Department : Water Affairs
and Forestry

Integrated Water Resources Management

# Guidelines for Groundwater Resources Management
## Volume 1: Strategic Framework
### Full Guideline

**DEPARTMENT OF WATER AFFAIRS AND FORESTRY**

# INTEGRATED WATER RESOURCES MANAGEMENT

## GUIDELINES FOR GROUNDWATER MANAGEMENT IN WATER MANAGEMENT AREAS, SOUTH AFRICA

INTEGRATED WATER RESOURCE MANAGEMENT
STRATEGIES, GUIDELINES AND PILOT IMPLEMENTATION
IN THREE WATER MANAGEMENT AREAS, SOUTH AFRICA

**DANIDA**
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**DOCUMENTS FOR OUTPUT 7: STRATEGIES, TOOLS AND SYSTEMS APPLIED WITHIN THE THREE SELECTED WMAS TO ACHIEVE SUSTAINABLE GROUNDWATER DEVELOPMENT AS AN INTEGRAL PART OF IWRM:**

1. a. Groundwater Management Strategy for National Water Resource Strategy, DWAF/DANCED, 2001
   b. Groundwater Management Strategy: Summary, DWAF/DANCED, 2002
   c. Groundwater Management Strategy: Executive Summary, DWAF/DANCED, 2002

2. **a. Guidelines for Groundwater Management in Water Management Areas, South Africa, Carl Bro a/s, IZNA Consortium, February 2002**
   b. Guidelines for Groundwater Management in Water Management Areas: Summary, South Africa, Carl Bro a/s, IZNA Consortium, February 2002
   c. Guidelines for Groundwater Management in Water Management Areas: Executive Summary, South Africa, Carl Bro a/s, IZNA Consortium, February 2002

**RELATED DOCUMENTS:**

First Edition National Water Resource Strategy, DWAF 2002

Integrated Water Resources Management Communication Strategy, DWAF

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Institutional Roles and Linkages: Phase 1 Report, Carl Bro a/s, IZNA Consortium, February 2002.

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Evaluation of the involvement of Previously Disadvantaged Individuals in the Catchment Management Agency establishment process the three Water Management Areas, date.

Capacity Building Overview Assessment Vol.1, Carl Bro a/s, IZNA Consortium, October 2001.

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## CHAPTER 1

## GROUNDWATER CO-ORDINATOR FUNCTIONS

## EXECUTIVE SUMMARY

### Context

Water resources management is presently in a state of flux, with many new water resources management institutions being established, or existing institutions being aligned with the directives of the National Water Act. As a result, huge changes are taking place in the institutional environment, with the roles and responsibilities of many of the new water resource management institutions still vague and unclear. So for example the structures that the Catchment Management Agencies adopt will vary depending of the influence of factors such as the nature of the water resources present in the Water Management Area, the water resource issues most pressing in the catchment, and the sort and degree of water stress being experienced.

### Role of the groundwater coordinator

It is expected that the groundwater coordinator will form a key link in the chain, integrating not only with other water resource managers, but also with land-use and development planners and user groups. In order to operate effectively, groundwater coordinators will need to understand their local groundwater systems and the local institutional systems that interact with the resource.

## 1.11 INTRODUCTION

This document provides an outline of the responsibilities and functions of a groundwater coordinator, and provides some perspectives on his/her relation and interaction with water resource management and related institutions.

An overview is provided on how functions and responsibilities are expected to be divided between the Department of Water Affairs and Forestry (DWAF) and the Catchment Management Agencies (CMAs). The groundwater coordinator should play a leading role in those functions or responsibilities that relate to his or her groundwater management duties.

It should be stressed that groundwater management is not seen as separate from any of the other Water Resources Management functions in the CMA. The individual responsible for coordinating the groundwater management function may be the same person responsible for the coordination of some of the other CMA functions. It is not envisioned that the groundwater coordinator would necessarily be a groundwater specialist. It is however expected that he or she have at least some understanding of the workings of groundwater systems. It is expected that the groundwater coordinator will rely on the specialist knowledge of staff within the groundwater management function. The groundwater coordinator should have an understanding of the level of skill available/necessary within the groundwater function, and should make decisions on when groundwater management tasks should be outsourced.

An illustration of the relationship of the groundwater coordinator to other water resources management institutions is given in Figure 1. The illustration tries to highlight the fact that groundwater management requires a holistic approach that requires regular interaction between the groundwater coordinator and other Water Management Institutions (WMIs). It is expected that the interaction with the Water User Associations (WUAs) and the managers of the other water management functions would be especially common. Where functions are outsourced to consultants a close working relationship is expected.

