Water Quality
Management Series

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A Guideline to the Water Quality Management Component of a Catchment Management Strategy

Department of Water Affairs
and Forestry

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Water Quality Management Series

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A GUIDELINE TO THE WATER QUALITY MANAGEMENT COMPONENT OF A CATCHMENT MANAGEMENT STRATEGY

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PREFACE

Reform of South African water resource management has been a key focus of the Department of Water Affairs and Forestry (DWAF) for a number of years. This reform process has already seen a number of highlights, prime amongst which was the formulation of a new National Water Policy in 1997 and promulgation of a new water statute, the National Water Act (Act No. 36 of 1998). These developments established, *inter alia*, a formal process of integrated water resource management according to 19 water management areas (WMAs). At the national scale, this process of integrated management is now structured by a National Water Resource Strategy (NWRS), while evolving Catchment Management Strategies (CMS) provide an integrated management framework at the catchment scale.

Sound strategies for catchment management require relevant information about the *water-related* natural attributes, infrastructure developments, human and ecological needs, human impacts, issues and economic development in a catchment. The process of collating, processing and interpreting such information in a water-related context is now generally called a "catchment assessment study". Although various forms of catchment assessments (sometimes called "situation analyses" or "basin studies") have been common-place in South African water resource planning for some time, a number of divers approaches have been followed which have not necessarily been of comparable standard and consistency. Furthermore, the particular mix of information needs that statutory strategy development invokes, brings new challenges in the field of water resource decision support.

In such a new and evolving management environment, consistency and acceptable standards of both strategy development and supporting information might easily suffer. Therefore, a clear need has arisen for guiding procedures to support the processes and decisions involved. (It should also be noted that Section 10(1) of the National Water Act enables the establishment of such "guidelines" for the preparation of catchment management strategies.) DWAF has responded to this need by initiating processes to develop a range of guideline documents in the integrated water resource management and catchment management fields. This document is one of a trio of inter-related documents specifically aimed at the domain of *water quality management*:

A Conceptual Introduction to the Nature and Content of the Water Quality Management and Assessment Components of Catchment Management Strategies
A Guideline to the Water Quality Component of a Catchment Management Strategy
A Guide to Conduct Water Quality Catchment Assessment Studies.

The development of these documents was informed by interviews with knowledgeable professionals operating in the water resource management field, as well as by the proceedings and outcomes of two dedicated Technical Workshops. The development process was guided by a Steering Committee under the auspices of the Director: Water Quality Management of the Department and with the support of the Director: Catchment Management. A series of three Training Workshops, using an early draft of these documents, were also conducted with Regional Office staff in three different regions of the country. Valuable comments and insights, contributed by the Training Workshop participants, were incorporated in the documents.

Comments from those using these three documents in the future will assist their revision and ongoing improvement. The documents will also be used for continuing capacity building and training and for conceptual and technical support to the unfolding implementation of the National Water Act.

Approved on ……..……for the Department of Water Affairs and Forestry

JLJ van der Westhuizen
Director: Water Quality Management

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Sub-Series no.	Report title
MS 8.1	A Conceptual Introduction to the Nature and Content of the Water Quality Management and Assessment Components of Catchment Management Strategies
MS 8.2	**A Guideline to the Water Quality Management Component of a Catchment Management Strategy (this document)**
MS 8.3	A Guide to conduct Water Quality Catchment Assessment Studies: In support of the water quality management component of the catchment management strategy

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EXECUTIVE SUMMARY

Background

Reform of South African water resource management has been a key focus of the Department of Water Affairs and Forestry (DWAF) for a number of years. This reform process has already seen a number of highlights, prime amongst which was the formulation of a new National Water Policy in 1997 and promulgation of a new water statute, the National Water Act (Act No. 36 of 1998). These developments established, *inter alia*, a formal process of integrated water resource management according to 19 water management areas (WMAs). At the national scale, the process of integrated management is now structured by a National Water Resource Strategy (NWRS), while evolving Catchment Management Strategies (CMS) provide a management framework at the catchment scale. Resource directed measures (RDMs) comprising a water resource classification system, implementation of a "Reserve" and the setting of resource quality objectives (RQOs) underpin this framework. The "Reserve" is that quantity and quality of water required for basic human needs, as well as that quantity and quality required to sustain aquatic ecosystems. RQOs are time-related management goals reflecting a path leading to an agreed future state for the catchment, as specified by the water resources class.

Important components of these new approaches are the over-arching requirements to ensure sustainable use of water resources and the equitable use[1] of the resource for the "optimum social and economic benefit" of the country. Coupled with these is the need for a transparent and participative approach to water resources management and the redress of inequitable access to water resources caused by past policies.

These policy principles must underlie the approach to water resources management on a catchment basis. Catchment water quality management is a component of this process, and as such is subject to these policy principles.

Sound strategies for catchment management require relevant information about water-related conditions, issues and developments in a catchment. The process of collating, processing and interpreting such information is now generally called a "catchment assessment study". Although various forms of catchment assessments (sometimes called "situation analyses" or "basin studies") have been common-place in South African water resource planning for some time, a number of divers approaches have been followed which have not necessarily been of comparable standard. Furthermore, the particular mix of information needs that statutory strategy development invokes, brings new challenges in the field of water resource decision support.

In such a new and evolving management environment, consistency and acceptable standards of both strategy development and supporting information might easily suffer. Therefore, a clear need has arisen for guiding procedures to support the processes and decisions involved. (It should also be noted that Section 10(1) of the National Water Act enables the establishment of such "guidelines" for the preparation of catchment management strategies.) DWAF has responded to this need by initiating development of a number of guideline documents. This document is one of a trio of inter-related documents specifically aimed at the domain of water quality management:

- A Conceptual Introduction to the Nature and Content of the Water Quality Management and Assessment Components of Catchment Management Strategies

[1] Most importantly, "Use" as defined in the National Water Act includes *inter alia* the consumptive use of the resource, as well as use of the resource to carry waste.

- *A Guideline to the Water Quality Component of a Catchment Management Strategy (this document)*
- *A Guide to Conduct Water Quality Catchment Assessment Studies.*

Why Does this Document Address Only Water Quality?

Water resources management occurs within a highly integrated environment, where water quality, water quantity and the aquatic ecosystem are all interlinked and interdependent. This integration is achieved at a national level by the national water resource strategy (NWRS), and by catchment management strategies (CMS) at a catchment or water management area (WMA) level. These strategies pull together the water quality, water quantity and aquatic ecosystem components of the water resource into a coherent management approach that aims to secure the beneficial, equitable and sustainable use of the water resource.

However, while it is important to integrate the management of these components, the complexities of the water environment usually require that they be addressed by different parts of the same water management institution (for example the different directorates of DWAF). Pragmatism therefore dictates that water quality, water quantity and the aquatic ecosystem are also likely to be managed somewhat independently at a catchment level. It is nevertheless still important integrate these components in some way. This document provides guidelines and procedures for integrating the *water quality management component* into IWRM at a catchment level. However, the approaches developed are largely generic, and should be appropriate to the quantity components of IWRM.

Purpose of this *Guideline to the Water Quality Component of a Catchment Management Strategy*

This document is aimed at DWAF officials, catchment management agencies (CMAs) and water management institutions (or their consultants) who are engaged in the ongoing development and revision of a CMS, or in giving effect to the CMS. The document provides a framework and particular guidelines for integrating water quality management into catchment water resources management by addressing the following issues:

- Identifying the stakeholders' needs with respect to water quality
- Developing resource water quality objectives or targets for water quality management.
- Formulating source management objectives to realise these resource water quality objectives.
- Developing sector specific user plans to realise these source management objectives.
- Developing source specific licensing requirements or directives to realise these plans.
- Developing "in-resource" remediation plans to help realise resource water quality objectives.
- Outlining procedures for local actions to give effect to these plans.
- Outlining the procedures for auditing compliance to these plans.

The WQM component of the CMS

Water quality management takes place at a local level and therefore water quality management plans, decisions and actions are generally at a sub-catchment scale. However, these have implications for downstream users (and upstream impactors), which requires alignment between sub-catchments within a WMA (and possibly between WMAs).

Catchment water quality management must give effect to the requirements of the resource directed measures and the national water resources strategy. Together these establish the water quality, water quantity and aquatic ecosystem attributes that are required to ensure a

given level of protection for the resource, to meet basic human needs, and to meet the requirements of strategically important water users. The process of developing a CMS may also identify stakeholders' needs with respect to use of the water resource over and above these requirements.

In order to develop the water quality management component of a CMS, the following approach, in stages, is proposed in this Guideline:

(a) Establish resource water quality objectives for use of the resource to dispose of waste, based on the needs expressed by the stakeholders:
What are the goals for water quality management?

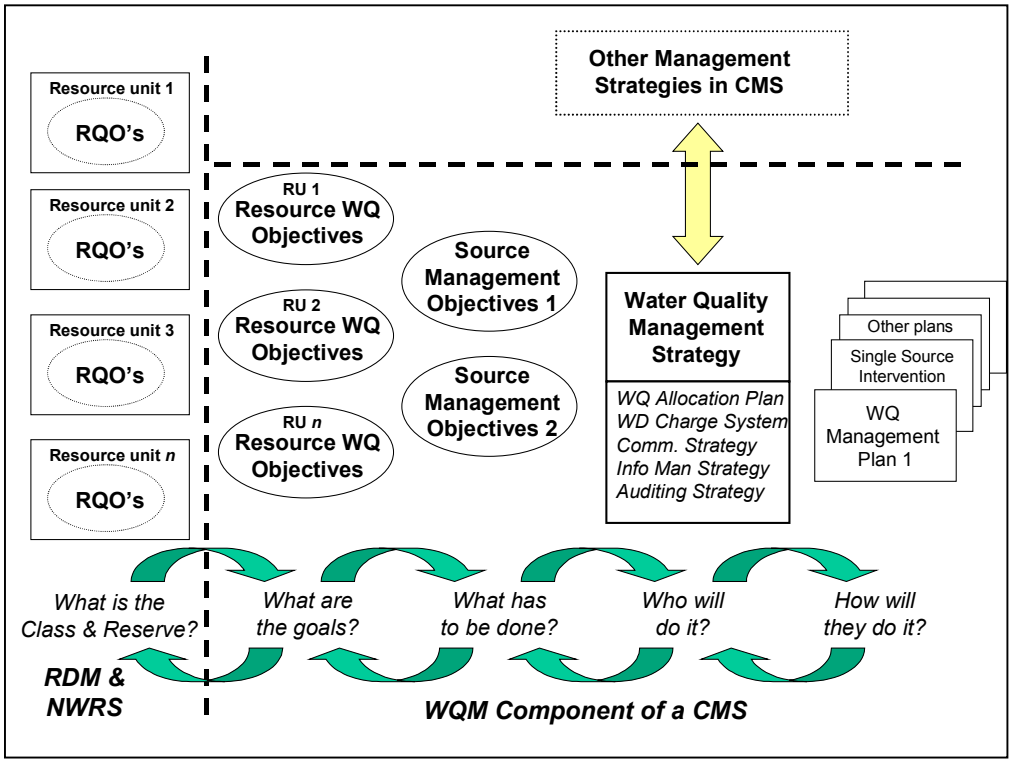
(b) Determine source management objectives to meet these needs:
What has to be done to achieve this?

(c) Formulate a water quality management strategy indicating the management requirements and responsibilities to achieve these objectives:
Who will do this?

(d) Develop individual stakeholder and sector specific plans to give effect to this framework:
How will they do it?

