the quality of discharged water containing waste is over time (if this exists), and the potential severity of impact. Consider imposing a higher monitoring frequency initially, at least until the behaviour of the discharged water containing waste and the resource are better understood. Only then permit the user to apply for a lowering of this frequency, if this is appropriate.
- *The relevant authority.* The authority's monitoring frequency should be determined by available resources and can be at a lower frequency than that used by the water user. For example, if the water user is monitoring monthly, a three-monthly interval might be adequate for the authority.

Sampling and analytical methods

The formal nature of compliance monitoring will require well-established standard methods to be used for sampling, sample preparation, sample transport and analyses (whether in the laboratory or on-site). Laboratories should be formally accredited for the chosen methods to ensure adequate data quality is achieved.

3.3.2.3 Information generation and dissemination

Data assessment

In the interim, General or Special Effluent Standards can be used to assess effluent data. South African water quality guidelines (among others) can be used to assess instream measurements (DWAF, 2001). When RQOs and RWQOs are established, these should be sensibly back calculated to effluent targets (see DWAF, 2005h).

Reporting frequency

The reporting frequency must be chosen in such away that corrective actions can be invoked in good time should problems be detected. Reporting may simply involve perusal of monitoring results received directly from the laboratory. However, if targets involve annual statistics, these statistics should be determined on an annual basis and compared with the target.

Reporting format

The reporting format should be simple and suit the requirements of both licensee and licensor.

3.3.3 Regional status and trends monitoring (strategic)

3.3.3.1 Introduction

Generic objectives

To measure, assess and report on a regular basis the status and trends relating to water quality in major water resources, in a manner that will support strategic management decisions in the water management area (WMA) in the context of fitness for use of water resources and aquatic ecosystem integrity.

Responsibility

The responsibility for funding and implementing this monitoring will lie with the CMA. However, considerable overlap is possible with national water quality monitoring programmes (see below). Funding and implementation of the latter programmes is the responsibility of the Department (Policy and Regulation).

Less confidence

The objective of this kind of monitoring is not as demanding as assessing authorisation compliance or performance monitoring. This means that less confidence in your results is acceptable as long as the objectives are achieved and managers can make informed decisions.

3.3.3.2 Data acquisition

Water quality variables

- *In the interim*. As a point of departure, it is sensible to choose the kinds of variables being used in the national water quality monitoring programmes. If there are other variables that are of particular concern to the WMA, these can be included.
- *When RQOs or RWQOs exist*. These should give further explicit guidance on what variables should be considered important.

Monitoring site selection

- *In the interim.* Monitoring sites should be chosen along main watercourses and major tributaries that can be regarded as strategically representative of those water resources. Take into account, if possible, the kinds of issues considered for determining RWQOs (i.e. ecological and water user requirements, etc.). Specifically, a desktop or rapid determination of RWQOs could be carried out (DWAF, 2005g).
- *When RQOs or RWQOs exist.* These will typically define where compliance is required. If these sites are of a sufficiently important strategic nature, use them. However, they may not exist at a sufficient number of sites to provide the WMA with the necessary resolution. In such a case, as above, take account of the kinds of issues considered for determining the RWQOs.

Also consider augmenting the sites that may exist for national monitoring programmes to provide a resolution that is more suitable for the WMA (Figure 3.4).

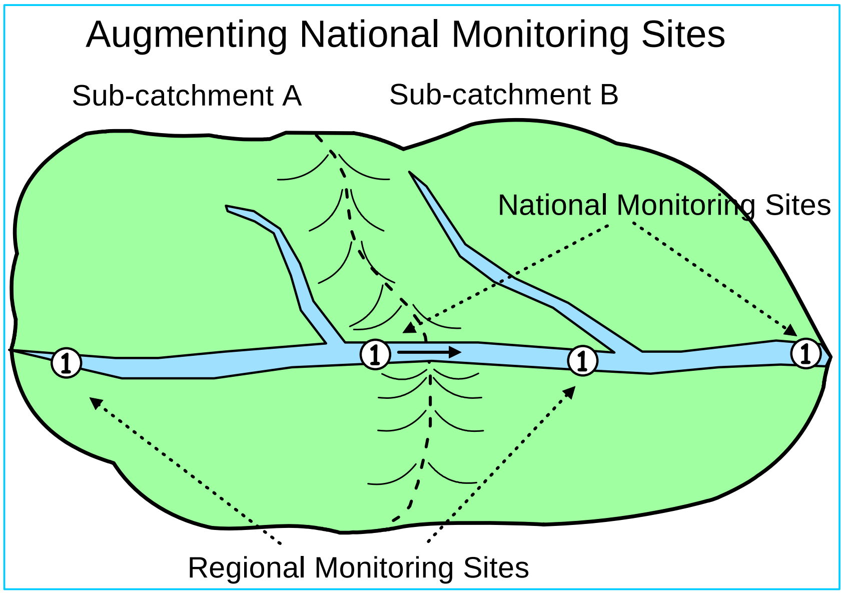

Figure 3.4: Augmenting national monitoring sites.

Monitoring frequency

In the interim. The following frequencies are recommended as "points of departure" in the types of water indicated and should be tailored to local circumstances.

Table 3.2: Monitoring frequencies that can be used as "points of departure".

Type of resource	Frequency	No. of samples per year
River / stream / spring etc.	2-weekly	26
Impoundment	Monthly	12
Borehole	6-monthly	2

Also take guidance from the national monitoring programmes. However, if a greater frequency is required, consider augmenting the monitoring done for the national monitoring programmes (see Figure 3.5).

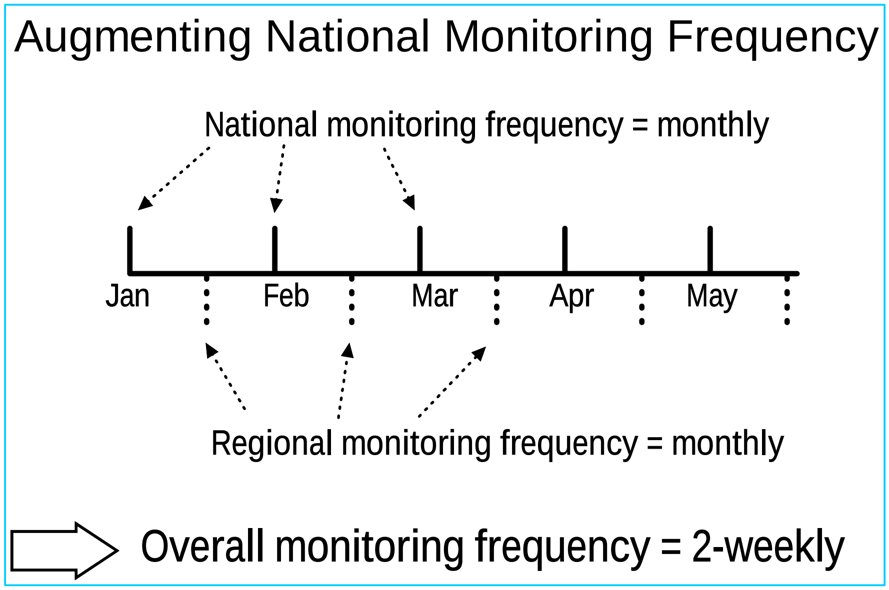

Figure 3.5: Augmenting national monitoring frequency.

If human and financial resources permit, seriously consider using a higher frequency (than recommended above) for the first year. Once the full year's data are available, submit the data to a statistician in order to determine whether or not the chosen frequency is satisfactory. They can examine whether or not temporal (or spatial) correlation exists. On this basis, change the frequency and/or the monitoring sites if necessary.

When RQOs or RWQOs exist. These are likely to define the required monitoring frequency. However, less confidence (than for performance monitoring) is acceptable so less frequent monitoring may be possible.

3.3.3.3 Information generation and dissemination

Data assessment

- *In the interim*. Take guidance from the national monitoring programmes.
- *When RQOs or RWQOs exist.* The RQOs and RWQOs will be the criteria against which measurements should be assessed.

3.3.4 Performance monitoring (Reserve, RQOs and RWQOs)

3.3.4.1 Introduction

Generic objectives

To measure, assess and report on a regular basis:

- ***The degree to which the resource water quality complies with the requirements of the determined ecological Reserve, and***
- ***The degree to which present resource water quality conforms to (a) resource quality objectives (RQOs) relating to water quality, and / or (b) resource water quality objectives (RWQOs), and hence***
- ***Whether a water resource is within its designated management class (in respect of water quality).***

RQOs and RWQOs

RQOs are quantitative or descriptive goals for resource quality (ecosystem health, water quantity, water quality, etc.), within which a water resource must be managed to maintain its designated management class and hence move towards the catchment vision. These have a formal legal, and hence regulatory, status (by being published in the *Government Gazette*).

RWQOs are similar but (a) relate only to water quality, and (b) do not have the legal status of RQOs (*i.e.* are not published in the *Government Gazette*). They may have a higher spatial and temporal resolution than the RQOs.

Management responsibility

The primary responsibility for management and implementation of performance monitoring programmes, and compliance with the Reserve and RQOs, will lie ultimately with CMA.

3.3.4.2 Data acquisition

Water quality variables

The Reserve determination will define the monitoring variables.

In respect of RQOs, the monitoring variables must relate directly to the RQO chosen for the designated management class for each water resource (DWAF, 2005g). If the RQO is expressed in terms of specific water quality attributes (e.g. pH must be between 6 and 9), then the chosen monitoring variable is self-evident (for this example, pH).

However, RQOs may be more narrative in nature and may not be explicitly expressed in terms of traditional water quality monitoring variables. In this case, these RQOs may need to be interpreted and a choice made regarding what water quality attribute is best monitored to enable an assessment of whether the RQOs are being achieved or not (if this cannot be achieved by the RQOs relating directly to water quality).

RWQOs, since their purpose is to give effect to the RQOs, should comprise the same variables as the RQOs.

Monitoring site selection

The Reserve determination and the RQOs will specify explicitly where they should apply and hence indicate where sampling should take place.

Similarly, RWQOs, since they will be determined in an equivalent way to the RQOs, will also inherently specify where they apply.

Monitoring frequency

The Reserve determination will give some indication of an appropriate monitoring frequency.

Since RQOs will have a formal status (by being published in the Government Gazette), particular care must be taken to ensure that data of adequate quality are collected. One aspect of this quality is that sufficient data must exist over the designated period (typically annual) to enable an accurate statistic to be determined that can be compared with a particular RQO. The factors described above will determine the optimum monitoring frequency.

The same applies to the RWQOs.

Sampling and analytical methods

The formal nature of the Reserve and RQOs will also require well-established standard methods to be used for sampling, sample preparation, sample transport and analyses (whether in the laboratory or on-site). Laboratories should be formally accredited for the chosen methods to ensure adequate data quality is achieved at all times.

The somewhat less formal nature of RWQOs means that the same level of analytical rigour need not be applied. However, it must be ensured that all methods are sufficiently standardised so that their purpose and interpretation is not compromised.

3.3.4.3 Information generation and dissemination

Data assessment

Because the Reserve and RQOs have a significant legal status, the confidence with which results are reported should be as high as possible. The most important issue is the relationship between the present state of the resource and its designated management class. The RQOs themselves are the objectives against which monitoring data are assessed.

Assessments of RWQOs need not be as formal, although it will be sensible to perform the same kinds of assessments as RQOs (since these protocols will exist anyway).

3.3.5 National status and trends monitoring (strategic)

3.3.5.1 Introduction

Generic objectives

To measure, assess and report on a regular basis the status and trends relating to water quality in South African water resources, in a manner that will support strategic management decisions in the context of fitness for use of water resources and aquatic ecosystem integrity.

Strategic nature

"Strategic" is used here in the sense of being large in scale, both spatially and temporally. The spatial scale is national and the temporal scale for reporting would typically be annual.

National design responsibility

As noted above, the Department (Policy and Regulation) has the responsibility for funding and implementing national monitoring programmes (DWAF, 2004b).

Where monitoring is already occurring for such national purposes, it is important that regional monitoring does not duplicate this. It should rather use the national data for its own purposes and supplement this (*e.g.* at more sites or more frequently at the national sites) to better meet regional objectives.

National target users

The users of the monitoring information are specifically those that are interested in a more strategic (national and long-term) perspective on the state of water quality in water resources. Target users go beyond just the CMA. However, the CMA can (and, indeed, should) benefit directly from the information contained in national reports.

Cost-effectiveness

The enormous spatial and temporal scale of national monitoring programmes has meant significant emphasis is given to cost-effectiveness. Specifically this means maximising the information provided to water resource managers while minimising the costs. Creative thinking has been necessary to achieve practical designs for these large-scale monitoring programmes. In particular, it has emerged that fundamentally different designs have been necessary for the different types of national monitoring (surface water versus groundwater, microbiological versus chemical, etc.).

These can be useful lessons for a CMA that must also monitor different attributes of water quality and different types of water resources, sometimes over large spatial scales. The national implementation manuals can be consulted for insights likely to be useful in designing monitoring programmes for a CMA.

Current national water quality monitoring programmes

The following national programmes relating directly to water quality are either in place or are envisaged fir future implementation (for a little more detail on each programme see DWAF, 2004a):

- ***National Chemical Monitoring Programme (NCMP).*** Monitors the status and trends of major inorganic ions and attributes such as pH, electrical conductivity, etc. Many sampling points exist throughout the country. In operation for many years.
- ***National Microbial Monitoring Programme (NMMP).*** Monitors the status and trends of either faecal coliforms or E. coli. Surface water monitoring has been implemented in some water management areas for a few years. The design for groundwater microbial monitoring is currently being tested prior to implementation.
- ***National Eutrophication Monitoring Programme (NEMP).*** Monitors the status and trends of mainly chlorophyll a and total phosphorous in impoundments only and determines their trophic status (oligotrophic, mesotrophic, trophic, hypertrophic). Also monitors algae and cyanobacteria. The programme has been implemented for a few years.
- ***National Toxicity Monitoring Programme (NTMP).*** Currently being designed. Will monitor status and trends of (a) toxic effects on selected organisms (algae, invertebrates and fish), and (b) selected individual toxicants in water (including some persistent organic pollutants (POPs)).

- ***National Radioactivity Monitoring Programme (NRMP***). Currently being designed. Will monitor the status and trends of radioactivity.
- ***Ecological Reserve Determination and Monitoring***. Currently being designed. Will monitor the status and trends and compliance of those variables important to the ecological Reserve.

3.3.5.2 Data acquisition

Water quality variables

Status and trends programmes choose monitoring variables that address various issues of national concern. These include the following:

- International responsibilities (that are not normally covered by performance monitoring).
- Keeping abreast of international Capacity creation upon which further region-specific capacity creation can be based when CMAs become operational.

The kinds of variables currently in use are indicated above.

Monitoring site selection

Monitoring sites are typically chosen at a fairly low spatial resolution but at strategically important sites from a national point of view.

Monitoring frequency

Monitoring frequency is typically relatively low (mainly to minimise costs) though it is sufficient to provide, for example, annual statistics with adequate confidence to meet the national objectives.

3.3.5.3 Information generation and dissemination

Data assessment & reporting formats

Data assessment protocols tend to be specific to the type of monitoring programme. For some national programmes (*e.g.* microbial and toxicity), guidelines have been developed specifically for these programmes.

3.3.5.4 Guidelines

Microbial monitoring (surface water)

Murray K, M du Preez, AL Kühn and H van Niekerk 2004. *A Pilot Study to Demonstrate Implementation of the National Microbial Monitoring Programme*. Water Research Commission Report No. 1118/1/04. Pretoria, South Africa. (Annexure contains implementation manual).

Microbial monitoring (groundwater)

Murray K, M du Preez, MB Taylor, R Meyer, R Parsons, E van Wyk, AL Kühn, H van Niekerk and MM Ehlers 2004. *National Microbial Monitoring Programme for Groundwater. Prototype Implementation Manual*. Water Research Commission Report No. 1277/2/04. Pretoria, South Africa.

Murray K, M du Preez, MB Taylor, R Meyer, R Parsons, E van Wyk, AL Kühn, H van Niekerk and MM Ehlers 2004. *National Microbial Monitoring Programme for Groundwater. Research Report*. Water Research Commission Report No. 1277/1/04. Pretoria, South Africa.

Eutrophication monitoring

DWAF, 2002. *National Eutrophication Monitoring Programme: Implementation Manual.* Department of Water Affairs and Forestry, Pretoria, South Africa. [Compiled by K Murray, M du Preez and CE van Ginkel].

Toxicity monitoring (surface water)

DWAF, 2004. *National Toxicity Monitoring Programme for Surface Waters: Draft Conceptual Design Framework and Record of Decision Report*. Department of Water Affairs and Forestry, Pretoria, South Africa. [Compiled by K Murray].

SECTION 4: A MONITORING VISION: BEYOND WATER QUALITY

4.1 Long-term perspective

Also useful now

Achieving sound water quality monitoring, as outlined above, is by far the most pressing need in respective of regional monitoring. The following sub-sections outline a more ambitious perspective on monitoring. Although this is only likely to be implemented in the long-term, the new paradigm introduced here can nevertheless also help authorities to understand and present the results obtained by the current monitoring programmes.

4.2 The PSIR framework and sustainable development

4.2.1 The thinking framework

DPSIR framework (precursor to PSIR)

The Driving force-Pressure-State-Impact-Response (DPSIR) framework was developed by the European Environment Agency. According to this framework, social and economic activities (driving forces) exert pressure on an ecosystem, and as a consequence, the state of that ecosystem changes. This change in state leads to various impacts (*e.g.* on socio-economic enhancement). These impacts can result in responses from society that ultimately aim at mitigating these impacts by directly addressing the driving forces, pressures, the state, or impacts. (The River Health Programme uses this framework).

Focus on PSIR

As driving forces are often difficult to manage, the DPSIR framework is sometimes adjusted to focus more on pressures rather than on the driving forces behind them. This is called the PSIR (Pressure-State-Impact-Response) framework.

Resource directed management of water quality is a very specific application in which responsibility for management of driving forces typically lies outside the mandate of the Department. For example, obvious driving forces include the multitude of land use practices that impact directly on water quality (such as agriculture and mining). It is considered more appropriate to focus monitoring efforts on identifying the pressures that result from these driving forces (such as non-point source agricultural runoff polluting water with pesticides). This is more directly relevant to the Department.

Beyond water resources

RQOs will be the most important sustainability indicators. However, they will not be sufficient on their own. Management of water resources must support decision-making that will facilitate using water resources in a way that ensures future generations can meet their basic water requirements while promoting socio-economic development and improved quality of life for all in the current generation. To do this effectively, water resource managers must think beyond water quality, and indeed even beyond water resources.

A number of frameworks that facilitate such thinking have been applied to state of environment (SoE) reporting. One in particular, PSIR, has already been successfully used in South Africa, including in the Department of Environment Affairs and Tourism (DEAT) National Environmental Indicators Programme (DEAT, 2002).

Applying the PSIR framework to resource directed management of water quality will enable managers to take monitoring beyond simply water quality to a level at which it can more usefully inform sustainable development.

Advantages

The PSIR framework has the following advantages:

- It facilitates the development of a balanced suite of sustainability indicators.
- It guides data and information collection processes (also identifying gaps).
- It helps managers to understand cause-and-effect relationships.
- It helps to structure reports and group related information.

4.2.2 PSIR categories defined

PSIR categories

The four PSIR categories (Figure 4.1) can be interpreted in the context of resource directed management of water quality as follows:

> ***Beware of the following PSIR-related terminology. The words Pressure, State, Impact and Response are commonly used to mean other things as well. Be sure that you understand the context in which they are being used in this document.***

- ***Pressure***. This refers to those wide-ranging human activities that can directly cause negative impacts on water quality in a water resource. The National Water Act (Act No. 36 of 1998) Section 21 water uses provide a series of obvious categories of likely immediate pressures on water quality.
- ***State***. In the current context, the state of water quality in water resources (surface water, groundwater and estuaries) is the specific focus. This includes concentrations or loads of chemicals or microbiological attributes as well as biological responses like toxicity.
- ***Impact***. Deteriorating water quality can impact directly on ecosystem health and on fitness for use (*e.g.* domestic, recreational, agricultural, industrial) and hence impact on quality of life and socio-economic enhancement. Impact in the current context therefore means "impact of changes in the state of water quality on the water resource, socio-economic enhancement or quality of life".
- ***Response***. This refers to decisive reactions of society, including government, to these negative impacts, that aim to solve or mitigate water quality problems. These can directly address the pressures (*e.g.* through regulation), state or impacts (*e.g.* through rehabilitation).

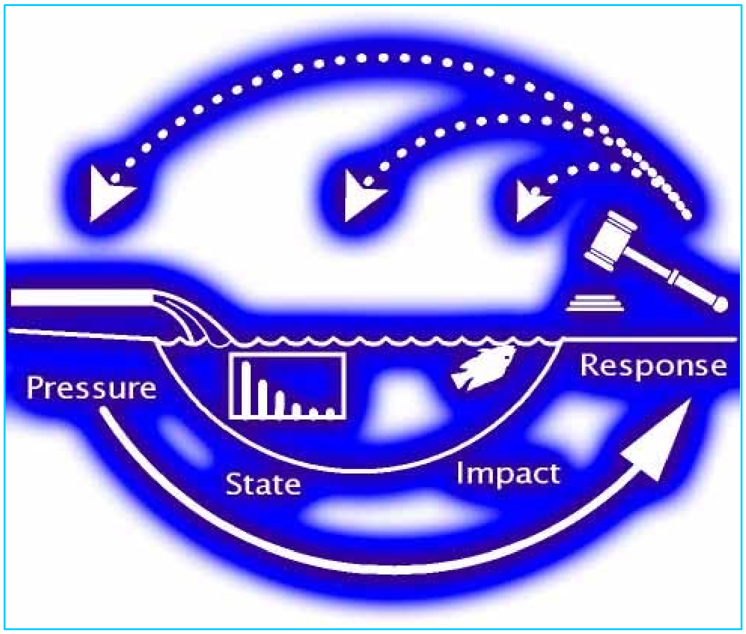

Figure 4.1: Illustration of the PSIR framework in a water quality monitoring context.

PSIR addresses sustainable development principles

Each of the four PSIR categories provides a particular kind of information that helps to determine the degree to which the six enabling principles of sustainable development (Section 1.2) are being achieved (DWAF, 2005b).

- *Pressure monitoring*. This provides some information relating to socio-economic enhancement (*e.g.* by quantifying the pressures put by polluters on water quality and by helping to quantify the degree of efficient water use). This information can also inform equitable allocation initiatives and hence achieving current equitable access. This monitoring is directly related to the management of water users.
- *State monitoring*. This provides direct information on the degree of protection of water resources and will also inform equitable allocation (by enabling quantification of allocatable water quality) that in turn informs the degree of current equitable access. This monitoring is directly related to monitoring the resource water quality and hence resource directed measures (fundamental to sustainable development).
- *Impact monitoring*. This measures both socio-economic and ecological impacts. Socio-economic impact data can help to quantify the degree of socio-economic enhancement that, in turn, enables optimal water use. Ecological impacts include those of deteriorating water quality on other resource quality attributes. Monitoring this contributes to a broader understanding of the degree of protection of water resources in general (beyond just water quality).
- *Response monitoring*. This supplements the information from impact monitoring by providing more specific information on the nature of societal needs. This can directly inform initiatives to achieve current equitable access and optimal water use (as well as, in some instances, the degree of protection of water resources).

Effective responses by the Department will require good governance (another enabling principle of sustainable development) since solutions to problems will frequently require close co-operation with other government departments and stakeholders.

Any monitoring that provides information relating to current equitable access and protection of water resources inevitably provides information that is relevant to equity between generations (a sustainability principle).

Furthermore, once all four kinds of monitoring are in place, only then can one confidently claim that the enabling principle of environmental integration is being addressed.

PSIR, catchment assessment and catchment visioning

Catchment visioning is about creating a common vision of the future aspirations of stakeholders in a catchment (DWAF, 2005e). The processes of (a) defining the vision, and (b) striving for that vision, depend heavily on catchment assessments to supply the quantitative data upon which sensible decisions can be based (DWAF, 2003b). The PSIR framework provides an excellent structure for focusing these assessments and thereby ensuring that catchment visioning is suitably comprehensive and holistic.

4.2.3 Issues-based indicators

Indicators depend on the issues

The framework itself does not provide any detailed guidance on what indicators should actually be measured. In order to identify the most appropriate indicators, a list of relevant issues can be compiled. The Policy, in particular, identifies many issues of national concern. These, supplemented with local catchment priority issues (*e.g.* identified through catchment visioning), can be used as a basis for identifying specific individual indicators.

Indicators can also be adapted from those that are used in similar applications of the PSIR framework in other countries. However, these will need to be carefully examined for their applicability to the South African context.

Policy issues

The Policy identifies a number of national issues relating to water quality (DWAF, 2005b) that can influence the choice of appropriate PSIR indicators:

- Quality of life;
- HIV/Aids;
- Poverty; and
- Racial and gender inequities.

Software decision support tool

A software decision support tool is available for assessing the probability that a licence should be issued (DWAF, 2005d). It is based on an assessment of each of the Section 27 considerations ((a) to (k)), using a multi-criteria decision support algorithm. A series of indicators are used upon which the assessment is based. Some of these could also be used for PSIR monitoring.

Applying this interpretation of the PSIR framework will ensure that resource directed management of water quality, through a careful choice of indicators, can be explicitly related to sustainable development and national, regional and local issues.

4.3 Monitoring programmes that support PSIR

Supporting programmes and data sources

As described in more detail in the following sub-sections, monitoring programmes that already exist (or that are envisaged) can provide useful support for Pressure, State, Impact and Response monitoring. Importantly, these "supporting programmes" exist in their own right and are designed to meet their own well-defined objectives. However, their data and results can be assessed within the PSIR framework. Figure 4.2 illustrates this.

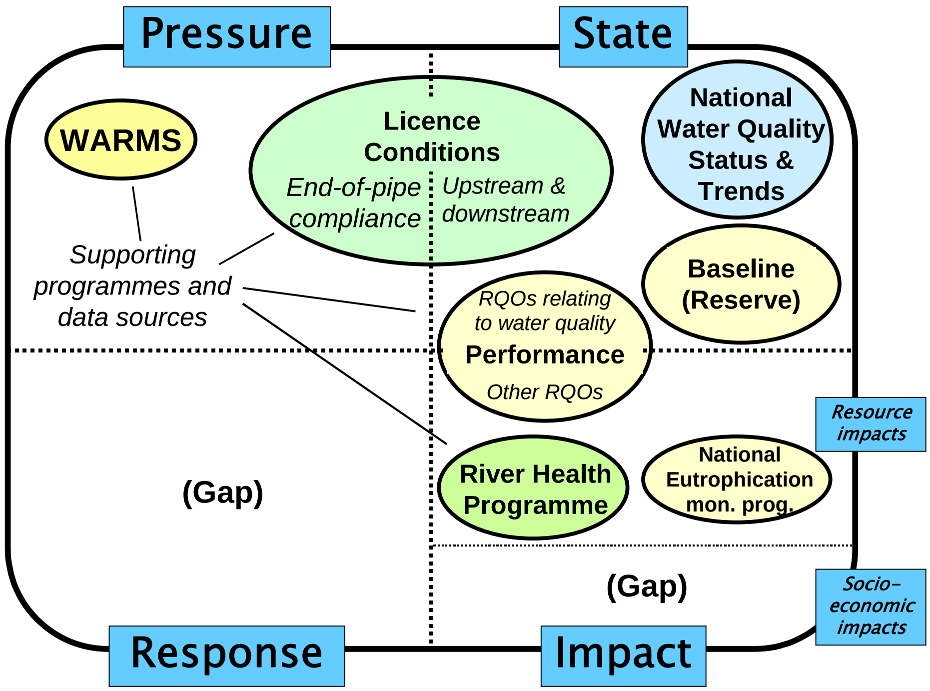

Figure 4.2: Illustration of some supporting programmes and data sources for PSIR-based monitoring.

Gaps

Figure 4.2 also illustrates that there are no existing standardised supporting programmes for socio-economic impacts and response monitoring. These gaps are addressed below.

4.4 PSIR monitoring

4.4.1 Introduction

Emphasis on indicators

This section describes in general the essential components of PSIR monitoring. Whereas the water quality monitoring described above measures specific water quality variables, PSIR monitoring tends to place greater emphasis on "indicators".

4.4.2 Documentation

Manual titles

For the same reasons as for water quality monitoring, a PSIR monitoring programme should have a "record of decision" report and an implementation manual. The title of the manual could be as follows:

PSIR MONITORING PROGRAMME: IMPLEMENTATION MANUAL

(UPPER VAAL WATER MANAGEMENT AREA)

Proposed structure

The structure of the manual can be based on that proposed for water quality monitoring (Section 3.2.2). Note, however, that "variables" will now typically be referred to as "indicators".

4.4.3 Monitoring objectives

Importance

Well-defined objectives for any monitoring programme are essential. They should be summarised into one or two sentences that make it clear why (not how) the monitoring will be done.

Specific objectives are proposed for pressure, state, impact and response monitoring programmes in the design frameworks below (section 1.4.5).

Target users

In general, the users of monitoring information that is related to resource directed management of water quality include the following:

Primary users:

- Water resource managers, water quality managers and water resource planners (in catchment management agencies, water use managers, water user associations and Department Head Office and Regional Offices).

Secondary users:

- Other national, provincial and local government authorities.
- Non-Government Organisations.
- All industrial sectors.
- Public.
- Any other interested party.

4.4.4 Data acquisition

Choice of indicators

The choice of indicators should be driven by national and catchment priority issues. Indicators may often be some statistic obtained from a raw data series. An indicator might also simply be an annual average or be a more complicated aggregation of data or other indicators.

It is preferable to choose indicators for which either national or international criteria exist against which they can be assessed. However, if such criteria do not exist, it may still be possible to perform a simple comparative assessment, either from one time period to the next or between different spatial areas. Such indicators may need to be normalised (*e.g.* per capita, per unit area, per unit volume, etc.).

***Further reading*:** Walmsley JJ, M Carden, C Revenga, F Gagona and M Smith, 2001. Indicators of sustainable development for catchment management in South Africa – Review of indicators from around the world. *Water SA*, **27**(4): 539-550.

DEAT, 2002. *National Environmental Indicators Programme*. Department of Environment Affairs and Tourism, Pretoria, South Africa.

Field data collection

Whatever the nature of the field data that need to be collected (including, for example, data on the incidence of waterborne diseases that may need to be collected from remote clinics), the factors mentioned above for water quality monitoring are important.

Monitoring frequency

When collecting data, from whatever source, carefully consider the variability of the data, available resources and temporal correlation (similar to monitoring water quality, as noted above). This is particularly so if the data are to be analysed statistically.