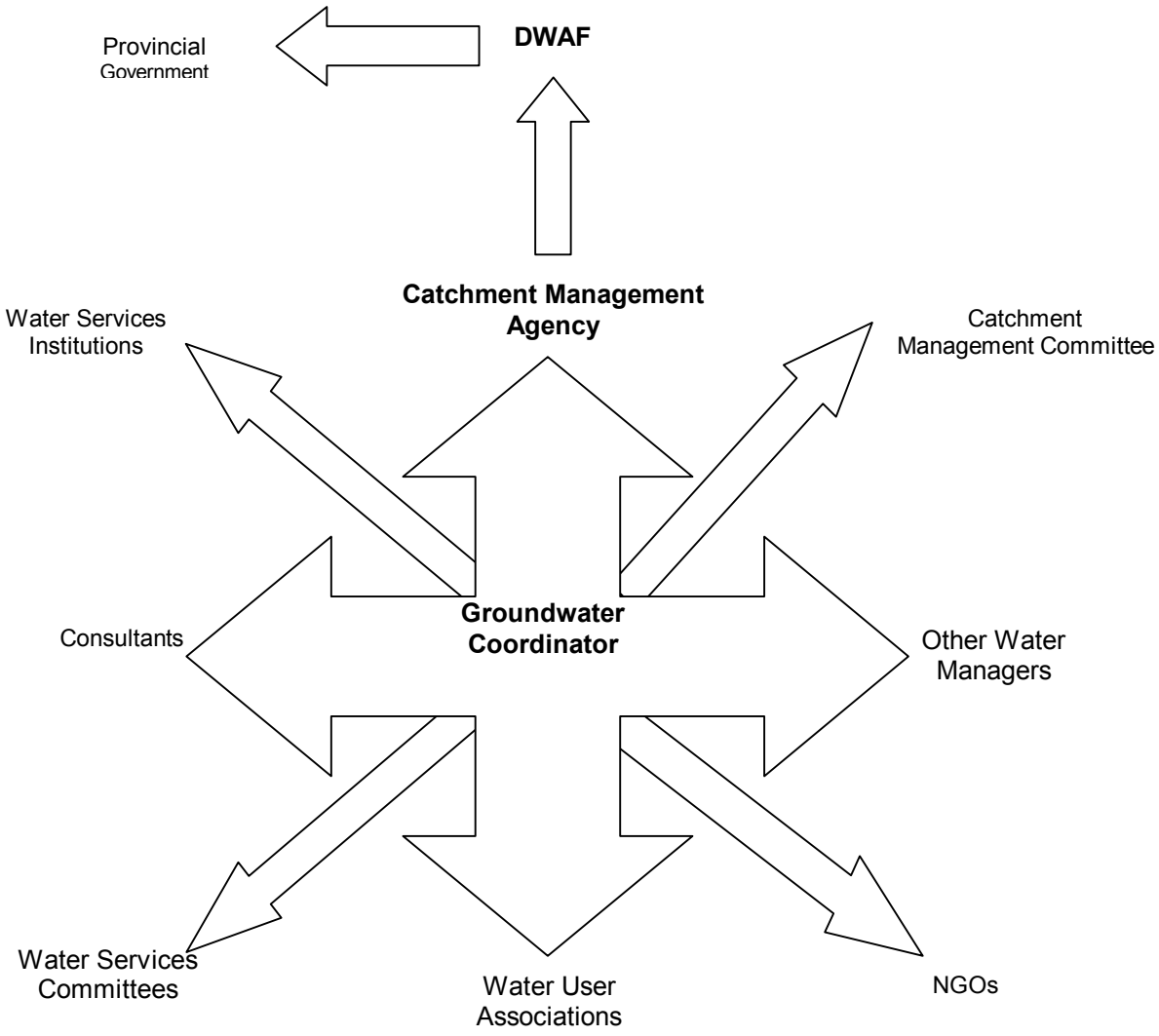


**FIGURE 1: ILLUSTRATION OF GROUNDWATER CO-ORDINATOR INTERACTIONS**

## 1.2 SUMMARY OF WATER RESOURCE MANAGEMENT FUNCTIONS

The following presents a discussion on the water resource management functions and the distribution of those functions between DWAF and the CMAs.

**Policy and Strategy Development**

The development of policy and strategy will be the primary responsibility of the national department (DWAF). This includes the development of a vision for the nations' water resource and developing a strategic plan to achieve this water resource vision. The department will also develop legislation and regulations that support the strategic plans and vision objectives. In part this is done through the National Water Resource Strategy (NWRS). A description of the water resource classes, the Reserve and the Resource Quality Objectives (RQOs) will form part of the NWRS, and will largely be developed by DWAF, but in some cases also by the CMAs.

It is also expected that the DWAF will provide the CMAs with methodologies and guidelines for water resources management, while planning for the reconciliation of water availability will be largely the responsibility of DWAF, with some aspects done at the CMA level. The development of a Catchment Management Strategy (CMS) will be the responsibility of the CMA. DWAF developed the ISPs (Internal Strategic Perspectives) to ensure that all the existing issues and strategies will be included as part of the CMSs. Financial and business planning will form part of this. The CMS should also include details on the Reserve, the RQOs and planning for the reconciliation of water availability.

**Water Use Regulation**

Most of the functions associated with water use regulation will be done at the CMA level. This includes the registration of water use, the authorisation of water use, and the setting, billing and collection of water use charges. Where necessary co-regulation and cooperative agreements will have to be negotiated with other statutory bodies. Cooperation on land-use planning and zoning is important if the sustainability of water resources is to be assured.

**Water Management Institutions**

The responsibility for the establishment of statutory institutions envisioned under the National Water Act of 1998 (Act 36 of 1998) (NWA) largely lies with the DWAF, though the CMA once established will have a key role to play in this process and in sustaining such institutions. It is expected that there will be coordination between DWAF and the CMA on the building of capacity, the resolution of conflicts, the coordination of the activities of the WMIs, the support of water resource planning and management activities, and intervention to overcome problems. The CMA is expected to take responsibility for the establishment of non-statutory consultative and participative bodies, to ensure that there is sufficient stakeholder participation in the WMIs.

**Resource Directed Measures**

Most of the water conservation interventions will take place at local level. It is therefore expected that the CMA take the lead in the implementation of measures such as the implementation of the Working for Water Programme, water demand management interventions, and the rehabilitation of water resources.

**Information Management**

The DWAF will be responsible for the development of data bases and information management systems, but it is expected that the CMAs will be responsible for the gathering, maintenance and management of the data bases.

It is expected that both the DWAF and the CMA will conduct research for inclusion in the data bases.

**Auditing**

It is expected that DWAF will develop the indicators to be used for auditing. A shared responsibility rests with both DWAF and the CMAs to perform financial and organisational audits of the WMIs, functional performance audits, water resources audits against RQOs, and to propose and facilitate corrective action.

## 1.3 INSTITUTIONAL ROLES OF THE GROUNDWATER CO-ORDINATOR

The following are mostly institutional coordination from the groundwater coordinator to ensure that Integrated Water Resource Management (IWRM) principles are communicated and incorporated at all water related institutions in the catchment.

**CMS Development**

The CMA is required to develop a CMS for the use, protection, development, conservation, management and control of the water resources in its WMA.

In order to develop such a CMS, a full appreciation of the groundwater resources is imperative. To achieve this, groundwater specialists will have to form part of the strategy development team, with sections of the strategy being developed by the groundwater specialists. (See Chapter 3).

The implementation of the management strategies developed in the CMS will be largely the responsibility of the groundwater coordinator and the CMA geotechnologists.

**CMC Input**

It is imperative that the CMC include representation of a groundwater specialist to provide technical input on groundwater management issues. This representation may either be through participation of the groundwater coordinator and/or an appointed groundwater specialist.