Together, these make up the water quality management component of the CMS. As such, they will be revised and updated on 5-yearly basis to accommodate the ongoing development of the catchment, and are aimed at securing a gradual and phased realisation of the stakeholders' requirements for the water resource and the public trust responsibility of DWAF.

The conceptual diagram presented below shows how these four stages allow for the gradual realisation of the stakeholders' goals for the catchment by harnessing the collective resources available at a local level.



The four stages result in the following types of output, the details of which are provided in the Guideline:

What are the goals for water quality management?

- *Resource Water Quality Objectives* reflect stakeholders' needs with respect to use of the water resources of the catchment. They include the objectives outlined in the NWRS and by RDM, but express stakeholders' needs over and above those outlined by these processes. These objectives outline stakeholders' needs with respect to water quality, as well as their needs with respect to the disposal of waste to the resource. The process of determining these objectives is a consultative, consensus-seeking process, which may be incorporated into the process of developing RQOs, where the classification and CMS processes are aligned.

What has to be done to achieve this?

- *Source Management Objectives* provide the focus for the actions required to give effect to the *resource water quality objectives*. As such, they outline the changes in pollution loads required to meet the immediate (5-year) resource water quality objectives. Source management objectives are not source type or sector specific, but outline pollution load targets on a catchment or sub-catchment basis. This is primarily a technical process, which iterates with the determination of the *resource water quality objectives*, and with the *water quality management strategy*.

Who will do this?

- The *Water Quality Management Strategy* outlines the framework for water quality management in a WMA, and as such represents the heart of the water quality management component of the CMS. It should specify the strategic approaches and plans for water quality management, the linkages to the other non-water quality management components of the CMS, and should specify the responsibility for formulating and implementing management required to meet the *resource water quality objectives*. As such, the *water quality management strategy* outlines who will be responsible and the requirements for achieving the *source management objectives*.

How will they do it?

- A *Water Quality Management Plan* specifies the management actions, responsibilities, resources and timeframes to mitigate or remediate the existing or future water quality impacts associated with priority sector-sources within a particular catchment area, in order to give effect to the load allocation specified in the *water quality management strategy*. A plan may be sector- or issue-oriented, and may include statutory and/or non-statutory approaches that are more stringent than the general requirements for these sources.
- *Single source interventions* indicate the requirements (actions, resources and timeframes) for mitigating or remediating the water quality impacts from a single source, under a water use authorisation, a cooperative agreement or a directive under the NWA. They will generally be applied to specific concerns that have a significant impact on the water quality of a water resource, and may be linked to a *water quality management plan*.

These four stages provide a logical sequence to move from the objectives for water resources management throughout a WMA to the actions required at a local level to achieve these objectives. The first three steps provide the basis for the WMA scale water quality management component of the CMS, while the last step provides the basis for the local catchment scale components of the CMA.

Layout of the Guideline

The layout of the Guideline is identical for each of the above stages and is structured according to following components:

- A detailed description of the stage.
- What steps must be taken to undertake the stage?
- What special considerations apply?
- What catchment assessment study support may be required?
- Who should be involved in undertaking the stage?

The Guideline closes with a conceptual template for the water quality component of a catchment management strategy, representing the combination of all the individual elements described in the document.

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Acronyms

CMA	- catchment management agency
CMS	- catchment management strategy
DWAF	- Department of Water Affairs and Forestry
DWAF HO	- DWAF: Head Office
DWAF RO	- DWAF: Regional Office
IWRM	- integrated water resources management
NWA	- National Water Act (Act No 36 of 1998)
NWRS	- national water resources strategy
RDM	- resource directed measures
RQO	- resource quality objectives
WMA	- water management area
WMI	- water management institution
WSI	- water services institution
WRM	- water resources management
WSA	- water services authority
WSP	- water services provider
WUA	- water user association

1 INTRODUCTION

1.1 Background to this Guideline

This guideline is the second in a series of three documents aimed at supporting the studies for the assessment of catchment water quality, and thereby the formulation of the water quality component of the catchment management strategy. The first document in the series *A Conceptual Introduction to the Nature and Content of the Water Quality Management and Assessment Components of a Catchment Management Strategy*, provides the philosophical background to this document and highlights the linkage with the assessment studies.

1.2 Why are we addressing only water quality in this document?

Water resources management occurs within a highly integrated environment, where water quality, water quantity and the aquatic ecosystem are all interlinked and interdependent (hence the definition of "Resource Quality" above). The National Water Act (NWA) makes provision for this by promoting *integrated* water resources management (IWRM). This is done both at a national level by the national water resource strategy (NWRS), and by catchment management strategies (CMS) at a catchment or water management area (WMA) level. These strategies pull together the water quality, water quantity and aquatic ecosystem components of the water resource into a coherent management approach that aims to secure the beneficial, equitable and sustainable use of the water resource.

However, while it is important to integrate the management of these components, the complexities of the water environment usually demand that they be addressed by different parts of the same water management institution (for example the different directorates of DWAF). Reality therefore dictates that water quality, water quantity and the aquatic ecosystem are also likely to be managed somewhat independently at a catchment level. It is nevertheless still important to integrate these components in some way. This document provides guidelines and procedures for integrating the *water quality management component* into IWRM at a catchment level. However, the approaches developed are largely generic, and should be appropriate to the quantity components of IWRM.

1.3 Purpose of this document

This document is aimed at catchment management agencies (CMAs) and water management institutions (or their consultants) who are engaged in the ongoing development and revision of a CMS, or in giving effect to the CMS. The document provides guidelines for integrating water quality management into catchment water resources management by addressing the following issues:

- Identifying the stakeholders needs with respect to water quality
- Developing resource water quality objectives or targets for water quality management.
- Formulating source management objectives to realise these resource water quality objectives.
- Developing sector specific user plans to realise these source management objectives.
- Developing source specific licensing requirements or directives to realise these plans.
- Developing “in resource” remediation plans to help realise catchment water quality objectives.
- Outlining procedures for local actions to give effect to these plans.
- Outlining the procedures for auditing compliance to these plans.

1.4 Way Forward

This guideline is a first edition that has been developed in the absence of a comprehensive catchment management strategy process being conducted. Furthermore, it only represents the water quality component of the CMS.

The guideline, together with the supporting assessment guide, will be tested in a pilot application within the next year, upon which it will be revised according to the lessons learned.

However, for completeness, a similar guideline should be formulated for the quantity and habitat components of the CMS, so that the various elements of resource quality may be addressed together in the interest of IWRM.

2 A FRAMEWORK FOR CATCHMENT WATER QUALITY MANAGEMENT

This Chapter develops a generic framework for developing the Water Quality Component of a Catchment Management Strategy within the constraints outlined in the previous Chapter. This framework provides the basis for the rest of the document, and as such the Chapter also outlines the Roadmap for the document.

2.1 Why develop a common framework for catchment management?

The NWA is not only based on securing the beneficial, equitable and sustainable use of the resource, but also on the need to ensure stakeholder participation in this process. The NWA therefore devolves management of the resource to a catchment level *via* CMAs. These agencies must include stakeholders in both the ongoing development of the CMS, and in giving effect to the strategy. The reason for this is simple - local communities or water user sectors are more likely to be able to identify their needs with respect to use of the resource, and to ensure local actions to realise these requirements. Furthermore, the NWA specifically requires public consultation for the development of strategies and the application thereof.

However, water flows over long distances within the catchment, and may even be transferred from one catchment to another. Local use of the water resource therefore affects users across the whole catchment, and potentially in neighbouring catchments. This makes it difficult to realise the benefits of local management of the water resource without a common framework within which to balance local actions with their catchment wide implications. The framework following below is proposed as a means for reconciling the often-diverging needs of water users within a common goal for the water resources of the catchment.

2.2 How big is a catchment?

A catchment may be any size, from a few square kilometers, to something like the Orange-Vaal River catchment, which dominates the larger portion of South Africa. Catchment Management may occur at any of these scales, from small groups aiming to protect a short stretch of river, to the national or even international goals of the NWRS. Economies of scale, nevertheless, dictate that Catchment Management Agencies, which must be economically viable, operate at least at the WMA level.

However, given the obvious lack of human resources, and the requirements for participative management in the NWA, the CMS cannot ignore catchment management efforts that occur at a smaller scale. Be this as it may, management efforts that occur at smaller scales must be compatible with the overall objectives of the CMS. The framework outlined below, and the rest of this document, therefore outlines how water quality management efforts that occur at different scales may be integrated into the formulation of the water quality component of the CMS.

2.3 The framework for catchment water quality management

Catchment water quality management must be informed by the requirements of the Water Resource Class, the Reserve, and the NWRS. Together these establish the water quality, water quantity and aquatic ecosystem attributes that are required to ensure a given level of protection for the resource, to meet basic human needs, and to meet the requirements of strategically important water users. The framework proposed below is based on identifying

the stakeholders' needs with respect to use of the water resource over and above these requirements. This is attained by:

a. Establish resource water quality objectives for use of the resource to dispose of waste, based on the needs expressed by the stakeholders:
What are the goals for water quality management?

b. Determine source management objectives to meet these needs:
What has to be done to achieve this?

c. Formulate a water quality management strategy indicating the management requirements and responsibilities to achieve these objectives:
Who will do this?

d. Develop individual stakeholder and sector specific plans to give effect to this framework:
How will they do it?

Together, these make up the framework for the water quality management component of the CMS. As such, they will be revised and updated on a 5 yearly basis to accommodate the ongoing development of the catchment, and are aimed at securing a gradual and phased realisation of the stakeholders' goals for the water resource. These four steps may occur at any scale, and the results could be fed into the formulation of the wider CMS. In these cases the CMS would have to ensure the compatibility of these processes with upstream and downstream processes and approaches. How this could be done is outlined in the following chapters.

Figure 1 shows conceptually how these four steps allow for the gradual realisation of the stakeholders' goals for the catchment by harnessing the collective resources available at a local level.

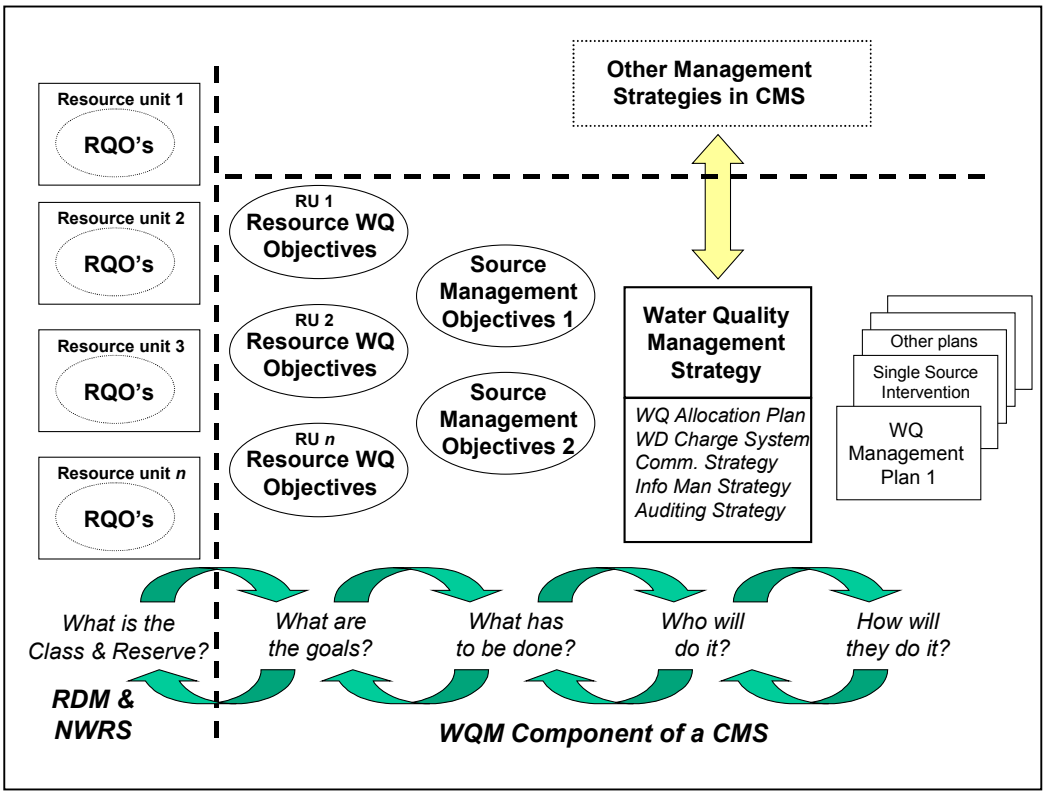


Figure 1. Outline of the WQM component of the CMS

2.4 A roadmap to this report

Chapters 3 to 7 provide detailed procedures and guidelines to formulate the water quality management component of a CMS within the framework outlined above. Chapter 8 then outlines a template for the water quality management component of the CMS, based on the individual elements outlined in the previous chapters. This procedure is captured in the "roadmap" in Figure 2, which also highlights the inputs required for, and outputs of, the process. This roadmap therefore also serves as a quick reference guide for the procedure outlined in this report.