Quality assurance and control

Carefully consider quality assurance and quality control (see Glossary). If data are to be collected from data sources whose compilation has been outside your control, then the level of confidence that you can reasonably associate with these data may be lower than you may wish. Accordingly, any assessment of such data should be conducted with caution.

4.4.5 Data management and storage

Human error

Data manipulation at any stage of the process must be designed to minimise the possibility of human error (*i.e.* unintentional mistakes). The greater the number of times that data must be re-typed, the greater is the likelihood of mistakes. Process data electronically as far as possible.

Databases

Ensure that databases that store the raw data, or the indicators obtained from the data, are effectively designed to simplify the following:

- Data capture;
- Long term storage (with frequent backups);
- Data retrieval; and
- Transfer to other databases.

4.4.6 Information generation and dissemination

Assessment criteria

Raw data should ideally be compared with criteria or guidelines that add value and place the data in context in a way that produces useful "information".

Reporting frequency

The frequency with which reports are disseminated depends primarily on the needs of the target readers. However, periods between successive reports should not be longer than one year.

Reporting format

The format of the report must satisfy the requirements of the target readers. Visual presentations (such as maps and graphs) are encouraged with careful use of icons, if necessary (with due attention given to possible misinterpretation of icons).

4.4.7 Implementation strategy

Management

See the management and implementation strategy section for water quality monitoring, described above.

Modularity

In order to be consistent with the Department's hitherto modular approach to monitoring programme design and implementation, it is proposed that four separate monitoring programmes be envisaged for Pressure, State, Impact and Response monitoring (and yet another for management performance monitoring). Catchment management agencies are encouraged to ensure that all types of monitoring programmes are in place.

This modular approach allows a degree of flexibility in implementation and more focussed thinking in each instance.

Integration

A potential disadvantage of such a modular approach is that an individual programme may be designed and implemented in a way that does not take sufficient account of the others. This must be avoided to ensure that the products of all of the separate programmes are appropriately complementary and hence allow a truly integrated overall assessment to be performed when all are eventually fully implemented.

Phased implementation

It is important that a phased approach be taken to implement the PSIR monitoring programmes. Accordingly, the following are recommended in order of decreasing priority for the initial stages of implementation:

- *State monitoring*. This is by far the most important monitoring that should be initiated in a water management area. Once in place, the results of this will inevitably drive the more detailed design of the remaining monitoring programmes.
- *Pressure monitoring*. This will quickly become important once a good picture is obtained of the state of water resources. This will allow more focussed source directed controls to be imposed by providing an overview of those activities that are causing the state of resource water quality to change.
- *Impact monitoring*. This information will begin to provide a broader spectrum of information that can facilitate the holistic thinking required to achieve sustainable development.

- *Response monitoring*. This will provide greater insight into (a) the impacts on society, (b) the real needs and priorities of society, (c) measures that may need to be enforced, and (d) successes or failures of responses (*e.g.* of rehabilitation efforts). This can be the last to be implemented.

4.5 Design frameworks

Basis for detailed design

The following sub-sections present frameworks that should form the basis of the design of the four PSIR monitoring programmes. Development of detailed designs can be highly resource intensive. It requires specialist input and should deal with all aspects of implementation from higher-level management, through the choice of monitoring variables to the lowest level technical specifications, if appropriate (such as sampling and analytical methods). The following sections only provide generic frameworks that can be used to guide these more detailed design processes.

4.5.1 "Pressure" monitoring

4.5.1.1 Introduction

Generic objectives

To measure, assess and report on a regular basis, the nature and extent of immediate pressures on water quality in the catchment in a manner that will contribute to an understanding of the causes of deteriorating water quality.

4.5.1.2 Data acquisition

Pressure indicators

The causes of deteriorating water quality will often be highly site-specific. Most of the water uses defined in the National Water Act (36:1998), Section 21, can potentially affect water quality; some to a greater and more obvious extent than others. (It can be assumed that any water use has potential for changing water quality in some way, albeit this may be minimally in some cases). The Section 21 water uses are the following (more or less arranged in decreasing order of general potential for significantly impacting on water quality):

(f) Discharging waste or water containing waste into a water resource.
(g) Disposing of waste in a manner that may impact on a water resource.
(h) Disposing of water containing waste from, or which has been heated in, any industrial or power generation process.
(e) Engaging in a controlled activity (including irrigation using waste or water containing waste, modification of atmospheric precipitation, power generation that alters flow regimes, and aquifer recharge using waste or water containing waste).
(k) Using water for recreational purposes.
(a) Taking water from a resource.
(d) Engaging in a stream flow reduction activity (commercial afforestation is the only activity currently declared as such an activity).

(j) Removing, discharging or disposing of water found underground for the efficient continuation of an activity or for the safety of people.
(i) Altering the bed, banks, course or characteristics of a watercourse.
(b) Storing water.
(c) Impeding or diverting the flow of water in a watercourse.

Pressure indicators appropriate to the current context would need to be closely related to the above activities, in particular, the extent to which they occur.

Link to management class

Focus on a choice of indicators that relate to important catchment issues. In particular, ensure that the indicators can be sensibly related to the RQOs and RWQOs associated with the designated management class and vision.

Examples of pressure indicators

Pressure indicators can include measures of water supply, water demand and waste and pollution. Examples include:

- Frequency and nature of non-compliance with water use licence conditions;
- Levels of water abstraction relative to water availability; and
- Number and volume of pollutant discharges from point and non-point sources relative to river flow.

Sources of data

The following sources of relevant data can be used:

- The WARMS (Water Authorisation and Registration Management System) database.
- Data collected from monitoring of end-of-pipe discharges, in particular discharge volumes and concentrations (and hence loads).

4.5.2 "State" monitoring

4.5.2.1 Introduction

Generic objectives

To measure, assess and report on a regular basis the degree to which the designated management classes in the catchment are being attained or maintained in respect of water quality, in a manner that will contribute to an understanding of the status and trends in water quality.

Management class

The most obvious focus relating to the "state" category will inevitably be whether or not a water resource is within its designated management class. As noted in the Policy, the resource management class is the "first line of defence" against unsustainable development. In other words, ensuring all water resources attain and maintain their designated management classes is the very least that should be achieved to be able to claim any degree of facilitation of sustainable development.

This strongly suggests individual indicators could be associated with answering two basic questions:

- Is the resource in its designated management class (in respect of water quality)?
- If not, is the trend towards or away from the designated class?

4.5.2.2 Data acquisition

State indicators

The high priority issues in a catchment must drive the choice of indicators. Consider the causes of water quality problems and the likely impacts of changes in water quality (on the water resource and socio-economic development) and choose state indicators related to these. For example, if human health is an important issue, consider microbiological variables. If there are sensitive ecosystems, identify those water quality variables to which those ecosystems will be most sensitive.

Data could come from the following supporting monitoring programmes (see Figure 4.1), in order of decreasing likely relevance:

- Performance monitoring of RQOs relating to water quality (see Section 3.3.4).
- National and regional water quality status and trends monitoring programmes. These typically provide a more strategic perspective of water quality (see Sections 3.3.3 and 3.3.5). However, if carefully designed, they also provide information directly related to the management class.
- Monitoring of impacts and licence conditions. Upstream and downstream monitoring of points of impact should be an important aspect of the licence conditions of water users that are likely to have significant impacts on water quality (see Section 3.3.2). See Section 6.3 for more details.

4.5.2.3 Data storage and management

Responsibility of supporting programmes

Since state monitoring can probably rely totally on the existence of other supporting monitoring programmes, all data storage and management is likely to be the responsibility of these other programmes.

4.5.2.4 Information generation and dissemination

Assessment criteria

The main assessment criteria will be the RQOs and RWQOs that define the limits of the designated management class. However, formal RQOs may not exist relating to other variables of concern. In this case, criteria will need to be developed and based preferably on nationally or internationally accepted guidelines. This task may require specialist expertise.

4.5.3 "Impact" monitoring

4.5.3.1 Introduction

Generic objectives

To measure, assess and report on a regular basis the impacts of deteriorating water quality in the catchment on (a) aquatic ecosystem integrity, and (b) socio-economic enhancement and quality of life, in a manner that will contribute to an understanding of the effects of inadequate water quality on aquatic ecosystems and water users.

Impact categories

Typically, impacts can be grouped into two main categories:

- *Relating to the principle of protection of water resources*. Impacts would be reflected in changes in the health (integrity) of aquatic ecosystems.
- *Relating to the principles of optimal water use and current equitable access*. Impacts would be reflected in the quality of life and the level of socio-economic enhancement and equitable access achieved, particularly relating to those water uses that areheavily dependent on water quality.

Indicators related to protection of water resources

The level of protection and the current and future uses should be identified in a catchment visioning process. The most desirable balance between protection and use will (ideally) have been captured in the designated management class. Therefore, to some extent, certain "impacts" (relating to water quality) may automatically appear in some indicators chosen to be RQOs. In particular, these may be RQOs <u>not involving water quality directly</u> (*i.e.* they are not water quality attributes such as concentrations, loads or biological effects like toxicity), but nevertheless show a significant degree of dependence on water quality. Since these are <u>resource</u> quality objectives, they are likely to reflect impacts of water quality on the resource. This means these can be interpreted in the context of impacts on "protection of water resources".

The River Health Programme already determines a number of indicators that relate to ecosystem integrity (*e.g.* riparian vegetation index, fish index, SASS5, etc.).

Indicators related to use (socio-economic)

On the other hand, use-related indicators would need to be quality of life or socio-economic indicators that reflect impacts on society, which do not measure anything in the water resource *per se*. The impacts considered here must refer to the kinds of, and degree of, impacts on users related to the catchment vision (and hence consistent with the designated management class). These may include any of the user sectors: domestic, recreational, irrigation, stock watering, aquaculture, and industrial.

4.5.3.2 Data acquisition

Indicators of socio-economic impacts

Socio-economic indicators could be associated with the following:

- Incidence of waterborne diseases. This relates directly to quality of life and is also affected by the prevalence of HIV/Aids. An example related to recreational use could be exposure of the population to contaminated recreational water through water sports.
- Impacts of water fluoridation (*e.g.* costs associated with dental fluorosis, immune and thyroid system disturbance or kidney damage).
- Irrigation of food (like fruit) exported to the European Union. The issues concern microbial and chemical contamination of irrigation and washing water in this agricultural industry.
- Blockage of irrigation systems (relating to suspended solids and algae). An indicator could be the financial losses incurred.
- Eutrophication (trophic status, economic impacts on water boards).

Supporting programmes

In respect of impacts on the water resource, performance monitoring programmes, such as the River Health Programme and the National Eutrophication Monitoring Programme (NEMP), could supply much relevant information directly.

Socio-economic information could be obtained from the Department of Health (particularly information on notifiable water-borne diseases such as cholera and typhoid). Economic impacts associated with blockage of irrigation systems and contamination of exported food may be obtained from the Department of Agriculture. It is also possible that data could be sought from *ad hoc* projects (*e.g.* carried out by universities or other stakeholders).

Socio-economic data acquisition

The following actions will be necessary to develop socio-economic indicators:

- *Incidence of waterborne diseases.* The Department will need to work closely with the Department of Health to establish the extent to which data are available to develop such an indicator. If available, mechanisms will need to be developed that facilitate data collection.
- *Irrigation (fruit export).* The Department may need to liaise closely with the Department of Trade and Industry and appropriate stakeholder organisations such as agricultural boards.
- *Irrigation system blockages.* The Department itself is extensively involved in this issue and should be able to provide some data on the extent of the problem.

4.5.3.3 Data storage and management

Supporting programmes

As supporting programmes with the necessary socio-economic data may not exist, it will be the Department's responsibility to ensure that appropriate data storage and management protocols are developed for the raw data that are needed to compile "Impact" indicators.

4.5.3.4 Information generation and dissemination

Data assessment

Data assessment should be kept simple and should be understandable by non-experts. Linkages with the following should be made as explicit as possible:

- The extent to which socio-economic enhancement is being hampered by inadequate water quality (the "burden of disease").
- The impact of inadequate water quality on those suffering from HIV/Aids because of their immune deficiency.
- Effects on general quality of life.
- The economic impacts of inadequate water quality within development sectors.

Assessment criteria

Preferably use criteria that are internationally accepted. However, when such criteria are not appropriate for South African conditions, more appropriate criteria should be developed that are meaningful in the local context.

4.5.4 "Response" monitoring

4.5.4.1 Introduction

Generic objectives

To measure, assess and report on a regular basis the decisive reactions of society, government or a catchment management agency to deteriorating water quality in the catchment, in a manner that will further contribute to a better understanding (by all stakeholders) of (a) the effects of inadequate water quality, (b) the desires of stakeholders in respect of water quality, (c) measures that may need to be enforced and (d) the successes or failures of response efforts.

Decisive societal responses

Decisive societal responses in order to achieve improvements in water quality may occur because:

- An aquatic ecosystem has been negatively impacted (leaving it with a diminished capacity to provide its goods and services). This may leave the immediate users of such products and services with no option but to respond decisively to a situation they regard as untenable to regain the use of those ecosystem goods or services. Or,
- The water cannot be productively used (whether for domestic, social, agricultural or industrial purposes). This may occur because increased costs have to be incurred to treat the water before it can be used. Responses occur when such users respond decisively to what they regard as an untenable situation in order to improve that situation.

In either case, the responses are often likely to be related to deviations from, or an apparent inability to attain, the designated management class and the associated catchment vision.

4.5.4.2 Data acquisition

Response indicators

Response indicators need to reveal the extent to which society is reacting to inadequate water quality. These responses may be reactive or even precautionary. In particular, they must demonstrate the efforts of society and decision-makers to resolve water quality issues. Possible response indicators may relate to the following:

- Resources allocated to regional offices for state monitoring.
- Relationship between Departmental water quality management posts available and the number of those posts that have been filled.
- Extent of enforcement in mitigation of existing impacts on water quality.
- Extent of remediation of existing impacts on water quality.
- Extent of cleaner production initiatives aimed at reducing pressures on water quality.
- Degree to which ISO-based self-regulation is encouraged.

4.5.4.3 Data storage and management

Supporting programmes

As supporting programmes with the necessary socio-economic data may not exist, it will be the Department's responsibility to ensure appropriate data storage and management protocols are developed.

4.5.4.4 Information generation and dissemination

Data assessment

Data assessment should be kept simple and should be understandable by non-experts. It should also be acknowledged and carefully considered, that a societal response can also be due to perceptions that the water quality is inadequate (while it may not actually be so).

Assessment criteria

Preferably use criteria that are internationally accepted. However, when such criteria are not appropriate for South African conditions, more appropriate criteria should be developed that are meaningful in the local context.

SECTION 5: MANAGEMENT PERFORMANCE MONITORING

Management performance monitoring

Management performance monitoring ensures that role players with identified responsibilities (relating to resource directed management of water quality) are held accountable for their actions (or inaction). In one sense, this is monitoring for quality control, but in a management context. It determines whether or not managers are executing their assigned tasks.

It is important that management performance monitoring, although serving an end in itself, should be designed to be adaptive and responsive to the results of water quality monitoring. It should also be closely aligned with any institutional goals that may comprise the "objectives hierarchy" of a catchment visioning process (DWAF, 2005e).

Resource water quality = ideal overall indicator

The ultimate overall indicator of management performance in the current context is the resource water quality. When management classes are designated for water resources, and associated RQO are defined, the degree to which these are being complied with (or movement towards such compliance is occurring) will also indicate overall management performance.

Generic objectives

To measure, assess and report on a regular basis the degree to which water resource managers in resource directed management of water quality are fulfilling the responsibilities associated with their respective roles.

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SECTION 6: WATER USE LICENCE CONDITIONS

6.1 Introduction

Introduction

Resource directed management of water quality depends heavily on effective monitoring. Licence conditions can, and should, impose requirements on water users to contribute to such monitoring. Monitoring can be expensive and time-consuming. Therefore, it must be as cost-effective as possible. The following sub-sections provide some basic guidance on how to choose the most appropriate monitoring variables and where to locate monitoring sites.

6.2 Variables of concern

Factors affecting choice of variables of concern

In essence, the water quality variables of concern in any specific case, depend on the following:

- The nature of the water use being authorised.
- The nature of downstream water use.
- The degree to which healthy aquatic ecosystems must be maintained.
- The resource quality objectives (giving effect to the management class that in turn gives effect to the catchment vision).

Each is associated with different sets of variables. The important variables of concern for licence conditions are illustrated in Figure 6.1.

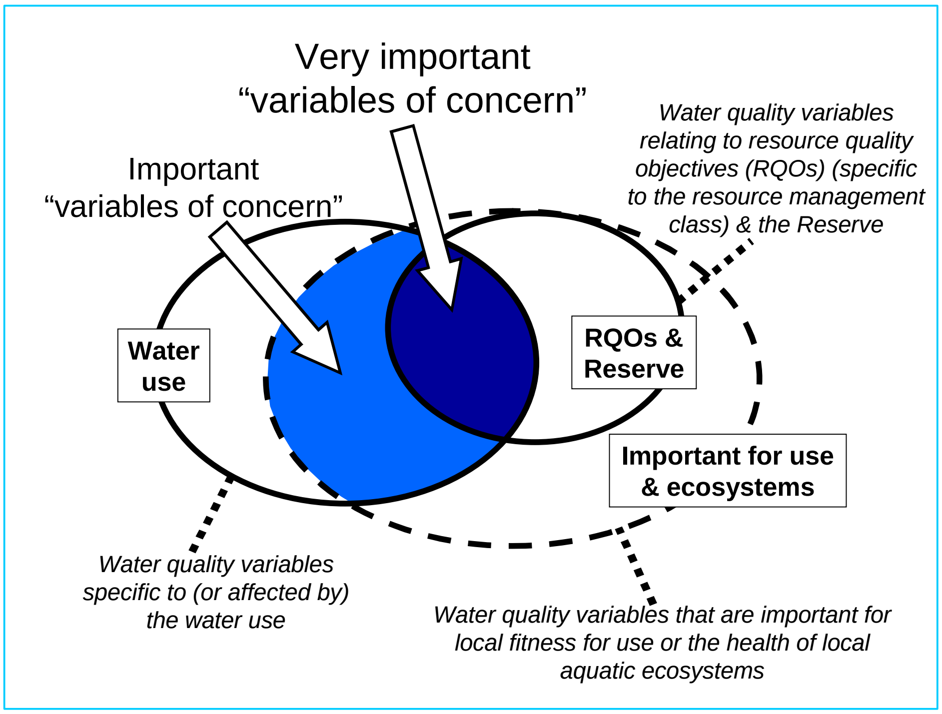

Figure 6.1: Illustration of appropriate water quality variables for licence conditions.

Nature of the water use

Different water uses can affect different water quality variables. For example, the concentrations of problematic chemicals or micro-organisms in a waste discharge would be regarded as the variables specific to that particular water use. These may not be the same as those for another local waste discharge whose chemistry or microbiology may be quite different.

Nature of downstream water use

Abstraction of water may decrease the allocatable water quality of the resource for downstream users. Variables of concern will therefore be those considered important to the downstream users. Importantly, downstream users can include:

- Users using the potentially impacted water directly (i.e. using the same surface water or groundwater) (Figure 6.2); and
- Users using a surface water impacted by a contaminated groundwater because of a significant contribution to the surface water's base flow (Figure 6.2 (a)); and
- Users using a groundwater impacted by contaminated surface water because of significant recharge to the aquifer from the surface water (Figure 6.2 (b)).

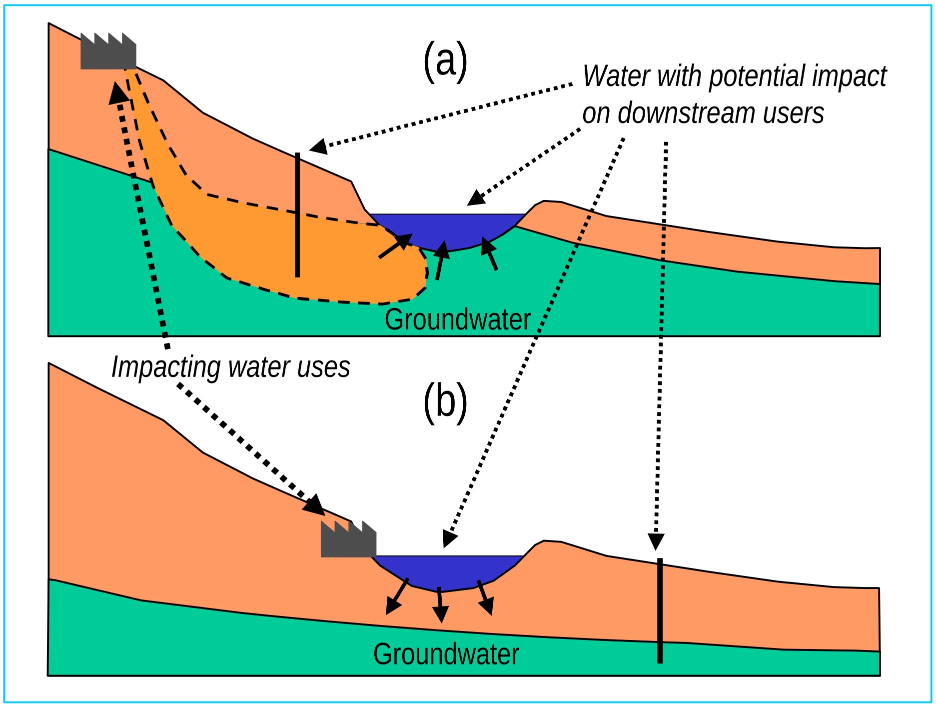

Figure 6.2: Illustration of downstream water users that depend on either surface water resources or groundwater resources.

Downstream aquatic ecosystems

The existence of downstream water-linked ecosystems will also influence the choice of variables of concern.

RQOs and RWQOs

Existing RQOs and RWQOs (which include objectives relating to the Reserve) provide the most obvious guidance for the choice of monitoring variables to be included in any licence condition. These are, by their very nature, resource-focused objectives. They arise directly from the management class designated for the resource. RQOs may be narrative, although quantitative RQOs will facilitate easier management. Some will explicitly relate to water quality. The remainder will refer to other aspects of resource quality (water flow, ecosystem integrity, etc.).

Variables of concern for licence conditions should comprise those that explicitly occur as RQOs or the Reserve (*e.g.* RQO = 6 < pH < 9, therefore monitor pH). However, they can also include those that are implicitly necessary to achieve the stated RQO or Reserve (*e.g.* RQO = 6 < pH < 9, therefore consider monitoring alkalinity or specific components that may significantly influence the pH).

Other important variables of concern

The essential water quality variables will usually be those variables that are directly related to RQOs and specific to (or affected by) the authorised water use (see Figure G10).

However, in some cases, there may be water quality variables specific to (or affected by) the authorised water use that is not associated with RQOs yet may still be problematic. Unusual chemicals (*e.g.* toxicants such as persistent organic pollutants (POPs) or radio nuclides) may not be obviously accounted for by RQOs. In this case, these are also important variables of concern.

Assessment guidelines

In all cases, when a variable is chosen it must be ensured that guidelines exist against which measured results can be assessed. These guidelines must be appropriate for the downstream water uses and ecosystems. Without guidelines a measured value is often useless. RQOs and RWQOs are, by definition, assessment guidelines (or specifically "objectives" in this case). However, if a variable is chosen that is not associated with an RQO or RWQO, then consider using the South African Water Quality Guidelines or other appropriate source.

National water quality monitoring programmes

The various national water quality monitoring programmes (mainly the responsibility of DWAF Directorate: Resource Quality Services) can sometimes provide further guidance for the variables of concern. Their monitoring variables will fall into the above "important" set of variables for fitness for use and ecosystem health. If RQOs are not in place, then the variables used in these national programmes can be chosen as the variables of concern for particular uses. Even if RQOs are in place, the national monitoring variables can supplement the list of variables of concern.

6.3 Monitoring sites

Upstream and downstream (surface water)

Frequently it is useful to monitor at sites located upstream of the most upstream point of impact and downstream of the most downstream point of impact. For some water uses, the impact on a surface water may be immediate (*e.g.* the reduction in allocatable water quality caused by an abstraction). However, for some uses (such as discharge of a water containing waste) there is a mixing zone immediately downstream of the initial point of impact in which a distinct concentration profile will exist across the cross-section of the water resource. Complete mixing is typically necessary for representative samples to be obtained (in order to properly assess likely impacts on downstream ecosystems and water users). Therefore, the downstream monitoring point must be located beyond this mixing zone. A fairly simple procedure for establishing the extent of this zone is available (USEPA, 1991).

Up-gradient and down-gradient (groundwater)

In the case of groundwater, the up-gradient monitoring borehole can be at any point up-gradient of the point or area of groundwater impact. However, care must be taken to ensure that samples are representative of the groundwater quality before any impact occurs caused by the use in question.

Typically a three-dimensional pollution plume is formed down-gradient of the initial point of impact. It is useful to monitor the extent and movement of this plume. Down-gradient boreholes therefore need to be sited by a competent geohydrologist in order to do this effectively.

Conservative versus non-conservative variables

A conservative variable is one whose original amount that entered the water resource remains essentially unaltered. Inorganic ions such as sodium, potassium, chloride (and even sulphate under oxidising surface water conditions) are commonly regarded as conservative. A non-conservative variable is one whose amount can change. Examples include ammonia (that can be oxidised) and all microbiological variables (like bacteria, viruses, etc.) that can die off.

Placing of monitoring sites is intimately dependent on the degree of conservatism. To monitor non-conservative variables, sites must be located relatively close to the initial point of impact. However, the cumulative impacts of conservative variables can often be detected far downstream.

Fate of substances

The fate of chemicals and micro-organisms must also be considered when deciding where to monitor and what medium (water column, sediments, biota, etc.) to monitor. Some migrate readily to sediments while others can volatilise into the atmosphere; still others bioaccumulate in biota. Many of the persistent organic pollutants (POPs) migrate over vast distances through the atmosphere, entering water resources, and though they may be only sparingly soluble in water, they end up accumulated in sediments and biota. Micro-organisms also adsorb readily onto the surfaces of suspended particles of sediment and detritus.

RQOs and RWQOs

If RQOs or RWQOs have been defined as applying everywhere in the resource unit, then monitoring of the variables of concern can be carried out at any point in the resource (subject to the usual conditions of accessibility, health and safety, logistics, resources required, etc.). However, if RQOs or RWQOs have been defined at specific sites in a catchment, then these sites can be used if they are sufficiently close to the points of impact of a water use (upstream and downstream).

In both cases, such monitoring can contribute directly to the "performance" monitoring required by the Department to monitor their achievement and compliance with RQOs.

National water quality monitoring programmes

The national water quality monitoring programmes (most of which are the responsibility of Resource Quality Services) usually have fairly well defined criteria for choosing monitoring sites. The location of these sites is focused on ensuring that the objectives of these national programmes are achieved. If the location of these sites is upstream or downstream of the licensee's point of impact and nearby, then the licencee may be able to contribute to the appropriate national programme by monitoring at these sites.

6.4 *Pro forma* licence conditions

Introduction

Table 6.1 provides some examples of licence conditions relating to monitoring of the resource and socio-economic impacts.

Table 6.1: Examples of licence conditions relating to resource monitoring.

Monitoring resource water quality	
Resource water quality monitoring. *The licensee shall implement a programme (approved by the Department) that monitors all water quality variables of concern. For surface water and groundwater resources this must include monitoring at sites (a) upstream of the most upstream / up gradient point of actual or potential impact of the water use, and (b) downstream / down gradient of the actual or potential impact of the water use.*	Early detection of resource water quality problems and monitoring of existing impacts and facilitation of identification of possible causes.
Variables of concern (RQO, Reserve & international obligations). *The licensee shall monitor at least those water quality variables that are (a) specific to, or affected by, the authorised water use and (b) included explicitly or implicitly in downstream resource quality objectives (RQOs), the Reserve or international obligations. Should water quality variables for the latter change, then the licensee shall modify the monitoring programme design to include such new water quality variables.*	To ensure that the most relevant monitoring variables are chosen.
Abstraction from a surface water resource. *The licensee shall monitor at points upstream and downstream of the point or area of water quality impact, at least those water quality variables in terms of which allocatable water quality is defined for (a) the authorised use and (b) all potentially impacted downstream users.*	Monitors degree to which the licensee does not exceed the allocated water quality and that the abstraction does not unacceptably reduce the dilution capacity for downstream users.
Seawater ingress into coastal freshwater aquifer. *The licensee shall monitor the salinity of the groundwater quality on the seaward side of the point(s) of groundwater abstraction at a frequency, site and depth determined by a suitably qualified geohydrologist.*	To backup the primary management of the aquifer (achieved by water level control) by detecting seawater ingress into the freshwater aquifer.
Artificial groundwater recharge. *The licensee shall monitor at frequent intervals (to be determined by a suitably qualified geohydrologist) the water quality of the water being used for the recharge (represented by the essential variables of concern) and, less frequently (also determined by such a geohydrologist) the water quality of the aquifer in boreholes sited to provide an adequate representation of the aquifer as a whole.*	Early detection of problems can help prevent irreversible impacts.