In order to elicit broader based groundwater specialist input, the CMC may decide to establish a groundwater management subcommittee. It is envisaged that the groundwater coordinator will play a central role in the coordination of the functions of this committee.

**Relationship with the WUAs**

The WUAs serve as a forum through which local communities can give input to the water resources planning process. At the same time, it serves as a vehicle for facilitating changes in the attitude and behaviour of water users. A close working relationship is therefore envisaged between the WUAs and the CMA groundwater coordinator. The interaction of the groundwater coordinator with the WUAs will be both educational and consultative. It is at the local level that a common vision and goals for water resources management can most effectively be developed.

**Water Services Institutions**

Water service providers will require some guidance on the development of their water resources. It is not envisaged that either the water service authorities of the water services providers will employ groundwater specialists. It is expected that they will rather outsource functions such as resource identification, development and monitoring to specialist consultants. Some interaction and consultation with the CMA groundwater coordinator will still be necessary. Especially important will be the exchange of information on the distribution of the groundwater resources, its quality, the rates and volumes of abstraction, and other information required for efficient management of the resource.

The CMA may provide some services to the water service providers. Such services may include;

- Management of groundwater databases;
- Resource assessment and development functions.

## 1.4 SUMMARY OF GROUNDWATER MANAGEMENT TASKS

The following tasks are logical tasks that will have to be overseen by the groundwater coordinator in his/her catchment. More detail of each of these tasks is given in Volume 2.

- *Management*
- *Assessing*
    - *The groundwater resource*
    - *Sustainable safe yield of an aquifer*
    - *Aquifer vulnerability to land-use activities*
    - *Contribution of groundwater to the environmental Reserve*
- *Registration of groundwater use*
- *Allocation to groundwater users*
- *Monitoring*
-
    - *Borehole water use*
    - *Groundwater quality*
    - *Water table drawdown*

## 1.5 IWRM – A GEOHYDROLOGIST'S PERSPECTIVE

Reliable information is critical to many of the functions and tasks of the groundwater coordinator that have been discussed in this document. The information acquired must provide support to:

- The Catchment Management Strategy, as stipulated by law and as required by stakeholders (Volume 1,Chapter 3);
- Assessment of groundwater supply and ideally groundwater demand (Volume 2, Chapter 1);
- Compulsory and ad hoc groundwater abstraction licensing;
- Assessing the role groundwater plays in maintaining aquatic ecosystems, spring flows and river baseflow;
- Groundwater monitoring (Volume 2, Chapter 4);
- Groundwater protection under-pinned by RQOs, taking into account land use activities (Volume 2, Chapter 3).
- Water balance determination – i.e. how much water is coming into the system
- Protection of groundwater is also very important, and protection zones and associated restrictions will have to be determined and monitored (Volume 2, Chapter 3).
- Reserve Determinations will have to be carried out, thus enabling the determination of how much water is available for allocation.
- Land use activities will need to be taken into account and modelling of different land use changes and the consequences to water volumes and quality.
- It is critical that groundwater levels, groundwater chemistry (including microbiology and isotopic data), and borehole data (such as borehole depth, equipment, water strikes etc) is recorded as completely as possible.
- Environmental impacts have to be assessed as a consequence of groundwater abstraction.
- Groundwater levels and water quality monitoring of water resources on a catchment scale.

## 1.6 COMMUNICATION TO ACHIEVE INCREASED PUBLIC AWARENESS OF GROUNDWATER PROTECTION AND POLLUTION PREVENTION

**GOAL**

CATCHMENT MANAGEMENT AGENCIES SHOULD SEEK TO RAISE THE LEVEL OF PUBLIC AWARENESS OF THE IMPORTANCE AND VULNERABILITY OF GROUNDWATER AND TO EMPOWER LOCAL COMMUNITIES TO MAKE INFORMED DECISIONS REGARDING THE PROTECTION OF THEIR GROUNDWATER RESOURCES.

Public participation is one of the guiding principles of recent legislation in South Africa and will be an important component of groundwater quality protection in the CMAs. Public participation is the subject of Output 4 of this project and materials have been developed to guide the public participation process.

The principles of public participation, identification of stakeholders and methods of communication will not be addressed in any detail in this chapter. For guidance on these issues the reader is referred to:

- DWAF, 2001. Generic public participation guidelines. 3rd draft. May 2001. Department of Water Affairs and Forestry.
- CarlBro International 2001. Guidelines for stakeholder participation in integrated water resources management in Water Management Areas in South Africa. Draft version. March 2001.

Extensive provision has been made in the NWA for stakeholder consultation and community involvement in decision-making. Community involvement in groundwater quality protection, however, can only be effective if the affected community is empowered to make informed decisions regarding the protection of their resources. Education is also needed to empower potential polluters so that they can manage their activities to prevent or minimise their impact on groundwater quality and reduce their environmental liabilities.

Educational initiatives need to be implemented by the CMAs to raise the level of awareness and develop skills needed by communities to protect their groundwater supplies. These will require cooperation with local authorities and non-government organisations (NGOs) that are currently working with communities.

Education programmes need to be targeted at various levels including:

- School children – Cooperation with the educational authorities is needed to ensure that learners are taught about groundwater as a part of the water cycle and the threat of groundwater pollution in their study of the Natural Sciences.

- Public education – Programmes are needed to raise public awareness of groundwater, particularly in communities where drinking water is provided from aquifers.
- Potential polluters – Best Practices for groundwater protection need to be communicated to managers and operators of a range of facilities in the industrial, commercial, agricultural and mining sectors.
- Regional and local authorities – CMAs need to communicate groundwater protection issues and promote capacity building in the institutions responsible for land use planning. CMAs need to be proactive in the land-use planning process.

**Public education**

Community education projects can provide a key component of a successful groundwater protection strategy. Many people who rely on groundwater for their drinking water don't know it. For most people, water comes from the tap or a pump and they may never have considered the types of activities that can threaten their water supply, steps that might be taken to protect it, or the possible consequences to the local economy and public health of doing nothing. A groundwater education project can help communities to understand these issues and the interrelationships between groundwater, drinking water and surface water

On the other hand, if local residents are acutely aware of their water source, it may be due to some crisis or controversy, perhaps a chemical spill has threatened the aquifer, for example, or a zoning decision has sparked heated debate. In these circumstances a groundwater education project can help clear the air and allow a reasoned discussion of relevant facts and issues. In any case, public education is an important first step toward the development of a protection plan that will adequately address local conditions and enlist the support of the community (LWVUS, 1994).