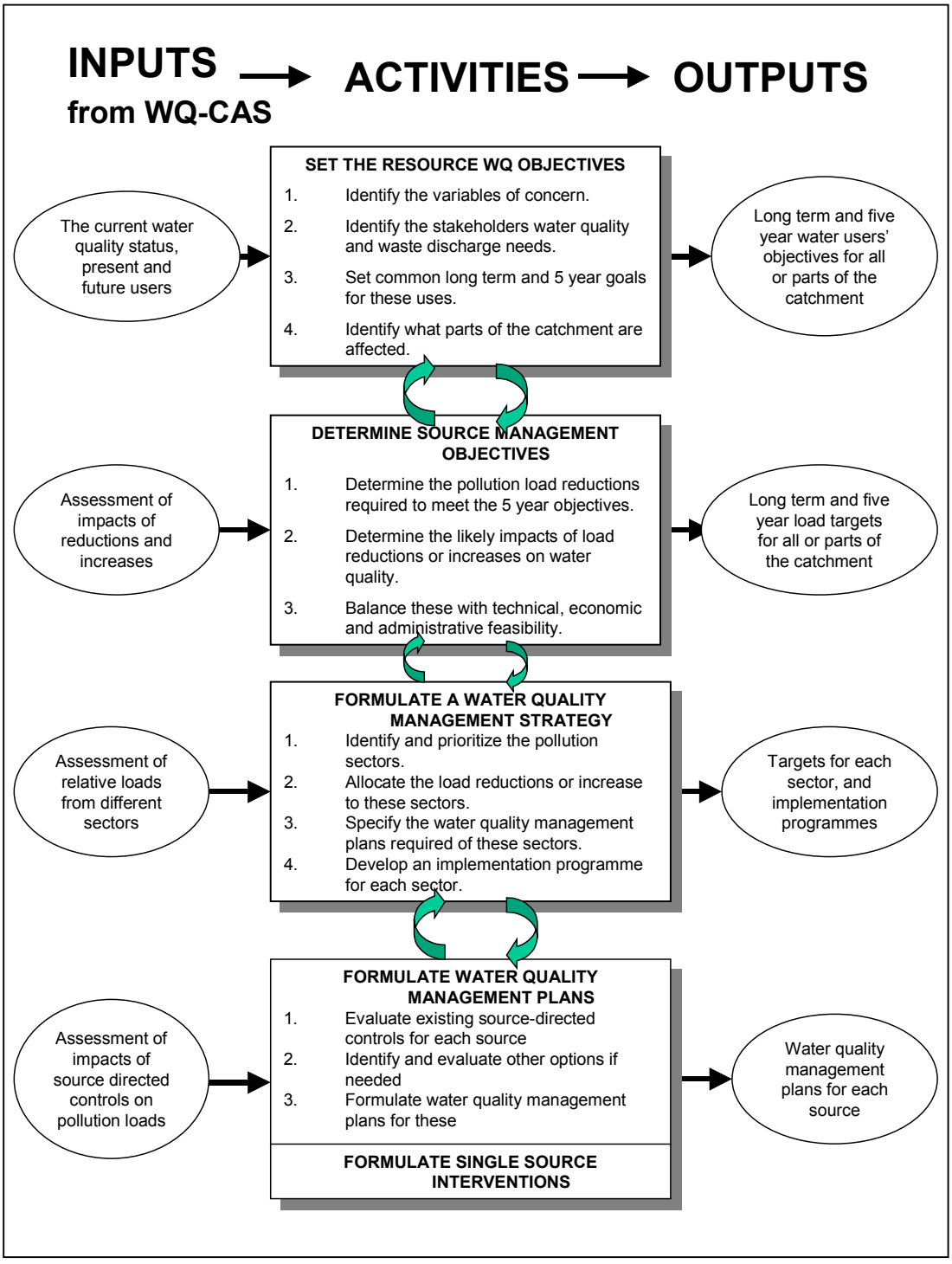


Figure 2. Roadmap to the Document

3 HOW TO DEVELOP RESOURCE WATER QUALITY OBJECTIVES

Resource water quality objectives reflect stakeholders' needs with respect to use of the water resources of the catchment. They include the objectives outlined in the national water resources strategy (NWRS) and by resource directed measures (RDM), but express stakeholders' needs over and above those outlined by these processes.
The *resource water quality objectives* both outline stakeholders' needs with respect to water quality, as well as their needs with respect to the disposal of waste to the resource. The process of determining resource water quality objectives is a consultative, consensus-seeking process.

3.1 Why develop resource water quality objectives?

Catchment water quality management is a highly complex task. The water quality, water quantity and aquatic ecosystem components of the resource are all interdependent and linked by a complex set of biological, physical and chemical interactions. Water quality changes continuously as effluent is added to the river, which is then further modified as the river flows downstream. Water quality may also be affected by abstractions, which rob the river of dilution water. Rivers may be impounded which then realises a whole new set of biological, physical and chemical interactions, or may occur underground and may be subjected to a different set of physical and chemical interactions.

However, catchment management must give expression to the constitutional obligations for subsidiarity. This is realised where local needs are identified, and where local action achieves these goals. Recommendations from the Rio-Copenhagen-Dublin-Onandagou process and Agenda 21 therefore place special obligations on signatory countries (which includes South Africa) to devolve water resources management to the lowest practicable level. The NWA requires that stakeholders be involved in water resources management process. However, water (particularly in South Africa) flows from one area to another over long distances, and may even be transferred from one catchment to another. Local water resources management, and stakeholders' needs, may therefore impact on users far removed from the immediate problems.

The complexities of Catchment Management, as well as the apparent paradox of subsidiarity of IWRM within large WMAs, demand that the development of the water quality component of a CMS is largely a technical process. This process must, nevertheless, be rooted in stakeholder participation, such that the technical process serve the needs of the stakeholders and in a manner which allows them to meaningfully contribute to the process. The need to devolve decision making to lower levels also means that stakeholders must identify their needs for use of the water resource, and must as far as possible implement local or sector-specific actions to realise these needs. The stakeholders' water quality needs, and their needs to use the resource to dispose of waste, must therefore be translated into technically and economically feasible resource water quality objectives, which can then direct the technical process. In addition, clearly defined and negotiated common resource water quality objectives promote local action to realise catchment wide needs.

The formulation of resource water quality objectives for water quality management therefore provides:-

- The opportunity for stakeholders to express their needs with respect to the quality of the water they abstract for use.
- The opportunity for stakeholders to outline their needs to use the resource to dispose of waste (both in terms of point and non-point sources).
- A focus for the technical process of formulating the water quality component of the CMS.

- A common, feasible and balanced approach to water quality management in the catchment.
- A framework within which local actions can contribute to a common goal.

3.2 What are the roles of resource directed measures and the NWRS?

The development of the water quality component of the CMS must give effect to the NWRS and to the resource directed measures. Together these two processes establish baseline resource objectives for each catchment or water resource, and as such place limitations on the formulation of resource water quality objectives, or may serve as a point of departure for these objectives. The implications of this are highlighted in this section.

The NWRS outlines the strategic objectives with respect to water resource management in the nineteen WMAs. As such it will estimate present and future water requirements in each WMA, will make provision for the transfer of water from water-rich catchments to water-poor catchments, and will provide broad-brush assessments of the water quality issues in each WMA. Nationally strategic water users (for example power generation) may be allocated priority use by the NWRS. Similarly, certain international water quality and quantity obligations with respect to rivers that cross our borders will be spelt out in the NWRS. Resource water quality objectives can not impinge on these strategic or international obligations.

Resource directed measures (RDM) are aimed at securing different levels of protection *via* a water resources classification system. This outlines those characteristics that are required for different resource classes, as well as the source directed controls appropriate to the Class. These characteristics are expressed as *resource quality objectives* (RQOs), which include water quality and quantity requirements, as well as characteristics for the aquatic ecosystem. The RDM also make provision for the determination of a *Reserve* for water resources. This Reserve represents that quality and quantity of water required to ensure the sustainability of aquatic ecosystems, and to meet basic human needs. It is the only water use by right, and must be given effect through the CMS. Resource water quality objectives, therefore, cannot impinge on the RQO and Reserve.

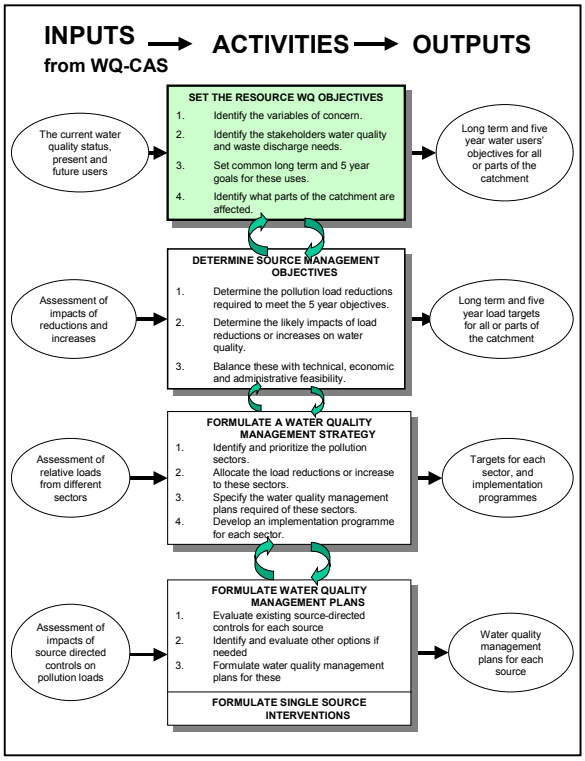
However, while stakeholder participation is required for the classification process, there is a risk to classifying the water resource outside of the catchment management process. This risk is realised where stakeholders may not be aware of the implications of classifying the resource on both downstream and upstream users without a catchment perspective. This may result in unrealistic RQOs that can not feasibly be met by the catchment management process. As such it is highly recommended that resource classification is conducted in parallel with the determination of the resource water quality objectives.