Mine dewatering (operations phase). *The licensee shall monitor, at appropriate intervals, sites and depths (to be determined by a suitably qualified geohydrologist), the water quality of the groundwater removed (represented by the essential variables of concern) and in appropriately placed boreholes at adequate intervals to reflect possible changes in the quality of the groundwater flowing in from surrounding aquifers.*	To detect potential changes in source aquifers from which the dewatered water is originating and hence detect potential impacts on other local water users or aquatic ecosystems.
Mine dewatering (post-closure phase). *The licensee shall monitor, at appropriate intervals, total period, sites and depths (to be determined by a suitably qualified geohydrologist), the water quality of the groundwater (represented by the essential variables of concern) to reflect the long-term water quality impacts of the mining operations on surrounding aquifers.*	To detect potential changes in aquifers that are currently being used, or that may be used in future, as the original water levels and groundwater flow regime is restored, and hence detect potential impacts on other local water users or aquatic ecosystems.
Groundwater acidifcation in dolomitic aquifers. *The licensee shall monitor, at appropriate intervals, sites and depths (to be determined by a suitably qualified geohydrologist), the water quality of the groundwater (represented at least by pH) to reflect the potential for dissolution of dolomite in the aquifers and hence the potential for subsidence.*	Early detection of problems can avoid catastrophic impact on aquifers, associated water-linked ecosystems and water users.
Persistent Organic Pollutants (POPs). *The licensee shall contribute to the National Toxicity Monitoring Programme (NTMP) by monitoring the water quality in the water resource in accordance with the specifications of the NTMP.*	Monitoring will contribute to (a) national status and trends monitoring, (b) local, regional and national management of the contaminants, and (c) fulfilling our international obligations (Stockholm Convention) in respect of these problematic pollutants.
Toxicity. *The licensee shall contribute to the National Toxicity Monitoring Programme (NTMP) by monitoring the water quality in the water resource in accordance with the specifications of the NTMP.*	Monitoring will contribute to (a) national status and trends monitoring, and (b) local, regional and national management of the contaminants.
Radioactivity. *The licensee shall contribute to the National Radioactivity Monitoring Programme (NRMP) by monitoring the water quality in the water resource in accordance with the specifications of the NRMP.*	Monitoring will contribute to (a) national status and trends monitoring, and (b) local, regional and national management of the contaminants.
Nutrients. *The licensee shall contribute to the National Eutrophication Monitoring Programme (NEMP) by monitoring the water quality in the water resource in accordance with the specifications of the NEMP.*	Monitoring will contribute to (a) national status and trends monitoring, and (b) local, regional and national management of the contaminants.
Monitoring resource quality (other than water quality)	
Positive ecological impact monitoring. *The licensee shall monitor the motivated ecological impact of the water use by providing a measure, at an appropriate time interval, of the following indicator(s). << Specify indicator(s) >>*	Ensures original claims of positive impacts on resource water quality are achieved.
Negative ecological impact monitoring. *The licensee shall monitor the potential ecological impact of the water use by providing a measure, at an appropriate time interval, of the following indicator(s). << Specify indicator(s) >>*	Ensures originally identified potential negative impacts on resource water quality are monitored to ensure that they remain within acceptable limits.
Variables of concern (ecosystem integrity). *The licensee shall contribute to the River Health Programme (RHP) by monitoring the resource in accordance with the specifications of the RHP.*	Monitoring will contribute to (a) national status and trends monitoring, and (b) local, regional and national management of the water resource use.
Monitoring socio-economic impacts	
Positive socio-economic impact monitoring. *The licensee shall monitor the motivated socio-economic impact (e.g. redress of past racial and/or gender discrimination) of the water use by providing a measure of said impact on an annual basis.*	Ensures original claims of positive impacts are achieved.
Negative socio-economic impact monitoring. *The licensee shall monitor the potential socio-economic impact of the water use by providing a measure of said impact on an annual basis.*	Ensures originally identified potential negative impacts on resource water quality are monitored to ensure they remain within acceptable limits.

SECTION 7: GLOSSARY

Data assessment. The evaluation or interpretation of raw monitoring data in a manner that adds value to the data in the sense of extracting useful information. (A common data assessment is comparison of raw data with guidelines).

Fitness for use. A scientific judgement, involving objective evaluation of available evidence, of how suitable the quality of water is for its intended use or for protecting the health of aquatic ecosystems.

Indicator. A simplified characteristic of a system that provides a means of conveying information about the presence or absence of change in that system.

Monitoring. The measurement, assessment and reporting of selected properties of water resources in a manner that is focussed on well-defined objectives. These monitoring objectives should also be linked clearly to water resource management objectives.

Monitoring design. The definition of all the aspects that are necessary for successful implementation of a monitoring programme. These include the monitoring variables, monitoring site selection, sampling methods, monitoring frequency, analytical procedures, data assessment, reporting formats, etc.

Monitoring variable. An attribute that changes over time and space, and whose measurement provides the raw data upon which a monitoring programme is based, and whose behaviour provides useful information to managers.

Principle. A statement providing guidance on what should be strived for, typically acknowledging an underlying values-based assumption.

Quality assurance. The implementation of all activities that minimise the possibility of quality problems occurring. These include amongst others, training, instrument calibration and servicing, quality control, producing clear and comprehensive documentation, and so on.

Quality control. The process of ensuring that recommended monitoring procedures are followed correctly by detecting and correcting quality problems when they arise, so that the accuracy of primary observations or measurements is (a) defined, (b) within acceptable limits and (c) recorded.

Resource quality. Includes all aspects of water quantity, water quality and aquatic ecosystem quality, the latter including the quality of in-stream and riparian habitats and aquatic biota.

Resource quality objectives (RQOs). Numeric or descriptive (narrative) goals for resource quality within which a water resource must be managed. These are given legal status by being published in a *Government Gazette*.

Resource water quality objectives (RWQOs). Numeric or descriptive (narrative) in-stream (or in-aquifer) water quality objectives that are typically set at a finer resolution (spatial or temporal) than RQOs, and that provide greater detail upon which to base prudent management of water quality.

Stakeholder. An individual, group or organisation that has an interest in, or is affected by, an initiative, and who may therefore affect the outcome of an initiative.

Stress, water quality. A state in which the water quality is inadequate for the desired water use. For many uses, water quality stress exists when there is no allocatable water quality.

Stressed water resource. A water resource for which the demand for benefits exceeds the supply. This can apply to either the quantity of water or to the allocatable water quality.

Sustainability indicator. An indicator conveying information about progress towards sustainable development.

Waste. Defined by the National Water Act as including any solid material or material that is suspended, dissolved or transported in water (including sediment), and which may be spilled or deposited on land or into a water resource in such volume, composition or manner as to cause, or to be reasonably likely to cause, the water resource to be polluted.

Watercourse. Defined by the National Water Act as a river or spring, a natural channel in which water flows regularly or intermittently, a wetland, lake or dam into which, or from which, water flows, and any collection of water that the Minister may declare to be a watercourse. Furthermore, reference to a watercourse includes, where relevant, its bed and banks.

Water quality. The physical, chemical, radiological, toxicological, biological and aesthetic properties of water that (1) determine its fitness for use, or (2) that are necessary for protecting the health of aquatic ecosystems. Water quality is therefore reflected in (a) concentrations of substances (either dissolved or suspended), (b) physico-chemical attributes (e.g. temperature), (c) levels of radioactivity, and (d) biological responses to those concentrations, physico-chemical attributes or radioactivity.

Water resource. Defined by the National Water Act as including a watercourse, surface water, estuary or aquifer.

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Appendix A

Philosophy of Sustainable Development

January 2005

Edition 1

water & forestry

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Appendix A

Philosophy of Sustainable Development

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DOCUMENT INDEX

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Bold indicates this report

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PROLOGUE

This document is a precursor to the Policy on the Resource Directed Management of Water Quality, Strategy and various management instruments. The document provides the reader with some background to the origins of the concepts of sustainability and sustainable development, and provides some meaning to the concept. Furthermore, the document makes mention of the approaches required for ensuring sustainable natural resource use and management. Finally, the reader is made aware of the challenges facing water resource managers, and is provided with some ideas on how these challenges can be addressed to try and ensure that a sustainability ethic is applied in prudent water resource management.

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ACRONYMS

DWAF	Department of Water Affairs & Forestry
NePAD	New Partnership for Africa's Development
NWA (36:1998)	National Water Act
RDMWQ	Resource Directed Water Quality Management
SADC	Southern African Development Community
UN	United Nations
WEHAB	Water, Energy, Health, Agriculture and Biodiversity Initiative
WQM	Water Quality Management
WSA (108: 1997)	Water Services Act
WSSD	World Summit on Sustainable Development

SECTION 1: THE PHILOSOPHY OF SUSTAINABILITY

1.1 South Africa's commitment to sustainable development

Embracing sustainable development through international initiatives

South Africa has committed itself to the principles of sustainable development and is party to a number of international initiatives that support and promote sustainable development. These include the Rio Earth Summit, the Millennium Development Goals, the New Partnership for Africa's Development (NePAD), the World Summit on Sustainable Development (WSSD), the Water, Energy, Health, Agriculture and Biodiversity Initiative (WEHAB) and the Southern African Development Community (SADC) vision for sustainable development. All of these initiatives have prompted a national response to introduce the principles and practice of sustainability in South Africa.

Key drivers of sustainability in South Africa

A variety of both positive and negative social, political and ecological pressures have also stimulated the need for sustainable development in South Africa. Examples of positive pressures include the democratic government system that supports the rights of all people, an active civil society demanding care of both people and the environment, and world-class natural resources of international significance.

In stark contrast to these positive pressures, South Africa also faces the challenges of poverty, crime, unemployment and environmental degradation, as well as marked geographical variability in the availability of water resources. These represent immediate challenges that need to be addressed urgently and in a manner that will facilitate the long-term socio-economic development of all South Africa's citizens. Sustainable development forms a useful conceptual and management framework within which these challenges can be addressed.

The need to face up to and address these positive and negative pressures has provided a strong stimulus for the uptake of sustainable development thinking into all aspects of the South African government's activities.

Key legislation promoting sustainable development

The South African Government's commitment to sustainable development is made explicit through several pieces of legislation, which set out the intent and define the national responsibility to sustainable development. The Constitution of the Republic of South Africa (Act No. 108 of 1996) and the National Environmental Management Act (Act No. 107 of 1998) are examples of over-arching legislation that state an explicit need and human right for sustainable development. This need has also been embraced formally by the water sector through the National Water Act (Act No. 36 of 1998) (NWA 36:1998), which is considered internationally as one of the most progressive pieces of environmental legislation in the world (MacKay, 2003).

The NWA (36:1998) is a legal instrument that articulates the vision for sustainable water use in the country, and contains defined provisions for the protection, use, development, conservation, management and control of all water resources in South Africa. This is reflected in the holistic view that all water resources are linked to each other by the hydrological cycle.

Due to the fact that all water resources are linked to each other and are affected by the biophysical environment and human activities, water resources must be managed by taking into account the relationships between water, the biophysical environment and social, economic and political factors. This requires a comprehensive and closely integrated approach to water resources management.

The NWA (36:1998) clearly recognises the need for water as a resource simultaneously to meet basic human needs, fulfil ecological requirements and promote social and economic development. Water is seen as a national resource that is available for the development of all South Africans. This sentiment is firmly located within the recognition that the ecosystem is not an infinite resource, and that ensuring an ecological Reserve is essential for the successful functioning of water resources and continued delivery of ecosystem goods and services to society.

1.2 Defining sustainable development

1.2.1 Origins of sustainability

Global crises stimulate sustainability awareness

The 1960's witnessed a widespread recognition of the impact of expanding global environmental crises due to industrialisation and this fuelled a growing realisation that if we continued on the current development trajectory, we would exceed most of the earth's ecological limits. At the 1972 Stockholm UN Conference on Human Environment, it was recognised that the environment-development conflict would have to be resolved in a mutually beneficial manner. The idea of sustainable development evolved out of the debates around environment and development as a means to promote development whilst still ensuring environmental protection.

Sustainable Development – the new "buzz-word"

The term "sustainable development" has become an accepted societal norm. It has become the "*raison d'être*" of many international agencies, governments, environmentalists, businesses and civil society. However, despite the exceptionally broad use of the term, there is still no international consensus on a single definition of sustainable development.

Perhaps the most widely accepted definition has been provided by the World Commission on Environment and Development (1987), which describes it as "development that meets the need of current generations without compromising the ability of future generations to meet their own needs and aspirations" (WCED, 1987).

Despite the absence of a standard or universally accepted definition of sustainable development, this has been recognised as a positive feature in some circles. According to Lele (1991) 'to some extent, the value of the phrase "sustainable" lies in its broad vagueness. It allows people with hitherto irreconcilable positions in the environment-development debate to search for common ground without appearing to compromise their positions'.

Sustainable development is an ecological concept

The expression and concept of sustainable development originated from a realisation that the earth's natural resource base can pose ecological limits to development. Therefore, it is important to realise that the concept of sustainable development originates from the ecological school of thought. Similarly, it must be recognised that the term sustainable development is often used outside of the context in which it originated, and expressions such as economic and social sustainability are also used.

The Constitution of the Republic of South Africa (Act No. 108 of 1996) clearly states that reasonable legislative and other measures should be used to "secure *ecologically* sustainable development and use of natural resources while promoting justifiable economic and social development" (Section 24 (b) (iii).

Accordingly, for the purposes of this document, the context in which the term sustainable development is used is an ecological one; thus, we are referring to development that is ecologically sustainable.

1.2.2 Current understanding

"Nested" systems

Sustainable development requires ongoing interaction between the ecological resource, the economic system and the social system (WCED, 1987; Mebratu, 1998). The economic system exists within and because of the social system, while the social system and human existence is only possible within the ecosphere (the ecological system). This conceptual "nesting" of systems represents the reality of how systems function (Figure 1.1).

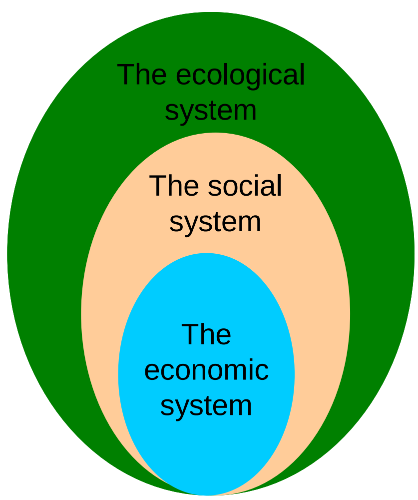

Figure 1.1: The cosmic interdependence model (adapted from Mebratu, 1998).

Dis-aggregation of systems results in imbalances

Modern society has tended to disaggregate these three systems in order to simplify their inherent complexity and also to attempt to understand and manage the world around us. Typically, this nested system has been separated into three separate components (namely three spheres).

However, most previous attempts to manage one system in isolation of the others have led to social injustice, unfair trade and economic imbalances, environmental degradation, and ineffective governance. The concept of sustainable development embodies the integration of these three systems, whereby there is a central area of overlap encircled by good governance (Figure 1.2).

Ultimately these three spheres should be closely aligned such that our understanding and management of the environment is underpinned by the <u>principles of sustainable development</u> and reflects the reality of how these systems function. The broad principles of sustainable development include ***futurity*** (providing goods and services for future generations); ***equity*** (a fair allocation of resources to all); ***participation*** (giving all stakeholders the right to participate), and ***ecological integrity*** (protecting the healthy functioning of natural systems).

Sustainable development is a process of development

Sustainable development is both a process of development and a series of stages along a development trajectory (Figure 1.2). The process of sustainable development requires the alignment of the economic, social and biophysical spheres through the application of a collective set of actions and decisions that will direct society towards the ultimate goal (which is depicted by the central area of overlap or alignment). Sustainable development can only be achieved through the recognition that all three spheres interact and must be addressed together in a holistic manner. This process is ordered, sustained and enhanced by good governance (Figure 1.2).

Sustainability is a journey, not a destination

It is perhaps most useful to think about sustainability as the direction we need to move in, in order to achieve an acceptable balance between the three spheres. ***Sustainability is about the actions we take and the decisions we make to realise sustainable development.***

The term “sustainable development” implies an end-point or tangible outcome. However, because ecological, social and economic systems are very fluid and dynamic, there cannot be a single static end-point but rather a ‘journey’ or a continual progression towards achieving sustainable development. This journey is in fact a continual process towards achieving a better quality of life while protecting the integrity of ecosystems.

Development goals in South Africa tend to change as people’s expectations change (MacKay and Ashton, 2004). Expectations change as higher levels of development are achieved. It is important to realise then, that as development goals change, so does the “goal" of sustainable development.

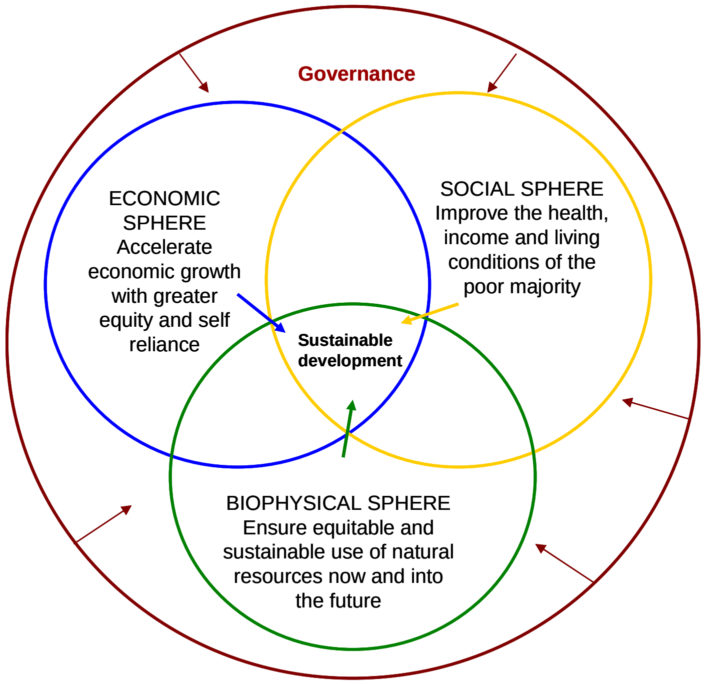

Figure 1.2: The trifocal approach of sustainability (adapted from MMSD, 2002).

1.3 Natural resource management

Human-centred approach

Natural resource management can vary substantially in terms of efficiency and effectiveness, and also depends on the underlying attitudes of society towards natural resources. In the early days of industrialisation, a human-centred approach dominated much of the world's thinking in the early half of the 20th century, with humans being seen as the most important species on earth. According to this attitude to natural resources:

- Humans are apart from, and in charge of, the rest of nature;
- The earth has an unlimited supply of resources to which we can gain access through science and technology;
- All economic growth is good and the potential for economic growth is unlimited;
- A healthy environment depends on a healthy economy; and
- Human success is dependent on how well we can control nature to our benefit.

This highly consumptive approach led to the global crises which, in turn, prompted the concept of sustainable development.

Ecocentric approach

In adopting the principles of sustainable development, it was recognized that a new approach was needed to guide human attitudes towards natural resources. This new approach, described as an ecocentric view, saw humans as working with and within nature. According to this approach:

- Nature exists for all of Earth's species and humans are neither apart from nor in charge of the rest of nature;
- Earth's resources are limited, should not be wasted, and should be used sustainably for use by humans and all other species;
- Some forms of economic growth are beneficial but some are harmful;
- A healthy economy depends on a healthy environment; and
- Our success depends on learning to co-operate with one another and the rest of nature (Tyler Miller, 1994).

Stewardship approach

In South Africa, natural resource management is underpinned by the recognition that humans have a duty of care for maintaining natural resources in a healthy state. This "stewardship approach" is eloquently captured in South African law through the Constitution of the Republic of South Africa (Act No. 108 of 1996), which sets out the right of every South African to have an environment that is "not harmful to their health or well-being; and to have the environment protected, for the benefit of present and future generations" (Republic of South Africa, 1996, section 24 a&b).This stewardship approach is also evident in the Department of Water Affairs and Forestry's appointment as the public trustee of the nation's water resources (National Water Act, Chapter 1, section 3(1)).

The recent shift in the way natural resources are viewed has thus stimulated a need for people to manage these resources in a manner that recognises our dependency upon the environment, and a need to understand the extent to which the environment can support and sustain development.

Multi-level considerations

In discussions about sustainable development and natural resource management, it is important to understand that there are different levels at which sustainability and natural resource management must be considered.

At a national level a strategy should be in place enabling us to apply an ethic of sustainable development to natural resource management. However, this strategy needs to take cognisance of lower, more local levels. To achieve sustainability at a national level one should also apply sustainability principles at lower levels (such as smaller geographical areas and institutional structures). At a national level it is necessary to ensure we have healthy, well-functioning natural resources able to meet both human and ecological needs.

However, at lower levels it is sometimes necessary to find the balance between the various needs of water users and the needs of ecological systems. In this context, balancing may imply or require a "trade-off".

This is defined as a compromise, settlement, or exchange wherein a loss is involved. Whilst it is inevitable that such trade-offs may occur, we need to understand the full extent of the costs and benefits of the decision for all users. These costs and benefits include both positive and negative impacts on the biophysical environment as well as the costs and benefits to society and to the national economy, now and in the future.

1.4 Water resource management

The goal of water resource management

Water resource management aims to protect, conserve and maintain water quality and quantity for aquatic and associated ecosystems and their biological diversity in order to assure justifiable social and economic development (DWAF, 2004). This approach seeks to ensure equitable use of water resources (and ecological systems as a whole) so as to ensure the availability of an adequate supply of water into the future.

Sustainable development and water resource management

Sustainable development in respect of water resource management seeks to ensure that future generations will still be able to meet their own basic water needs, while promoting socio-economic development and improved quality of life for all in the current generation. This can only be done in a manner that uses water resources in general within the ability of the ecosystem to satisfy such needs, both now and in the future (DWAF, 2005a).

Challenges for water resource managers

Inevitably, there will be conflicting demands for water at the water management area and local levels. These include the conflicting needs for water for economic development, water to meet basic human needs and water to maintain ecosystems. The water resource manager must therefore at a local level manage the development of different types of capital. Water resource managers, however, need to understand how the management of their particular area contributes to the achievement of the national vision in the long-term.

The water resource classification system and trade-offs

The National Water Resource Strategy aims to find a balance between protection of water resources and social and economic development. The strategy states that “it is not possible for all resources throughout the country to be given a high level of protection without prejudicing social and economic development. Equally, it is not desirable for all resources to be classified at a uniformly low level so as to permit maximum use” (DWAF, 2004). The net result must therefore ensure that a balance between the social, economic and ecological imperatives of the country can be achieved without unsustainable compromises.

At national level, effective water resource management in South Africa requires an accepted national vision for our water resources. This vision seeks to ensure that water resources are sustained into the future to meet future needs while still improving the quality of life of present generations – a sustainability ethos is thus encouraged.

This sustainability approach can be demonstrated through the classification system, whereby a certain proportion of the country's resources will be maintained in classes that require a high level of protection, thereby ensuring the sustained healthy functioning of these systems. The classification system is to be aligned with the National Water Resource Strategy and therefore provides the primary vehicle for implementing a sustainability ethic within water resource management.

When undertaking water resource management, the needs of society, industry and biophysical systems must be understood and managed holistically (*i.e.* joint consideration of all needs), by applying the principle of "environmental integration". However, the classification system also allows for some water resources to be classified in states that require less protection, but not to result in them being unsustainable. This implies a degree of trade-off of natural capital which may prove to decrease the ecological sustainability of some areas in the long-term.

The principles of water resource management

The main principles adopted by the Policy on the Resource Directed Management of Water Quality (DWAF, 2005a) are the following:

- Protection of water resources;
- Optimal water use;
- Equity between generations;
- Current equitable access;
- Environmental integration; and
- Good governance.

Although developed for resource directed water quality management, these principles are necessarily those of water resource management in general. They provide more specific substance to the above-mentioned broad principles of sustainable development. For example, equity between generations addresses "futurity", and equity between generations and current equitable access address "equity", good governance refers to "participation", and so on.

1.5 Application

Application of a sustainability ethic

The application of a sustainability ethic to resource directed water quality management in particular is embodied in the associated Policy (DWAF, 2005a), Strategy (DWAF, 2005b) and all of the associated management instruments. These are the actual instruments of application of the above philosophy in that they try to ensure that the resource directed management of water quality is conducted in a sustainable manner.

The monitoring guidelines provide a water quality monitoring framework which will allow for the capture and consideration of socio-economic data related to water quality. In this way, a better understanding of the social and economic needs, costs and benefits will be achieved.

Similarly, the guidelines for generating a catchment vision promote the development of a catchment vision that is consensus-derived. The catchment visioning process also sets the scene for a desired future – shared by stakeholders (thereby firmly applying the "futurity" principle).

Resource quality objectives (RQOs) will define the limits of the chosen management class for an individual water resource and take account of all users, as well as the Reserve (DWAF, 2005b). As such they will be the most important sustainability indicators that will guide water resource management.

1.6 Conclusion

This document on the philosophy of sustainable development is intended to provide:

- Some background on the origins of sustainable development; and
- An interpretation of sustainable development in South Africa, in terms of natural resource management in general and water resource management in particular.

Sustainable development is a concept that has arisen from the recognition that the earth's resource base can no longer sustain infinite development. The challenges to water resource managers are significant - prudent and sensible decision-making will require a sound understanding of the meaning of sustainable development and how this can best be achieved with the resources available.

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Appendix B

Conceptual Review for water licence application from a RDMWQ perspective

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1.7.1	Volume 4.1: Guidelines on Catchment Visioning for the Resource Directed Management of Water Quality
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Bold indicates this report

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ACRONYMS

DWAF	Department of Water Affairs & Forestry
NePAD	New Partnership for Africa's Development
NGO	Non Governmental Organisation
NWA (36:1998)	National Water Act (Act No. 36 of 1998)
RDM	Resource Directed Measures
RDWQM	Resource Directed Water Quality Management
RDWQMP	Resource Directed Water Quality Management Policy
SADC	Southern African Development Community
WEHAB	Water, Energy, Health, Agriculture and Biodiversity Initiative
WMA	Water Management Area
WQM	Water Quality Management
WSA (108: 1997)	Water Services Act (Act No. 108 of 1997)
WSSD	World Summit on Sustainable Development

SECTION 1: INTRODUCTION

1.1 What is in the Conceptual Review

1.1.1 General overview of contents

Purpose and use of the Conceptual Review

Section 1 provides:

- A description of the purpose of the pre-application package and for whom it is written (Section 1.1.2); and
- An overview of the two main approaches adopted by DWAF for managing water resources, namely Resource Directed Measures (RDM) and Source Directed Controls (SDC) (Sections 1.2 – 1.4).

Roles and Responsibilities

Section 2 provides a brief description of the various roles and responsibilities and information flows in the licence application process.

Definitions

Section 3 provides explanations of terms most often used in the licensing process.

Licence application process

Section 4 discusses the licence application process as well as closely related issues and considerations in this regard.

1.1.2 Purpose of the pre-application package

Purpose of the pre-application package

The overall aim of this document is to provide the broader context of the water use licensing process, by:

- Providing the context of the water use licensing process in terms of the National Water Act (NWA (36:1998)) (Act No. 36 of 1998);
- Explaining important terms used in the licensing process;
- Explaining in a step-by-step fashion how and where to apply for a water use licence, how a licence application is processed within DWAF, and noting what other aspects to consider ;
- Providing advice to assist with the completion of a licence application form; and
- Providing a list of relevant sources of supporting information.

Importantly, it should be noted that this document does not replace the consultation process between a (potential) water use license applicant and the DWAF Regional Office, but aims to assist in streamlining the process.

Who is this document aimed at?

This document is designed to assist every individual who either wants to apply for a water use licence, or who facilitates the licence application process.

1.2 Managing the water resources of South Africa

1.2.1 Two main approaches adopted by DWAF

Managing South Africa's water resources

This section provides the context of the water use licensing process in terms of the NWA (36:1998), by providing a brief overview of the two main approaches adopted by DWAF to manage South Africa's water resources, to explain what is meant by a permissible water use and how such a use must be registered.

What is a resource?

A water resource is:

- A river or a spring;
- A natural channel in which water flows regularly or intermittently;
- A wetland, lake or dam into which, or from which, water flows;
- Any collection of water which the Minister may declare to be a watercourse; and
- Surface water, estuaries and aquifers (underground water).

All water bodies in the hydrological cycle, including underground water, are regarded as water resources.

Water as a national resource

The fundamental principle guiding the NWA (36:1998) of South Africa is that water is a national resource, owned by the people of South Africa and where National Government has overall responsibility for and authority over the management thereof. This principle allows the state to have total control and manage the utilisation of all aspects of the resource.

DWAF's management functions

Some of the most important management functions of the Department of Water Affairs and Forestry (DWAF) are:

- Protection of the nation's water resources by ensuring that sufficient water quantity and appropriate water quality is available to satisfy the basic human needs and ecological Reserve;
- Management and control of the nation's water resources to ensure that they are used in a sustainable way in the long-term; and
- Equitable allocation of available water to different water users.

To achieve the above objectives, the national water policy (DWAF, 1997) and the NWA (36:1998) presents two sets of complimentary strategies that lawfully bind all water users. These are: **Resource Directed Measures (RDM)** and **Source Directed Controls (SDC)**. Resource Directed Measures focus on the quality of the resource itself, specifically on the resource as an ecosystem rather than a commodity. Source Directed Controls focus on managing the quality and quantity of water that enters a resource after use, to control the impact that it might have on that water resource. These two complementary strategies and their components are discussed in more detail below.

1.3 Resource Directed Measures (RDM)

1.3.1 Introduction

***NWA (36:1998) Chapter* 3**

Chapter 3 of the NWA (36:1998) contains measures that are designed to ensure comprehensive protection of all water resources. These measures are referred to as the **Resource Directed Measures**.

These measures are based on a **Classification System** which, according to the NWA (36:1998), must provide a standard set of rules and procedures to determine the class of water resources, the determination of the **Reserve**, and **Resource Quality Objectives.**

Sustainable water resources

Society benefits immeasurably from water resources such as rivers, wetlands, lakes and estuaries. In fact, survival of human society depends entirely on water, the resources associated with water, and the goods and services that they provide. These goods and services include for example: water supply; waste disposal; processing and dilution; natural products (e.g. fish, reeds, medicinal plants); biodiversity conservation; flood control; and places for rituals or spiritual needs.

The NWA (36:1998) acknowledges that water resources are ecosystems by providing for the protection of aquatic ecosystems. However, it is not necessary for a water resource to be left untouched by humans for it to remain functional. Environmentally sustainable water use seeks to balance water use with the protection of the resource in such a way that resources are not degraded beyond the point at which they are able to recover. Also, they seek to ensure that properly managed aquatic ecosystems continue to supply people with different goods and services into the future. Importantly, aquatic ecosystems cannot continuously offer the whole range of goods and services at the same time and in the same place. For example, if heavy use is made of water supply for waste disposal – then the ecosystem is unlikely to provide well for nature conservation, recreation or “a sense of place”. Therefore, people need to be able to choose which services they want from specific ecosystems in time and space (DWAF, 2002a). This forms part of a process where a vision for a particular resource or catchment is set.

Catchment visioning

Catchment visioning is a process whereby stakeholders articulate a collective statement of their future aspiration of society’s relationship with the resource – of the benefits derived from aquatic ecosystem goods and services and the costs associated with their use. The visioning process includes the generation of a vision statement and the unpacking of the vision statement (the ‘vision’, or desired future state) and agreeing on the focus areas that, given appropriate attention, will move society towards the attainment of the vision. Managing water quality forms part of the process of managing towards the attainment of the vision and as a result, the visioning process unpacks objectives with regard to water quality, amongst many other objectives.

A vision statement must be converted into, and explicitly linked with, objectives that are useful at the operational level. Unless a vision is linked to practical end-points, or goals for management, a vision will simply remain a statement and it will not be supported by those who are involved in the allocation and licensing processes.

1.3.2 Classification of Water Resources

NWA (36:1998), Chapter 3, Section 12-15

Classification System

It is useful for stakeholders to know how healthy an aquatic resource is in order for them to make choices about the kinds and degrees of use of aquatic ecosystems. The NWA (36:1998) (Section 12) makes provision for the development of a national classification system to classify all significant water resources. The purpose of a classification system is thus to provide a set of nationally consistent rules to guide decision making about water resources - what will be allowed to happen in our water resources, and what not be allowed to happen.