**Knowledge surveys**

A knowledge survey is designed to determine how much a community already knows and what they care about most concerning their water supply. Survey results will be more meaningful if they reach a broad spectrum of the community. Such a survey can:

- identify misconceptions/myths about where groundwater comes from and how it can become contaminated,
- demonstrate a community need for information on local water resources,
- help target your efforts for the most impact and benefit,
- attract attention and support for groundwater projects,
- encourage local officials who participate in the survey to become better informed,

A typical survey asks community residents:

- where their drinking water originates; and
- what they consider to be the most serious health risks to drinking water.

Several sources of public information and educational materials about the nature of groundwater and groundwater protection measures are given at the end of the chapter.

### 1.1.7 CO-OPERATIVE GOVERNANCE IN LAND-USE PLANNING

**GOAL**

CATCHMENT MANAGEMENT AGENCIES SHOULD PARTICIPATE IN LAND USE PLANNING ACTIVITIES AND COOPERATE WITH AUTHORITIES RESPONSIBLE FOR THE ALLOCATION OF LAND FOR PRESCRIBED PURPOSES, SO THAT GROUNDWATER INTERESTS CAN BE PROTECTED.

All spheres of government and organs of state in South Africa are obliged by the Constitution of the Republic to observe and adhere to the principals of cooperative government (Act 108 of 1996, Section 40, 41).

Cooperative governance in land use planning is critical for successful water quality management in South Africa, and particularly for groundwater quality management since most groundwater pollution threats arise from land-based activities. All government departments in South Africa agree in principle that cooperative governance is needed, but the instruments to achieve this are still lacking.

Influence over and regulation or prohibition of land-based activities, and especially involvement in the planning and decision making process which leads to the allocation of land for prescribed uses, are central to the management of groundwater quality. Provision for regulating land-based activities is made in Section 13 of the NWA and by the declaration of controlled activities under Sections 37 and 38.

Most decisions on land use are outside the direct control of the CMA. CMAs, therefore, need to develop close working relationships with institutions that do control development, such as regional and local government.

CMAs need to participate proactively in land-use planning and to cooperate with local government to ensure that potentially polluting activities and facilities are located in areas where aquifers are least vulnerable or where no exploitable groundwater exists. One of the methods of achieving this may be by developing and maintaining memorandums of understanding with other authorities responsible for land-use allocation. DWAF may assist in the process by prescribing in legislation to land-use planning authorities the location of such activities (Viljoen, *in prep*.). Where required, this should be preceded by consultation with relevant stakeholders.

The groundwater coordinator should be directly involved in:

- Awareness-building in local authorities of groundwater-related issues.
- Becoming a stakeholder in the drafting of Water Services Development Plans by municipalities.

A land-use planning programme has been proposed by DWAF (2000) through which the Department will seek to play an increasingly prominent role in influencing land-use planning processes and decisions in order to provide the best possible level of protection to groundwater resources. Under this programme, land development objectives (LDOs) will be set after due consideration of impacts to groundwater.

One of the goals of the land-use planning programme is to establish the legal and administrative framework within which DWAF can exercise the appropriate level of influence over land use planning decisions and the regulation or prohibition of land-based activities. The land-use planning programme will need:

- ❖ take cognisance of the roles of other state organizations and especially the role of local government in making land use decisions.
- ❖ to develop capacity in water management officials to enable them to inform decision makers, and
- ❖ to develop land-use planning guidance notes and educational literature on groundwater protection to be distributed to all public and private sector institutions involved in planning.

**Cooperation with government departments**

DWAF assumes the lead role for management of the quality of water resources at a national level, but relies on other departments to assist in the execution of this role and, in particular, to influence land use. The decentralisation of water management functions to the CMAs will require CMAs to become involved with other government departments, such as the:

***Department of Provincial Housing and Local Government:*** May request municipalities to produce Water Services Development Plans (WSDP). The Municipal Structures Act (1999) and the Municipal Systems Act (2000), facilitate the formation of demarcation boards, integration of district council and local authorities and makes funding available subject to a WSDP being produced.

**Department of Environmental Affairs and Tourism (DEAT):** Concerned with activities that the affect the natural social and built environment through Environmental Impact Assessments (EIAs), Environmental Management Plans (EMPs), Strategic Environmental Assessment (SEA)for example water and air pollution. One of DEAT's tasks is to evaluate the sustainability of water (or any other) development project in accordance with EIA requirements – interaction with DWAF or the CMA is desirable in this process.

Examples of environmental legislation controlling land use:

- Permit requirement for waste disposal sites (Environmental Conservation Act (ECA), Section 20), which are administered by DWAF
- Scheduled activities (ECA Section 21) require authorisation and impact study. Scheduled activities which might impact groundwater include:
    - ⇒ the construction or upgrading of schemes for the abstraction or utilisation of ground or surface water for bulk supply
    - ⇒ the construction or upgrading of sewage treatment plants and associated infrastructure
    - ⇒ land use changes from residential to industrial, light industrial to heavy industrial, grazing to other agricultural uses
    - ⇒ land use changes from general agricultural, conservation or zoned open space to any other use

⇒ intensive animal husbandry

⇒ waste disposal in terms of Section 20 of the ECA.

**Department of Agriculture and Land Affairs:** Some of this Department's activities have a direct impact on water use. For example it is responsible for the optimal use of water resources through planning and effective use of irrigation water and to create farming opportunities for new entrants on a sustainable basis. Agriculture is the largest water use sector at present and efficiency of water use in this sector is going to receive increasing attention in the management of water resources. The Department also has a influence on land use and hence water demand, it is involved with planning and relocation of disadvantaged persons, especially those displaced by water resource development, Management of land restitution must be sympathetic to access to water.

**Department of Minerals and Energy**: Required to authorise opening and closure of mining operations that impact on water resources e.g. sand and rock quarries. There is a legal requirement for approval of an EMP for mining activities under Section 39 of the Minerals Act (Act 50 of 1991).