> **Note:** The National Water Resources Classification System is still under development, and will still be subjected to a stakeholder review process. There is consequently still some uncertainly as to the exact nature of the Classification system. This section has therefore been based on the statutory requirements of this system as outlined in the National Water Act.

3.3 What are resource water quality objectives?

Resource water quality objectives reflect the stakeholders' needs with respect to the water quality of the catchment over and above those outlined in the NWRS and by the RDM, but include stakeholders' needs with respect to the disposal of waste to the resource. Together

these form the goals for water quality management in the catchment, and will be one of the key components of the CMS.



However, as a wide range of substances can impact on the quality of the water, resource water quality objectives must focus on the priority water quality issues in the catchment. Similarly, resource water quality objectives may not be applicable to the whole of the water management area, but could refer to a specific point (e.g. an irrigation water abstraction point), or a sub-catchment area (e.g. the catchment of an impoundment). The overall resource water quality objectives for the WMA could therefore include a range of water quality issues, and may for example focus on eutrophication related issues in one area, and on salinity in another. Similarly, resource water quality objectives may be expressed by given interest groups, for example to restore the natural riparian vegetation along a given river reach within a 15 year period.

Resource water quality objectives will become part of the CMS, and will consequently be reaffirmed, reviewed or updated on a 5 yearly basis.

Resource water quality objectives have several possible components;

- A narrative description of the required water quality. *For example:- The water must be suitable for a lifetime of irrigation of all vegetable crops without yield loss.*
- A description of the point or area where these will apply. *For example:- At the Brits Irrigation Board abstraction point.*
- A maximum allowable concentration, or a range of concentrations, or a statistical expression of the concentration. *For example:- The 90%tile for electrical conductivity must be less than 40 mS/m.*
- A description of the goal for the next 5 years. *For example:- In 5 years' time the 90%tile must be below 50mS/m.*
- A description of the current water quality status. *For example, currently the 90%tile is 60mS/m*.
- A narrative description of the point or non-point source need to dispose of waste for this sector. *For example:- Saline irrigation return flow may return the irrigated salts in 10% of the water.*

(The *Guide to Conduct Catchment Assessments with a Water Quality Management Focus,* outlines some of the tools that could be used to express these objectives in a meaningful way. The SA Water Quality Guidelines provide the narrative descriptions of water quality associated with different concentration ranges for a wide range of substances.)

3.4 Including scale issues in the formulation of resource water quality objectives

As outlined in the previous chapter, catchment management actions may occur at any scale. More importantly, catchment management is not new to South Africa, and since the initiation of the Water Law Review in 1994 a number of catchment forums have been initiated. These initiatives typically reflect the stakeholders local needs with respect to the use of the water resource, and in many cases these local bodies have already formulated some "objectives" for their part of the catchment. It is therefore important that the process of formulating resource water quality objectives recognises these initiatives and contributes or builds onto these processes.

However, it is equally important that these objectives be integrated into the wider catchment perspective. In this respect, the focus of the catchment forum or stakeholder group can be important. For example, the objectives established by environmental interest groups for the protection of the riparian zone may be localised, and will not affect downstream or upstream users. But, irrigation interest groups are significantly affected by upstream users, and in turn impact on the downstream use of the resource. In general terms, objectives for conservative substances are likely to have wider implications, while those for non-conservatives may be more localised.

3.5 How do you develop resource water quality objectives?

Resource water quality objectives are based on the stakeholders' water quality requirements, and their needs to dispose of waste in water. However, many of these needs may be incompatible, or may not be technically or economically feasible within the catchment context. The establishment of resource water quality objectives is therefore an iterative process of assessing the implications of the objectives on other water users, and revising the objectives according to these implications. The formulation and refinement of resource water quality objectives is consequently both a stakeholder driven and technical process.

The following steps form part of the process of establishing the resource water quality objectives:-

Step 1: *Determine the water quality variables and areas of concern. (A technical process)*

As it is impractical to determine resource water quality objectives for every water quality variable, the water quality variables of concern must be identified. This can be done by comparing the water quality data that are available to the SA Water Quality Guidelines. Additional variables of concern may be identified from the land use data. GIS systems provide the ideal tool for this form of assessment, as they not only identify potential water quality problems, but also the parts of the catchment where these occur. The following steps are based on determining resource water quality objectives for these variables of concern.

Step 2: *Assist the stakeholders and water user sectors to identify their water quality requirements, and the requirements for the use of the water to dispose of waste. (a stakeholder-driven process)*

Stakeholders or water user sectors must express their water quality requirements in terms of the impact of water quality on their livelihoods. This process will have to be assisted by providing a description of the current water quality status of the resource, and the potential for improved water quality. The SA Water Quality Guidelines and the *Guide to Conduct Water Quality Catchment Assessment Studies* provide a basis for this process. This is likely to result in an idealistic vision of the desired water quality, which would have to be balanced with the concomitant impacts of the land use on water quality. (Almost all water use activities will generate either point or non-point source pollution, i.e. can one expect ideal water

quality, when one's activity contributes to the deterioration in water quality?). This, therefore, leads to both the identification of the need to use the water resource to dispose of waste (or of the non-point source problem), and to the formulation of more realistic water quality requirements.

Step 3: *Compare these water quality requirements with the present water quality status. (A technical process)*

This process can have three potential results;

a) The water quality is significantly better than that required by the stakeholders (i.e. an "unstressed" situation). In this case, the water quality requirements can be adopted as resource water quality objectives.
b) The water quality is close to that required by the stakeholders (i.e. a "threatened" situation). In this case, the need for development in the catchment (and hence the increased use of the resource) would have to be balanced with the expected impacts on water quality. It may be necessary to either revise the water quality requirements, or the need to discharge waste in these cases. (This does not imply no further development, but simply that new developments would mean more stringent standards to maintain total loads).
c) The water quality is worse than that required by the stakeholders (i.e a "stressed" situation). In this case, an iterative process of assessing the implications of these requirements on other stakeholders would have to be initiated.

Step 4: *Iterate between the stakeholders' requirements and the implications for other users. (a facilitated process, driven by stakeholders and technical staff)*

In a threatened or stressed situation it will become necessary to balance the conflicting demands for use of the water resource. This is an iterative process driven by the need to ensure the beneficial, equitable and sustainable use of the water resource. It serves to balance the water quality needs of the users, with the use of the water resource to carry waste. As outlined above, this may be done on a localised basis for water quality variables which are rapidly assimilated (e.g. microbiological contamination), or on a sub-catchment basis for variables with regional impacts (e.g. nutrient contamination). Conservative water quality variables (e.g. salts) may require the iteration to be done on a catchment wide basis, and may have to consider the implications of importing salts *via* inter-basin transfers.

This process is a facilitated dialogue that specifically aims to bring conflicting demands (or requirements) for use of the resource to the table. It is informed by the technical process, and aims to highlight different stakeholders' standpoints. This builds a greater understanding of the integrated nature of the water resource among stakeholders, and may result in the formulation of more realistic and balanced requirements. This may result in either a revision of the water quality requirements, or the re-assessment of the use of the water resource to dispose of waste.

Step 5: *Determine the resource water quality objectives and get stakeholders' comments (a technical process)*

Steps 1 to 3 are aimed at determining *realistic* requirements for each of the stakeholders or water user sectors. This step aims at collating these into a set of *economically and technically feasible* resource water quality objectives. These resource water quality objectives need not represent the immediate, or even 5 year, goals of the CMS, but could represent medium to long term (10-15 year) goals for catchment water quality management i.e. the Resource water quality objectives are the vision for the resource. Stakeholders in the catchment must be given the opportunity to comment on these before they are finalised.

This step may be supported by water quality assessments that predict the implications of future developments and water quality management actions on catchment water quality. (It should nevertheless be remembered that this form of modelling is resource intensive and is not always necessary). Once finalised, the resource water quality objectives determine the status of the sub-catchments, or different parts of the resource. As in step 3, these may result in unstressed sub-catchments or resources, threatened sub-catchments and resources, and stressed sub-catchments and resources.

Step 6:- *Determine the immediate (5 year) resource water quality objective*

While Step 4 outlines longer-term objectives for a catchment, the CMS is based on a 5-year timeframe. It is therefore necessary to determine immediate (or 5 year) resource water quality objectives for the CMS. These should aim to realise the gradual and phased realisation of the resource water quality objectives. The steps in this process are determined by status of the resource. Immediate resource water quality objectives for unstressed resources may be based on development scenarios for the catchments. In threatened resources, immediate objectives may be aimed at maintaining the current state of the resource, while in stressed catchments immediate objectives would outline the first step in improving the water quality. The size of this step is determined by the pollution sources, and their potential for management i.e. how easy is it to manage the sources.

3.6 What do you need to consider?

The formulation of viable resource water quality objectives is perhaps one of the most important steps in the catchment water quality management process. Resource water quality objectives that have the support of the stakeholders will secure their participation in the ongoing process. It also sets the goals that drive the technical process of formulating source management objectives, the use allocation strategies, and the sector-specific plans. It is therefore critical to ensure that this process produces viable goals that stakeholders can identify with.

The following general considerations are, therefore, offered to further guide the process:-

- This process focuses on stakeholders requirements over and above those expressed by the RDM and NWRS. These already secure sustainable and strategic use of the resource. This process must therefore focus on securing the beneficial and equitable use of the resource on a catchment basis.

- This process has the potential to formulate "pie-in-the-sky" objectives. In this regard, it is important to test the objectives against beneficial and equitable use, and the economic implications on the catchment as a whole.

- The objectives should initially concentrate on the water quality issues, and on the stressed resources. Catchment management is a progressive and phased process, and there will be opportunities to revise, update and expand the resource water quality objectives.

- While the process of determining the resource water quality objectives includes stakeholders, it need not be consensus driven, but should strive to determine a common objective wherever possible. Ultimately, the water resource managers (DWAF or the CMA) formulate these objectives based on stakeholders' input, and bear the ultimate responsibility for meeting these objectives.

3.7 What assessment support do you need?

The formulation of the resource water quality objectives is largely based on the catchment water quality situation assessment, and on an assessment of the major point and non-point sources of pollution in the catchment. However, there will be some degree of iteration between these assessments and the formulation of the resource water quality objectives. For example, initial water quality assessments would be based on the SA Water Quality Guidelines, but the water quality assessments must be based on the resource water quality objectives once these have been established.

Similarly, initial assessments of the sources of pollution would be broad-brush assessments of all potential sources, but once the resource water quality objectives have been established, pollution source assessments would be based on the critical pollution sources. Water quality assessments and pollution source assessments should therefore run in parallel with the process of formulating the resource water quality objectives. These assessments therefore provide the ongoing support to stakeholders in this process.

3.8 Who should be involved?

The first consideration with respect to stakeholder participation in this process is that all stakeholders are afforded the opportunity to comment on the resource water quality objectives once notice of the CMS has been published in the Gazette. However, it is impractical to involve all stakeholders in the formulation of these resource water quality objectives. Stakeholder involvement should, therefore, be based on the regional extent of the water quality problem, and should include both the impactors and the stakeholders affected by the impacts. Localised problems, such as microbiological contamination, may therefore only include local stakeholders, while catchment wide problems, such as salinity, may involve a wider range of stakeholders (see Section 3.4).

Given that the process is iterative, and is based on facilitated dialogue between the different demands for water use, smaller groups of stakeholders are more likely to be successful. Smaller groups can actively participate in the debate, and may have to receive specific capacity building in this regard. These stakeholders would typically only be those directly affected by the resource water quality objective, and different small groups could address different resource water quality objectives. This would typically be done in a workshop environment.