At present, the national water resource classification system is still under development. Although the development of the classification system is largely based on ecological considerations, social and economic aspects will also be taken into account when deciding within which class the resource will be managed for. When the ecological component of the classification system is referred to, the term “ecological categories” are generally used. When ecological, social and economic aspects are considered, reference is made to a “management class”.

When many people use a water resource (*e.g.* a river, wetland, estuary), this has a variety of effects on the habitat, the plants and the biota of that resource. As a consequence, the character and the health of the resource changes. Such diminution of the health of a water resource will still enable the resource to function and provide certain goods and services. However, if the resource continues to deteriorate (thereby compromising the principle of sustainability), it will eventually degrade beyond recovery and will result in a complete loss of these goods and services to society.

Management Class

The final management class of a water resource is a combination of the ecological requirements for the resource and the requirements of other water users within the catchment. The ecological requirements are determined by assessing the present ecological category (A-F) (1) and the desired ecological category (A-D).

Ecological Categories:

- A – unmodified natural
- B – largely natural
- C – moderately modified
- D – largely modified
- E – seriously modified
- F – critically modified

Categories used to define the present ecological state (A-F) and the desired ecological state (A-D), the basis for assessing the Reserve and associated ecological specifications for the Resource.

A classification system that incorporates other water users within a catchment has not as yet been finalised by the Department. However, the categories of Ideal, Acceptable, Tolerable and Unacceptable have been widely used within the Department and are used in this document.

Based on the resource protection requirements and the socio-economic goals of the resource, the management class may be set as a gradient in aquatic ecosystem health and integrity from Natural to Heavily used [(1)] (Figure 1.1), as listed below:

- Natural - unimpacted, no or minimal changes.
- Moderately used / impacted - slightly to moderately impacted.
- Heavily used / impacted - heavily impacted.

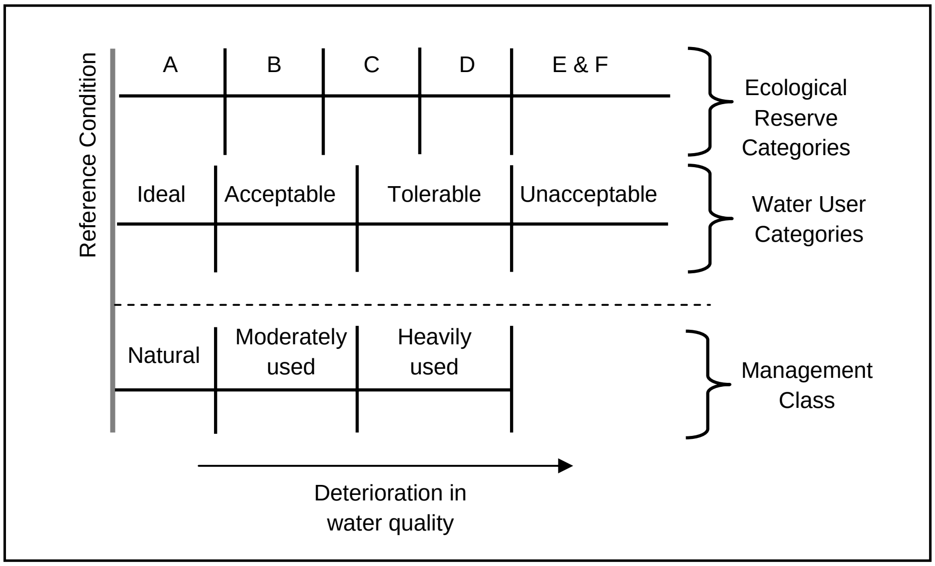

Figure 1.1: Relationship between interim classification systems (DWAF, 2004)

Note: The boundaries between Ideal, Acceptable, Tolerable and Unacceptable, as they relate to the ecological categories or management class have not been finalised and are only represented here schematically.

1.3.3 The Reserve

NWA (36:1998), Chapter 3, Section 16 – 18

What is the Reserve?

According to the NWA (36:1998), the Reserve is defined as:
the quantity and quality of water required to satisfy the basic human needs, and to protect aquatic ecosystems, in order to secure ecologically sustainable development and use of the relevant water resource.

The Reserve is the only water right that is specified as being inviolable in the law (DWAF, 1997).

Water for basic human needs has the highest allocation priority in the country. The ***basic human needs Reserve,*** includes water for drinking, food preparation and personal hygiene. The intention of the basic human needs Reserve is to secure the quality requirements for basic human needs with minimal treatment. Currently the amount is calculated as a minimum of 25 litres per person per day.

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(1) Since the revised water quality Reserve Methodology (DWAF, 2002c) is still under development, it is recommended that the Categories A-F be applied to the ecological category (water quality) in addition to/or instead of Natural – Poor, to ensure consistency in integration of ecological components. Similarly, the water use classification should allow for a comparable six tier classification to allow for integration with the A-F ecological classification (water quality).

(1) Terminology for management class adopted from Chapter 3 of the National Water Resource Strategy, Amendment V3.0

Apart from basic human needs, the only other right to water remaining in law is the water quantity and quality required to protect aquatic ecosystems "…in order to secure ecologically sustainable development and use" of significant water resources (such as rivers, streams, wetlands, lakes, estuaries and groundwater) (DWAF, 2000). The intention of the ecological Reserve is to secure water to maintain aquatic ecosystems in such a form that they can continuously provide the desired set of socio-economic goods and services to society. The intention is not to protect ecosystems *per se*. The objective of the Reserve is to serve the needs of the people who depend on ecosystem-based goods and services (Van Wyk *et al*., 2003).

All water uses under the NWA (36:1998) are subject to the requirements of the Reserve. Thus water use licences cannot be issued for different types of water uses without the Reserve having been determined and taken into account.

Preliminary determination of the class and the Reserve

A transitional phase is allowed for in Chapter 3 of the National Water Act. This means that until such time as the Minister prescribes by notice the full classification system and procedures for Reserve determination, a preliminary classification and Reserve determination may be carried out (NWA (36:1998) sections 14 and 17), and water use licenses may be issued on that basis.

The NWA (36:1998) also states that no water use license may be issued without at least a preliminary determination of the Reserve having been undertaken. Once the classification and Reserve determination procedures have been prescribed, that preliminary determination must be reviewed, after which the associated licenses may also be reviewed. It must be noted that, until the classification and Reserve determination procedures have been prescribed in the Government Gazette, all RDM determinations are considered to be preliminary.

The only substantial difference between preliminary determinations under NWA (36:1998) sections 14 and 17, and determinations under NWA (36:1998) sections 13 and 16, is that preliminary determinations do not have to be published in the Government Gazette, and the rigorous consultation and comment procedures do not necessarily have to be applied in full (DWAF, 1999b).

1.3.4 Resource Quality Objectives (RQOs)

NWA (36:1998), Chapter 3, Section 13 – 15

What are RQOs?

The NWA (36:1998) defines Resource Quality Objectives (RQOs) as "*clear goals relating to the quality of the relevant water resources*" and these are set in accordance to the class specified for the resource in question. The integrated RDM manual (DWAF, 1999a) defines RQOs as "*a numerical or descriptive statement of the conditions which should be met in the receiving water resource,…, in order to ensure that the water resource is protected*", and remains in a state to provide goods and services expected of it. Essentially, RQOs dictate the specific objectives for controlling impacts on the water resource, through regulatory measures such as the licensing of water use.

RWQOs on the other hand are the water quality component of the Resource Quality Objectives (RQOs); these are defined by the National Water Act (NWA) (36:1998), "as clear goals relating to the quality of the relevant water resources." "The RWQOs outline both water user needs with respect to water quality, as well as their needs with respect to the disposal of water containing waste to the resource. The process of determining RWQOs is consultative, but requires strong technical support" (DWAF, 2003c).

It must be noted that the NWA (36:1998) allows for the setting of preliminary RQOs for water resources before the formal classification system has been established. Until a final classification has been approved, all RQOs will be considered to be preliminary and may be revised at a future date when the final classification system has been accepted.

1.3.5 Resource Directed Measures (RDM) in relation to water allocation responsibilities in DWAF

Considering and taking account of Resource Directed Measures before issuing a licence

The NWA (36:1998) prescribes that before a water use can be considered for licensing, it is necessary to determine and take into account the class, Reserve and Resource Quality Objectives (collectively referred to as Resource Directed Measures) for the relevant water resource unit(s) (NWA (36:1998) 17(1)(b)).

The water required for the Reserve can be explained in terms of the concept of a bucket or tank of water, as illustrated in Figure 1.2., where a certain volume and quality of water is required to satisfy basic human needs and protect aquatic ecosystems. The quantity and quality of water that is still available (unused) can then be utilised for other purposes (DWAF, 1999b).

Note that the Reserve (basic human needs and ecological) has priority over all other water uses, and the requirements of the Reserve have to be allowed for before any use is licensed. Authorisation of all water uses in terms of a licence is therefore conditional on a Reserve determination having being carried out, and taken into account in determining the remaining water resource available for allocation. However, where the resource is already fully allocated for use, the requirements of the Reserve may need to be met over time, by progressively adjusting (reducing) the allocations to other users (DWAF, 2002b).

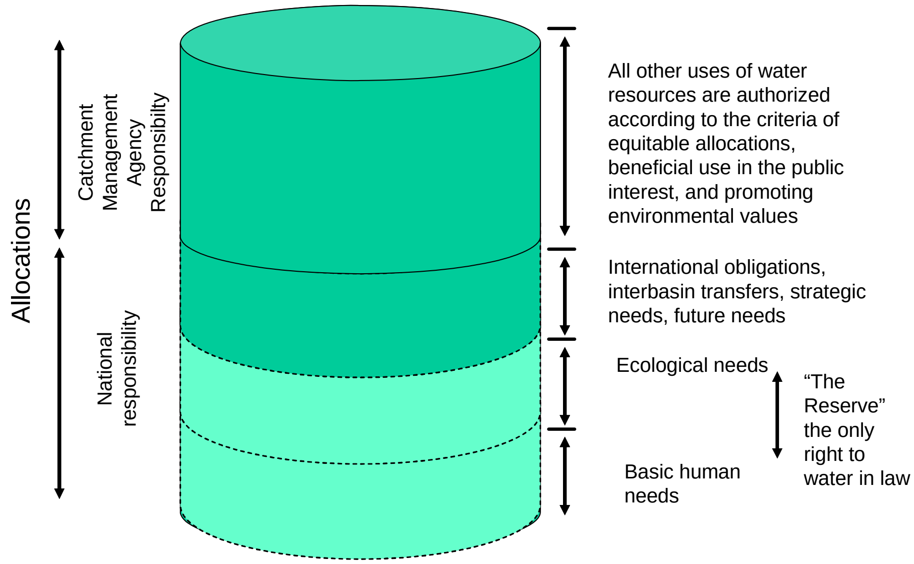


Figure 1.2: Conceptualisation of the Reserve (DWAF, 1999b)

Where Resource Directed Measures provide certain guidelines and procedures to protect water resources, the enforcement of resource protection takes place through a system of Source Directed Controls. Source Directed controls are the essential link between the protection of water resources and the regulation of their use (DWAF, 2002b).

1.4 Source Directed Controls

1.4.1 Introduction

NWA (36:1998), Chapter 4

Chapter 4 of the NWA (36:1998) focuses on Source Directed Controls (SDC) and deals with the regulation of water use. This section of the NWA (36:1998) also describes in detail the circumstances under which a water use requires a licence and when a particular use does not require a licence. Source Directed Controls are used to control sources of impacts in such a way that any impact on a water resource does not exceed the limits allowed by the RDM (DWAF, 2000a).

Purpose of Source Directed Controls

Source directed controls (SDCs) aim to control and minimise potential impacts on the water resource so that resource protection objectives can be achieved. These controls include principles for regulating water use, such as water quality standards for waste water, waste water discharges, pollution prevention, and waste minimisation technologies. Additionally, progressive implementation of self-regulation is encouraged by DWAF while economic incentive mechanisms are also implemented by DWAF (DWAF 1997).

Water use authorisation

The authorisation of a water use is an important source directed control mechanism that enables DWAF to give effect to the principles of sustainable water utilisation. Authorised water users have both a **right** to use a portion of the water resource in question, as well as a **responsibility** to carry out the water use in accordance with all of the terms and conditions of the authorisation (DWAF, 2000a). It is through the prudent design and application of the terms and conditions of water use authorisations (e.g. water use licences and general authorisations) that the environment will be protected, thereby allowing the needs of other water users to be safeguarded as far as possible.

1.4.2 Water Uses

NWA (36:1998), Chapter 4, Section 21

Section 21 of the NWA (36:1998) lists eleven different kinds of water uses (see Section 3 (3.2) for a detailed description) that require formal authorisation:

- Taking water from a water resource – such as from a stream, river, aquifer, wetland or estuary;
- Storing water;
- Impeding or diverting the flow of water;
- Stream flow reduction (e.g. commercial afforestation);
- Engaging in controlled activities – such as irrigating with wastewater;
- Discharging wastewater directly into water resources;
- Disposal of wastewater – such as into oxidation ponds, evaporation dams, pit latrines, etc.;
- Disposal of heated wastewater from industries and power stations;
- Altering the position or size of the beds and banks, course or characteristics of a watercourse;
- Removal of underground water for the continuation of activities such as mining and construction; and
- Recreation.

1.4.3 Permissible Water Use

NWA (36:1998), Chapter 4, Section 22(1)

What is a permissible water use?

A person can only be entitled to use water if the use is permissible under the NWA (36:1998). Permissible water uses are described in Section 22 of the NWA (36:1998). A person may only use water:

1. **Without a licence for:**
   - Schedule 1 use; or
   - Continuation of an existing lawful use (for more information see the Source Management Strategy in South Africa, First Edition Appendix C.1, 2003); or
   - Use that is authorised under a General Authorisation;
2. **If it is a licensed use under the NWA (36:1998); and**
3. **If the responsible authority has dispensed with a licence requirement as described in Chaper 4, Section 22(3)(4).**

An overview of these mechanisms for regulating water use is provided below. (Some of the information listed below was taken verbatim from **A Guide to the Registration of Water Use,** Published by the Department of Water Affairs and Forestry, March 2000).

Schedule 1 use of water

"Schedule 1" refers to Schedule 1 of the NWA (36:1998), which lists a range of permissible water uses. A Schedule 1 water use is NOT required to be registered or licensed.

The following water uses detailed in Schedule 1 need NOT be registered:

- Taking water directly from any water resource to which a person has lawful access, for:
  - Reasonable domestic use in a person's household; or
  - Small gardening (but not for commercial purposes); or
  - Watering of animals (but not for commercial purposes, thereby excluding feedlots), provided that the use is not excessive in relation to the capacity of the water resource and the needs of other users.
- Storing and using run-off water from a roof;
- In emergency situations, taking water from any water resource for human needs or fire fighting;
- Recreation, if a person has lawful access to that water resource; and

Discharge of waste, or water containing waste, or run-off water (including storm water) into a canal, sea outfall or other conduit, provided that these are controlled by persons that have been authorised to purify, treat or dispose of this wastewater.

Existing lawful use of water

- Existing lawful use means the lawful use of water authorised by or under any law, and which took place at any time during the period from 1 October 1996 to 30 September 1998, i.e. the two years before the NWA (36:1998) came into effect.
- If a water user discontinued a water use, or took steps to implement a water use but did not begin the water use before 30 September 1998, the water use can be declared an existing lawful use.
- Certain stream flow reduction activities and controlled activities also fall under the requirements of existing lawful use (See Section 3, 21(d) & (e) for definitions).
- Existing lawful users will be required to register their use in terms of a Notice issued under the Registration Regulations.

General authorisations to use water

A General Authorisation is an authorisation to use water without a licence, provided the water use is within the limits and conditions set out in the General Authorisation. A General Authorisation is valid for a period of five years from the date of publication, unless:

- It is amended at any review period, which period shall be at intervals of three years from the date of publication of this notice in the Government Gazette;
- The period is extended by a notice in the *Gazette*;
- It is replaced with a General Authorisation in relation to a specific water resource or within a specific area; or
- The water user is required to apply for a licence in terms of the National Water Act.

An individual water user will not receive a document (as with a water use licence) that constitutes a General Authorisation. If the user complies with the conditions of the General Authorisation, then the user is legally regarded as generally authorised to use water. If the water use does not meet the conditions of General Authorisations, the user must apply for a licence (DWAF, 2000a).

Schedule 1 water uses are not included under the General Authorisations, as they are already permissible in terms of the Act and do not require further authorisation.

1.4.4 Registration of Water Use

NWA (36:1998), Chapter 4, Section 26(1)(c) & 34(2)

What is registration of a water use about?

Registration of water use is required in terms of the NWA (36:1998). It is a process of officially notifying DWAF of a water use. The most important reasons why water users are required to register their water use are:

- Officially notifying the Department of a (lawful) water use;
- To manage and control water uses for future planning and management;
- To ensure fair and equitable allocation of water among all user groups; and
- To understand the extent to which the country's water resources have been allocated.

Registration of a water use is not an entitlement to use water and must not be confused with a water use licence.

Who does not have to register?

The following water uses need NOT be registered if the water use:

- Is listed in Schedule 1 of the Act (see Section 1.4.3);
- Is excluded from the requirement to register in terms of a Notice issued under the Registration Regulations, or under a General Authorisation;
- Is part of the services offered by a Water Services Provider, such as a Local Authority (municipality) or a Water Board. An example of this is the water and sanitation services provided to households by a municipality. Each household is not required to be registered. However, the municipality must register its use; or

Has been licensed under the National Water Act.

SUMMARY

A person may only use water without a licence if:

- The water use is permissible under Schedule 1; or
- The water use is permissible as a continuation of an existing lawful use; or
- The water use is generally authorised; or
- The responsible authority has dispensed with a licence requirement.

The purpose of registration is to notify the DWAF of a water use. It does not entitle a person to use water without a water use licence.

SECTION 2: ROLES AND RESPONSIBILITIES

2.1 Introduction

Purpose

Many people and organisations can be involved in the preparation and processing of an application for a water use licence. The applicant will need to deal directly with a number of them. This section summarises the following:

- The overall roles of the Department and the applicant;
- The responsibilities of each; and
- The kind of information flow taking place.

This section is largely restricted to those roles and responsibilities that are directly relevant to the applicant. The purpose is to provide understanding of who is involved at each stage of the overall process.

For detailed information on the water use authorisation process, please consult “The Source Management Strategy. Department of Water Affairs and Forestry. No: M6.0. First Edition”.

The sections that follow are deliberately brief. For more detail, contact your regional DWAF representative and consult the NWA (36:1998).

2.2 Principles

Sustainable development

The ultimate driving force for each step in the licensing process is the sustainable utilisation/development of South Africa’s water resources. This specifically involves addressing the following issues:

- The rights of water users;
- The quantity and the quality of water available for use other than that which has been reserved for basic human needs and the protection of aquatic ecosystems;
- Possible impacts that the proposed water use might have on the water resource intended for use;
- The desired biophysical state of the water resource (water quantity, water quality, in-stream and riparian habitats, biota) in their catchments.

DWAF is the custodian of the nation's water resources and enforces the NWA (36:1998). The National Water Act (Act No.36 of 1998) is the specific legislation that the Department is mandated to apply.

2.3 Applicant

Responsibilities of the applicant

The primary role of the applicant is to prepare the appropriate licence application form(s) and to comply with all the applicable legal provisions and requirements of the regulations, so that the relevant authorities can properly assess the application.

Through pre-consultation with the appropriate DWAF regional office, the applicant should:

- Ensure that a licence applicant is legally required to submit a licence application;
- Determine if other legislative or potential legal constraints (*e.g.* zoning requirements) are applicable to the water use;
- Obtain general information and reports required for the licence application;
- Determine who the responsible Regional Officer is;
- Determine whether or not the water use licence is subject to a policy moratorium on the issuing of certain types of licences (*e.g.* no abstraction water use authorisations in catchments that are stressed from a water quality or quantity perspective);
- Determine if other authorities are involved; and
- Obtain the appropriate application forms for each intended water use from the regional DWAF office.

Furthermore the applicant must:

- Notify all appropriate authorities other than DWAF of the intended water use licence application (*e.g.* Department of Minerals and Energy, Department of Environmental Affairs and Tourism, Local Government for disposal of high risk sewage and solid and liquid waste disposal);
- To conduct all processes, and provide all information, reports and plans necessary to comply with regulations and in support of the licence application;
- Ensure that the appropriate authorities have access to all relevant information;
- Pay all costs incurred in applying for a water use licence;
- Conduct all public participation activities that may be required by notifying all downstream users and any other water users that may potentially be affected by the intended use, and deal appropriately with their responses; and
- Indemnify the Government from any liability arising from procedures for which the applicant is responsible for, in terms of the regulations.

2.4 Interested and affected parties

Active engagement of interested and affected parties is essential throughout the process

Interested and affected parties are water users and any other water users that might be affected by the intended water use, especially those that are located downstream. It is the responsibility of the licence applicant to inform the relevant interested and affected parties of a proposed water use. The DWAF Regional Office can be consulted for guidance in this regard. It is the responsibility of the interested and affected parties to:

- Raise issues of concern so that the extent of any investigations that may be required are conducted at an appropriate level of detail;
- Make sure that all the issues are addressed adequately in the final application; and
- Provide input through recommendations within the timeframes set by the Department and the applicant.

2.5 The Department of Water Affairs and Forestry

The Department's involvement and responsibility in the water use authorisation process is at three levels, namely: administrative, technical and control responsibilities. The responsibilities of the Department are shown in Figure 2.1.

2.5.1 The Regional Offices of DWAF

Administrative responsibilities

DWAF Regional Offices are responsible for the administrative tasks associated withthe authorisation process. These include:

- Ensuring that all stakeholders involved in the process of water use authorisation understand all aspects of the application process and their responsibilities towards the process;
- Ensuring close co-operation and consultation and effective implementation of the regulations by each responsible department;
- Managing the information received and serving as conduit for communication between the Department and the applicant and all other involved parties;
- Evaluating all applications according to guidelines and procedures (*e.g.* according the Section 27 of the NWA (36:1998)), and ensuring that the evaluation takes place within the agreed timeframes;
- Monitoring the progress and recording decisions regarding the licence application and reporting to the responsible Regional Officer; and
- Informing the client in writing, of the outcome of decisions regarding the water use application.

2.5.2 The National Office of DWAF

Administrative responsibilities

At National level, the responsible National Officer is responsible for all administrative and co-ordination tasks associated with the authorisation process in the National office. These include:

- Determination of required inputs to the authorisation process in the National Office and the co-ordination of inputs required from various sector-specific sub-directorates;
- Evaluation of all applications according to guidelines and procedures (*e.g.* according the Section 27 of the NWA (36:1998)), and ensuring that the evaluation takes place within the agreed timeframes; and
- Receiving, collating and making recommendations on the technical reports and maintaining adequate records of decisions.

2.5.3 Technical responsibility

Need for Specialist inputs

The Assistant Director: Water Use Authorisation may, at his/her discretion, require specialist input from the sector-specific sub-directorates in the National Office for the technical evaluation of an application. The responsibility of each party is to:

- Provide the required technical input efficiently and promptly;
- Ensure that investigations required from the client are conducted at the appropriate level of detail and are technically competent;
- Oversee, control and report on technical investigations conducted by the Department; and
- Evaluate the technical content of the application according to required guidelines, principles and procedures.

2.5.4 Delegated Authority

Role of the Delegated Authority

The Delegated Authority is the person within the Department with the authority to issue the water use authorisation. The delegated Authority is currently the Manager: Water Use, who must ensure that:

- The licence is issued in accordance with legislation;
- It does not contravene other statutes or rights; and
- Principles of sustainable development were duly considered.

The delegated Authority has the final decision with regard to issuing or rejecting a water use authorisation.

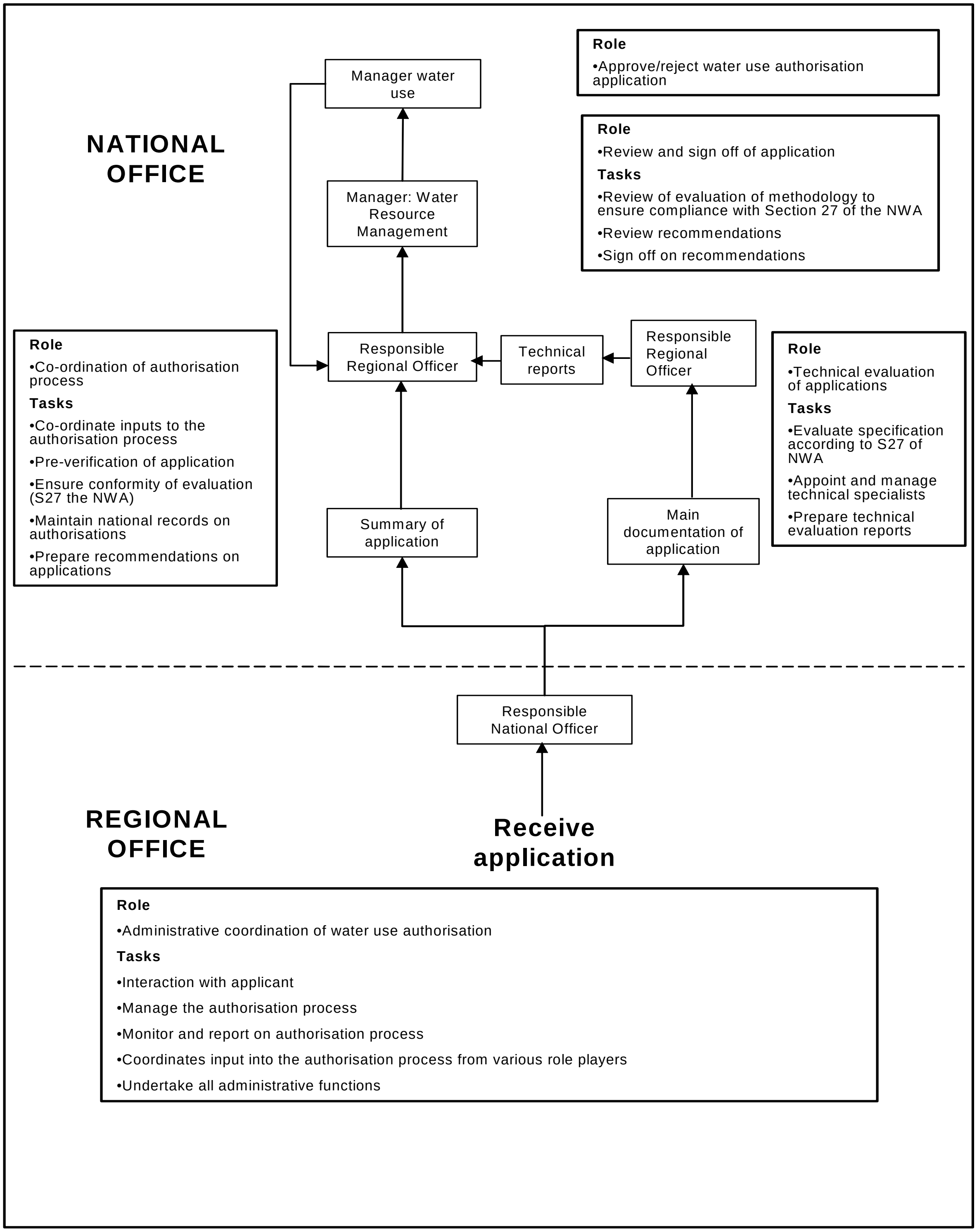


Figure 2.1: Roles and responsibilities of DWAF staff in the water use authorisation process (adapted from DWAF, 2003b).

SECTION 3: EXPLANTION OF TERMS

3.1 Introduction

Following are explanations of terms often used in the licensing process, which will assist an individual to complete the various application forms. Technical definitions for certain fields on the Part 2 forms are also included. The key water uses are listed in Section 21 (a to k) of the NWA (36:1998). Each of these is briefly outlined below.

3.2 Section 21 Water Uses

S21(a) of Act

Taking water from a water resource

Commonly this use involves pumping of water from a dam or river, or from a borehole.

S21(b) of Act

Storing water

This use includes:

- Water that is stored in a dam, reservoir, or other impoundment.
- A storage dam that can be in a watercourse, or off-channel.
- Commonly the stored water is from natural runoff or river water.
- This water use also includes water that contains waste, for example water collected through a sewer system, or wastewater from an industrial plant.
- Weirs built on rivers may also store water, unless there is an outlet for drainage under low flow conditions. These structures also have to comply with the Dam Safety Regulations.

S21(c) of Act

Impeding or diverting the flow of water in a watercourse

- Impeding or diverting flow does not normally cause any loss in flow.
- Impeding or diverting structures can fully or partially extend into a river, forcing the natural flow direction to be re-directed around the structure.
- Impeding or diverting can be temporary, for example during construction of a road bridge. It can also be permanent, such as the building of a low water bridge across a river where the flow is permanently impeded as it moves under the bridge.
- A flow gauging weir is an example of an impedance if, under low flow conditions, there is no storage behind the weir. If there is water retained in the weir, then the water use is considered to be “storing water” and not “impeding or diverting flow”.

S21(d) of Act

Engaging in a stream flow reduction activity

- Commercial afforestation is currently the only activity that has been declared to be a stream flow reduction activity.
- Examples include commercial pine, eucalyptus, wattle or poplar forests and woodlots for commercial purposes.

S21(e) of Act

Engaging in a controlled activity identified as such in section 37(1) or declared in section 36

Currently, the following are controlled activities:

- Irrigating land or crops with waste water;
- Modification of atmospheric precipitation (cloud seeding);
- Power generation, which alters the flow regime of a water resource; and
- Intentional recharge of underground water with wastewater.

A common controlled activity is irrigation with wastewater, typically taken from a water treatment works. This can be a productive use of water if a crop (not to be consumed by humans) is grown with the wastewater. Some wastes may pose a health hazard.

S21(f) of Act

Discharging waste or water containing waste into a water resource through a pipe, canal, sewer, sea outfall or other conduit.

- This water use entails the discharge of waste or wastewater directly into a water resource.
- Common examples of this water use are waste released into a river or dam at a discharge point such as a pipe or canal that discharges waste water from factories, or partially treated wastewater from treatment plants.

Waste discharged into a municipal sewer is NOT included in this water use. However, the waste discharged by the municipal treatment works into a water resource is an example of this water use.

S21(g) of Act

Disposing of waste in a manner which may detrimentally impact on a water resource

- Typically, this disposal takes place into on-site facilities such as French drains, conservancy tanks, pit latrines and soak-aways.
- Another example of this water use is disposal into wastewater treatment systems, such as oxidation ponds that do not have an outlet into a water resource. If the oxidation pond has an outflow into a river or dam, it is defined as water use (under 21(f) above) for discharging wastewater into a water resource.