**Department of Public Works**: Acquires land for State development as well as disposes of severance land.

**Department of Health:** On matters of regional and national health, which could be affected by water borne diseases or health impacts of water contamination.

The National Environment Management Act (NEMA, Act 107 of 1998) enables role players from various government departments to take part in the Committee for Environmental Co-ordination. This forum provides the opportunity for potential conflicts to be addressed and resolved and for Departments that have an influence on land use to be informed and equipped regarding water resource classification.

NEMA also makes provision in Chapter 3 for cooperative governance in environmental management through the requirement that every national department exercising functions which may affect the environment and every province prepare an environmental implementation plan (EIP).

**Cooperation with local government**

The functional areas of competence of local government include a number of activities that are relevant to catchment management such as municipal planning, waste management, water supply, sanitation and storm water management. It is evident therefore that local government can make a useful contribution in the planning and the development of catchment management strategies.

Municipalities have a legal obligation under the Municipal Systems Act (Act 32 of 2000) to undertake developmentally oriented planning and to prepare Integrated Development Plans (IDPs) to address issues such as service provision and spatial planning. The drafting of IDPs is a key area where the CMA will need to be involved with the municipalities in the Catchment Management Area.

The Municipal Systems Act (2000) gives as one of the core components of an IDP (Section 26):

> *"A spatial development framework, which must include the provision of basic guidelines for a land use management system for the municipality"*

This provides an opportunity for the groundwater coordinator to publicize groundwater protection issues, by ensuring that these become a consideration in the spatial development framework.

Overlapping jurisdictions are a potential area of conflict between local and national government. Local government has control over land development and use, but both the Minister of Water Affairs and the Minister of Environmental Affairs and Tourism can potentially control land-based activities. For example, the Minister of Water Affairs has the power to declare controlled activities under section 38 of NWA and the Minister of Environmental Affairs and Tourism can control land use, which may have a detrimental effect on the environment under section 21 of the ECA.

**New developments**

Further integrated pollution control mechanisms will be developed under the joint National Waste Management Strategy, issued by the DEAT and DWAF. A White Paper on Integrated Pollution and Waste Management for South Africa was published in March 2000. In this document, effective institutional framework and legislation and holistic and integrated planning are set out as strategic goals. The DEAT is undertaking a law reform process to identify all the requirements for new and amended legislation relating to all aspects of the environment, including pollution and waste management.

One of the aims of the process is establish a single, streamlined and efficient administrative system for the authorisation process and reporting requirements of controlled activities, replacing the current fragmented and inefficient systems. As the guardians of water resource quality, CMAs should be involved in this process.

New land use planning legislation is also in development. A new government policy on land use planning was published in July 2001 by the Ministry of Agriculture and Land Affairs in the form of a White Paper on spatial planning and land use management. The white paper proposes:

- The establishment of Land Use Regulators. These will be authorities able to take the different types of decision falling into the realm of spatial planning and land use management. The most prevalent land use regulators will be Municipalities i.e. operate at local government level.
- Integrated Development Plan (IDP)-based local spatial planning. An IDP is required from each Municipality under the Municipal Systems Act (Act 32 of 2000). The Municipal IDP will be required to include a spatial development framework.
- The development of a uniform set of procedures for land development approvals. One set of procedures will be developed for the whole country for proposed developments, which are not permissible in terms of prevailing land use management schemes. These procedures will be aligned with those presently required in terms of the Environmental Conservation Act (1989) for EIAs.

The white paper also sets out principles and norms for land use and management which aim, among others, to promote the sustainable use of land resources in the country and in addition promote cooperative governance and wider information sharing in plan-making and implementation.

Two of the principles of interest to groundwater quality protection and cooperative land use planning are:

- Principle of sustainability: Land use planning and development should protect existing natural, environmental and cultural resources
- Principle of integration: Land use planning and development decisions should take account of and relate to the sectoral polices of other spheres and departments of government.

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# CHAPTER 2

# GROUNDWATER IN THE NATIONAL WATER RESOURCE STRATEGY

## EXECUTIVE SUMMARY

### Context

The groundwater coordinators in the CMA's will have an important role to play in providing input based on their experiences. Nationally, the Directorate of Information Management is expected to play a strong role in funnelling groundwater experience towards the development of the NWRS, prior to the establishment of the majority of CMAs, and in collating experiences relevant for its review in the long term. In the interim, the DWAF Regional Offices will take the role of CMA

A national groundwater strategy aligned to the NWRS has been produced under the DWAF-DANIDA project and key elements and objectives of that document are presented in this chapter. The strategy addresses a host of issues at a national level, with recommendations for a range of role players.

### Role of the groundwater coordinator

The first draft of the NWRS will have been gazetted by the time groundwater coordinators are established in their water management areas (WMAs) within the first established CMA's. This chapter highlights key areas of the NWRS, as defined under the NWA, where groundwater coordinators may contribute towards regular review. In this way the groundwater coordinator can ensure that the NWRS undergoes its intended iterations and incorporates critical considerations for groundwater management in the national framework for IWRM. A check-list is presented for review and it is expected that this list of considerations will be strengthened during the life of the working document.

### Key recommendations

An important recommendation of the National Groundwater Strategy is re-emphasised here: the need to include hydrogeologists at all levels of decision making in CMAs and nationally, particularly in National Planning. This is essential if we are to realise IWRM.

An essential prerequisite to meaningful representation from a catchment level is that the Department of Water Affairs and Forestry assumes the role of coordinator and makes available resources to ensure that the NWRS and national planning office take groundwater issues into account.

## 2.1 INTRODUCTION

The National Water Resources Strategy (NWRS) is in the final approval stage by DWAF to provide a national framework for water resource management, and guide the preparation of the Catchment Management Strategies.

Part 1 of the National Water Act of 1998 (Act 36 of 1998) (NWA) requires the progressive development, by the Minister, after consultation with society at large, of a national water resource strategy. The NWRS provides the framework for the protection, use, development, conservation, management and control of water resources for the country as a whole. It also provides the framework within which water will be managed at regional or catchment level, in defined water management areas. The NWRS, which must be formally reviewed from time to time, is binding on all authorities and institutions exercising powers or performing duties under this Act. The outcomes of the NWRS are set out in the NWA Chapter 2, Section 6.