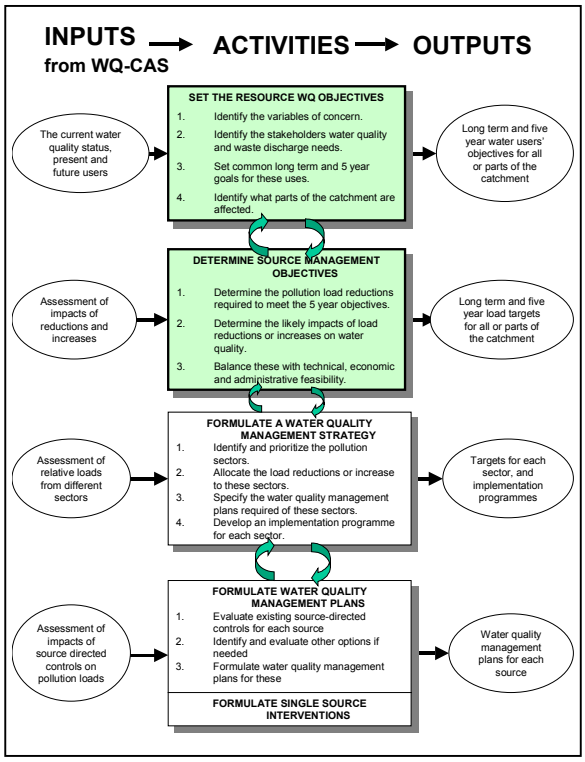
Be this as it may, there must be wider information dissemination with regard to the process, and the resource water quality objectives that are distilled from this process. This could be in the form of newsletters that inform a wide group of stakeholders of the results of the stepwise process outlined in section 3.5

4 HOW TO FORMULATE SOURCE MANAGEMENT OBJECTIVES

Source management objectives provide the focus for the actions required to give effect to the *resource water quality objectives*. As such, they outline the pollution load reductions (in stressed catchments), pollution load maintenance (in threatened catchments), or pollution load increases (in unstressed catchments) required to meet the immediate (5-year) resource water quality objectives. *Source management objectives* are not source or sector specific, but outline pollution load targets on a catchment or sub-catchment basis. This is primarily a technical process, which iterates with the determination of the *resource water quality objectives*, and with the *water quality management strategy*.

4.1 What are source management objectives?

Source management objectives outline the overall pollution load targets for the catchments and sub-catchments of the Water Management Area. They outline *what* needs to be done to realise the immediate objectives, but not *who* or *how* this will be done. Source management objectives, therefore, specify the pollution load reductions (in stressed catchments), or increases (in unstressed catchments) required to realise stakeholders' requirements for use of the water resource in each sub-catchment. Source management objectives may also indicate that total pollution loads should be maintained in the face of increasing development in the catchment (in threatened catchments). Source management objectives may also include heuristic descriptions of actions required to meet the resource water quality objectives. For example the desire to reduce pollution loads by implementing existing protocols, or to rehabilitate given river reaches.



Source management objectives are set for each of the immediate resource water quality objectives (see previous section), and aim to realise these objectives within a 5-year timeframe. The source management objectives are not source or sector specific, but are determined by the CMA on a catchment ,sub-catchment or river reach basis.

4.2 How do you determine the source management objectives?

Source management objectives are determined by balancing pollution load targets with the technical, economic and administrative practicalities of achieving these targets. This is an extension of the process of determining resource water quality objectives, and forms the link to the water quality management strategy, which indicate who will give effect to the pollution load targets. As such, source management objectives are determined in an iterative process

of testing what needs to be done to give effect to the immediate objectives, against the feasibility of achieving these goals.

In order to ensure administrative simplicity, source management objectives are set for whole catchments, sub-catchments, or river reaches (e.g. A phosphorus load reduction target for the catchment of a eutrophic impoundment), and not for individual sources within these catchments. Source management objectives are also set for each of the water quality issues identified in the catchment water quality situation analysis. This process sets common targets for all the sources within the catchment, and hence promotes the formulation of catchment wide sector-specific actions to achieve these targets within the water quality use allocation strategies and local and sector specific actions. (See Chapters 5 and 6)

This approach, therefore, allocates pollution load targets to whole catchments. These catchment pollution load targets are then re-allocated to specific sectors or sources within the use allocation strategies. As these use allocation strategies are developed in close co-operation with the affected sources and sectors, this process forces the water users to think within the catchment perspective when allocating targets for specific sectors. This avoids many of the problems associated with the source-specific receiving water quality objectives (RWQO) approach[2]. However, where the total pollution loads in a catchment are dominated by single sources, source-specific source management objectives may be specified.

In addition, the process of determining source management objectives need not be based on quantifiable cause-effect relationships. (Unlike the RWQO approach, which calculated allowable waste loads using modelling of the instream fate of pollutants.) As such, source management objectives can be based on simple heuristic understandings of the likely effects and feasibility of specific load reductions (or increase), or on previous modelling studies on the likely effects of given changes in loading.

Source management objectives need not only be expressed in terms of pollution loads, and may include objectives for the rehabilitation of river reaches, or to simply reduce pollution loads from any given sector (like dense settlements). Source management objectives may therefore be expressed by a given stakeholder groups of catchment forums in response to their local resource water quality objectives (see Chapter 3). For example, a local authority or catchment forum may wish to rehabilitate the riparian zone and instream characteristics of their local river. Similarly, a catchment forum may propose an existing protocol or strategy as a source management objective, for example the "Dense Settlements" strategy or groundwater protocol, to address a specific local need.

4.3 What do you need to consider?

The feasibility of achieving the source management objectives is determined by the type of pollution source, and the load reduction required. In cases where source management objectives are expressed in terms of the need to implement existing protocols, the CMS may also need to consider the local capacity required to implement the protocol. The most important issues to consider when establishing the source management objectives for each sub-catchment are therefore:

- The difference between the current state and the resource water quality objective.
- The type and number of sources that contribute to the water quality problems.
- The expected growth in these pollution sources, both in number and discharge volume.

[2] The Receiving Water Quality Objectives (RWQOs) approach, advocated in the 1980's, was aimed at determining source-specific pollution (or waste) loads for each discharger. This approach proved to be resource intensive and difficult to implement. It was also difficult to allocate waste loads to the different sources within the catchment.

- The pollution control technology available to the pollution sources and sectors.
- The local capacity required to achieve the source management objective.

The following paragraphs provide more detail on how to establish source management objectives within these considerations.

The difference between the current state and the resource water quality objective:

The difference between the current state and the resource water quality objective indicates the overall reduction or increase in pollution loads that should be considered.

In stressed catchments, resource water quality objectives will differ significantly from the current state, and considerable load reductions may be required to realise the resource water quality objectives. Many of the water resources in these catchments are also likely to have a lower resource class, and hence less stringent source-directed controls. It is, therefore, possible that additional catchment specific standards and management practices will be required to meet the resource water quality objectives. In these cases, the economic and technical feasibility of source management objectives will have to be carefully weighed against the likely impacts of the load reductions on water quality. The management emphasis will be on assessing the overall load reductions required to realise the resource water quality objectives. This may require detailed assessments of the likely effects of pollution load reductions on downstream water quality, and is likely to be resource intensive.

In threatened catchments, source management objectives are likely to specify that there should be no overall increase in pollution loads. This need not prevent further development of the catchment, but rather indicates that development in the catchment has to be balanced by reductions in pollution loads elsewhere in the catchment. The management emphasis in these cases will, therefore, be on allocating pollution loads to different sectors within the water quality management strategy. This is likely to require the least investment in assessing the impacts on downstream water quality, and formulation of the source management objectives will be the least resource intensive.

In unstressed catchments, source management objectives will specify the possible increases in pollution loads that may be accommodated without threatening the resource water quality objectives. However, this is not necessarily a licence to increase pollution loads, and proposed increases in pollution loads should only be considered if there are clear social and economic benefits to the catchment as a whole. In these cases, the water quality management strategy (and allocation plans) would have to allocate these increases to the various sectors based on the principles of beneficial and equitable use of the resource[3], taking account of the principles of sustainable development. This process must consider the natural growth in the catchment, as well as any proposed developments that may occur. The management emphasis in these cases will be on assessing what increases can be considered without risking the resource water quality objectives. This may have to be supported by assessments of the likely impacts of pollution load increases on downstream water quality, and must include assessments of the increases in pollution loads that are associated with the planned developments in the catchment.

The type and number of sources that contribute to the water quality problems:

The type and number of pollution sources that contribute to the current pollutant loads provides clues as to the feasibility of pollution load reductions. In general terms, where a few large sources contribute to the overall pollution loads, significant load reductions are more feasible, and where a great many pollution source contribute to the problems, reductions in

[3] In unstressed catchments, source management objectives will always indicate that additional pollution loads can be accommodated, but these may not always be allocated simply as there is no economic and social benefit to the catchment as a whole.

pollution loads may be more difficult. Smaller individual sources are also less likely to be able to afford costly capital investments in pollution control technology. However, this largely depends on the type of sources in the catchment. It is generally more difficult to manage the water quality impacts from nonpoint sources, than from point sources. The formulation of source management objectives is therefore also informed by the point and nonpoint source assessments in the catchment, which indicate who is contributing to the overall pollution loads.

The pollution control technology available to the pollution sources and sectors:

The type of sources that contribute to the overall loads may also impact on the feasibility of pollution load reductions. Cost-effective pollution control technology is available for many source types, but is not necessarily seeing wide use in South Africa. Similarly, "cleaner-production" approaches, which often realise savings for the industry while reducing overall pollution loads, have not taken root within the South African context. Significant load reductions are therefore possible in many sectors types, without significant economic implications for the individual sources.

The capacity of the local implementing agent:

This is particularly important where resource water quality objectives, and subsequently source management objectives aim to address localised problems, for example where the source management objective is to implement an existing protocol. In these cases the viability of the source management objective has to be carefully weighed against the capacity of the stakeholders to implement the protocol. This capacity may be determined by the technical or skills required, the financial resources required, and the institutional arrangements required to implement the protocol. In cases where the capacity is very limited, the CMS may have to give consideration to building this capacity.

4.4 What assessment support is required?

The above paragraphs have outlined to some extent the type of assessment support required to establish the source management objectives. Assessment techniques that support the formulation of source management objectives are those which;

- Indicate the likely effects of pollution load increases or decreases on downstream water quality, and
- Indicate the number and type of sources contributing to the overall pollution loads.
- Highlight the protocols required to address specific pollution problems.

Assessment techniques that indicate the effects of pollution loads on water quality are likely to be the most important tools in the formulation of the source management objectives. These tools indicate what decreases in loads are required to realise the resource water quality objectives, or what increases in loads can be accommodated without threatening the resource water quality objectives. These assessment techniques may range from complex water quality process models for non-conservative variables, to simple mass balance models for conservative substances. Simple heuristic models based on previous studies may also prove to be valuable tools. In general, these assessment techniques should not focus on processes that lead to pollution, but rather on the impacts of pollution loads on water quality.

Catchment wide point and nonpoint source assessment techniques are also important in the formulation of source management objectives, as they indicate which sources are contributing to current pollution loads. These models may be quantitative or qualitative, and contribute to assessing the feasibility of pollution load reductions (see the previous section).

4.5 Who should be involved?

The formulation of source management objectives is largely a technical process of determining the load reductions or increases that are required to realise the resource water quality objectives. However, the source management objectives must be technically and economically viable. This means that the individual sources and sectors that contribute to the water quality problems must be involved in the process. Participation of these sources focuses on the iteration between the source management objectives and water quality management strategy/plan, and tests the overall reductions in pollution loads with the sources who will be expected to give effect to these source management objectives.