Evaporation dams are another common example of this water use.

S21(h) of Act

Disposing in any manner of water which contains waste from, or which has been heated in, any industrial or power generation process

- This water use refers specifically to the increased **temperature** of the wastewater that may have a significant effect on the aquatic environment.

S21(i) of Act

Altering the bed, banks, course or characteristics of a water course

- This water use refers to the physical changes that are made to a watercourse, for instance to widen or straighten the channel of a river.
- Alteration of the bed and banks is usually needed for construction and infrastructure development located near or across a river.
- Sand mining is another common example of this water use.
- Alteration of the course of a watercourse refers to the diversion of the watercourse.

The river channel is usually constructed or replaced with a canal that may extend for several kilometres from the original course.

S21(j) of Act

Removing, discharging or disposing of water found underground if it is necessary for the efficient continuation of an activity or for the safety of people

- This water use applies when water must be removed for efficiency or safety reasons.
- An example of this use to ensure safety in underground mining.
- Many construction sites also require underground water to be removed, especially for safety reasons.
- This water use does NOT apply to the taking of water referred to in 21(a) above.

S21(k) of Act

Using water for recreational purposes

- This water use refers to organised water sports, fishing competitions, floating restaurants, etc.
- The recreational activity of a person who has lawful access to a water resource is defined in Schedule 1 of the Act as permissible water use and need NOT be registered.

3.3 Terms often used in the licensing process

Allocatable water quality

The maximum worsening change in any water quality attribute away from its present value that maintains it within a pre-determined range (typically management objectives) that reflects the desired future state.

If the present value is already at or outside the pre-determined range, this indicates that none is accessible and that either rehabilitation of the resource and/or reduced pollution loads relating the affected attribute(s) is necessary.

The attributes may be quantified by water quality objectives, criteria or targets (*e.g.* in-stream or in-aquifer resource quality objectives, or a target water quality range or criteria). These may be expressed in terms of concentrations or loads (*i.e.* linked to water quantity, and flow in particular).

Biodegradable industrial waste water

- Biodegradable industrial wastewater is wastewater that contains a high concentration of organic waste arising from industrial activities and premises.
- Biodegradable industrial wastewater does not contain any substances that may accumulate and cause deleterious effects in the environment, such as heavy metals and persistent organic compounds.
- Biodegradable industrial wastewater is generated by activities such as:
  - Milk processing;
  - Manufacture of fruit and vegetable products;
  - Sugar mills;
  - Manufacturing and bottling of soft drinks and water bottling;
  - Production of alcoholic beverages in breweries, wineries and malt houses;
  - Manufacturing of animal feed from plant or animal products;
  - Manufacturing of gelatine and glue from hides, skin and bones;
  - Abattoirs; and
  - Fish processing and feedlots.

Categories of mines

Mines are classified into three categories, according to the perceived severity of the potential impacts that may occur on water resources due to the mining activity: Category A, B and C.

Category A mines

Category A mines include:

- All gold and coal mines, irrespective of their size; and
- Any mine with any kind of extractive metallurgical process, including heap leaching. This includes most other precious and base metal mines, and mines where iron pyrite occurs in the mineral deposit.

Category B mines

Category B mines include mines with potentially significant and/or permanent impact only on aspects of the water environment other than water quality, such as a reduction in the yield or availability of water, altered dynamics of the river, altered riparian use, etc.

Category C mines

Category C mines are all other mines, including large mines with no significant impact on the water environment, and small- or low-impact mines and prospecting operations.

Catchment Management Agency

A Water Management Institution which is a statutory body governed by a board representing the interests of users, local and provincial government, and environmental interest groups. It manages all water resources within a defined Water Management Area.

Catchment Management Strategy

Every catchment management agency (CMA) has to develop a catchment management strategy for the water resources within its water management area.

A catchment management strategy sets out principles and procedures for allocating water to existing and prospective water users, taking into account all matters relevant to the protection, use, development, conservation, management and control of water resources.

Dams with a safety risk

Because the storage of water is a water use, as outlined in 21(b) below. Safety of dams is also regulated in terms of Chapter 12 of the Act and the Dam Safety Regulations (Government Notice R1560 of 25 July 1986). Specific considerations include:

- Registration of dams with a safety risk is required in terms of Section 120 of the Act.
- These are dams with a storage capacity larger than 50 000 cubic metres and/or those that have a dam wall higher than 5 metres, or have been declared by the Minister as a category of dams or a dam with a safety risk.

A dam is any structure that is capable of containing, storing or impounding water. This includes weirs, even though these may not have been originally constructed for the purpose of storing water.

Domestic waste

- Domestic wastewater is defined as consisting of 90% or more wastewater by volume that arises from domestic use, or sewage that arises from commercial activities and premises, or water that may contain sewage.

Domestic wastewater includes household waste from washing, bathing, and toilets.

Individual end of pipe standards

The existing end of pipe discharge standards are referred to as the existing general standard (EGS), which is applicable in unlisted areas, and the existing special standard (ESS), which is applicable in all listed areas, including the special standard for phosphate.

Industrial waste

- Industrial wastewater consists of 10% or more wastewater by volume that arises from industrial activities and premises.
- Industrial wastewater may also contain domestic wastewater and sewage.
- Industrial wastewater is generated by a wide range of activities such as:
  - Chemical industries;
  - Metal plating;
  - Plastics;
  - Leather processing; and
  - Pulp and paper manufacture.

Pollution

Pollution is the direct or indirect alteration of the physical, chemical or biological properties of a water resource so as to make it:

- Less fit for any beneficial purpose for which it may reasonably be expected to be used; or
- Harmful or potentially harmful to:
  - The welfare, health or safety of human beings;
  - Any aquatic or non-aquatic organisms;
  - The resource quality; or
  - Property.

Principle

A statement providing guidance on what should be strived for, typically acknowledging an underlying values-based assumption.

Resource Directed Measures

A series of measures (classification system, Reserve, Resource Quality Objectives), described in Chapter 3 of the NWA (36:1998) that are together intended to ensure comprehensive protection of all water resources.

Resource Quality

Includes all aspects of water quantity, water quality and aquatic ecosystem quality, the latter including the quality of in-stream and riparian habitats and aquatic biota.

Resource Quality Objectives

A numerical or descriptive statement of the conditions that should be met in the receiving water resource, in order to ensure that the water resource is protected.

SIC codes

The diverse range of industrial activities is classified according to Standard Industrial Codes (SIC). These Codes are published in the Standard Industrial Classification of All Economic Activities (5th Edition) by Central Statistical Services (SIC, 1993).

Examples of some common SIC Codes are:

23 000 – mining of gold and uranium.

30 202 – manufacture of butter and cheese.

30 203 – manufacture of ice cream and other edible ice.

31 500 – dressing and dying of fur.

61 221 – wholesale trade in foodstuffs.

Waste site

- Disposing of waste in a manner that may impact on water resources is a water use, described in 21(g) under the definition for Water Uses, below. Disposal of waste is also regulated in terms of Section 20 of the Environment Conservation Act, 1989 (Act No. 73 of 1989).
- Waste disposal sites have to be registered in terms of Section 20(4) of the Environment Conservation Act.
- Waste disposal sites include, for example, landfills, municipal dumps and co-disposal sites.
- Some categories of waste are excluded from registration of waste sites, such as industrial ash dumps and mine dumps. Soak-aways, French drains, conservancy tanks, pit latrines and other onsite disposal methods for household waste are also excluded.
- These excluded categories are regulated under the NWA (36:1998) as outlined in Section 21(g) in the NWA (36:1998).

Source Directed Controls

Source Directed Controls are the measures that contribute to defining the limits and constraints that must be imposed on the use of water resources to achieve the desired level of protection. They are primarily tools that are designed to control water use activities at the source of impact, including tools such as standards and the situation-specific conditions that are included in water use authorisations.

Waste

Waste includes any material that is dissolved, suspended or transported in water and which is deposited on land or into a water resource in such volume, composition or manner as to cause, or to be reasonably likely to cause, the water resource to be polluted.

Wastewater

Wastewater is water containing waste, or water that has been in contact with waste material.

- Waste includes:
  - Domestic wastewater;
  - Biodegradable industrial wastewater; and
  - Industrial wastewater.

Water resource

A water resource is:

- A river or a spring;
- A natural channel in which water flows regularly or intermittently;
- A wetland, lake or dam into which, or from which, water flows;
- Any collection of water which the Minister may declare to be a watercourse; and
- Surface water, estuaries and aquifers (underground water).

All water bodies in the hydrological cycle, including underground water, are regarded as water resources. Each of these falls within the jurisdiction of DWAF.

Water quality

The physical, chemical, toxicological, biological (including microbiological) and aesthetic properties of water that determine sustained (1) healthy functioning of aquatic ecosystems, and (2) fitness for use (*e.g.* domestic, recreational, agricultural and industrial). Water quality is therefore reflected in (a) concentrations or loads of substances (either dissolved or suspended), or microorganisms, (b) physico-chemical attributes (*e.g.* temperature), and (c) certain biological responses to those concentrations, loads or physico-chemical attributes.

SECTION 4: WATER USE LICENCE APPLICATION

4.1 Water use licence

4.1.1 Introduction

Applying for a water use licence is a legal process with very specific statutory and policy requirements under the NWA (36:1998). **The onus is on the applicant to provide the required information within timeframes that are appropriate for both the applicant and DWAF**. An application fee of R114 (R100 + 14% VAT) is payable for processing a licence application. Charges for the actual water use will be determined according to the Department's water pricing policy (DWAF, 2000a).

In broad terms, the application for and subsequent issuing of a water use licence is an integrated process consisting of three procedures:

- A procedure to generate appropriate and sufficient information to enable an assessment of the potential impacts of the water use/s in terms of quantity, quality and the resource quality requirements;
- An evaluation procedure to determine whether a licence application should be duly authorised or rejected; and
- A procedure for the administration of the application for a licence to use water.

Licences are the principal legal instruments used to give effect to source directed controls in terms of the NWA (36:1998) (DWAF, 2000a).

4.1.2 Conditions of licensing

What is a licence?

A licence is a legal document that entitles a person to use water strictly **within the terms and conditions** of that licence. The Act makes provision for two kinds of conditions under which water uses are considered and licences are issued:

- The normal (default) situation makes provision for a Schedule 1 use, registration of existing lawful use, general authorisation and licences (the latter are referred to as individual licences).
- A condition where all uses have to be licensed (compulsory licences).

Individual licences

Any current water use that:

- Is NOT a Schedule 1 water use, or
- Does not comply with the terms and conditions of the General Authorisations, and
  - Is not an existing lawful water use, or
  - For which authorisation lapsed prior to 1 October 1999, or
  - For which the water use has changed, or conditions governing the existing lawful water use have changed, or
  - A request for an application for a water use licence has been issued, must be formally authorised by the issuing of a licence.

Compulsory licences

Compulsory licences will be initially called for in stressed resources where there may be problems experienced from over-utilisation of the available resources and competing water users. This is a mechanism to consider jointly all the water use authorisations in an area, and to ensure that all people are fairly and equitably considered for access to the limited available water (DWAF, 2000a).

General, compulsory licensing of existing and potential new water users will be undertaken in accordance with the requirements of Chapter 4, Part 8 of the Act. Section 43(1) provides criteria for assessing the necessity for compulsory licensing, and thus provides for such exercises to be carried out progressively over time, in different parts of the country, and according to the circumstances prevailing in particular areas or water resources (DWAF, 2002b).

In stressed catchments **all** water uses, irrespective of:

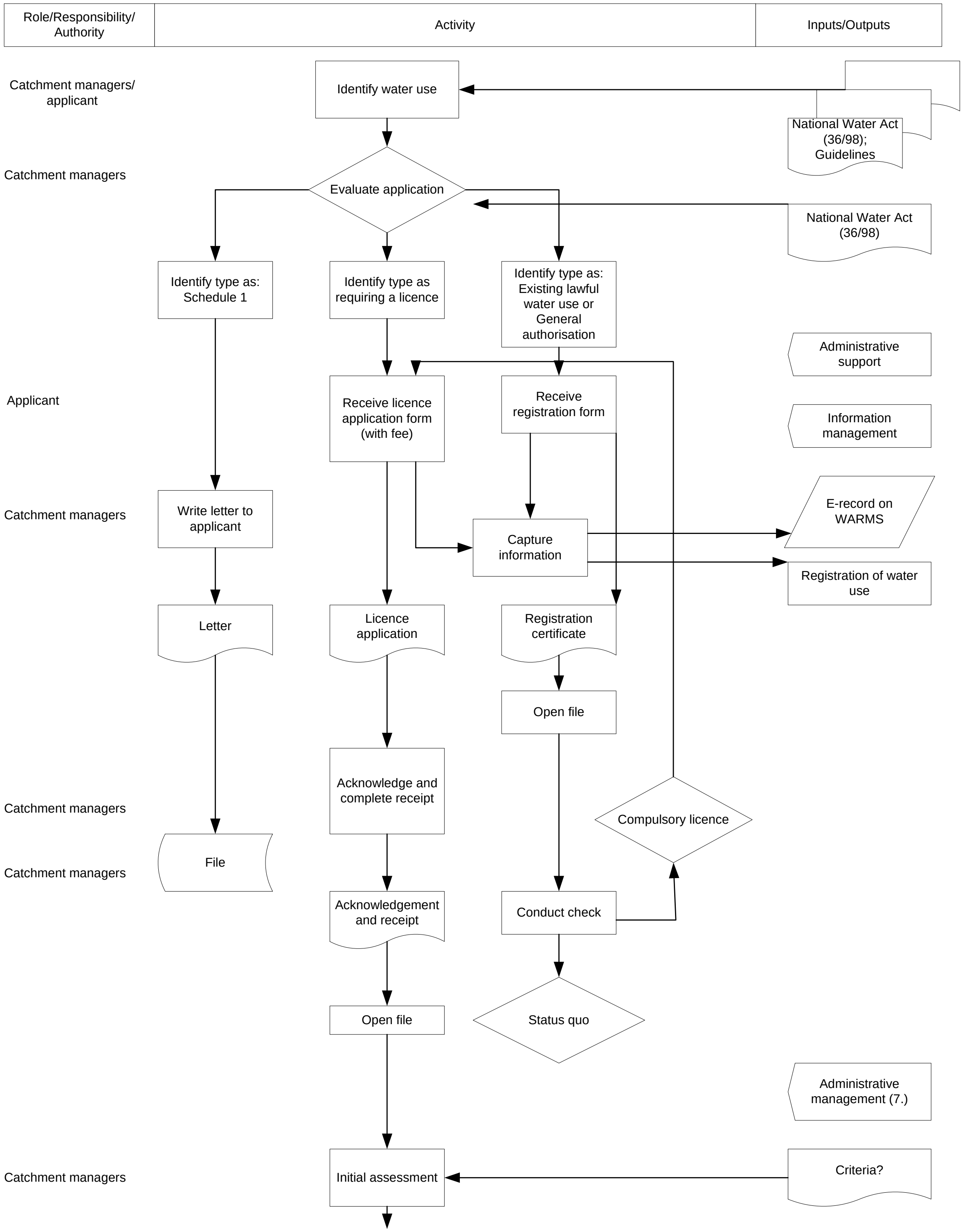
- Authorisation under general authorisations, or
- Existing lawful water use must be authorised by a licence.

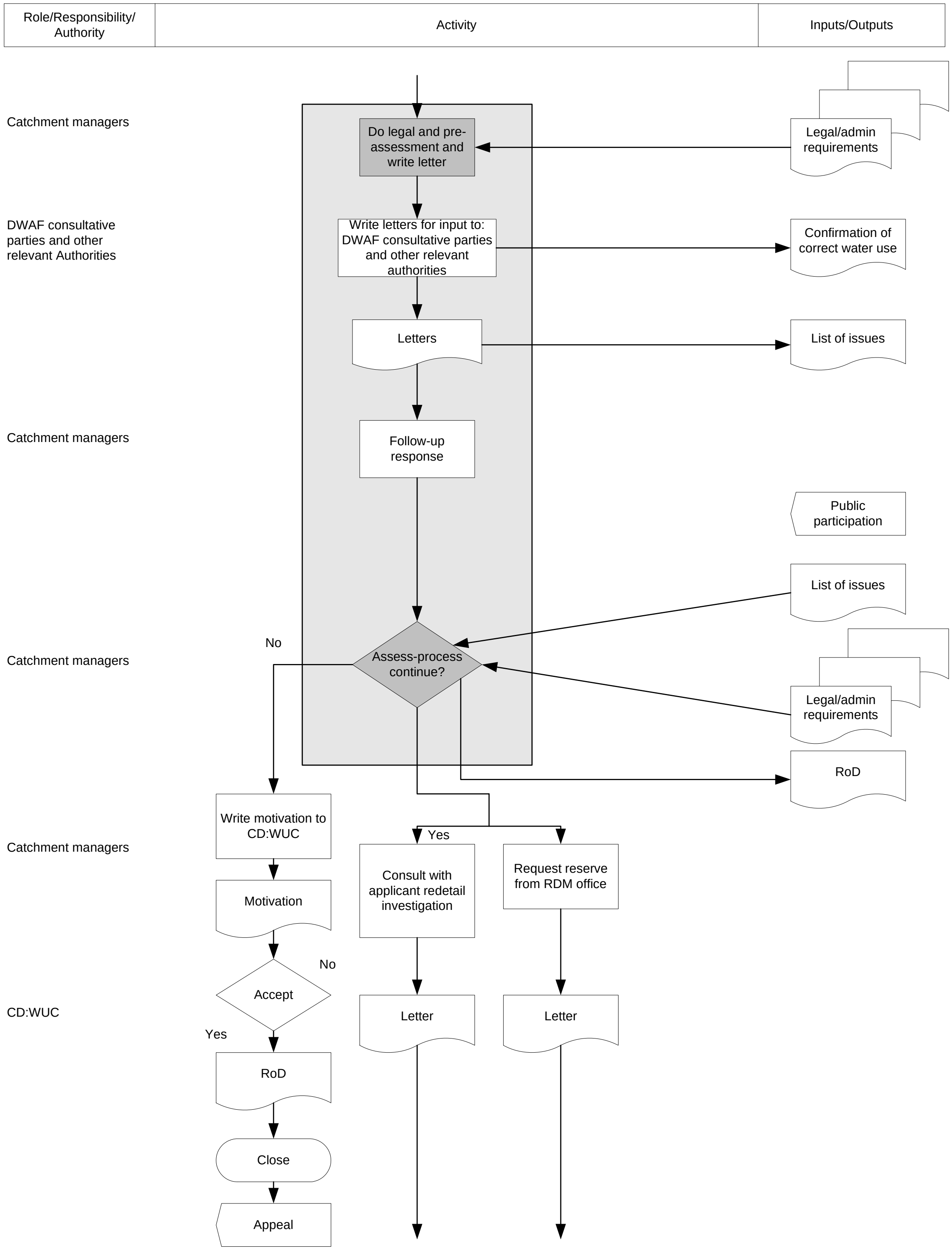
Water users located in stressed areas may be required, through notices in the Gazette and other media, to apply for a licence. Water users should acquaint themselves with Government Notices that will appear from time with regard to compulsory licensing. These notices can be accessed via the DWAF website, at the following address:

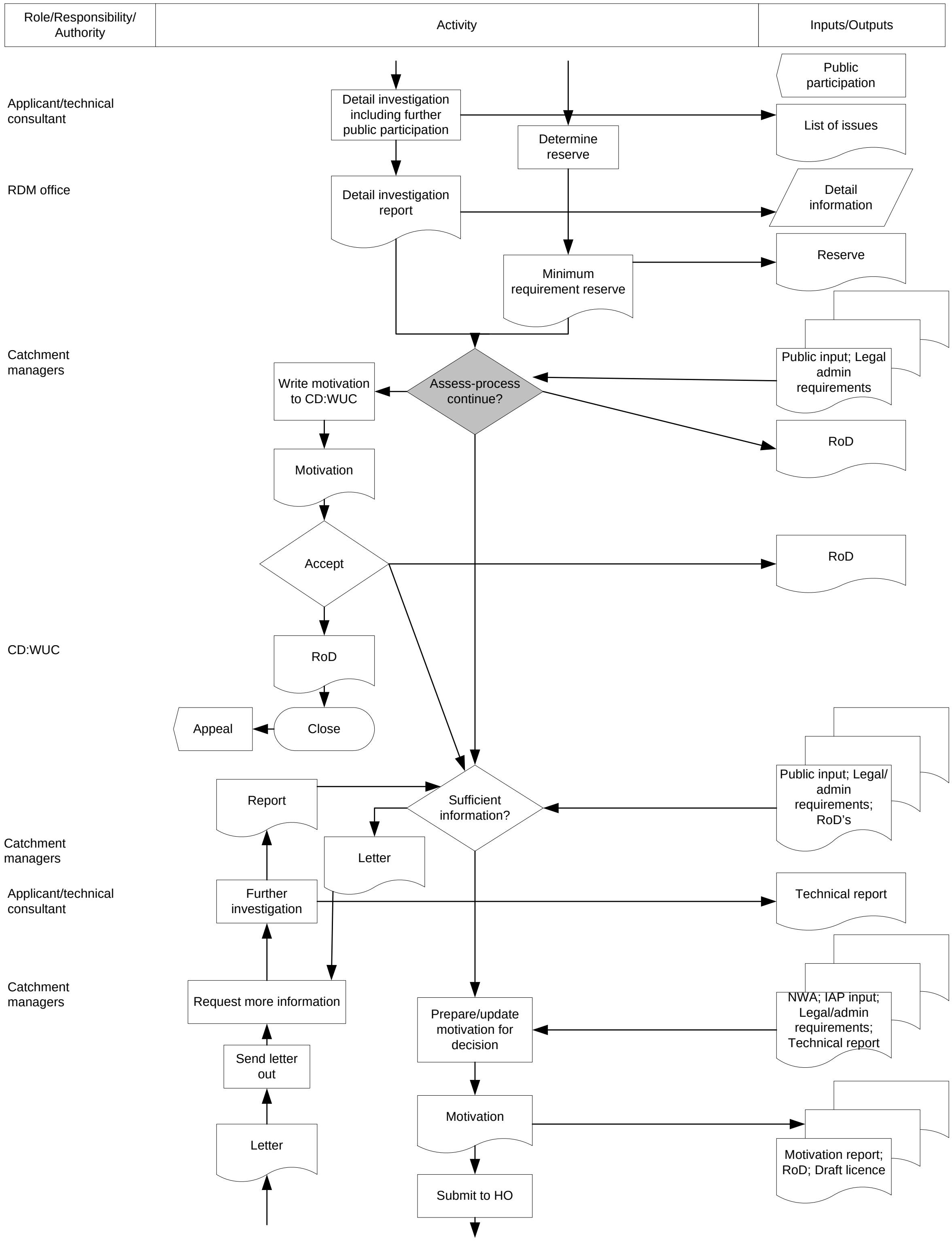
http://www.dwaf.gov.za/Documents/.

4.2 Stepwise Procedure

A detailed stepwise procedure which starts with the initiation of the water use licence application process to the approval stage is described in (Figure 4.1). It also describes the roles and responsibilities and inputs and outputs of each step.


Role/Responsibility/ Authority
Activity
Inputs/Outputs
Catchment managers/ applicant
Identify water use
National Water Act (36/98); Guidelines
Catchment managers
Evaluate application
National Water Act (36/98)
Identify type as: Schedule 1
Identify type as requiring a licence
Identify type as: Existing lawful water use or General authorisation
Administrative support
Applicant
Receive licence application form (with fee)
Receive registration form
Information management
Catchment managers
Write letter to applicant
Capture information
E-record on WARMS
Registration of water use
Letter
Licence application
Registration certificate
Open file
Catchment managers
Acknowledge and complete receipt
Compulsory licence
Catchment managers
File
Acknowledgement and receipt
Conduct check
Open file
Status quo
Administrative management (7.)
Catchment managers
Initial assessment
Criteria?


Role/Responsibility/ Authority
Activity
Inputs/Outputs
Catchment managers
Do legal and pre-assessment and write letter
Legal/admin requirements
DWAF consultative parties and other relevant Authorities
Write letters for input to: DWAF consultative parties and other relevant authorities
Confirmation of correct water use
Letters
List of issues
Catchment managers
Follow-up response
Public participation
List of issues
No
Catchment managers
Assess-process continue?
Legal/admin requirements
RoD
Write motivation to CD:WUC
Catchment managers
Yes
Consult with applicant redetail investigation
Request reserve from RDM office
Motivation
No
Accept
CD:WUC
Yes
Letter
Letter
RoD
Close
Appeal


Role/Responsibility/ Authority
Activity
Inputs/Outputs
Applicant/technical consultant
RDM office
Catchment managers
CD:WUC
Catchment managers
Applicant/technical consultant
Catchment managers
Public participation
Detail investigation including further public participation
List of issues
Determine reserve
Detail investigation report
Detail information
Minimum requirement reserve
Reserve
Public input; Legal admin requirements
Write motivation to CD:WUC
Assess-process continue?
RoD
Motivation
Accept
RoD
RoD
Appeal
Close
Report
Sufficient information?
Public input; Legal/ admin requirements; RoD's
Letter
Further investigation
Technical report
Request more information
Prepare/update motivation for decision
NWA; IAP input; Legal/admin requirements; Technical report
Send letter out
Motivation
Letter
Motivation report; RoD; Draft licence
Submit to HO

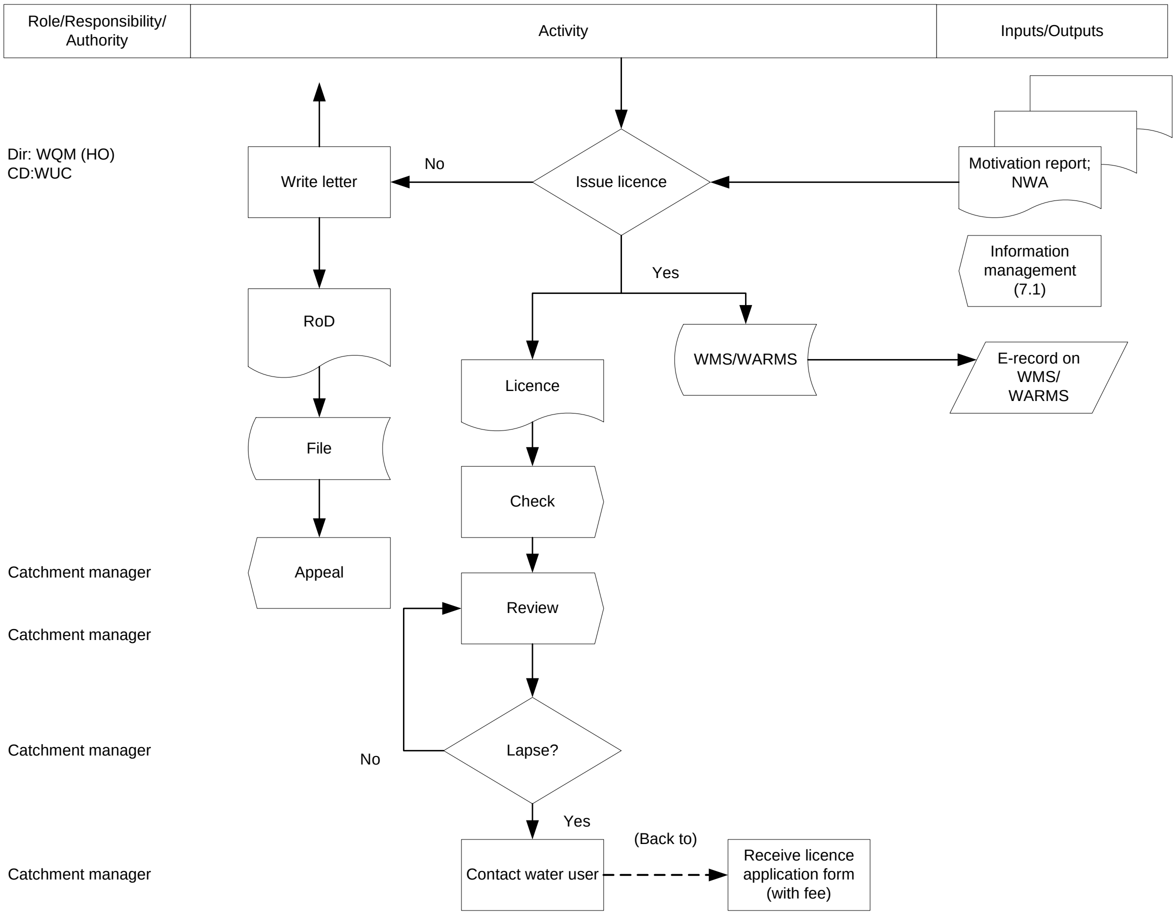


Figure 4.1: Stepwise procedure: water use licence application process.

4.3 Legislative requirements of other government departments

The onus is on the applicant to ensure compliance with other environmental legislation. It must be emphasised that an authorisation for any activity under another Act does NOT imply that a water use licence will be granted automatically in terms of the NWA (36:1998).

Legal provisions that are considered relevant in this context are summarised below.

Environmental Conservation Act (ECA), No 73 of 1989

Of particular importance in the ECA are the regulations promulgated in terms of Section 26 of the ECA. This relates to Environmental Impact Assessments (EIA's) provided for in Sub-sections 21 and 22 of this Act and provisions dealing with waste management under Section 20.

Policies promulgated in terms of the ECA are also relevant, such as the General Policy on Environmental Conservation (1994). This policy states that measures should be employed to support economic growth and social welfare without affecting, overstraining or irreversibly damaging the natural environment and resources in the process.

The principle that the polluter should pay for the negative environmental consequences of disposal or discharge actions is incorporated in the Policy on Hazardous Waste Management (DWAF, 2000b).

Environmental Impact Assessment (EIA) Regulations

Regulations promulgated in terms of Section 26 of the ECA aim to control activities that may have a detrimental effect on the environment, as prescribed under Sub sections 21 and 22, and are referred to as "controlled activities". In terms of this regulation, any new development that may entail a controlled activity will be subjected to an EIA. An EIA process has to be carried out and an EIA report submitted to obtain authorisation for the continuation of the proposed development. The administration of these regulations, including the granting or refusal of authorisations, has been delegated to the Provincial Departments of Environmental Affairs (PDEA).

Controlled activities that relate to water use are indicated in Table 4.1. These activities are stipulated in Schedule 1 of Government Notice Regulation 1182 (GG 5999) and Government Notice R670 (Gazette No. 23401) and must be authorised under EIA regulations **before** an authorisation under the NWA (36:1998) can be issued. According to Section 22(1), no person may undertake an identified controlled activity unless s/he has obtained a written authorisation issued by the Minister of Environmental Affairs and Tourism or his/her designated officer.