A specific Groundwater Strategy for the NWRS was produced by the DWAF in partnership with DANIDA in 2001. This aimed to provide:

- Groundwater input to the NWRS, and
- Present a groundwater strategy in a standalone document, which would help take groundwater from a neglected private water status to that of a significant resource managed as part of IWRM.

The report lists a suite of 29 strategies (presented as objectives and intermediate objectives), which aim to facilitate the achievement of IWRM through the NWRS. Of the 29 strategies suggested, five core strategies are identified as priorities:

- Groundwater must be integrated into the management of water resources for the benefit of all of South Africa's peoples;
- Groundwater needs to be promoted so water resource managers, water users and the public are more aware of the role, occurrence and value of groundwater;
- Hydrogeologists need to be encouraged and enabled to work outside their line function, and be integrated in broader water resource planning and management functions;
- A larger, skilled and experienced specialist hydrogeological workforce is required; and
- Groundwater monitoring and development of a hydrogeological information system are required to assist in the provision of data to those who need it.

## 2.2 HOW DOES GROUNDWATER FIT INTO THE NATIONAL WATER RESOURCE STRATEGY?

Expecting the NWRS to be gazetted by the time the CMAs are established, the main role of the groundwater coordinator will be to provide relevant information for the review of the NWRS. The main areas of the NWRS are outlined below and opportunities for contributions from the groundwater coordinator identified by means of a checklist. The groundwater coordinator should bear these opportunities in mind and be prepared during the review period to raise these issues through the CMA to DWAF.

**The requirements of the Reserve and water resources from which particular requirements must be met.**

- Population developments will influence requirements for the basic human needs Reserve. Is groundwater viably located and protected to meet these needs?
- Refinement of understanding of groundwater fed baseflow to surface water may give a better indication of the ecological Reserve requirements for different aquifers.

**International rights and obligations.**

- What are the hydrogeological boundary conditions at international boundaries?
- Have abstraction regimes or longer-term changes in recharge conditions changed the initial boundary conditions in these areas?

**Actions to be taken to meet projected future water needs.**

- Where are the key areas for population growth or increasing demand from industry and agriculture?
- Is groundwater viably positioned to meet these needs?
- Are groundwater resources going to be placed under increasing risk as a result of these changes?

**Water use of strategic importance.**

- The NWRS specifically considers water demand for power generation. Is there an improved understanding of the role of groundwater fed baseflow, upgradient of hydro-electric schemes?
- The fact that groundwater is often less susceptible to climatic variations may make it a more secure source of supply to some strategic uses, e.g. power generation.
- The view of strategic importance may evolve, as issues of water and food security become more pressing. The critical role of groundwater in supporting all strategic uses should be outlined.

**Establish water management areas and determine their boundaries**

- There may be significant trans-boundary flow of groundwater between WMAs. Are the boundary conditions of groundwater a source of contention between CMAs?

**Estimates of present and future water requirements or needs**.

- Are key areas of growth located in areas with greater access to groundwater than surface water?

**State the total quantity of water available within each water management area.**

- What new information and understanding has been developed with respect to sustainable groundwater resources available?
- Have original estimates been refined since the last NWRS?

**State water management area surpluses or deficits.**

- Have improvements in water conservation or demand management, or reductions in demand, made more groundwater available for allocation?
- Is there a groundwater 'overdraft' as a result of over-exploitation in the past?
- Are the requirements of the ecological Reserve met?

**Provide for inter-catchment water transfers between surplus water management areas and deficit water management areas.**

- Can aquifers be used to transfer water from water-rich to water-poor WMAs using artificial recharge or by reversing regional gradients?
- What would be the environmental impacts of such a scheme compared to piped surface water transfer?

**Set out principles relating to water conservation and water demand management.**

- What key success stories of groundwater conservation should be up-scaled to national level?
- State the objectives in respect of water quality to be achieved through the classification system for water resources provided for in this Act.
- Are the Resource Quality Objectives (RQOs) for groundwater, including the Reserve, being met and leading to an optimal balance of protection and use?
- What revisions to the RQOs are necessary to realise effective protection?

**Set objectives with respect of water quality to be achieved through the classification system.**

- Is the remediation of aquifers required?
- Does baseflow quality meet the class and Reserve requirements?

**Objectives for the establishment of institutions to undertake water resource management.**

- Which forums and associations are proving most effective in participating in sustainable IWRM?
- What are the key factors for success of these groups and their contributions?

**Determine the inter-relationship between institutions involved in water resource management.**

- What has contributed to the success of a relationship with stakeholder groups?
- How could agencies and departments responsible for land-use planning and control be engaged more effectively?

**Promote the management of catchments within a water management area in a holistic and integrated manner**

- How could groundwater management be further integrated with surface water and other aspects of IWRM?
- Where are the key gaps in integration?

In addition to the specific sections of the NWRS, it is important that groundwater coordinators keep in mind the overall aims of the NWRS and the NWA. It is recommended that on an annual basis the responsible person among groundwater coordinators must facilitate a discussion on the realisation of IWRM from a groundwater perspective. The session should aim to identify generic obstacles to the integration of groundwater in catchment management and set objectives to overcome these at a national and catchment level.

## 2.3 NATIONAL STRATEGY FOR GROUNDWATER AS PART OF INTEGRATED WATER RESOURCE MANAGEMENT.

For groundwater to be integrated successfully in water resource management in South Africa, a suite of practical, feasible and affordable strategies must be developed and implemented. This section draws some key considerations from the Groundwater Strategy for the NWRS document (Parsons,R., Jolly, J., Titus, R., Toksvad, T).