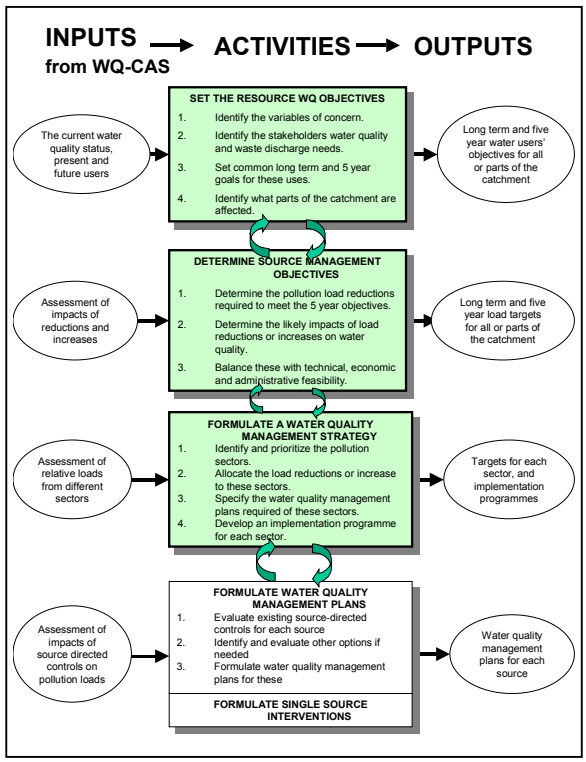
However, source management objectives focused on addressing local needs may have to be negotiated with the relevant stakeholder groups.

5 HOW TO FORMULATE A WATER QUALITY MANAGEMENT STRATEGY

The *Water Quality Management Strategy* outlines the framework for water quality management in a WMA, and as such represents the heart of the water quality component of the CMS. It should specify the strategic approaches and plans for water quality management, and the linkages to the other non-water quality components of the CMS, and should specify the responsibility for formulating and implementing the management required to meet the resource water quality objectives. As such, the water quality management strategy outlines who will be responsible for realising the source management objectives.

5.1 What is a water quality management strategy?

The water quality management strategy provides the strategic framework for water quality management in the WMA to achieve the source management objectives and hence the immediate (5-year) objectives for identified water quality problems in key sub-catchments in the WMA. It includes a water quality allocation plan, similar to the CMA allocation plan required by Section 9(e) of the NWA.



It should allocate the available discharge load, defined by the source management objectives to different water user groups and dictate which user groups (sectors) need to develop sectoral or single source plans to achieve these loads. It may also indicate who will assume the responsibility for implementing the pollution management protocols specified as source management objectives. This would address both point sources and nonpoint sources. In doing this, it should indicate the types of management approach that should be adopted for that source type, including possible:

- statutory authorisation requirements, such as compulsory licensing with more stringent conditions, for point source discharges or nonpoint source activities defined as water use under Section 21 of the NWA;
- particular direct structural or operational management interventions to address a specific problem;
- cooperative governance initiatives, with other government departments and spheres of government, such as Department of Agriculture;
- capacity building and awareness programmes to change peoples' behaviour and improve the management/operation of key activities; and/or
- specific requirements of the management protocols selected as source management objectives.

Furthermore, the management strategy should indicate the need to develop instream management plans (where internal loading is significant or where rehabilitation is required)

or use management plans[4] (where the water quality of abstracted water is not fit for certain use).

In general, the management strategy will incorporate a suite of interventions for critical source types, matching the approaches to the characteristics of each source type. For example, cooperative governance and awareness approaches may be most appropriate for dryland agricultural activities, while statutory licensing and associated management practices may be specified for irrigated agriculture.

Being at the heart of water quality management, the management strategy must define the component (sector or source) water quality management plans than need to be formulated and a programme for development/implementation, including the actions, resources, timeframe and responsibilities for developing these plans. The requirements for water quality management monitoring-evaluation and auditing-review must also be outlined.

5.2 What is its relationship to other components of the CMS?

The water quality management strategy is a key element of the total CMS. As such it must highlight the inter-relationships between the component water quality management plans and the linkages with the other non-water quality components of the CMS, as described in the *Generic Framework for Catchment Management Strategies* (DWAF, 2000). These include:

- RDM and NWRS (Class, Reserve and RQOs) intervention strategies
- Water Resource Operating Strategies
- Water Management strategy
- Pricing Strategy
- Institutional Development Strategy
- Communications/Awareness Strategy
- Land use planning/management Strategies

5.3 How do you develop a management strategy?

The management strategy represents the translation of the total allocable load for a specific water quality problem in a catchment, into the load for a sector and/or a source. This must focus on the sources with the greatest contribution to the load, and must reflect national water quality management policies and strategies. Care must be taken not to make these sector allocations too specific, but rather to use broad sectoral categories. Where the source management objective has been specified as the need to implement a given pollution management protocol, the use allocation plan would prioritise the sources for implementation. For example the prioritisation of settlements for implementation of the "Dense Settlements" strategy.

The following steps are proposed in the development of a water quality use allocation plan.

Step 1*: Prioritorise the sector-sources-activities that require management in each catchment*

The range of sources that contribute to the pollution load in a sub-catchment must be prioritised for management purposes, i.e. where to allocate attention and resources. All source types (or particular sources) with significant contributions (greater than 10% of the load) should be considered.

[4] A use management plan includes options to treat the water before use, or to use alternative sources.

Those source types or areas with the greatest total impact on a water quality concern should be a priority for management. However, those sources with the highest relative impact (eg. unit area or per capita loading) should also have a higher priority for management, because the interventions may be more effective in these areas. Similarly, the potential future impacts of these sources should be a major consideration, because these impacts may be more easily mitigated before they are realised.

The manageability of a source indicates whether the impacts from that source may be controlled and therefore the prioritisation should consider:

- *background* contributions, which are largely unmanageable; and
- *technical* possibilities for management, based on existing practices and the nature of the source types and processes.

Furthermore, managing the priority source types or areas requires a mixture of political will, legal mandate, institutional capacity, economic resources and social commitment. The resources and management- institutional environment required to manage the priority sector-sources should be part of the prioritisation process.

Where the existing resources and/or environment are not currently adequate, but there is the possibility of accessing them, this should be the emphasis of management, before identifying approaches that may not be implementable. Alternatively, in those situations that an enabling environment or resources are unlikely to be available in the short to medium term, it may be necessary to review the prioritisation process and concentrate on sources that have less stringent requirements. However, the implications for efficiency and equity between sectors-sources must be considered.

Step 2*: Allocate the available load between sources in each catchment (or identify the sources where existing protocols should be implemented).*

The source management objectives in each sub-catchment with identified water quality problems must be compared to the existing (and projected) pollutant load, and evaluated in terms of being:

- stressed (a particular immediate objective is already exceeded);
- threatened (is likely to be exceeded in the next 5 years); or
- unstressed (in unlikely to be exceeded in the next 5 years).

For stressed situations, the existing load must be reduced. This must include the expected increase in loading due to development, which may be restricted or phased in, as other source loads are reduced. In some cases, implementation of existing general authorisation requirements may be sufficient to meet the source management objectives. It may be necessary to make more stringent water use authorisation conditions for particular sources, or to require compulsory licensing under Section 43 of the NWA. However, only activities that are defined as water use may be managed in this way, which applies to most point sources. Nonpoint source activities may be permissible under general authorisation, or it may be necessary to determine controlled activities in the WMA for critical nonpoint sources. On the other hand, cooperative governance agreements or awareness programmes may be more appropriate.

A similar process must be conducted for threatened situations, although reductions in loads are only necessary to meet the expected increase in load associated with future development in the catchment. Finally, for unstressed situations, implementation of the general authorisation requirements should be adequate, except where intensive development is likely.

Regardless of the situation or the approach, the proposed load allocations or protocols associated with the key source types in an area must be developed for the critical water quality problems. This must engage the possible effect of instream management, associated with remediation, dilution and/or reservoir operation. There will be some iteration between these load allocations, based on the possibilities for management, the necessary considerations and the inter-relationships between loads from a particular source type.

The process of defining resource water quality objectives, source management objectives and the water quality management strategy must be iterative, as this enables the affected sectors/sources to evaluate what particular resource water quality objectives relate to management requirements at the source. Similarly, the process must recognise that the realisation of the resource water quality objectives is a gradual and progressive process.

***Step 3**: Specify required water quality management plans*

Once the various sectoral loads have been proposed for a particular source type (or source) in a catchment, these need to be combined into a requirement for a water quality management plan, to give effect to the loading allocations for that source (see Chapter 6). This will dictate the loading allocation for the next 5 years, the groups or individuals responsible for developing the management plan and the timeframe within which it must be implemented. These management plans may relate to:

- point source discharges, such as municipal waste water, mining, industrial, manufacturing;
- nonpoint source discharge, such as irrigated agriculture, dryland agriculture, settlements;
- instream management, including rehabilitation, minimum streamflows or operating rules.
- specific pollution management protocols.

It may not be necessary to require separate management plans for different sectors/sources in a sub-catchment, particularly where compulsory licensing is not required. In this case, multi-sector water quality management plans may be developed to meet the source management objectives, possibly with some guidance in the relative allocations between the sectors.

***Step 4**: Formulate linkages with other components of the CMS*

It is critical that these allocations and requirements are consistent with the other components of the CMS, particularly in terms of water quantity allocation, pricing, institutional development and communications-awareness. These linkages and any assumptions must be explained.

***Step 5**: Develop a programme for implementation*

Local water quality management plans must be developed and implemented within specified timeframes. The programme for implementation presents these timeframes, together with the responsibilities for action and providing the necessary resources. This must also highlight the responsibility for monitoring and auditing the implementation of the water quality use allocation plan.

5.4 What do you need to consider?

As with all water use authorisation (general authorisation and licensing), the factors outlined in Section 27(1) of the NWA must be considered in the allocation of loading between groups. These factors include:

(a) existing lawful water uses;

(b) the need to redress the results of past racial and gender discrimination;
(c) efficient and beneficial use of water in the public interest;
(d) the socio-economic impact -
(i) of the water use or uses if authorised; or
(ii) of the failure to authorise the water use or uses;
(e) any catchment management strategy applicable to the relevant water resource;
(f) the likely effect of the water use to be authorised on the water resource and on other water users;
(g) the class and the resource quality objectives of the water resource;
(h) investments already made and to be made by the water user in respect of the water use in question;
(i) the strategic importance of the water use to be authorised;
(j) the quality of water in the water resource which may be required for the Reserve and for meeting international obligations; and
(k) the probable duration of any undertaking for which a water use is to be authorised.

These factors provide the principles for allocation, but need to be unpacked to be useful in the allocation process. As indicated above, the approach and considerations may differ between stressed, threatened and unstressed situations.

Where loads have to be reduced, this must be equitable, with a clear indication of what user sectors are required to reduce loads , taking account the principles of equitable and beneficial use and technical and economic constraints. In threatened situations, an approach may be to maintain existing levels for a sector, with further development being based on load reductions from existing sources. However, this may be modified according to predicted shifts in development patterns, such as from agriculture to manufacturing.

Where compulsory licensing is required, any reduction in load allocation from the existing level (water use), in order to meet the Reserve, does not require compensation. This has important implications for the definition of the Reserve (as opposed to resource quality objectives).