Table 4.1: Activities subject to the EIA-Regulations that could relate to a Water Use (DWAF 2000b).

1.	The construction or upgrading of:	
	(b)	Nuclear reactors and installations for the production ... and disposal of nuclear fuels and wastes;
	(c)	…structures, and … storage … facilities for any substance which is dangerous or hazardous and is controlled by national legislation;
	(i)	Canals and channels, including diversions of the normal flow of water in a river bed and water transfer Schemes between catchments and impoundments;
	(j)	Dams, levees or weirs affecting the flow of a river;
	(k)	Reservoirs for public water supply;
	(l)	Schemes for the abstraction or utilisation of ground or surface water for bulk supply purposes;
	(m)	Public and private reports and associated infrastructure; and
	(n)	Sewerage treatment plants and associated infrastructure.
2.	The change of land use from (c) agricultural or undetermined use, or (e) nature conservation or zoned open space, to any other land use.	
3	The concentration of livestock…including aquaculture and mariculture.	
8	The disposal of waste in terms of section 20 of the Environmental Conservation Act, (Act No. 73 of 1989).	
	When waste or water containing waste or runoff water is discharged into a waterworks controlled by another person authorised to provide or undertake the purification, that industry is regarded as a Schedule 1 use controlled by the Water Services Act, (Act No. 108 of 1997).	

The granting of an authorisation by the PDEAs does not mean that the activity will automatically be authorised by DWAF.

Minerals and Petroleum Resources Development Act, Act No. 28 of 2002

No prospecting, mining technical co-operation operations, reconnaissance operations, or exploration operations for minerals or petroleum may take place or be undertaken without a right or permit issued by the Regional Manager of the Department of Minerals and Energy Affairs. An approved Environmental Management Plan (EMP) or - Programme, in terms of Section 5 of this Act, is furthermore required before such an activity may be undertaken.

DWAF will, based on the content of such an EMP, consider whether or not to authorise any water use(s) that relate to the prospecting or mining of minerals.

Relating specifically to the Mining sector the following additional Acts are applicable:

- Occupational Health and Safety Act.
- Conservation of Agricultural Resources Act, 1983 (Act No. 43 of 1983).
- National Heritage Resources Act, 1999 (Act No. 25 of 1999).
- Air Pollution Prevention Act, 1965 (Act No. 45 of 1965).
- Restitution of Land Rights Act, 1994 (Act No. 22 of 1994).

Water Services Act, No 108 of 1997

The Water Services Act (WSA) provides the framework for the provision of water services. Developments for the provision of such services will usually result in water use that requires authorisation, irrespective of the source of funding for such developments. This implies that the authorisation process should be followed in parallel with the funding mechanisms that are in place, as well as with the EIA-Regulations, if applicable.

Importantly, according to Section 22 of the NWA (36: 1998), when waste or water containing waste or runoff water is discharged into a waterworks controlled by another person authorised to provide or undertake the purification of such waste or water containing waste, such as a water service institution under the WSA, the water use of that industry does not require a licence under the NWA (36: 1998), but is controlled under the WSA (108: 1997), Section 7, and is regarded as a Schedule 1 water use (DWAF, 2000b).

4.4 Other legislation

Cognisance should be taken of the following legislation:

- National Environmental Management Act, (Act No. 107 of 1998);
- Health Act, 1977 (Act No. 63 of 1977);
- In terms of township development the submitted documentation should always refer to the following Acts:
    - Section 96(1) of the Town Planning and Townships Ordinance, 1986 (Ordinance 15 of 1986);
    - Restitution of Land Rights Act, 1994 (Act No. 22 of 1994);
    - Section 6 A of the Physical Planning Act, 1969 (Act No. 88 of 1969).

The applicability of the legislation will depend on the specific water uses and their impacts. A licence cannot be issued if there are unresolved issues pertaining to land claims.

4.4.1 Authorisation for dam safety

NWA (36:1998), Chapter 12

What is a dam with a safety risk?

Chapter 12 of the NWA (36:1998) contains measures that are designed to improve the safety of new and existing dams with a safety risk, so as to reduce the potential for harm to the public, damage to property or resource quality. A dam with a safety risk means any dam which can contain more than 50 000 m^3 of water (irrespective whether such water contains substances or not), and/or which has a wall with a vertical height of more than five metres, or which has been declared as a dam with a safety risk.

General Notice Regulation 1560 of 25 July 1986

Dam Safety Regulations published in General Notice Regulation 1560 of 25 July 1986, are still in force under the NWA (36:1998) and require that dams with a safety risk must be classified into categories and licensed before any task relating to a specific category may commence. These regulations also prescribe the conditions, requirements, and procedures to classify, register, obtain a licence to construct a new dam, impound water within a dam, or alter an existing dam.

Dam safety licence

Such a dam safety licence is entirely different from a water use licence. Under no circumstances may a dam safety licence be issued unless the associated water use licence has been issued first.

4.5 Considerations before issuing a licence

NWA (36:1998), Chapter 4, Section 22,27; Chapter 5, Section 41

Several factors, which are set out in various sections of the NWA (36:1998), particularly in Section 27, are taken into account by the licensing authority **before** a licence is issued. These factors are illustrated in Figure 4.2 below.

Section 27 consideration

These factors include:

- Use without a licence (s22(1));
- Existing lawful water uses (s27(1)a);
- The need to redress the results of past racial and gender discrimination (s27(1)b);
- Efficient and beneficial use of water in the public interest (s27(1)c);
- The socio-economic impact either if the use is authorised, or if it is not authorised (s27(1)d(i));
- The socio-economic impact of the failure to authorise the water use or uses (s27(1)d(ii));
- The catchment management strategy applicable to the relevant water resource (s27(1)e);
- The likely impact on the water resource and on other water users of that water resource (s27(1)f);
- The class and resource quality objectives of the water resource (s27(1)g);
- Investments already made and to be made by the water user in respect of the water use in question (s27(1)h);
- The strategic importance of the water use to be authorised (s27(1)i);
- The quality of water in the water resource which may be required for the Reserve and for meeting international obligations (s27(1)j);
- The probable duration of any undertaking for which a water use is to be authorised (s27(1)k);
- A responsible authority may not issue a licence to itself without the written approval of the Minister (s27(2)); and
- Regulations made under Section 26 of the Environmental Conservation Act, 1989 (Act No. 73 of 1989) (s41(3)).

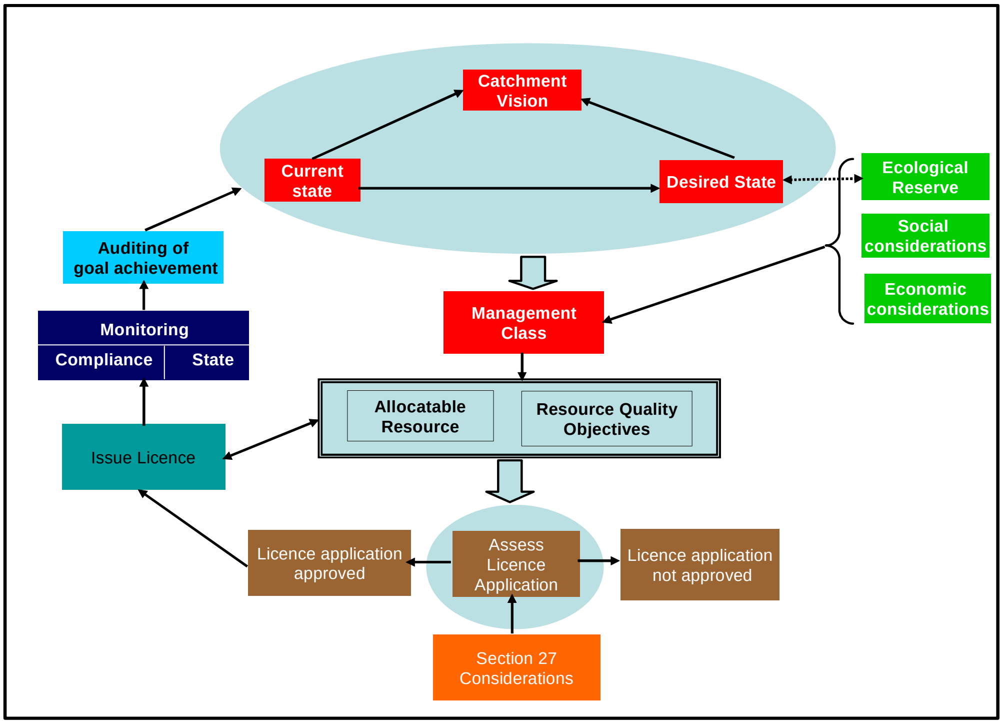


Figure 4.2: Factors that determine the issuing of water use licences.

4.6 Appeal / Water tribunal

NWA (36:1998), Chapter 15, Section 148 149

The Water Tribunal is an independent body, which can hear and adjudicate appeals against administrative decisions made by the Minister, the Department, or another water management institution. Should a person not be satisfied with the Tribunal's decision, they may appeal to the High Court, although there is no appeal against certain decisions such as the class, Reserve or resource quality objectives set by the Minister (Reed and De Wit, 2003).

4.7 Requirements and conditions of licences

NWA (36:1998), Chapter 4, Section 28 & 29

Licensing period

A licence may be issued for a **maximum** of 40 years. The period will depend on various factors, for example the strategic importance of the activity, the number of jobs dependant on the activity, etc. The period would be set to ensure a reasonable return on investment by the water user.

Licensing conditions

When a licence is granted, it entitles the licence holder to use water within the terms and conditions of the licence. These terms and conditions may be reviewed at a review period listed in the licence, which may be any period not exceeding five years. The review period allows reasonable changes to be made in the licence conditions. The licence period can never be changed. All amendments must be reasonable and, where possible, acceptable to both the water user and the DWAF.

Once licences have been issued, their conditions can only be amended (Section 49) when:

- It is necessary to prevent deterioration of the water resource quality; or
- There is insufficient water to accommodate all the authorised water uses, after allowing for the Reserve and international obligations; or
- It is necessary to accommodate demands brought about by changes in socio-economic circumstances providing it is in the public interest to do so.

Should any amendment of a licence condition severely prejudice the economic viability of an undertaking, the licensee may claim compensation (Section 22). The Act also safeguards DWAF (Section 31) in that the issue of a water use licence does not imply a guarantee relating to the availability of water or quality of water, for example where these may be affected by prolonged droughts.

4.8 Surrendering or transferring a licence

Surrendering, transferring or inheriting a licence

A water use licence may be:

- *Surrendered* by the water user, once the water use ceases (NWA (36:1998), Chapter 4, Section 55);
- *Withdrawn* by DWAF if the water user is in violation of any of the terms and conditions of the licence (NWA (36:1998), Chapter 4, Section 54);
- *Transferred* to another person (NWA (36:1998), Chapter 4, Section 25). (Either all or part of the licence and either temporarily, for example for two years, or permanently). Transfer of licences is a form of trading in water use. Trading in water use is possible because the Act acknowledges that water is also an economic good and it can be traded on the open market according to free market principles.
- *Inherited* by a successor-in-title from a licensed water user (NWA (36:1998), Chapter 4, Section 51). Note that any outstanding charges associated with the licence will also be inherited!

SUMMARY

- Be pro-active and initiate the licence application process well in advance of starting the water use.
- Close liaison with a DWAF Regional Official **before** submitting the licence application forms is crucial in preventing unnecessary expenditure and wasting of time.
- Complete the correct application forms in full.
- Attach proof of payment of the licence processing fee and a certified copy of your Identity Document.
- Be sure to comply with all other relevant legislation.

SECTION 5: REFERENCES

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Addendum A:

Completion of licence application forms

A1. Overview

A1.1 Licence application forms

Licence application forms are available from Regional DWAF Offices or the National DWAF Office. They are also available on the following internet site: http.//www.dwaf.org.za.

Licence application forms consist of Part 1 and Part 2 as well as Supplementary forms.

- Part 1 forms require personal information on the applicant and associated users, the property where the water use takes place and the particular water use activity.
- Part 2 forms require information specific to the water resource and the precise nature of each intended water use.
- Supplementary forms require technical information on, for example, pump data and irrigation system types.

One Part 1 form must be completed. One Part 2 form must be completed for each water use identified during discussions with a DWAF officer.

A1.2 Licence application form numbers

A1.2.1 Part 1 licence application form numbers

DW769	Individual.
DW770	Water Services Provider, including Water Boards.
DW771	Company Business or Partnership, National or Provincial Government.
DW772	Water User Association, including Irrigation Boards, Subterranean Water Control Boards, Water Boards for Stock Watering, Settlement Boards, Water Conservation Boards.

A1.2.2 Part 2 licence application form numbers

DW773	Taking water from a water resource.
DW774	Storing water.
DW775	Impeding or diverting the flow of water in a watercourse.
DW776	Engaging in a stream flow reduction activity.
DW777	Engaging in a controlled activity: Irrigation of any land with waste or water containing waste.
DW778	Discharging waste or water containing waste into a water resource through a pipe, canal, sewer, sea outfall or other conduit.
DW779	Disposing of waste in a manner which may detrimentally impact on a water resource.
DW780	Disposing of water which contains waste from, or which has been heated in, any industrial or power generation process.

DW781	Altering the bed, banks, course or characteristics of a watercourse.
DW782	Removing, discharging or disposing of water found underground if it is necessary for the efficient continuation of an activity or for the safety of people.
DW783	Using water for recreational purposes.

A1.1.3 Supplementary form numbers

DW784	Taking water from a water resource. Pump technical data.
DW787	Taking water from a water resource. Irrigated field and crop information.
DW788	Taking water from a water resource. Power generation, industrial or mining use.
DW790	Storing water. Dam and basin technical data.
DW799	Discharging or disposing of water. Quality of water, waste or water containing waste.

A2 Important notes

- Make sure that the correct Part 1 and all of the applicable Part 2 forms are completed
- The information fields or blocks marked with a dot, are compulsory and must be filled in.
- Make sure that the correct information is provided.
- Please write clearly in black ink.
- Use capital letters.
- Use one letter or digit per square.

Return forms to the nearest office of the Department of Water Affairs and Forestry.

Addendum B:
Additional information

B1.1 Introduction

The reader's attention is drawn to the DWAF website, http.//www.dwaf.org.za, where documentation containing important information to facilitate the licence application process can be obtained. It is in the interest of the applicant to avail him/herself, with the help of the DWAF Regional Officers, of the latest documents and regulations pertaining to the intended water use. Specific reference to some of the most important documents that the water use licence applicant has to consult where applicable, are made below.

B1.1.1 References pertaining to the licence application procedure

Aide-Mèmoires and Annexures

- Aid- Mèmoires and Annexures have been compiled to assist in planning comprehensive environmental water management plans.
- Aide-Mémoire and Annexures for the preparation of a water quality management report to support the application for licences for sewage purification works in terms of the requirements of the National Water Act, 1998 (36: 1998).
- Aide-Mémoire and Annexures for the preparation of a water quality management report to support the application for licences for industrial use in terms of the requirements of the National Water Act, 1998 (36: 1998).
-

Documents in support of a licence application

- Permissible utilisation and disposal of sewage sludge. Edition 1. WRC Document TT85/97.
- Addendum to the Guideline on Permissible utilisation and disposal of sewage sludge. Edition 1. WRC Document TT 154/02.
- Example of a licence application in terms of Section 40 of the National Water Act, (36: 1998), Sections 21 (x and y) water use.
- Draft Regulations in terms of section 26(1)(e) and (f) of the National Water Act, 1998 (36: 1998) for the protection of the public and to safeguard human life and the proposed registration of waterworks and persons.
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- Department of Water Affairs and Forestry (DWAF) 2004. Strategy and Management Approaches for Setting Waste Discharge Standards. Draft Report

Other documents

The reader's attention is also drawn to the following documents that are also available on the DWAF website cited above.

- The Water Use Authorisation Document, 2001;
- Licence application forms Part 1 and Part 2;
- Regulation No. R2834 and the necessary forms;
- Operator schedules that are in line with the South African Quality Association and National Quality Federation requirements;
- Sludge guidelines and its addendum; and
- Department of Health's Irrigation Guidelines.

Addendum C:
DWAF contact information

DEPARTMENT OF WATER AFFAIRS AND FORESTRY: CONTACT INFORMATION

REGION	ADDRESS	CONTACT	DETAILS
Northern Province	Regional Director: Northern Province Dept. of Water Affairs and Forestry Private Bag X9506 Pietersburg 0700	TEL. CELL. FAX	015 - 290 1410 082 802 3052 015 - 295 3249
Mpumalanga	Regional Director: Mpumalanga Dept. of Water Affairs and Forestry Private Bag X11259 Nelspruit 1200	TEL. CELL. FAX	013 - 759 7397 082 806 0699 013 - 755 1678
Gauteng – North	Regional Director: Gauteng - North Dept. of Water Affairs and Forestry Private Bag X995 Pretoria 0001	TEL. CELL. FAX	012 - 672 2948 082 807 5720 012 - 672 2936
Gauteng - South	Regional Director: Gauteng - South Dept. of Water Affairs and Forestry Private Bag X995 Pretoria 0001	TEL. CELL. FAX	012 - 672 2896 082 807 3522 012 - 672 2885
Free State	Regional Director: Free State Dept. of Water Affairs and Forestry P. O. Box 528 Bloemfontein 9300	TEL. CELL. FAX	051 - 430 3134 082 808 5625 051 - 430 8146
North-West	Regional Director: North-West Dept. of Water Affairs and Forestry Private Bag X5 MmaBatho 2735	TEL. CELL. FAX	012 - 253 1093 082 807 6098 012 - 253 1905
KwaZulu-Natal	Regional Director: KwaZulu-Natal Dept. of Water Affairs and Forestry P. O. Box 1018 Durban 4000	TEL. CELL FAX	031 - 336 2744 082 808 9916 031 - 304 9546
Eastern Cape	Regional Director: Eastern Cape Dept. of Water Affairs and Forestry P.O. Box 7019 East London 5200	TEL. CELL. FAX	043 – 722 3805 082 802 8564 043 - 743 3910
Western Cape	Regional Director: Western Cape Dept. of Water Affairs and Forestry Private Bag X16 Sanlamhof 7532	TEL. CELL. FAX	021 - 950 7100 082 807 3542 021 - 946 3664
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Resource Directed Management of Water Quality

PROJECT DOCUMENT

Appendix C

Guidelines for Setting Licence Conditions for RDMWQ

September 2004

Edition 1

water & forestry

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Water Affairs & Forestry
REPUBLIC OF SOUTH AFRICA

Water Resource Planning Systems Series

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Resource Directed Management of Water Quality

PROJECT DOCUMENT

Appendix C

Guidelines for Setting Licence Conditions for RDMWQ

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Co-ordinated by:

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DOCUMENT INDEX

Reports as part of this project:

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1.3	Glossary of terminology often used in the Resource Directed Management of Water Quality
1.4	Volume 1: *Policy Document Series*
1.4.1	Volume 1.1: Summary Policy
1.4.2	Volume 1.2: Policy on the Resource Directed Management of Water Quality
1.5	*Strategy Document Series*
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Bold indicates this report

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ACRONYMS

DWAF	Department of Water Affairs & Forestry
NePAD	New Partnership for Africa's Development
NGO	Non Governmental Organisation
NWA (36:1998)	National Water Act (Act No. 36 of 1998)
RDM	Resource Directed Measures
RDWQM	Resource Directed Water Quality Management
RDWQMP	Resource Directed Water Quality Management Policy
SADC	Southern African Development Community
WEHAB	Water, Energy, Health, Agriculture and Biodiversity Initiative
WMA	Water Management Area
WQM	Water Quality Management
WSA (108: 1997)	Water Services Act (Act No. 108 of 1997)
WSSD	World Summit on Sustainable Development

GUIDELINES FOR SETTING LICENCE CONDITIONS FOR RESOURCE DIRECTED MANAGEMENT OF WATER QUALITY

PHOTO: K MURRAY

1.1 Introduction

Giving effect to RDMs

In the context of water use licence conditions, resource directed measures (RDMs) - the resource management class (the desired future state) aligned with the catchment vision, and the Reserve and resource quality objectives (RQOs) - are relatively new concepts. This document addresses the issues around formulating appropriate licence conditions that will ensure that they are given effect specifically in the context of resource directed management of water quality. (Examples of conditions appear in the appendix).

NWA Section 27 considerations

Section 27 of the NWA (36:1998) contains many factors that must be taken into account before issuing a licence. Most of these also appear in Section 2 and should form the basis of licence conditions. In other words, there should be continuity between the considerations for authorising a water use and the conditions written into the licence for that use. This document does not concern itself with the authorisation process *per se*. It focuses on the nature of the resource directed licence conditions.

Software decision support tool

A software decision support tool is available for assessing the probability that a licence should be issued (DWAF, 2005b)). It is based on an assessment of each of the Section 27 considerations ((a) to (k)), using a multi-criteria decision support algorithm. It allows a different relative importance (weight) to be assigned to each consideration, depending on local conditions. It also takes account of uncertainties in the individual assessments of the indicators used for each consideration. These indicators can also be used, directly or indirectly, to inform the wording of individual licence conditions.

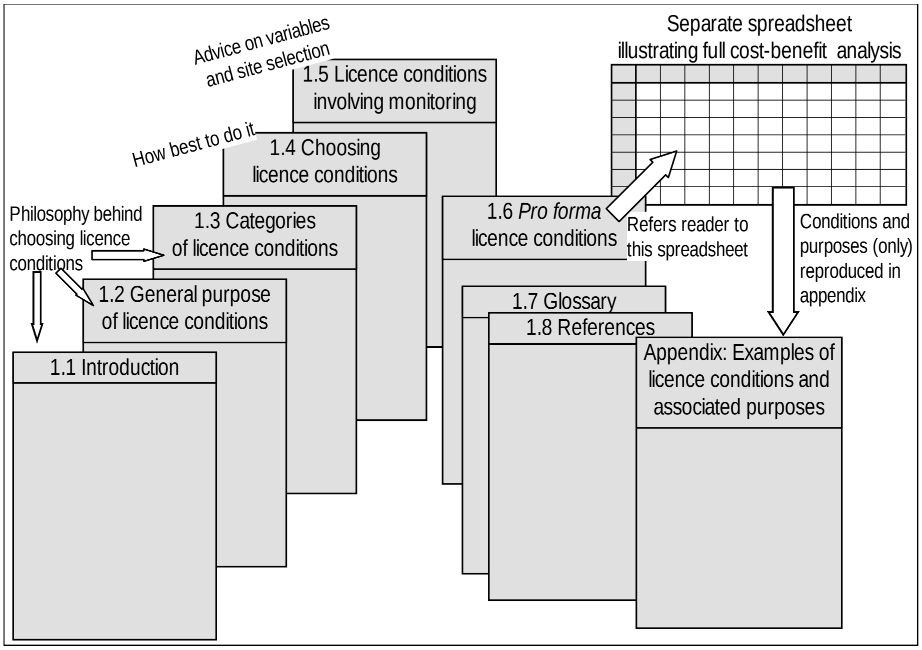

Figure 1.1: Illustration of document contents and relation to cost-benefit analysis spreadsheet.

1.2 General purpose of licence conditions

General scenario

Typically, a licence is required when there is potential for adverse impacts on water resources as a result of the water use in question.

The National Water Act (NWA, 36:1998) states that a water use must be licensed unless:

- It is listed as a Schedule 1 use (like reasonable domestic use, non-commercial gardening, etc.);
- It is an existing lawful use;
- It is permissible under a general authorisation; or
- If a responsible authority waives the need for a licence.

This quite simply means that the context is one in which impacts are real or at least possible and therefore licence conditions serve a very important purpose.

Purpose

The purpose of licence conditions is two-fold:

- To ensure that water is used for the authorised purpose(s) only; and
- To facilitate the Department achieving its water resource management objectives (such as RQOs), and hence contribute to sustainable development.

Authorised purpose

The authorised purpose is formally one or more of the water uses defined in Section 21 of the NWA (36:1998). These include:

- Taking water from a resource;
- Storing water;
- Impeding or diverting flow;
- Stream flow reduction;
- Controlled activities;

- Discharging waste through a pipe, etc.;
- Disposing of waste in a way which may impact on a water resource;
- Altering the bed, banks, course or characteristics of a watercourse;
- Removing water from underground; and
- Using water for recreational purposes.

Management objectives

The Department's management objectives for water resources are encapsulated at various levels, namely national, regional and catchment/local. Some are narrative while others are quantitative.

- In the catchment vision (narrative).
- In the management class (narrative), giving effect to the vision.
- The Reserve (narrative or quantitative) and RQOs (narrative or quantitative), giving effect to the management class.
- RWQOs (narrative or quantitative), the related source management objectives - which are actually load-based resource requirements and not user-specific - (quantitative) and individual (user-specific) load allocations (quantitative) [see DWAF, 2005c for more information on these]. These must give effect to the Reserve and RQOs.

Compliance with individual load allocations relates primarily to the source of impact and is therefore not addressed further here (since the current context is resource directed management of water quality).

Sustainable development

Sustainable development relating to the use of water entails ensuring that at least the enabling principles of sustainable development are applied (DWAF, 2005a)). The designated management class should have considered and balanced these in alignment with the catchment vision. Attaining and maintaining the management class, through the RQOs, is the most important factor in facilitating sustainable development.

RQOs are the Department's responsibility

It is formally the Department's responsibility to comply with RQOs, not individual water users. However, licence conditions may be imposed on individual water users that enforce an active contribution to the Department's execution of this duty.

1.3 Categories of licence conditions

Introduction

Categories of licence conditions in the NWA (36:1998) identify general reasons for imposing licence conditions. Section 29 in particular, and Section 27 and Section 2, are the most relevant.

NWA Section 29 categories

Section 29 describes conditions for the issue of both general authorisations and licences. On the one hand, some sub-sections describe conditions for specific water uses (like controlled activities, taking and storage of water, and also relating to return flow and the discharge or disposal of waste). However, more importantly, there are four more general categories that are not specific to particular water uses that provide reasons for conditions. It can be noted that they are not necessarily mutually exclusive, *i.e.* individual conditions may fall into more than one such category.

- Protection (Section 29(1)(a)). These are imposed to (1) prevent, (2) minimise the likelihood of, or (3) detect unacceptable negative impacts by monitoring the water resource. Preventing and minimising impacts on (i.e. "protecting") downstream users is also relevant.
- Water management (Section 29(1)(b)). These are designed to facilitate effective management of water, both on-site (by the licensee) and in the water resource (mainly by the Department). Sub-section (i) refers to management practices and general requirements for any water use. Sub-section (ii) refers specifically to monitoring every water use. Monitoring resource water quality directly supports water management ("you can't manage what you can't measure").
- Achieving the purpose for which the licence was issued (Section 29(1)(g)). Although a licence is issued primarily to authorise a water use, it may be issued because the water use, for example, facilitates socio-economic enhancement or achieves more equitable access.
- Compliance with (other) provisions of the Act (Section 29(1)(h)). All of the above categories are themselves provisions of the NWA (36:1998) (such as water resource protection). This Section could be invoked for provisions not included in the above. The provisions are summarised in Section 2 of the NWA (36:1998). Examples include meeting international obligations or redressing the results of past racial or gender discrimination (and many others). (Licence conditions imposed under this category may often overlap with the previous category, namely achieving the purpose of the licence).

1.4 Choosing licence conditions

1.4.1 Introduction

Reasonable & relevant conditions

Besides ensuring that the water is used for the authorised purpose only and that the Department achieves its water resource management objectives (and hence facilitates sustainable development), individual licence conditions must also:

- Be within the Department's ability to monitor, manage, and enforce.
- Not impose unreasonable demands on the licensee.
- Have a purpose that is clear to both licensee and the Department.

Recommendations versus conditions

It is necessary to distinguish between recommendations and conditions:

- A condition is a legally enforceable consideration or action demanded of the water user. It is written into the formal licence. Typically, to be legally enforceable, it is necessary to have an agreed method of establishing the degree of compliance (such as monitoring), i.e. how implementation of the condition will be measured.
- A recommendation is advice to the water user usually appearing in the covering letter of a licence. Typically a consideration or action will be recommended if it is not extremely important or the degree of implementation is difficult to measure.

The choice between condition and recommendation is likely to depend heavily on site-specific circumstances.

1.4.2 Suite of conditions

Protection

Some of the licence conditions in any licence must ensure that ecosystem integrity will be sufficiently well protected ("protection of water resources" principle). It must also ensure that downstream users will be adequately protected ("current equitable access" principle). Licence conditions in this category will contribute directly to the degree of sustainable development in the area, although this is encapsulated in the designated management class. The class specifically enables a balance to be achieved between "protection of water resources", "optimal water use", "current equitable access" and "equity between generations", all enabling principles of sustainable development.

Water management

There must also be licence conditions relating to water quality management. These must:

- Be directly related to actual or potential resource water quality impacts caused by the specified water use (supporting the "polluter pays" principle); and
- Contribute in a well-defined practical manner to the Department's mandate to achieve and comply with the resource quality objectives (associated with the designated management class).

Other categories

Other general reasons for imposing licence conditions are the following:

Achieving the purpose for which the licence was issued: The original application for the licence may have been motivated on the basis of significant positive benefits (such as redress or socio-economic enhancement). If achievement of this is aligned with the NWA (36:1998) and Departmental policy (as redress and socio-economic enhancement, among others, would be), it is reasonable to make it a condition of the licence. The Department is accountable for facilitating such ends and accountability is another enabling principle of good governance (to which the Department is committed). Such conditions are therefore important.

Compliance with (other) provisions of the Act: This category can overlap with the former category. For the same reason as above (accountability of the Department to the provisions of the NWA (36:1998)), the Department is demonstrating its adherence to sound principles of accountable governance by imposing appropriate licence conditions relating to such provisions. It is therefore obliged to do so.

1.4.3 Purpose of individual conditions

Introduction

The above-mentioned Section 29 categories are themselves general "purposes" for which particular licence conditions may be set (*i.e.* "protection", "water management", etc.). However, a more detailed analysis of each individual licence condition is necessary to ensure that the condition is reasonable and relevant. The purpose of each individual condition should be carefully considered and documented.

Summary of purpose

For each potential licence condition a single clear purpose, comprising one or two sentences, should summarise the reason(s) for the condition. These reasons, clearly linked to their respective conditions, can appear as an appendix to the written licence, comprising, in effect, a "record of decision".

Cost-benefit analysis

Ideally, a number of factors should be considered for each licence condition. These include the following (though some may not be relevant in certain circumstances):

Disadvantages (costs)

- Economic, to the licensee; and
- Economic, to the Department.