| | |
|---|---|
| **Groundwater Management** | All water resource management at national, catchment and local levels must be based on the principles of IWRM |
| | Groundwater must be recognised as an integral part of a catchment's water resources, and properly managed according to sound scientific assessments and participative planning |
| | Each CMA must be required to include a groundwater management plan as part of the catchment management framework |
| | Each CMA is required to have sufficient groundwater specialists available to oversee sustainable development, monitoring and management of groundwater resources |
| **Groundwater Protection** | Improve public awareness and involvement as a guard against degradation of groundwater resources. The public must be empowered to understand groundwater issues and appreciated the value of the resource |
| | Protect water resources using instruments such as land-use zoning, classification of aquifers, environmental management plans and EIAs |
| | Involve groundwater institutions and specialists in the debated and decision–making processes regarding South Africa's resources and environment. |
| **Monitoring** | Ambient hydrogeological monitoring is to be implemented at a catchment level, with data storage and management facilitated by the central authority. |
| | Monitoring of aquifer response to abstraction and potential pollution is to be driven by licensing and permitting, with the CMA responsible for implementation. |
| | The central authority is to provide guidance regarding monitoring protocols and requirements, as well as audit monitoring undertaken at a local scale. |
| **Data and Information Management** | A national hydrogeological information system is to be developed and implemented as a matter of urgency. |
| | Widespread promotion and use of the information system amongst the hydrogeological community is to be fostered, so that hydrogeological data and information exchange readily can be achieved. |
| **Priority Use of Groundwater** | Groundwater is to be used in instances where comparison to surface water resources shows it to be economically and environmentally superior. |
| | To promote conjunctive use of groundwater and surface water as a part of integrated water resource management. |

| | |
|---|---|
| **Institutional Arrangement** | CMAs are to integrate groundwater management with their own activities |
| | Groundwater Advisory Groups are to be established to provide assistance and guidance to CMAs or groups of CMAs |
| **Human Resources** | Experienced hydrogeologists must become active participants in the planning and management hierarchies of both DWAF and CMAs |
| | Every CMA has groundwater expertise at management level. |
| **Education and Training** | Specialist groundwater education and training programmes, including an IWRM component, must be developed and promoted |
| | Principles of IWRM are to be included in all water related education and training curricula. |
| **Capacity Building** | Enhance the capacity of non-specialists with respect to groundwater management as an integral part of IWRM |
| | Enable institutions, including historically disadvantaged institutions, to sustain development of well qualified water managers |
| **Promotion of Groundwater** | Initiate a multilevel information campaign to promote knowledge and awareness of groundwater |
| | Establish a South African Groundwater Trust to develop and lead a multilevel awareness and education campaign, both inside and outside the public sectors. |
| | Disseminate information about successful groundwater schemes, while offering reasons for the failure of less successful projects |
| | Encourage the hydrogeological fraternity to present lectures and talks to schools, business organisations, learned societies, environmental societies etc. |
| **Research Needs** | Relevant and applied groundwater related research should be promoted, so practicing hydrogeologists have both knowledge and appropriate tools to manage South Africa's groundwater resources in an integrated manner |
| | Research should be used as a vehicle to accelerate education, capacity building, transformation and implementation of integrated water resource management |

## 2.4 REFERENCES

**National Water Resources Strategy draft:** review available on website: http://dwaf.gov.za.

**National Water Act of 1998 (Act 36 of 1998)**

**Parsons, R., Jolly, J., TITUS, R., Toksvad, T, 2001: STRATEGIES** for Inclusion of Groundwater in the National Water Resources Strategy, Department of Water Affairs and FORESTRY, Pretoria.

# CHAPTER 3

# GROUNDWATER IN CATCHMENT MANAGEMENT STRATEGIES

## EXECUTIVE SUMMARY

### Context

An important component of integrated water resources management is the development of a catchment management strategy. The role of the catchment management strategy is to provide the direction and intermediate objectives to achieve the vision of the stakeholders in the water management area. It should outline objectives, strategies, plans, guidelines and procedures to achieve effective integrated water resources management.

Groundwater should not have an independent strategy but be included where appropriate in the general catchment management strategy. Much of the technological and management expertise in the catchment management agencies is, however, expected to have surface water focus. This may result in a bias toward surface water resources at the cost of groundwater. It is recommended that special attention be paid to the inclusion of groundwater in the first catchment management strategy to establish direction for future revisions. The following strategies outline groundwater components of catchment management strategies.

### Foundation Strategies

- Overall strategy to increase the use of groundwater to address issues such as general water shortages, poverty alleviation, public health improvement and job creation;

- National Water Resource Strategy-oriented strategies to meet the requirements of the National Water Resource Strategy on issues such as the Reserve, water availability, water balance, transfers, international obligations and strategic uses;

- Stressed catchments strategy to alleviate the water resource situation in stressed catchments;

- Institutional development strategy to deal with existing institutions and development of a new institutional framework. The groundwater co-ordinator is expected to form a key link in the chain, integrating not only with other water resource managers, but also with land-use and development planners and user groups;

- Land-use planning strategy to influence groundwater related aspects of land-use planning and integrate development initiatives with catchment management strategies;

- Resource-directed measures strategy for management classes and resource quality objectives;

- Human resource strategy to secure the availability of the specialised skills necessary for effective groundwater management. Many of the groundwater management functions could be outsourced;

- Co-operative governance strategy on liaison with other government role players in catchment management and a communication strategy for joint planning;

- Public involvement / interaction strategy to optimise the process of reaching stakeholders and secure their meaningful participation;

- Data collection and information management strategy to secure collection of new hydrogeological data;

- Capacity building/education strategy to cultivate an understanding and appreciation of the role and functioning of groundwater;

- Auditing and review strategy that identifies the catchment management strategy aspects to be audited, audit standards and indicators;

- Conflict management strategy to address the potential conflicts caused by the change from private to public ownership of groundwater and the economic and social consequences of this, and

- Financial strategy to ensure financial viability of the catchment management agency in general and the groundwater-related activities in particular.

**Supporting Strategies**

- Overall management strategies for quantity and quality management, protection, use, development, conservation, ecological sustainability and financial viability of the resource;

- Water resource protection strategies for maintaining resource quality objectives, and for dealing with sources of pollution and ecosystem threats;

- Water use strategies for various water-use scenarios, pricing strategies and water allocation;

- Water resource development strategies, including assessment of existing water supply schemes and strategies for new development proposals;

- Water resource conservation strategies, including conjunctive use, artificial recharge and demand management strategies;

- Water resource control strategies for groundwater monitoring and risk management.

**Integration of Strategies**

The foundation strategies are not totally independent of the supporting strategies, but should be kept separate to facilitate preparation of the catchment management strategy. The catchment management agency should bear in mind the potential linkages before preparing the individual strategies so that duplication can be avoided and streamlining optimised.