5.5 What assessment support is required?

In order to make the load allocations between sectors/sources, information is required about the relative load contribution from each source type (or large source) both currently and due to expected future development. The manageability of that contribution must also be estimated, in terms of the background levels, the technical effectiveness of available management options (technologies) and the social and economic impacts of those management options. Although accurate sector/source load estimates, based on detailed point and nonpoint source modelling (based on monitored data) would provide the greatest support for management decisions, simpler and qualitative assessment approaches may be used, particularly in less stressed situations. Particular assessment support may also be required for specific pollution management protocols; for example the groundwater protocol requires knowledge of the aquifer and soil characteristics.

5.6 Who should be involved?

The load allocation is a technical process that needs to be negotiated with the affected sectors and sources, to ensure that the social and economic considerations of Section 27 of the NWA are adequately addressed, stakeholder support for decisions is fostered and the spirit of participatory management is ensured. Therefore, water quality managers should drive the process, but with input from the affected water users and sectoral representatives.

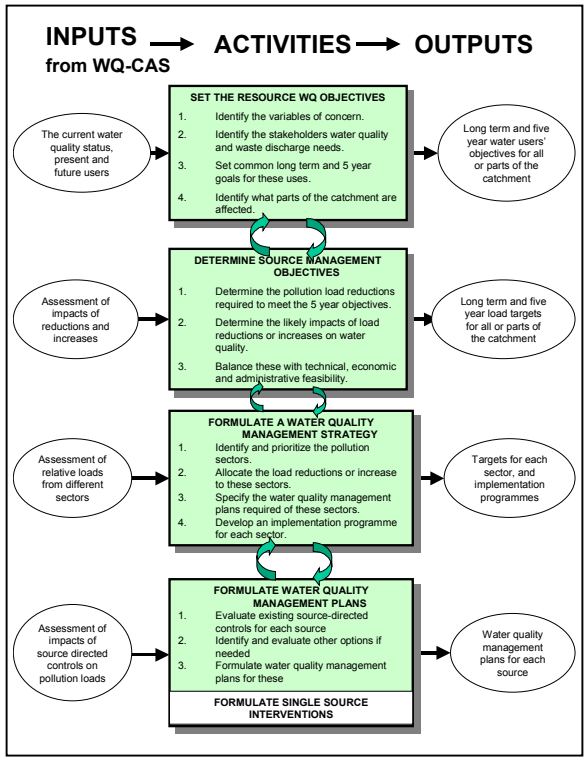
However, in some cases the CMA may direct a water user sector to develop its own water quality allocation plan for consideration.

6 HOW TO DEVELOP WATER QUALITY MANAGEMENT PLANS

A *Water Quality Management Plan* specifies the management actions, responsibilities, resources and timeframes to mitigate or remediate the water quality impacts associated with priority sector sources within a particular catchment area, to give effect to the load allocation specified in the water quality management strategy. This may include statutory and/or non-statutory approaches that are more stringent than the general requirements for these sources.

6.1 What are water quality management plans?

Water quality management plans specify the management actions, responsibilities, resources and timeframes required to achieve the 5-year load allocations specified in the water quality management strategy. These should include both technical and non-technical approaches to water quality management.



Depending upon the nature of the problem and the cooperation between sectors, these plans may be:

- sector/source specific or multi-sectoral within an area;
- point or nonpoint source, instream (operation or remediation) and/or use oriented;
- single water quality constituent or multiple (integrated) water quality problem focused;
- based on statutory authorisation, direct intervention, cooperation and/or capacity building; and
- based on the requirements of specific protocols, for example the requirements for participatory problem solving in the "dense settlements" strategy.

6.2 How do you develop a water quality management plan?

The development of any water quality management plan should follow the three steps outlined below:

Step 1: *Evaluate existing source directed controls*

In most cases, the existing nationally (or regionally) defined conditions on water use authorisation (general authorisation or licensing) should be adequate to protect the resource quality of a water resource, if these are specified according to the resource class. The point of departure for a water quality management plan should therefore be the existing authorisation conditions.

The impact of full compliance with relevant water use authorisation conditions should be evaluated, for existing and expected levels of development. This should be done for all load

allocations for each sector-source type specified in the water quality management strategy. Where non-compliance is widespread, this should be the focus of the water quality management plan. Only where full compliance would not meet the sectoral load allocations, should more stringent conditions be considered.

Step 2: *Identify and evaluate other possible options*

Where the existing authorisation conditions are not adequate to meet the allocated load, other management options must be explored. These may include:

- Statutory controls on water use, including more stringent authorisation conditions (through area specific general authorisation or licences) or compulsory licensing of relevant water quality based water users.
- Waste discharge charges used as an economic incentive to reduce loads to the required levels, together with funding of direct interventions to implement technologies and practices to manage loads from particular sources.
- Non-statutory options, particularly cooperative governance and capacity building to improve the effectiveness of land use and infrastructure management that has an impact on water quality and to change peoples' behaviour to mitigate impacts.
- Instream management, through remediation of the water resource, reservoir system operation and/or ensuring adequate water quantity allocation to streamflow for dilution and assimilation of loads (possibly above the Reserve and RQOs).

The impact of these options needs to be evaluated, in terms of their effectiveness in reducing loads and the socio-economic considerations discussed below. This evaluation should not only be viewed in terms of the 5-year impact, but also the longer term requirements to ensure a paradigm shift in the behaviour and operation of people with an impact on water quality loads, to a self-regulatory and responsible management culture.

Step 3: *Formulate water quality management plan*

The suite of management options that should achieve the load reductions and support long-term paradigm shift in the relevant sectors-sources should be formulated into a management plan. This must specify, at least the:

- Management actions required to achieve the load allocations;
- Responsibilities for planning and implementing these actions;
- Timeframe for implementation;
- Resources required to plan and implement these actions; and
- Monitoring and auditing requirements to indicate successful implementation.

6.3 What do you need to consider?

In addition to the effectiveness of the options proposed in a management plan, the following criteria should be evaluated:

- *Efficiency* reflects the cost-effectiveness of the option (i.e. the reduction for every unit of resource required). This should be assessed in terms of the initial implementation cost, as well as the ongoing operational costs.
- *Suitability* represents the adequacy or appropriateness of an option to the local conditions, and whether it will work and is adaptive to possibly changing (dynamic) situations.
- *Acceptability* indicates whether the polluters or those people who are affected will support the option. If not, the effectiveness of the option may be reduced through mis-use or sabotage, even though it may be technically appropriate.

- *Affordability* of an option depends both upon the efficiency (cost) and the acceptability (willingness-to-pay) of the polluters. Unaffordable option will not be implemented, unless severe penalties are applied.
- *Sustainability* is dependent upon technical criteria, such as the ongoing maintenance requirements, as well as the efficiency, affordability and acceptability of the option. In some cases, it may be necessary to adopt unsustainable short-term solutions, while implementing long-term sustainable solutions.

These criteria ensure that the economic, social and institutional requirements of the options in the water quality management plan have been addressed and should be evaluated against the available resources and the enabling environment.

6.4 What assessment support is required?

As indicated above, the process of identifying and evaluating management options, and formulating associated management plans must consider the effectiveness of the plan in achieving the allocated load. It may not be possible to define the absolute effectiveness of a management option, because site specific conditions have a considerable impact. However, it should be adequate to assess the relative effectiveness of different options.

The selection of an assessment approach should be based on a trade-off between the resources required to use a particular technique and the increase in the accuracy and reliability of the results. Unfortunately, many of these techniques are generally unreliable without extensive data and thus detailed assessment is not rewarded.

6.5 Who should be involved?

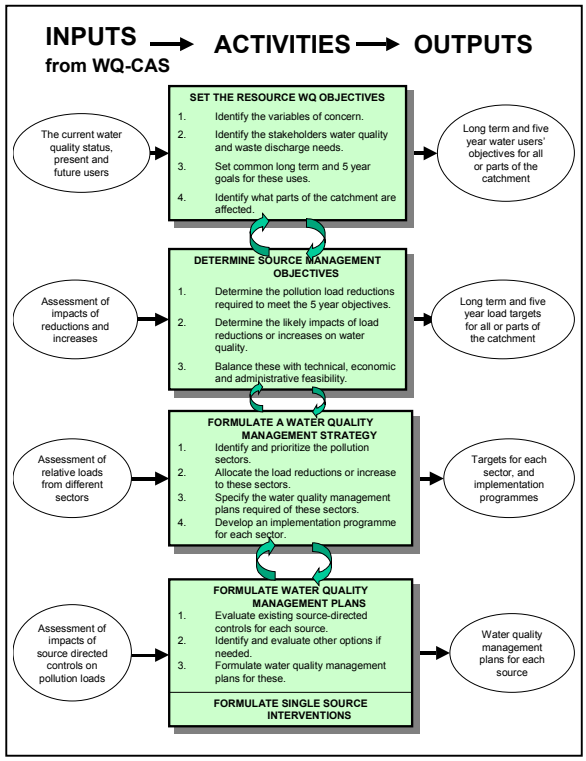
The development of management plans should be driven by the affected sectors-sources where possible, as they will generally be responsible for implementing the actions. However, this may be facilitated and technically supported by water quality managers (DWAF or CMA).

7 HOW TO DEVELOP SINGLE SOURCE INTERVENTIONS

Single source interventions indicate the requirements (actions and time-frames) for mitigating or remediating the water quality impacts from a single source, as part of a water use authorisation, a cooperative agreement or a directive. They will generally be applied to specific concerns that have a significant impact on the water quality of a water resource.

7.1 What are single source interventions?

Whereas sector specific water quality management plans are aimed at addressing the impacts or discharge requirements of whole sectors on a catchment or sub-catchment basis, single source interventions address the impacts or requirements of single sources. Single source interventions, therefore, include licences, co-operative agreements or directives issued to a specific water use. These agreements may also be based on existing pollution control protocols.



Single source interventions are indicated when:

- Significant impacts (severity or risk) are associated with a particular source.
- Hazardous, toxic or bio-accumulatory substances may be present.
- The impacts differ from other sources within the sector.
- The single source is in close proximity to a sensitive water user.
- Remediation efforts are required due to historical impacts from the source.
- Little or no impacts are expected on the water resource.
- There are special social or economic circumstances.
- The source is of special national strategic importance.

7.2 How do you develop a single source intervention?

Source specific interventions are developed on the request of either the Water Management Institution (DWAF or the CMA), or the specific source in question. In the former case, the Water Management Institution may wish to focus special attention on the source due to its significant impact on the water resource or other water users. While in the latter case the source may wish to request a relaxation of existing requirements due to site-specific circumstances. In both cases, the source in question would have to bear the costs of the site-specific investigation.

Source specific interventions must balance the site-specific requirements of the source against the impacts of the source on the immediate resource water quality objectives and the Resource Quality Objectives. This may require site specific cause-effect modelling to determine the likely impacts on downstream water quality. However, single source

interventions, particularly those aimed at hazardous, toxic or bio-accumulatory substances, may only address specific activities or processes within the source. In these cases, source specific interventions may be focused on cleaner production and may not require cause-effect modelling. (For example the phasing out of certain processes or activities.) Source specific interventions may also be developed for specific time frames or conditions, for example high or low flow conditions.

Source specific interventions are, therefore, site-specific water quality impact assessments. As such, they follow the guidelines outlined in "*The Procedures to Assess the Impacts of Effluent Discharges* " (DWAF, 1995), and in the nonpoint source management guide which is currently under preparation. The procedures to determine site-specific requirements for single source interventions are addressed in considerable detail in these documents, and are therefore not repeated here.