Advantages (benefits)

- Economic, to the licensee;
- Economic, to the Department;
- Social; and
- Ecological.

Note that these disadvantages and advantages refer to each licence condition, not to the water use as a whole. In other words, consider these disadvantages and advantages assuming that the water use will go ahead. For example, compare the economic disadvantages of monitoring or limiting turbidity levels in runoff, or creating in-house capacity with the economic advantages of doing these things.

"Economic"

"*Economic*" generally means anything related to the manufacture, distribution or consumption of goods and services. It therefore means much more than simply "financial" (which relates to money only). For a licensee who manufactures certain goods, the potential effects of a licence condition on all three aspects must be considered. This includes consideration of potential financial costs. On the other hand, the Department does not supply goods but can be considered to be providing a service (*e.g.* regulation). Consider whether or not imposing a licence condition makes the provision of this service more difficult (*e.g.* more difficult to manage).

Social and ecological disadvantages

It is apparent that individual licence conditions seldom have direct social and ecological disadvantages of any great significance. (Consider some of the individual licence conditions listed in the appendix and try to imagine how these might impact directly and negatively on the social or ecological environment).

Note that it is possible, in extreme cases, to imagine social impacts that may be caused indirectly by the licence condition being imposed. For example, if the financial costs to the licensee of a particular condition are so high that the licensee has to cut back on staff numbers, there may be social costs (the job losses). However, this social cost is as a result of the economic impact (as defined above). Economic impacts will be noted separately. It is therefore unnecessary to separately note such job losses as a social impact. (It can be mentioned directly under economic disadvantages, if necessary).

The eecological impacts of individual licence conditions will also typically be negligible. Drilling a borehole for monitoring purposes could strictly be regarded as having a negative ecological impact (since the borehole will disturb the natural groundwater flow in its immediate vicinity). However, this is not regarded as a sufficiently significant impact to warrant its explicit mention.

For these kinds of reasons, it is proposed that it is unnecessary to flag social and ecological disadvantages as requiring explicit consideration as primary factors in the overall cost-benefit analysis.

Fast-tracking

At the very least, the above factors should be used as a checklist and the purpose recorded directly (without recording the assessment for each factor). However, it should be remembered that the purpose should also be clear to the water user. It should therefore be carefully worded.

Template to facilitate analysis

Because the purpose of the condition is so important, it is recommended that the above cost-benefit analysis be carried out using a formal template structured as indicated in the Table 1.1. It is particularly useful to set up a spreadsheet with this structure and simply capture responses (the costs and benefits) in individual cells. This makes the construction of the summary purpose much easier.

Table 1.1: Recommended template for licence condition cost-benefit analysis.

		Disadvant-ages (costs)		Advantages (benefits)				Categories				
Licence condition	Purpose (summary)	Economic, to licensee	Economic, to Dept	Economic, to licensee	Economic, to Dept	Social	Ecological	Protection Sect 29(1)(a)	Water management Sect 29(1)(b)	Return flow, waste discharge Sect 29(1)(c)	Achieve purpose of licence Sect 29(1)(g)	Other provisions of the NWA Sect 29(1)(h)

State licence condition here

Summarise purpose here (based on these advantages)

State any disadvantages here

State the advantages here

Mark with an X, or indicate the subsection [(i), (ii), etc.], those categories to which the condition applies

1.4.4 To impose or not to impose

Introduction

When a list of possible licence conditions and respective purposes is available (*e.g.* based on another similar licence), it is necessary to make a final choice on the most appropriate suite of conditions.

Sequence of questions

Table 1.2 presents a sequence of questions that should be asked of each potential licence condition to determine whether or not it should be imposed on the water user. The questions are heavily based on the summarised purpose.

One perspective for considering the appropriateness of a particular licence condition is to consider what the costs (or disadvantages) would be if the condition was not imposed. The costs of not imposing the condition are, generally speaking, that its purpose may not be achieved. This aspect is captured in the sequence.

Table 1.2: Sequence of questions to be asked of each potential licence condition.

	Question	Response
Q1	Is the purpose of this condition relevant to this particular water use?	Yes: Go to Q2. No: Ignore this condition.
Q2	Is the purpose of this condition very important to achieve for this particular water use?	Yes: Go to Q3. No: Ignore this condition or consider invoking it as a recommendation instead.
Q3	Is the water user already achieving the purpose, or will the water user achieve the purpose, without imposing this condition, and is this likely to remain so in future? (For example, is the purpose already being achieved, or will it be achieved, through another similar condition?)	Yes: Consider (a) not imposing the condition, or (b) invoking it as a recommendation instead. No: Go to Q4.
Q4	Are the costs (disadvantages) to both licensee and the Department acceptable to both parties?	Yes: Go to Q5. No: Ideally, (a) negotiate with licensee and agree on mutually acceptable terms that ensure the purpose is not significantly compromised, and (b) impose the condition. Alternatively, consider invoking this as a recommendation instead.
Q5	Does this condition add significant value to the suite of conditions already chosen? For example, is there an inadequate mix of "protection" and "water management" conditions?	Yes: Impose condition. No. Consider (a) not imposing the condition, or (b) invoking it as a recommendation instead.

1.4.5 Advantages of approach

Advantages of transparency

Going through the process of considering the costs and benefits, even subjectively, and making both known to water users, applies the principle of transparency (a key enabling principle of good governance and hence sustainable development). This will have many advantages:

- Cost-effectiveness. Both the licensee and Department officials will be aware of the costs to both sides. This transparency ensures that particularly demanding conditions (on the licensee or the Department) can be avoided or modified accordingly. This increases the overall cost-effectiveness and practicality of licensing.
- Increased likelihood of trust and cooperation. Making the purpose clear is more likely to create trust and hence ensure the cooperation of the licensee simply because they understand the benefits of the condition. This is as opposed to the more "command and control" approach of simply stating the condition in a way that suggests the licensee has no say in the matter.
- Opportunity for dialogue. Being clear about the purpose of a condition allows a dialogue to be initiated with the licensee, whichshould enable more effective stakeholder engagement in general (this is fundamental to many of the enabling principles of sustainable development).
- Misinterpretation of condition minimised. In situations of apparent violation of the licence condition, the original intention of the condition (i.e. interpretation of the formal wording of the condition) is likely to be clearer. This should minimise the likelihood of dispute or conflict.

1.5 *Pro forma* licence conditions

Spreadsheet

To provide examples of the above approach, a number of licence conditions in the context of resource directed management of water quality have been subjected to the above cost-benefit analysis. Each factor has been considered and a brief subjective assessment made. It not meant to be exhaustive but rather to demonstrate the essence of the proposed approach. The full assessment is captured in a spreadsheet because the size of the resulting matrix is too large to be conveniently displayed in A4-size tables. However, for convenience, the individual conditions and their summarised purposes are presented in the appendix.

Generic versus site-specific

By their very nature, llicence conditions are usually specific to a particular water use at a particular site. In some cases, a licence condition may be applicable generically to different licences (*i.e.* able to appear unchanged in multiple licences for different water users). However, the licence conditions that are presented as examples should rather be regarded as providing general guidance, whichshould be tailored to the specific water use and nature of the local water resource.

Social and ecological costs

The generic nature of the licence conditions presented in the spreadsheet makes it is impossible to generalise as to when social and ecological impacts may or may not occur. This is an entirely site-specific situation. However, if social and ecological costs are considered to be relevant to particular conditions, then these should obviously be noted.

1.6 Glossary

Economic. Relating to the manufacture, distribution and consumption of goods and services.

Financial. Relating to money.

Resource quality. Includes all aspects of water quantity, water quality and aquatic ecosystem quality, the latter including the quality of in-stream and riparian habitats and aquatic biota.

Resource quality objectives (RQOs). Numeric or descriptive (narrative) goals for resource quality within which a water resource must be managed. These are given legal status by being published in a Government Gazette.

Resource water quality objectives (RWQOs). Numeric or descriptive (narrative) in-stream (or in-aquifer) water quality objectives that are typically set to a finer resolution (spatial or temporal) than RQOs, and whichprovide greater detail upon which to base management of water quality.

Source Management Objectives. Objectives relating to (a) incremental reduction, (b) maintenance or, under special circumstances, (c) incremental increase in waste loads calculated to give effect to resource water quality objectives. They refer to the water resource management unit as a whole, not to specific water users, though they do consider technical, economic and administrative realities.

Water quality. The physical, chemical, radiological, toxicological, biological and aesthetic properties of water that (1) determine its fitness for use, or (2) that are necessary for protecting the health of aquatic ecosystems. Water quality is therefore reflected in (a) concentrations of substances (either dissolved or suspended), (b) physico-chemical attributes (*e.g.* temperature), (c) levels of radioactivity, and (d) biological responses to those concentrations, physico-chemical attributes or radioactivity.

1.7 References

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USEPA, 1991. *Technical Support Document for Water Quality-based Toxics Control*. Office of Water, Washington, DC. EPA/505/2-90-001. Section 5 Part 1, (pages 31-38).

Annexure A:

Examples of licence conditions and associated purposes

Table A1: Examples of licence conditions and associated purposes relating to resource water quality.

Licence Condition	Purpose
Catchment management	
Catchment visioning. *The licensee, or suitable representative, shall participate in the catchment visioning process.*	To keep a licensee informed of other user's requirements and give them the opportunity to influence the vision and the strategy to achieve it. Also encourages holistic thinking regarding the relation between the authorised use and protection of water resources.
Catchment forums. *The licensee shall participate in catchment forums and catchment committees to ensure effective Integrated Catchment Management.*	To keep a licensee informed of other user's requirements and give them the opportunity to influence water resource management in their catchment.
Downstream users. *The licensee shall identify all downstream users and aquatic ecosystems that are potentially or actually impacted by the water use and take into account, and not compromise, their respective water quality requirements during any operational activity.*	To ensure a licensee is (a) conscious of downstream users, and (b) shows them due consideration.
Catchment management strategy. *The licensee shall not carry out any new activity that may threaten the ability of the catchment management agency (CMA) to successfully implement its catchment management strategy. In particular, no activity may threaten the ability of the CMA to achieve its resource quality objectives relating to water quality.*	To avoid potential negative resource water quality impacts that have not been anticipated and/or quantified.
Capacity	
In-house awareness. *The licensee shall implement measures to promote and sustain staff awareness regarding the potential for, and nature and consequences of, negative impacts on local water quality in water resources.*	To decrease the likelihood of unintentional impacts (caused through ignorance or negligence).
In-house capacity. *The licensee shall develop and maintain in-house capacity relating to the nature of the actual or potential impacts on the water quality in the water resource, sufficient to understand the most important causes, effects and other inter-relationships.*	To create a holistic understanding of water quality impacts, increasing a licensee's ability for meaningful engagement with other stakeholders. Also reduces chances of unintentional impacts (caused through ignorance or negligence).
General conditions relating to the water use	
Recycling & concentration effects. *The licensee shall monitor the on-site water balance taking cognisance of concentration effects of any continuous recycling. Possible risks to local water resources must be identified. Management plans, approved by the Department, must be in place to (a) mitigate these risks, and (b) put contingency actions in place to address incidents affecting resource water quality*	(a) Minimisation of the risk of resource water quality impacts through early identification of potential water quality impacts, and (b) impact minimisation should an incident occur.
Efficient use. *The licensee shall at all times use the allocated water quality in the resource in an efficient (non-wasteful) manner by applying accepted Best Practice, even when well within the allocated water quality.*	Unnecessary (easily avoidable) impacts on resource water quality are avoided.
Turbidity. *Activities that lead to elevated turbidity levels shall be minimised. Erosion control measures shall be put in place for all operational activities, and access roads, if any, must be well maintained.*	To avoid (a) reduced light penetration and direct impacts on some biota, and (b) increased water treatment costs downstream.
General conditions relating to water resource	
Riparian vegetation. *Riparian vegetation shall remain intact, and may not be altered, disturbed, removed or replaced in any way due to the actions or activities associated with the water use.*	Minimises impacts on resource water quality by mitigating effects of surface runoff.
Activities in close proximity to resource. *No new activities are permitted within the 1:100 year flood line or within a 100 metre horizontal distance from any watercourse.*	Minimises possible impacts on resource water quality by limiting new activities to areas that are located well away from the resource.

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Appendix D

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Support System for RDWQM

September 2004

Edition 1

water & forestry

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Bold indicates this report

APPROVAL

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ACRONYMS

DWAF	Department of Water Affairs & Forestry
ACWUA	Assessment of Consideration for Water Use Applications
NWA (36:1998)	National Water Act
RDM	Resource Directed Measures
RDMWQ	Resource Directed Management of Water Quality
RQO	Resource Quality Objectives
RWQO	Resource Water Quality Objectives
SDC	Source Directed Controls
WQM	Water Quality Management
WRC	Water Research Commission

SECTION 1: GETTING STARTED

Background

To ensure that South African water resources are controlled in an equitable, efficient and sustainable manner, the South African National Water Act (NWA, Act No. 36 of 1998) has given a new direction to Water Resource Management, especially Water Quality Management. To ensure the effective use of water resources, quantitative techniques are needed to assist authorities in evaluating license applications for the use of water resource.

ACWUA

A decision support instrument, named “Assessment of Consideration for Water Use Applications” (ACWUA), has been developed to allow multiple criteria decision analysis, which utilizes indicators to inform decisions on license allocations. Evidence in terms of indicators is characterized on the basis of impact (extent to which criteria are met) and uncertainty (level of confidence in the available evidence). ACWUA uses Bayesian mathematics to quantify the extent to which one would expect a licence to be granted, given the set of evidence. The user is also prompted to provide narrative support for evidence related to each indicator. The above information is stored and reported as part of the Record of Decision.

ACWUA guides regional authorities by supporting their decision-making despite the limitations caused by incomplete, imprecise, and variable information. The decisions are based on multiple criteria such as socio-economic factors, race and gender considerations, and alignment with catchment strategy. While it integrates and presents information to inform decision-making, the responsible authority should evaluate the available information and ACWUA results when making the decision.

System Requirements

Before installing the application, make sure that the computer meets or exceeds the following minimum specifications:

- Windows® 98/2000/ME/XP
- Pentium® or comparable processor
- 128 MB RAM
- 70 MB free disk space
- 32 bit display adapter at 1024 by 768 resolution
- Ms Office 97/2000/XP
- Mouse or any similar controlling device
- CD-ROM or DVD-ROM

Installation

Before installing the application, it is advisable to close all the other applications. To install the program:

- Insert the ACWUA CD in the CD-ROM drive of the computer

Note: If the setup file does not run automatically, double-click the My Computer icon, and then double-click on the CD-ROM. When the displaying window shows up, double-click the setup.exe file.

Follow the instructions when prompted by the installation menu.

Help

To use the application 'Help' functionality:

- Click 'Help' > 'Contents' and use the '>>' button to scroll through the pages.
- Click 'Help' > 'Search For Help on'. A 'Help' window will appear. Type a keyword in the box and click the 'Display' button.

Two ways to become familiarised with the application are to: follow 1) the User Guide, or 2) the 'Walkthrough' in the application 'Help' functionality.

User Guide

The purpose of the User Guide is to:

- Guide the user on how to install the ACWUA application;
- Introduce the user to some of the application functionality; and
- Guide the user on how to use the application.

Walkthrough

'Walkthrough' in the application 'Help'.

Take a 'tour' through the system by following the walkthrough process. The existing walkthrough's in the application 'Help' are:

- Create New Licence Application From an Existing One.
- Edit Existing Licence Application.
- How to use the 'Walkthrough':
- Start the ACWUA application and log in using a user name and password.
- On the menu bar, go to 'Help' → 'Contents'.
- Use the '>>' button to scroll through the pages until you reach the 'Walkthrough' page.

OR:

- On the menu bar, go to 'Help' → 'Search For Help On'.
- A 'Help' window will appear. Type 'Walkthrough' in the box and click the 'Display' button.
- When the 'Main Window Title' window appears with the heading "Walkthrough", use the '>>' button to scroll through the pages.

SECTION 2: GETTING TO KNOW ACWUA

Starting and Exiting

To start the program:

- If your desktop has the ACWUA icon, you can start the program by double-clicking the License Supporting Tool icon.
- You can also start the program by clicking the start button, then click 'Program' > 'License Supporting Tool' > 'License Supporting Tool'.

To exit the program:

- Click the 'Close' button in the upper right-hand corner of the program window.
- Click the Decision Support Tool icon at the upper left-hand corner of the title bar and click close.
- Click 'License Process' at the menu bar at the top under the title bar, and then click 'Exit'.
- Click the 'Exit' button in the Main Window.

Login

A user can only log into the application if the administrator has created a user account. The login window contains a username dropdown box, which contains all the registered users, and a password entry box.

To log in:

- Click on the 'Username' entry box, and choose your username.
- Enter your password
- Click the 'Login' button

Note: A user can also log-out from the system without closing the whole program by clicking 'Administrator' and choose 'Log-out'. Note that by clicking the 'Log-out' button, the program will close or be terminated.

Main Window

After opening the application and logging in, ACWUA displays the main window. The main window contains a menu bar with three menus, namely 'User Administration', 'Licence Process' and 'Help'.

The window also has three shortcut buttons to create or edit a license application as well as to exit the application.

SECTION 3: ADMINISTRATION

Add New User

To add a new user:

- Click on ‘User Administrator’ > ‘Add New User’.
- On the ‘Add New User’ window - Enter details in the entry box about the user’s details.
- Click the ‘Add New’ button.
- Click the ‘Back’ button to go back.

Delete User

To delete an existing user:

- Click ‘User Administrator’ > ‘Delete User’.
- On the ‘Delete User’ window - Click the name of the user in the current user list.
- Click the ‘Delete’ button.
- Click the ‘Back’ button to go back.

Edit User

To edit details of an existing user:

- Click on ‘User Administrator’ > ‘Edit User’.
- On the ‘Modify User’s Details’ window – Click the name of the user whose details you wish to update and then enter the new details in the active entry box.
- Click the ‘Update User’ button
- Click the ‘Back’ button to go back.

Change User Passwords

To change the password for an existing user:

- Click on ‘User Administrator’ > ‘Change User Password’.
- On the ‘Change Password’ window – Click the name of the user whose password you wish to change and then enter the new password in the ‘New Passwords’ entry box and confirm the new password in the ‘Confirm Password’ entry box.
- Click the ‘Change Password’ button.
- Click the ‘Back’ button to go back.

SECTION 4: LICENCE PROCESS

Create

To create a new license application:

- Click ‘License Process’, and then click ‘Create New License’, Or
- Click ‘Create New License’ button
- Enter all needed information in the entry box
- Click the ‘Save’ button, to add data to the database

Note: The new license application will be added to the list of existing license applications. To start evaluation on the new licence application, use the ‘Edit Existing License’ button.

Edit

To edit an existing license application:

- Click ‘License Process’, and then click ‘Edit Existing License’
- Click ‘Edit Existing License’ button
- Click the particular license application in the list and then click the ‘Proceed’ button; the ‘Decision Process’ window will display for you to complete the license application questions.

Evaluate

The ‘Decision Process’ window contains a number of questions related to the licence application. Each question consists of:

- A set of options to answer the question.
- A slider bar to specify your certainty about the answer provided.
- A ‘Record of Decision’ button that leads to a new window where a record of the decision of the answer provided must be given.

To access and use the ‘Decision Process’ window:

- Click on ‘Edit Existing License Application”.
- From the list of ‘Existing Licenses’, Choose the specific license that you want to work on.
- Click the ‘Proceed’ button; the ‘Decision Process’ window will display.
- Go through all the questions following the ‘Next’ button at the bottom right hand of the window.
- Read the question clearly, and click one of the set of option buttons to answer the question.
- Indicate the certainty associated with your answer by moving the slider bar to the appropriate percentage.
- Click the ‘Record of Decision’ button to motivate the answer.

Weights

After all the questions have been answered, the user will be prompted to change the relative weights of questions related to sections of the Water Act. The system will record and report both the un-weighted and weighted results.

Record of Decision

The Decision window is used to motivate the answer to the question as well as to provide additional information that might be relevant towards the answer. The motivation is divided into four categories: Subjective, Expert Opinion, Evidence and General Comments.

To add information on the Decision window:

- Click on the entry box and enter your emphases to support your answer according to the heading on top. Do this for each heading.
- Click the ‘Save’ button.
- Go to the next question.

To complete the application:

Repeat the same procedure, from ‘Evaluate License Application’ to ‘Record of Decision’, for all the questions on all the tabs.

Once a motivation is saved in the ‘Record of Decision’ window, the red disk on the ‘Record of Decision’ button in the ‘Decision Process’ window will turn to green, indicating that the ‘Record of Decision’ information has been added to the database.

The ‘Grant License’ screen, at the bottom of the ‘Decision Process’ window, shows the impact of the answer concerning the ‘License Application’ towards the decision-making.

When all the questions have been answered, all the disks on the ‘Record of Decision’ button, in ‘Decision Process’ window, are green. The evaluation of the licence application is completed and after evaluating the results, the user can close the current licence application by using the ‘Close’ button.

History

With the history facility, you have an opportunity to view all of the licence applications that are already captured in the system. The ‘History’ page also contains the details of users who have been involved in the trend of updating the License Application.

To view the History:

- Click “License Process”, and then click ‘Create New License/Edit Existing License’, or
- Click ‘Create New License/Edit Existing Licence’ button.
- There are two pages in Main window, namely ‘License Details’ and ‘License History’. Click the ‘License History’ page.
- View all captured licenses and their updated history.

SECTION 5: REPORTS

Formats

The production of reports can be in the form of MS Word (.doc) or ASCII text (.txt). The 'License Details' and 'History', which contain full details of license applications, can be saved to these formats to be printed, filed or distributed.

MS Word

This format is well-suited for viewing in Microsoft Word, or other applications that can open .doc documents.

To download to MS Word

- Click 'License Process' > 'Edit Existing License' or click 'Edit Existing License' button.
- Choose the 'License Application' you want to download in the 'License Detail' List.
- Click the 'Download Current License' button if you want to download only the current License Application or click 'Download Current License' button if you want to download the entire License Applications.
- The 'Save' window will display; save the data as ".doc" with a proper name to your chosen folder.

ASCII Text

This format can be opened with most applications and is ideal for further processing.

To download to ASCII text:

- Click 'License Process' > 'Edit Existing License' or click 'Edit Existing License' button.
- Choose the license application you want to download in the 'License Detail' List.
- Click 'Download Current License' button if you want to download only the current License Application or click Download Current License button if you want to download the entire License Applications.

The 'Save' window will display; save the data as text with a proper name to your chosen folder.

SECTION 6: SCREEN DISPLAY

Adjusting

If the programme windows do not fit onto the screen, the display has to be adjusted to 1024x768.

To adjust the display resolution:

- Right-hand click on the desktop icon for your computer and choose ‘Properties’ in the dropdown menu
- On the ‘Display Properties’ window, choose the ‘Settings’ page.
- There is a ‘Screening Resolution’ group-box, move the slider to 1024 by 768 pixels
- Click the ‘Apply’ button and then click ‘OK’ to close the window.

SECTION 7: REFERENCES

Department of Water Affairs and Forestry (DWAF) 1999. *Guideline for the Assessment of Water Use Authorisations and Licence Applications in Terms of the National Water Act*, 1998. Department of Water Affairs and Forestry, Pretoria.

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1.4	Volume 1: *Policy Document Series*
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Abiotic	In the absence of living organisms.
Acid mine drainage	Effluent created by the oxidation of iron pyrite in rocks during mining operations, resulting in the production of sulphuric acid and waters that usually have a low pH value and high concentrations of iron and sulphate ions and total dissolved salts.
Agrochemicals	Chemicals used to fertilise soil, and to control animal pests and weeds in agriculture.
Algae	Any group of chiefly aquatic, non-vascular plants (i.e. without roots, stems and leaves). Typical examples are pond scums and phytoplankton.
Algal	Pertaining to algae.
Alien invasive species	Animals and plants that invade and becoming established in areas where they do not normally occur.
Allocatable water quality	The maximum worsening change in any water quality attribute away from its present value that maintains it within a pre-determined range reflecting the desired future state (typically defined by resource quality objectives). If the present value is already at or outside the pre-determined range, this indicates that none is allocatable, and that (a) reduced pollution loads relating that affected attribute(s), and/or (b) remediation of the resource may be necessary.
Allocation plan, water quality	A part of a water quality management framework plan, developed as a sub-strategy of a catchment management strategy, which specifies how allocatable water quality will be apportioned among water users in the water management area.
Alkalination	Conversion of a soil to a form that is high in sodium chloride, often with a high (alkaline) pH.
Alkaline	In an environmental context, having a pH above 8,4. In a pure chemical context, having a pH above 7.
Alkalinity	The sum of the anions of weak acids, plus hydroxyl, carbonate and bicarbonate ions in water.
Ambient standard	A quantitative pollutant level that may not be exceeded, or may be exceeded only for a specific frequency or duration, in order to ensure that the water containing such a pollutant remains fit for a designated use.
Anion	Negatively charged ion (atom or molecule).
Anthropogenic	Generated by human activity.
Aquifer	Underground accumulation of water in certain types of geological formation that is capable of transmitting groundwater rapidly enough to directly supply a borehole or spring.

B

Basic sanitation	The prescribed minimum standard of services necessary for the safe, hygienic and adequate collection, removal, disposal and purification of human excreta, domestic waste water and sewage from households including informal households.
Basic water supply	The prescribed minimum standard of water supply services necessary for a reliable supply of sufficient quantity and quality of water to households, including informal households, to support life and personal hygiene.
Benthic	Living on the bottom of a river, lake or ocean.
Benthos	Benthic organisms.
Best practicable environmental option	Defined by the National Environmental Management Act (107:1998) as the option that provides the most benefit or causes the least damage to the environment as a whole, at a cost that is acceptable to society, in the long-term as well as in the short-term.
Best practical means	The minimum set of decisions and management actions needed to meet the requirements of present legislation.
Biodiversity	A measure of the number and relative abundance of biological species.
Biological oxygen demand (BOD)	The amount of oxygen consumed by biota in water. It is a measure of the portion of organic carbon that is relatively easily oxidised by micro-organisms. It is used as an indicator of dissolved organic carbon, often in conjunction with chemical oxygen demand (COD). Total organic carbon (TOC) = BOD + COD.
Biome	Large ecological region characterised by similar vegetation and climate (such as the deserts, tundra, etc.) and groupings of living organisms in it.
Biomonitoring	The monitoring of living organisms to determine the biotic integrity of the aquatic environment. Also the gathering of biological information in both the laboratory and the field for the purpose of making an assessment or decision, or determining whether or not quality objectives have been met.
Biosphere	The entire area occupied by living organisms, or favourable for their occupation, i.e. all living organisms of the earth and its atmosphere.
Biota	Animal and plant life characteristic of a region or system.
Biotic	Of or pertaining to living organisms.
Buffered	Resistant to change. Usually used in the context of pH.

C

Capacity building	The process whereby people are enabled to better perform defined functions either as individuals, through improved technical skills and/or professional understanding, or as groups aligning their activities to achieve a common purpose
Carcinogenic	Ability to cause cancer.

Catchment	The area from which rainfall will drain into the watercourse or watercourses or part of a watercourse, through surface flow to a common point or common points. The land area from which a river or reservoir is fed, also known as a drainage basin or watershed.
Catchment management agency	A water management institution that is a statutory body governed by a board, representing the interests of water users, potential water users, local and government and environmental interest groups. It manages water resources within a defined water management area.
Catchment visioning	Development of a collective vision of catchment stakeholders and using it to steer diverse activities towards a common purpose.
Cation	Positively charged ion (atom or molecule).
Chemical oxygen demand (COD)	A measure of the oxygen requirement of organic matter in water. It is used as an indicator of dissolved organic carbon, often in conjunction with biological oxygen demand (BOD). Total organic carbon (TOC) = COD + BOD.
Class	Protection and management class of a water resource as determined by the classification system (Section 13 of the NWA). Preliminary class is a class that has not yet been Gazetted.
Classification system	Method of classifying South Africa's water resources to assist in water use allocation and management on a sustainable basis.
Cleaner production	A comprehensive preventive approach to environmental protection, including conservation; elimination of toxic and dangerous raw materials and product constituents, and reduction at source of the quantity and toxicity of all emissions and wastes being emitted to air, land and water.
Coastal zone	The area of land and sea along the coast, including estuaries, onshore areas and offshore areas; wherever they form an integral part of the coastal system.
Compliance monitoring programme	A monitoring programme designed to measure, assess and report on a regular basis the degree to which individual water users are remaining within (*i.e.* complying with) the conditions defined in their water use authorisations (licences).
Compulsory licensing	Compulsory licensing will apply if: it is desirable that water use in respect of one or more water resources within a specific geographic area be licensed; to achieve a fair allocation of water from a stressed water resource; when it is necessary to review prevailing water use to achieve equity in allocations; to promote beneficial use of water in the public interest; to facilitate efficient management of the water resource and to protect water resource quality.
Conductivity	The ability of water to conduct an electrical current. This depends on the number of ions in solution and is a measure of the total quantity of salts dissolved in the water. It is also used as a measure of salinity.
Conservation (water)	The efficient use and saving of water achieved through measures such as water saving devices, water-efficient processes, water demand management and water rationing.

Conservation (resource)	The protection of the aquatic ecosystem so that it is able to provide a desired range of ecosystem goods and services (including water) to society.
Co-operative governance	The sum of the many ways that individuals and institutions, public and private, manage their common affairs. It is a continuing process through which conflicting or diverse interests may be accommodated and co-operative action may be taken. It includes formal institutions and regimes empowered to enforce compliance, as well as informal agreements that people and institutions either have agreed to or perceive to be in their interest.
Co-regulation	An interactive relationship between the regulator and the regulated. Normally, the public authorities (regulator) will prescribe the environmental objectives, while the regulated industry will choose the methods to achieve the objectives.
Cost benefit analysis	Estimate and comparison of short-tern and long-term costs (losses) and benefits (gains); an economic analysis of an undertaking, often involving the conversion of all positive and negative aspects into common units (*e.g.* money), so that the total benefits and the total costs can be compared.
Cultural resources	Natural features and features adapted and created by humans in the past and present. These features are the result of continuing human cultural activity and reflect a range of community values.
Cumulative effects	The combined effects of multiple actions.

D

Decision-making	An intellectual activity comprising the making of a rational choice between alternatives.
Degradation	Reduction in quality.
Desertification	Land degradation in arid, semi-arid and dry sub-humid areas resulting from various factors, including climatic variations and human activities.
Dissolved solids	Inorganic salts dissolved in water.
Duty of care principle	Every person or organisation has a duty to act with due care to avoid damage to others, or to the environment.

E

Ecological succession	Manner in which ecosystems evolve and become more complex over time. This involves a change in species composition from a few early colonising pioneer species towards a more complex climax community of species.
Ecoregion	Relatively large area of land and water that contains geographically distinct assemblages of natural communities.