The water management institution may also require additional environmental or other assessments, which may be subject to independent review, as part of the process of developing a single source intervention. These requirements will be highlighted in the application process, and may include:

- Environmental impact assessments where catchment-level environmental impacts are expected.
- Economic assessments where relaxation of authorisation conditions are motivated on economic grounds.
- Assessments of the specific water quality needs of downstream users.

The development of single source interventions is a resource intensive process, and will require special attention from the Water Management Institution. As such, single source interventions should be the exception rather than the norm, and should only be considered if circumstances specifically warrant special attention. DWAF may also chose not to delegate decision making on single source interventions to Catchment Management Agencies under certain circumstances.

7.3 What do you need to consider?

Single source interventions may take one of three forms (the considerations for each of these cases are discussed separately below):

- Site specific requirements due to the "uniqueness" of the source.
- Relaxation of authorisation conditions in cases where little or no impacts are expected.
- More stringent standards due to site-specific circumstances.

Once again, the factors outlined in Section 27(1) of the NWA must be considered, including:

(a) existing lawful water uses;
(b) the need to redress the results of past racial and gender discrimination;
(c) efficient and beneficial use of water in the public interest;
(d) the socio-economic impact -
(i) of the water use or uses if authorised; or
(ii) of the failure to authorise the water use or uses;
(e) any catchment management strategy applicable to the relevant water resource;
(f) the likely effect of the water use to be authorised on the water resource and on other water users;
(g) the class and the resource quality objectives of the water resource;
(h) investments already made and to be made by the water user in respect of the water use in question;

(i) the strategic importance of the water use to be authorised;
(j) the quality of water in the water resource which may be required for the Reserve and for meeting international obligations; and
(k) the probable duration of any undertaking for which a water use is to be authorised.

Unique sources

Unique sources are those which, due to their water quality impact, special economic conditions, or national strategic importance, require special attention. Unique sources may require more stringent standards due to the severity or risk of their impacts on the water resource, or by virtue of their special economic conditions may require more lenient approaches (relaxation of conditions). For example marginal mines may be addressed differently (over a specified time period) to those which are on a sound economic basis.

In these cases, single source interventions must consider the strategic, economic and labour characteristics of the source, as well as the impacts on the resource. These considerations must ensure an appropriate balance between the beneficial and equitable use of the water resource in the interests of stakeholders and the country as a whole.

Relaxation of conditions

These would be considered in cases where sources require more lenient approaches than those proposed as class-based, sectoral or (sub)-catchment specific standards. Relaxation would be considered when site-specific circumstances mitigate the impacts on the water resource, and would typically be considered when the impacts on the water resource are negligible. Relaxation may, therefore, be considered in cases where there is considerable assimilative capacity, where the source is situated far from the water resource, or where the effluent may be evaporated or irrigated without impacting on the groundwater resource.

In these cases, the impacts of relaxation on downstream water quality, specifically with respect to ensuring the requirements of RQOs or immediate objectives are met, would have to be carefully weighed against the social and economic benefits accrued. In these cases, the flow regime and reliability of flow would have to be carefully considered. Relaxation may therefore be based on certain high flow conditions.

Relaxation for some sources may also be considered together with water use charges that could be used to manage other regional water resource problems, as part of a waste discharge charge system.

More stringent requirements

In some circumstances more stringent standards will be required of a particular source, in order to ensure compliance with the RQOs, or immediate objectives. These would typically include cases where sensitive users occur in close proximity to the source discharge. However, in these cases the source may not have any "unique" characteristics, and it will be critical to demonstrate the impacts on downstream water quality, and to balance this against the costs of achieving the more stringent standards. Again, the flow regime and reliability of the flow is an important consideration. More stringent requirements may also be linked to low flow conditions.

7.4 What assessment support is required?

The " *Procedures to Assess the Impacts of Effluent Discharges* " (DWAF, 1995), and a recently initiated study to address the nonpoint source assessment techniques in a similar fashion, outline the assessment support required for single source interventions. These detailed requirements and processes are therefore not repeated here.

However, it should be noted that the intention of the site-specific investigations required in this process is to assess the impacts of different management practices or effluent standards. This requires detailed modelling of the impacts of different management practices on downstream water quality. For point sources this requires detailed instream modelling of the fate of pollutants from the point of discharge, which is even more critical for non-conservative substances that may undergo chemical or biological assimilation within the water resource.

For nonpoint sources, models that disaggregate nonpoint source processes are critical to assess the likely load reductions from different management practices. These may have to be supplemented by instream models that assess the downstream fate of pollutants once in the water resource.

7.5 Who should be involved?

Single source interventions are prepared by the source in question for approval by the relevant Water Management Institution (DWAF or the CMA). The primary involvement in the preparation of the intervention therefore comes from these two bodies. However, it is critical (and in fact a legal requirement) that other stakeholders have the opportunity to comment on this process, and on the final interventions before the directives, licences or co-operative agreements come into effect. This will be particularly important when relaxation of conditions is being considered.

Wider stakeholder participation should therefore occur at two points, when the source is identified for a single source intervention, and when the final interventions are agreed. In the former case, stakeholders must be informed of why the source has been identified, and the intention of the single source intervention (i.e. is relaxation of conditions or more stringent requirements being considered). Once the interventions have been agreed between the source and Water Management Institution, these must also be made available for comment.

Directives and co-operative agreements in respect to single source interventions are also subject to the provisions of sections 40 and 41 of the National Water Act. These specify the requirements for the application of a licence for a particular water use, and that the assessments may be subject to independent review. In addition, water use entitlements, directives and co-operative agreements may be included as part of the Catchment Management Strategy, notice of which has to be published in the Gazette for comment. As such any stakeholder may also comment on the interventions at that point.

8 HOW TO STRUCTURE THE WQ COMPONENT OF A CMS

This Chapter provides a possible template for the water quality component of a catchment management strategy, representing the combination of all the individual elements described in this guideline.

8.1 Resource and source management objectives

The first water quality management component of a CMS must be a description of the:

- *resource water quality objectives* (see Chapter 3), which define time-referenced water quality management goals for priority contaminants to be achieved within the five years (addressed by the CMS), in the surface and ground water resources of the WMA; and
- *source management objectives* (see Chapter 4), which translate these resource water quality objectives into the total allowable source and/or internal loadings of priority contaminants within key sub-catchment areas.

The following Table highlights how these objectives may be defined.

Sub-catchment	Contaminant	Resource water quality objective	Source management objective
Elands River (A22)	Phosphorus	TP to remain below ***0.2 mg/l*** 95% of the time	Total allowable load of TP less than ***20 ton/annum***
	E.coli	*E.coli* counts to be be ***<1000 #/100ml*** for 80% of the time	Dry weather discharge to average ***<5 000 #/100ml***
	Dense Settlements	*To reduce the impacts of settlements on the quality of the resource.*	Implement the "dense settlements strategy on settlements in the catchment.

8.2 Water quality management strategy

As highlighted in Chapter 5, the water quality management strategy represents a sub-catchment load allocation to different sector-source types, to achieve the specified source management objectives. It also highlights the water quality management plans required to give effect to this load allocation, and a programme for implementation.

The following Table outlines the possible form of the water quality management strategy:

Source management objective	Sector-Source type	Load Allocation	Management Plan Responsibility
Total allowable load TP ***<20 ton/annum***	Waste water Works	5 ton/annum (*30% reduction in 3 years*)	Phosphorus point source WQMP to be developed by local authorities discharging in the sub-catchment
	Urban washoff	5 ton/annum (*nil increase*)	Local authorities to formulate an urban cooperative NPS management plan to mitigate storm water impacts
	XXX paper and pulp factory	2 ton/annum (*20% reduction in 2 years*)	XXX paper and pulp to formulate a single-source plan to reduce effluent discharge and irrigation load

	Dryland Maize	3 ton/annum (*nil increase*)	Farmers and Dept. of Agriculture to formulate cooperation agreements to improve fertilizer management
	Internal loading	1 ton/annum (*5% reduction in 5 years*)	Dam operators to develop operating strategy to reduce internal loading and phosphorus mobilisation in dams
	Other sources	4 ton/annum	Unmanageable background and insignificant individual sources

The water quality management strategy may also specify a priority list of settlements for implementation of the "dense settlements" strategy, or a list of priority sources for other pollution management protocols.

8.3 Water quality management plans

Water quality management plans are typically sub-catchment based, focussing on either a number of water quality impacts from a particular sector-source type or on a particular water problem associated with a number of source types.

8.3.1 Sector point or nonpoint source management plan

These sectoral plans would generally focus on a number of water quality contaminants associated with a generic source type, and would be required to achieve the load allocation specified in the water quality management strategy (within the specified time-frame). This would outline the proposed actions, timeframe, responsibilities, resources and monitoring required to achieve these load allocations. This could also include the planning required to implement given pollution control protocols.

8.3.2 Multi-sectoral management plan

In some cases, the water quality management strategy would indicate that a number of sectors or sources need to develop an integrated water quality management plan, thereby achieving the specified load allocation. This places the onus on the sectors to allocate the total load between different sector-source types, through a cooperative process, which may improve the understanding and buy-in between sectors. Once again the proposed actions, timeframe, responsibilities, resources and monitoring must be outlined.

8.3.3 Resource remediation or operating plan

Where water resource remediation or system operation is necessary to achieve the load allocations, this would be specified in a plan, with the required actions, responsibilities, resources, timeframes and monitoring.

8.4 Single source interventions

Single source interventions may take the form of a directive, a licence, or a co-operative agreement. Each of these may be used in any circumstance, but some are more appropriate to certain conditions. These are briefly outlined below.

8.4.1 Directives issued to specific sources

A Water Management Institution may, under Section 19 of the NWA, issue a directive to a specific source to undertake special measures to address their specific impacts. These are particularly appropriate to address specific sources for special attention, and would be issued when the general or existing water use authorisation conditions are insufficient to

address the site-specific impacts of the single source. Directives issued to specific sources would, therefore, be issued where more stringent standards or actions are required of the source.

8.4.2 Licences issued to specific sources

Section 40 of the National Water Act makes provision for the issue of licences to specific sources, based on the considerations in Section 27, with conditions outlined in Section 29. These would be the case of water use that is not generally authorised under Section 39, and would also be appropriate when site-specific relaxation of sectoral, class or area based conditions may be considered. Section 41 of the NWA outlines the procedures for the application of a licence.

8.4.3 Co-operative agreements

Co-operative agreements are particularly suited to situations where simple changes to certain processes or activities may realise significant water quality benefits. This is particularly important as licences and directives can only address the actual discharge to, or impact on the water resource. For example, a water user may co-operate in the phasing out of a hazardous substance in favour of innocuous substances without the need to specify effluent standards for the hazardous substance that may be difficult to police.

REPLY SHEET

Your comments on the Guideline to the Water Quality Management Component of a Catchment Management Strategy (MS 8.2) will be of great value in improving the document. To comment, please complete the following and fax or mail it to the Project Management Committee, or send us the information by e-mail (the Reply Sheet can be e-mailed to you on request for completion, if you prefer).

Comments should be addressed to :

The Director : Water Quality Management
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Private Bag X313, Pretoria, 0001
For Attention : Jurgo van Wyk
Phone : (012) 336 8407; Fax (012) 323 0321; jurgo@dwaf.pwv.gov.za)

Title (Mr/Ms/Dr) …….. First name and surname ……

Organisation ……

Position ……

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Tel : (……..) …… Fax : (……) ……

E-mail : …… Cell : ……

I suggest that you ensure the following people/organisations are contacted for their comments :
(please include any contract details you may have at your disposal)

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I wish to make the following comments at this stage on the Guide to conduct Water Quality Assessment Studies ***(please use another page if necessary)***

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