Ecosystem	An ecosystem consists of plants, animals and microorganisms that live in biological communities and which interact with each other and with the physical and chemical environment, with adjacent ecosystems and with the water cycle and the atmosphere (Odum, 1989).
Effluent	Liquid waste generated by human activity.
Effluent standards	Generic (*i.e.* not site-specific) values of water quality variables that can be used for end-of-pipe licence conditions.
Effluent targets	Site-specific values of water quality variables that can be used for end-of-pipe license conditions, typically back-calculated from downstream RWQOs or RQOs.
Environmental audit	A regular formal examination to ascertain whether or not an organisation or facility is operating in terms of its environmental performance requirements or some other measure of performance.
Environmental economics	Environmental economics includes the real and potential monetary costs and benefits to human well-being and the well-being of the biosphere as a whole, plus the sustainability of the system, when studying the flow of money in the economy.
Environmental impact assessment (EIA)	A detailed study of the environmental (social, economic and biophysical) consequences of a proposed course of action.
Environmental management programme (EMP)	In terms of the Mineral and Petroleum Resources Development Act (Act No. 28 of 2002) every mine must submit an EMP to the Department of Minerals and Energy. An EMP contains elements of environmental assessment (see EIA) plus management plans. Once it has been approved, it is enforceable by law.
Environmental management system (EMS)	Documented procedures drawn up as described in an SABS Code of Practice to implement the requirements of 1S0 14000. Operating, emergency, data collection and documentation procedures are set out along with procedures for training, the transfer of information and all procedures of a complete management and quality control system.
Environmental sustainability	The ability of an activity to continue indefinitely at current and projected levels, without depleting the social, cultural and natural resources required to meet present and future needs.
Environmental values	Particular values related to the water resource that are conducive to public and/or environmental benefit/use, welfare, safety or health and that require protection from the effects of impaired water quality. Several environmental values may be designated for a particular water resource.
Equality	As defined in Section 9 of the Constitution, equality implies that decisions regarding water resources may not discriminate on the basis of race, gender, sex, pregnancy, marital status, ethnic or social origin, colour, sexual orientation, age, disability, religion, conscience, belief, culture, language or country of birth.
Equitable	Fair and just in the sense of being based on laws and accepted principles.
Equity	The quality of being equitable.

Estuary	A partially or fully enclosed body of water, which is open to the sea permanently or periodically, and within which the seawater can be diluted to an extent that is measurable with fresh water drained from land.
Eutrophic	A state of an aquatic ecosystem rich in nutrients, very productive in terms of aquatic animal and plant life and exhibiting increasing signs of water quality problems.
Eutrophication	The process whereby nutrients accumulate in a body of water to the extent that problems occur with macrophyte, algal and cyanobacterial growth.
Existing lawful use	Rightful use of water as defined in Section 32 of the National Water Act, (Act No. 36 of 1998).
Externality	The impact (mainly negative) of changed environmental conditions on people and/or systems that do not cause the change.

F

Faecal coliforms	Bacteria derived from the intestines of warm-blooded animals, including man. Used as an indicator of faecal pollution.
Fauna	The animal life of a region.
Fitness for use	A scientific judgement, involving objective evaluation of available evidence, of how suitable the quality of water is for its intended use or for protecting the health of aquatic ecosystems.
Floodplain	Low-gradient land onto which a river regularly overflows its banks.

G

General authorisation	Authorisation that replaces the need for a water user to apply for a licence in terms of the National Water Act (36: 1998).
General waste	Waste that does not pose an immediate threat to man or to the environment.
Gross Domestic Product (GDP)	Total value of final production of goods and services within a specific time frame (usually one year).

H

Habitat	The normal abode or locality of a living organism defined by the set of physical, chemical and biological features.
Half-life	The time required for one half of a quantity to undergo change. In radioactivity, this is the period of time in which 50% of an element's atoms decay and become transformed into other substances. The longer the half-life of an element, the lower is its specific activity.

Hazardous waste	Waste, including radioactive waste, which is legally defined as “hazardous” in the state in which it is generated. The definition is based on the chemical reactivity or toxic, explosive, corrosive or other characteristics, which cause, or are likely to cause, danger to health or to the environment, whether by itself or when in contact with other waste.
Heavy metals	A metallic element with atomic number greater than 20 (*i.e.* that of calcium). Many can be toxic.
Hydrographs	Graph showing the level of water or the flow of water in a river or lake, usually over a period of time.
Hydrological	Pertaining to water flow.
Hydrological cycles	The cyclical flow of water, from rainfall to rivers, to evaporation and cloud formation.
Hydrosphere	The area of occurrence, distribution and movement of water on and under the land surface.
Hypersaline	Containing excessive quantities of salts.
Hypertrophic	Containing excessive quantities of nutrients.

I

Indigenous	Born, growing, or produced naturally (native) in an area, region, or country.
Industrial	Resource use patterns linked to or influenced by commercial / industrial benefits.
Informal settlement	A small or large group of houses (often of a temporary nature) erected on land, of which the majority have not formally been proclaimed and serviced for residential use.
In-stream habitat	Includes the physical structure of a watercourse and the associated vegetation in relation to the bed of the watercourse.
Integrated catchment management (ICM)	A systems approach to the management of natural resources, particularly water resources, within the bounds of a geographical unit based on the catchment area of a river system.
Integrated environmental management (IEM)	A philosophy that prescribes a code of practice for ensuring that environmental considerations are fully integrated into all stages of the development process, in order to achieve a desirable balance between conservation and development.
Integrated water resource management (IWRM)	Philosophy of managing the water resources of a catchment in an integrated manner. It relies on the recognition that all components of the hydrological cycle are intimately linked, and each component is affected by changes in other components. It is inherent in the concept of ICM.
Interbasin transfer	The conveyance of water across a drainage or river basin divide into another river basin or catchment. Also called trans-basin diversion.

Intergovernmental	Involving different spheres of government or different government agencies in the same sphere of government within a country. Also used to describe interactions between the governments of different countries.
Internalisation of externalities	Externalities, also called external costs, spill-overs or social costs, are costs generated by a producer but paid for by someone else. A typical example is a water user that discharges polluted water into a stream. The downstream user may then need to treat the water before it can be used. This treatment in effect means that the downstream user is paying part of the production costs of the upstream user. Internalising these externalities means the polluter should be responsible for these costs.
ISO 14001	The international standard relating to good environmental practices.

L

Landfill	Commonly used method of solid waste disposal.
Leachate	Liquid that flows through and out of a landfill.
Limnology	Originally the study of lakes; now more commonly used to describe the study of the physical, chemical and biological characteristics of inland (both fresh and saline) aquatic systems.

M

Macroeconomics	A study of national economic aggregates.
Macrophyte	A large plant able to be seen by the naked eye, especially one associated with an aquatic habitat.
Management approaches	General courses of action, including formal regulatory command-and-control methods and self-regulatory and supportive mechanisms, which enable a strategy to be implemented.
Management instruments	Detailed procedures, guidelines and software decision support that enable a strategy to be implemented.
Mean annual runoff (MAR)	The average total volume of stream discharge, consisting of surface flows and sub-surface flows derived from rainfall onto the catchment surface within one year, which can theoretically be utilised. Usually expressed in cubic metres of water per year.
Meta-principle	A principle providing guidance on the relative importance of principles.
Metabolite	Product of metabolism, and which may be taken in from the environment (e.g. amino acids and vitamins).
Metal	An element that is a good conductor of electricity and whose electrical resistance is directly proportional to absolute temperature.
Microbial contamination	Contamination by micro-organisms, some of which may be pathogenic (disease causing).
Micro-organisms	Microscopic biological organisms such as bacteria, viruses, protozoa, etc., some of which cause diseases.

Minimum requirements	A regulation or standard set by the Department that specifies the very least that should be complied with.
Minister	The Minister of Water Affairs and Forestry.
Monitoring	The measurement, assessment and reporting of selected properties of water resources in a manner that is focussed on well-defined objectives. These monitoring objectives should also be clearly linked to water resource management objectives.
Monitoring design	The definition of all aspects necessary for successful implementation of a monitoring programme. These include the monitoring variables, sampling site selection, sampling methods, sampling frequency, analytical procedures, data assessment, reporting formats, etc.
Mutagenic	Causing damage or change to the genetic material of an organism or cell.

N

Non-point source	A source of pollution whose initial impact on a water resource occurs over a wide area or long river reach (such as un-channelled surface runoff from agricultural land or a dense settlement).
Non-renewable resource	Resource that either cannot be renewed once it is used or lost.
Nutrient	Substance that supports growth and reproduction. In aquatic biology, the most important nutrients are nitrogen, phosphorus, silica and carbon.
Nutrient depletion	Reduction of essential nutrients (through plant uptake and removal of plant and animal residues.

O

Opportunity cost	The cost of foregoing one activity for another.
Over-exploitation	Use of an environmental resource at a rate that exceeds the natural regeneration rate.

P

Pan	A small closed basin that temporarily filled with water, generally a feature of semi-arid areas of low relief.
Particulate	Containing solid particles.
Per capita consumption	The amount of a commodity used by each person.
Perennial rivers	Rivers that flow throughout the year.

Performance monitoring programme	A monitoring programme designed to measure, assess and report on a regular basis the degree to which present resource quality conforms to resource quality objectives (RQOs), and hence whether a water resource is within its designated management class, or improving towards it or deteriorating away from it.
pH	The negative base 10 logarithm of the hydrogen ion activity (pH = 7 is neutral; pH < 7 is acid; pH > 7 is alkaline.
Phytoplankton	Plant plankton, (usually microscopic), found floating in a water body.
Point source	A source of pollution whose initial impact on a water resource is at a well-defined local point (such as a pipe or canal).
Policy	Guidance for decision-making and action that helps to set priorities and hence allocate human and financial resources.
Pollution	Defined by the National Water Act as the direct or indirect alteration of the physical, chemical or biological properties of a water resource so as to make it: Less fit for any optimal water use for which it may reasonably be expected to be used, or Harmful or potentially harmful to (a) the welfare, health or safety of human beings, (b) any aquatic or non-aquatic organisms, (c) the resource quality, or (d) to property.
Polluter-pays principle	The principle that those responsible for environmental damage must pay the repair costs, both to the environment and to human health, and must also pay the costs of preventive measures to reduce or prevent further pollution and environmental damage.
Pollution prevention	Control of the handling and discharge or disposal of hazardous substances, such that the degradation or further degradation of water resources is avoided.
Precautionary principle	An approach that exercises caution when uncertainties exist, generally assuming a worst-case scenario.
Precipitation	Condensation from the atmosphere, falling as rainfall, snow, hail or sleet.
Preliminary classification	An interim classification of a water resource established in the absence of the formal classification system required by Section 12 of the National Water Act. A preliminary classification is permitted in terms of Section 14.
Preliminary resource quality objective's	An interim resource quality objective established in the absence of the formal classification system required by Section 12 of the National Water Act. Preliminary resources quality objectives are permitted in terms of Section 14.
Principle	**A statement providing guidance on what should be strived for, typically acknowledging an underlying values-based assumption**.
Protection (water resource)	The maintenance and improvement of the integrity of water resources including their water quality, so as to regain or sustain their capacity to provide goods and services.

Q

Quality assurance The implementation of all activities that minimise the possibility of quality problems occurring. These activities include (amongst others) training, defined sets of procedures, formal review processes, etc.

Quality control The process of ensuring that recommended procedures are followed correctly by detecting and correcting quality problems when they arise.

Quality of life Physical, psychological, social, cultural, religious and material wellbeing.

R

Radioactivity The spontaneous decay of an atomic nucleus (especially of elements with a high number of protons in it) by emitting either electromagnetic radiation (gamma-radiation) or high energy particles (protons: alpha radiation, electrons: beta radiation).

Redress To put right by compensation. In the current context, to redress is to explicitly favour persons that were subject to past discriminatory practices. It contradicts explicitly the principle of equality. It is, nevertheless, constitutional (Section 9(2)).

Remediation Direct intervention in (a) degraded land, to minimise contamination risk to a water resource, or (b) a degraded water resource, to maintain or improve water quality in the water resource.

Renewable resource A resource produced as part of the functioning of natural systems at rates that are comparable to its rate of consumption. Limits to renewable resources are determined by flow rates and such resources can provide a sustained yield.

Reserve Defined by the National Water Act as the quantity and quality of water required:

To satisfy basic human needs by securing a basic water supply, as prescribed under the Water Services Act (Act No. 108 of 1997), for people who are now or who will in the reasonably near future, be (a) relying upon, (b) taking water from, or (c) being supplied from, the relevant water source; and

To protect aquatic ecosystems in order to secure ecologically sustainable development and use of the relevant water resource.

Since the Reserve is a legally binding quantity, it is typically not subject to rivalry. However, its very nature creates excludability since water uses not encompassed by basic human needs and maintaining aquatic ecosystem health are explicitly excluded. Therefore, the Reserve is strictly a quasi-public good.

Resource quality Includes all aspects of water quantity, water quality and aquatic ecosystem quality, the latter including the quality of in-stream and riparian habitats and aquatic biota.

Resource quality objectives (RQOs) Numeric or descriptive (narrative) goals for resource quality within which a water resource must be managed. These are given legal status by being published in a Government Gazette.

Resource-directed water quality management	An approach to water quality management that takes into account the ecosystem requirements of the water resource, whilst still providing for the needs of other water users.
Resource water quality objectives (RWQOs)	Numeric or descriptive (narrative) in-stream (or in-aquifer) water quality objectives typically set a finer resolution (spatial or temporal) than RQOs that provide greater detail upon which to base management of water quality.
Riparian	Referring to or relating to areas adjacent to water or influenced by free water associated with streams or rivers on geologic surfaces occupying the lowest position in a catchment.
Risk assessment (risk-based decision making)	A process of gathering data and making assumptions to estimate short- and long-tern harmful effects on human health or the environment from exposure to hazards associated with the use of a particular product or technology; or establishing the probability of an event occurring, the factors that could bring about that event, likely exposure levels and the acceptability of the impact resulting from exposure.
Runoff	The total stream discharge of water, including both surface and subsurface flow, usually expressed in cubic metres of water yield.

S

Salinisation	Increase in the amount of inorganic salts or dissolved solids in the water.
Salinity	The amount of dissolved inorganic solids, or salts, in the water.
Schedule 1 use	A permissible use of water as described in Schedule 1 of the National Water Act.
Self-regulation	Method of environmental regulation, whereby business voluntarily chooses both the environmental target and the provisions of accomplishing compliance.
Servitude	Right of way for the supply of, or access to, certain services.
Significant water resource	All water resources in South Africa, with the exception of those that have been declared to be insignificant.
Single source intervention	The act of intervening in the impacts or requirements of a single pollution source.
Source Management Objectives	Objectives relating to (a) incremental reduction, (b) maintenance or, under special circumstances, (c) incremental increase, in pollution loads, calculated to give effect to resource water quality objectives. They refer to the water resource management unit as a whole, not to specific water users, though they do consider technical, economic and administrative realities.
Source-directed water quality management	Management of water quality using source-based measures including pollution prevention and minimisation.
Stakeholder	An individual, group or organisation that has an interest in, or is affected by, an initiative and who may therefore affect the outcome of an initiative.

Standard methodology	Widely accepted, well-defined and tested scientific method, often used in chemical analysis.
Stewardship	The responsible provision of supervision and guidance.
Strategic use	A water use (such as electricity generation) of strategic national importance, as defined in the National Water Resource Strategy or designated as such by the Minister.
Strategy	Broad course of action focussed on the implementation of a policy.
Stress, water quality	A state in which the water quality is inadequate for the desired water use. For many uses, water quality stress exists when there is no allocatable water quality.
Stressed water resource	A water resource for which the demand for benefits exceeds the supply. This can apply either to the quantity of water or to the allocatable water quality.
Subsidiarity	The process of devolving decision making down to the lowest possible appropriate level.
Suspended solids	Particles suspended in the water column.
Sustainability indicator	An indicator conveying information about progress towards sustainable development.
Sustainable development	The endeavour to ensure that future generations can meet their own needs while promoting socio-economic development and improved quality of life for all in the current generation. This should be done in a manner that uses water resources in general, and water quality in particular, within the ability of the ecosystems to satisfy such needs now and in the future.

T

Teratogenic	Capable of causing the formation of congenital abnormalities and monstrosities in embryos.
Terrestrial ecosystem	A system of plants, animals, nutrients and elements, and the interactions between them that is found on the land.
Tolerance limits	The limit to which a plant or animal can withstand changes in the environment (*e.g.* the maximum amount of pollution that a plant can withstand, and still grow in that area).
Total dissolved solids (TDS)	Total amount of inorganic salts dissolved in water. TDS is directly proportional to electrical conductivity of water.
Total suspended particulate matter	The total amount of particulates of all sizes suspended in water.
Toxic	Poisonous.
Toxicant	A chemical substance capable of causing a toxic effect.

Toxic effect A dose-related effect that is manifest as an impairment of the activity of the organism or the cellular or sub-cellular system. In the current context, these effects are also limited to those that can be detected, either currently or potentially, locally or internationally, by a “toxicity test”, as defined here.

Toxicity In the current context, the degree to which a water exhibits toxic effects.

Trace metals Metallic elements that are essential for growth but only in very small quantities.

U

Unbuffered Not resistant to change.

Uniform Effluent Standards Standards set to regulate the discharge of point sources of pollution by enforcing compliance with effluent quality standards. Often leads to a cumulative pollution effect.

Urban Built up area.

Urbanisation The process by which an increasing proportion of an area's population becomes concentrated in (legally or statistically defined) urban areas.

V

Volatile organic compounds Carbon compounds that evaporate at everyday temperatures.

Vulnerability Susceptibility to harm.

W

Waste Defined by the National Water Act as including any solid material or material that is suspended, dissolved or transported in water (including sediment) and which is spilled or deposited on land or into a water resource in such volume, composition or manner as to cause, or to be reasonably likely to cause, the water resource to be polluted.

Water allocation The apportionment of water or allocatable water quality among water users.

Water management area An area established as a management unit in the national water resource strategy, within which a catchment management agency will conduct the protection, use, development, conservation, management and control of all water resources.

Water Management Institution Defined by the National Water Act as a catchment management agency, a water user association, a body responsible for international water management or any person who fulfils the functions of a water management institution in terms of the Act.

Water quality	The physical, chemical, radiological, toxicological, biological and aesthetic properties of water that (1) determine its fitness for use, or (2) that are necessary for protecting the health of aquatic ecosystems. Water quality is therefore reflected in (a) concentrations of substances (either dissolved or suspended), (b) physico-chemical attributes (*e.g.* temperature), (c) levels of radioactivity, and (d) biological responses to those concentrations, physico-chemical attributes, or radioactivity.
Water quality management plans	Specification of management actions, responsibilities, resources and time frames to achieve the stated resource quality objectives.
Water quality standard	A rule establishing, for regulatory purposes, the limit of some unnatural alteration in water quality that is permitted or accepted as being compatible with some particular intended use or uses of water.
Water resource	Defined by the National Water Act as including a watercourse, surface water, estuary or aquifer.
Water use	According to the National Water Act (Act No. 36 of 1998) water uses include: taking water from a water resource and storing water; conducting activities that reduce stream flow; waste discharge and disposal; controlled activities (activities which could impact detrimentally on the water resource); altering the size or position of a water course; removing water found underground for certain purposes; and recreational use.
Water use licence	Enabling tool for existing or prospective water users to gain formal access to water for productive or beneficial purposes.
Watercourse	Defined by the National Water Act as a river or spring, a natural channel in which water flows regularly or intermittently, a wetland, lake or dam into which, or from which, water flows, and any collection of water that the Minister may declare to be a watercourse. Furthermore, reference to a watercourse includes, where relevant, its bed and banks.
Wetlands	Areas of land that are periodically or permanently waterlogged such as vleis, bogs, mires, dolomitic eyes and pans. Wetlands are usually distinguishable from terrestrial (dryland) areas by the characteristics of their soils and the water-dependent plants that grow there.

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REVIEWER'S REPORT ON THE SERIES OF DOCUMENTS (9 REPORTS PLUS 5 APPENDICES) REPRESENTING THE FINAL OUTPUTS OF THE:

RESOURCE DIRECTED MANAGEMENT OF WATER QUALITY – MANAGEMENT INSTRUMENTS

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INTRODUCTION AND BACKGROUND

This Reviewer's Report provides an overview of the impressions gained during the review of this series of 14 documents (listed in **Appendix A** to this Reviewer's Report), in response to the request from Ms Hanlie Hattingh, the Project Manager for this assignment. The Project Reviewer's brief was to evaluate the documents in terms of their logical flow of information, technical approach, consistency and scientific soundness, as well as the use of language and readability. These documents have been prepared on behalf of the Department of Water Affairs and Forestry, and Ms Hattingh specifically requested that attention should be focussed on the technical content of the document, with particular attention paid to possible information gaps and inconsistencies.

Since these documents are technical manuals, it is also important to ensure that the rationale, explanations and recommended approaches are presented unambiguously, and are supported by clear cross-references to appropriate sources of information. Specific comments and suggestions have been indicated in the text of the reports, where the particular wording and/or minor grammatical issues need to be adjusted to enhance clarity and eliminate possible misunderstandings.

Each of the documents has been scrutinized against the above criteria and has been 'scored' on a matrix template; the scores for each document are shown in **Appendix B**. Changes, corrections and suggestions have been inserted into each document using the "track changes" facility in MSWord. Electronic versions of the annotated documents (containing these "track changes") have been transferred electronically to Ms Hattingh, to enable her to evaluate the suggested changes and finalize the items that have been queried as soon as possible. Ms Hattingh will arrange for the authors of the various documents to provide any missing information / details that have been called for in this review.

GENERAL COMMENTS

The set of documents is attractively and appropriately structured, suitable for their intended purpose as internal and external sources of information regarding water quality management. The layout of individual documents is somewhat variable; for example, some documents include an attractive photographic illustration at the start of each chapter while others do not; the style of diagrams is also very variable across the set of documents. This lack of consistency is a relatively minor issue but improved consistency would enhance the overall impression. Within documents, the choice of the information mapping approach is most appropriate as this lends itself to the type of document produced.

In most documents, the rationale, evidence and arguments within each section are clearly and sensibly presented. Proper support is provided for the conclusions that are drawn and the recommendations made in each document. The writing style is somewhat variable – no doubt due to the number of different authors – and the same comment is true for the style used to list reference materials. More consistency and attention to detail is needed here.

On the whole, the writing style is clear, precise and easy to understand – this is a most refreshing change from many other policy documents and technical manuals, where a far more long-winded style results in documents that are difficult to read and comprehend. The different documents contain very different numbers of errors or items of language, grammar and punctuation that need to be corrected. All of these have been marked using "track changes". Most of the errors that I did note were relatively minor in nature, though several were ambiguous statements and posed the distinct possibility that non-technical readers could misinterpret the recommendations in some sections. I have indicated appropriate suggestions at each of these points to eliminate ambiguities and thereby minimize the potential risk that readers may misinterpret the information contained in the document. This does not mean that the comments in the text should be interpreted as being purely 'cosmetic' – far from it. They offer the opportunity to improve a product that is already of high quality.

However, the "Institutional Arrangements" document provides the single exception to the very positive comments that I have listed above. This particular document is in marked contrast to the others – particularly in terms of the way that it includes very few useful technical definitions, lacks appropriate cross-references to other documents in the set, is written in a rather loose and vague style that conveys somewhat ambiguous messages to the reader, contains unfortunate diagrams that have an unusual mix of colours and which are almost illegible in printed form, and provides no insight into some of the central problems of creating appropriate technical capacity (and institutions of practice) in water quality. Sections of this document should either be re-written or the document should be omitted from the set of documents.

Overall, I offer my sincere congratulations to the team of authors, and to the Project Manager, for the way in which they have written and compiled this excellent set of documents. I anticipate that these documents will provide a solid 'benchmark' for future technical documents, in terms of their easily readable technical content, clarity of explanation and presentation, and high production quality.

COMMENTS ON DOCUMENT STRUCTURE

Each document needs to include a short executive summary (of no more than a single page) – this should be written in a way that enables the recommendations to be "executable" by decision-makers.

Each document contains a list of participants, a detailed table of contents, a list of abbreviations used, a glossary containing clear explanations for the key technical terms and concepts that have been used in the report, and is then followed by text chapters. These text chapters are then followed by a list of important references that were consulted or referred to in the text. The ordering sequence of the material within each of the documents follows a logical sequence and each successive text chapter in each document builds upon the foundations created and presented in earlier chapters.

Those documents that contain simple flow-diagrams that are used to illustrate the sequence of events at particular points in the document provide very useful visual signals for readers. These diagrams are clear and unambiguous, and add considerable value to the document.

The structure and layout of the documents is entirely appropriate for their intended purpose.

POSSIBLE FUTURE OPTIONS

This set of documents represents the culmination of considerable technical activity and detailed consultations with key stakeholders, carried out over a prolonged period of time. The technical content of the documents provides an extremely useful basis for a dramatic change in the way that water quality management issues are to be addressed in South Africa. The information presented provides clear and unambiguous details of the various roles and responsibilities from national to local (CMA) levels and how these will be incorporated into the overall (national-scale) efforts to manage water quality. The different role-players that are likely to be involved in these activities now need to examine the final version of the documents and reach consensus on how best to proceed. Clearly, a decision to adopt the recommendations and procedures described in these documents will have important implications in terms of funding, staffing and equipment. In essence, the set of documents provide a scientifically sound and pragmatic approach to the complex and complicated procedures that comprise water quality management. This should enable the Department of Water Affairs and Forestry to meet its mandate in terms of the National Water Act and many other international agreements signed by South Africa.

SPECIFIC RECOMMENDATIONS

Arising from my review of the NTMP document, I make the following **six** specific recommendations for consideration by the Department of Water Affairs and Forestry.

1. The final revised versions of 13 out of the 14 RDMWQ documents should be accepted by the Department of Water Affairs and Forestry as having achieved the objectives that were originally set for this complex and comprehensive assignment.
2. Here, it is important to single out the one document on "Institutional Arrangements". In its present form, this document is well below the standard set by the other documents and, because of its loose / vague writing style, does not match the high-quality information provided by the other documents in this series. **However, recognizing that institutional arrangements are critically important in all aspects of water resource (and water quality) management, it will be extremely important for the Department of Water Affairs and Forestry to decide if this document is sufficiently important (to the RDMWQ series) that the deficiencies document should be remedied. If this is not the case then this document should be removed from the series**.
3. The remaining 13 documents are well-matched in the level and comprehensiveness of the information that they contain. These documents provide an easy-to-read and soundly scientific basis for the management of water quality, it is recommended that the Department of Water Affairs and Forestry consolidate the production and distribution of the complete set of documents to all Departmental staff that are engaged in or linked to the management of water quality in South Africa.
4. The Department of Water Affairs and Forestry should consider using the final versions of these 13 documents as the basis for a carefully structured training programme aimed at improving the levels of awareness and skills in all existing staff that are engaged in water quality management issues.
5. The 13 "Acceptable" documents also provide a very useful background and basis for "fast-tracking" the development of skills and understanding in any newly-appointed water quality management staff in the Department of Water Affairs and Forestry and within the emerging Catchment Management Agencies. These documents could also provide the necessary background material for other, more specialized, training in specific areas of concern – for example, the design and operation of water quality monitoring programmes.

6. The Department of Water Affairs and Forestry should announce the availability of these documents as soon as they have been printed. They represent a very valuable, informative and 'visible' set of assets arising from a comprehensive and inclusive process of stakeholder participation. As such, and particularly in the clear and unambiguous way that these documents deal with all policy-related issues, they provide an extremely useful 'model' that other reports should seek to emulate.

P.J. Ashton

21 August 2006

APPENDIX A

List of Specific RDMWQ Documents Reviewed.

Document No.	Document Title	Document Size (Pages)
1	**WQP 1.4** – Summary Policy	24
2	**WQP 1.4.2** - Policy	102
3	**WQP 1.5.1** – Strategy	86
4	**WQP 1.5.2** – Institutional Arrangements	37
5	**WQP 1.7.1** - Guideline for Catchment Visioning for the Resource Directed Management of Water Quality	66
6	**WQP 1.7.2** - Guideline for Determining Resource Quality Objectives (RWQO), Allocatable Water Quality and the Stress of the Water Resource	80
7	**WQP 1.7.2.1** - User's Guide: Resource Water Quality Objectives (RWQO) Model (Version 2.0), Edition 2	26
8	**WQP 1.7.3** – Guideline on Monitoring and Auditing for Resource Directed Management of Water Quality, Edition 1	71
9	**WQP 1.8 - I**ntroduction to the Resource Directed Management of Water Quality Series	20
10	**Appendix A**: Philosophy of Sustainable Development, Edition 1	19
11	**Appendix B**: Conceptual Review for Water Licence Application from a RDMWQ Perspective, Edition 1	54
12	**Appendix C**: Guidelines for Setting Licence Conditions for RDMWQ, Edition 1	21
13	**Appendix D**: ACWUA Decision-making Support System for RDWQM, Edition 1	13
14	**Appendix E**: Project Glossary, Edition 2	23
	Total number of pages:	**642**

APPENDIX B

Raw Review Scores for Each of the Fourteen Documents Reviewed - on a scale of 1 [Unacceptable] to 5 [Excellent].

Document No. (as per Appendix A)	Technical Content of Document					Presentation Style of Document				General Overall Impression	Total Score (A – I) (%)
	Completeness of Information (A)	Structure of Information (B)	Logical Flow (C)	Technical Definitions (D)	Cross-References (E)	General Layout (F)	Language & Punctuation (G)	Writing Style / Presentation (H)	Diagrams & Tables (I)		
1	5	5	5	5	5	5	4	5	5	Excellent	98
2	5	5	5	5	5	5	4	5	5	Excellent	98
3	5	5	5	5	5	5	4	4	5	Excellent	95
4	3	4	4	2	1	4	3	3	2	**Poor**	**58**
5	5	5	5	4	3	5	5	4	5	Excellent	91
6	5	5	4	4	4	5	4	4	5	Very Good	89
7	5	5	5	5	5	5	4	5	5	Excellent	98
8	5	5	5	5	5	5	4	5	5	Excellent	98
9	4	5	5	5	4	5	4	4	4	Very Good	89
10	5	5	5	5	5	5	4	5	5	Excellent	98
11	5	5	5	5	5	5	4	4	4	Excellent	93
12	5	5	5	5	5	5	4	5	5	Excellent	98
13	5	5	5	5	5	5	4	4	5	Excellent	95
14	5	5	5	5	5	5	4	4	5	Excellent	95

Note #1: "Track Changes" notes have been made in every document to assist the authors to revise their documents.