## 3.1 INTRODUCTION

Integrated Catchment Management (ICM) in South Africa is still dominated by a surface water background and focus. The NWA is widely considered to be forward thinking and robust legislation that enables Integrated Water Resources Management (IWRM). However, much of the technological and management expertise incumbent in current IWRM has a surface water focus. The development of measures to implement the National Water Act is therefore in danger of biasing surface water resources. This would undermine truly integrated water resources management and result in the under utilization and under protection of South Africa's important groundwater resources. The consequences of this could be a constraint on the full and equitable socio-economic development of the country.

An important component of the ICM process is the development of a Catchment Management Strategy (CMS) that facilitates water management at the WMA level in each of the 19 Water Management Areas. The CMS should aim to facilitate the management of the water resources environment and influence human behaviour to achieve equitable, efficient and sustainable use of water for the benefit of all users (DWAF, 2001).

This chapter aims to highlight the role that the Catchment Management Strategy will play in the management of the groundwater resources of catchments. If the value and importance of groundwater in meeting basic supply, sustaining ecosystems, and increasing the assurance of supply are to be realised, groundwater specialists and managers will have to give meaningful input to the development of the Catchment Management Strategies.

Furthermore this document serves to highlight those sections of the CMS where groundwater focussed input is likely and appropriate. This is done through a description of the principles that underlie the CMS development process, the pre-requisites for developing a CMS, and a description of the CMS development process. This is followed by a description of those strategies that enables an environment suitable for the execution of water management strategies (including the CMS). The role of groundwater is described for each of these strategies.

The CMS will not be a once-off plan for managing water resources in a catchment, but rather a 'phased implementation of a dynamic, participative, integrated process' that must be regularly reviewed (at least once every 5 years) (DWAF, 2001). The CMS development process consists broadly of the following steps: data collection, investigation, information assimilation, planning, implementation, monitoring and control, auditing and review. These components need to be integrated and implemented through an institutional framework that is yet to be developed. The components generally contain "action items", which are designed towards implementing the objectives of the strategy, and to explain who is going to do what, where and when, as well as why and how.

If water resources management is to be effective, a number of conditions need to be met. These may be summarised as follows (DWAF, 2001):

- Appropriate and adequate information,
- Appropriate strategies and plans,
- Adequate financial and human resources and
- Sufficient involvement and support of stakeholders.

Many of the components that add to the CMS is discussed in the other chapters of this document. The reader is referred to these when addressing specific components to be included in the CMS. Among the topics discussed is the role of the National Water Resources Strategy plays in providing a national framework for the management of water resources and the expected context of groundwater in the NWRS. While the NWRS gives a description of the water resources in catchments, the CMAs are expected to refine these for their own WMA.Volume 2, Chapter 2 of this document gives guidance and a description of the tools for the assessment of the water resources in the WMA. Volume 1, Chapter 1 and Chapter 4, as well as Volume 2, Chapter 2 and Chapter 3 discusses methods to achieve the goals of IWRM, including, the role of the groundwater coordinator in facilitating integrated planning and development; the optimisation of groundwater use through tools like conjunctive use, artificial aquifer recharge, and others; the allocation of groundwater resources with due regard for the principles of equity, efficiency and transparency; and guidelines on the implementation of water quality management strategies. Volume 2, Chapter 4 and Chapter 5 discuss the monitoring of groundwater resources and the use of information systems in groundwater resources management.

## 3.2 PRINCIPLES, PRE-REQUISITES FOR AND DEVELOPMENT OF THE CMS

### 3.2.1 Principles

The role of the Catchment Management Strategy (CMS) is to provide the 'road map' (directions and intermediate objectives) to achieve the vision of the stakeholders in the water management area. Section 9 of the NWA outlines the contents of the strategy, which need to be covered to achieve this. These can be summarised as follow:

**Neighbourliness** The CMS must meet the requirements of the National Water Resources Strategy (currently being drafted by DWAF). This will give a first indication of allocatable water in the catchment and dictate its obligations to Inter-Basin Transfer and International obligations.

**Current status** The CMS should consider the natural and anthropogenic character of the catchment – in other words the strategy must follow a situational analysis detailing the local economy, population distribution, geology, run-off, etc.

**Public participation** The strategy must state how it will enable the public to participate in managing water resources.

**Balance** The strategy must outline how it will protect, use, develop, conserve, manage and control water resources in its catchment.

**Protection** The CMS must include a strategy to meet the Resource Directed Measures (Reserve, Class, Resource Quality Objectives) given by the minister in that specific WMA.

**Development** In the spirit of cooperative governance, the CMS should be aligned to national and regional plans, in particular Water Service Development Plans and Integrated Development Plans, and should influence these.

**Conservation** A specific strategy for demand management should be included in the CMS. This should include controlling demand from bulk suppliers as well as individuals and should firstly focus on cutting losses and inefficiency.

**Use** The CMS should aim to address the needs and expectations of existing and future water uses. The allocation plan outlines the principles, which will guide the authorisation of water use. These principles will be decided by the stakeholders in the catchment. The allocation plan further outlines the philosophy for allocation (who has priority, etc), the allocation schedule comes later and says who gets what. (See Volume 2 Chapter 2.)

**Institutional arrangements** The CMS should give an indication of the institutions to be established. The strategy is likely therefore to precede the full establishment of the CMA. If the aim is to establish the structure of the CMA around its functions (and goals), these should be outlined first. Whatever the initial institutional arrangements they should remain flexible and able to respond to evolving needs. Catchment management will be established in a phased and progressive manner.

**Efficiency** The CMA is required to fulfill its functions in an efficient manner. Monitoring of this efficiency should be outlined in the CMS and Key Performance Indicators (KPIs) selected. KPIs should monitor the efficiency and effectiveness of the CMA in financial, participatory, delivery and environmental terms.

**Effectiveness** A plan for information and knowledge management will be key to the effectiveness of CMAs. A database should be collated with the first situational analysis.

The CMS should outline objectives, strategies, plans, guidelines and procedures to achieve effective integrated water resources management within its catchment. The level of detail required will therefore range from broad aims to specific procedures, so the full strategy will exist in many layers. The basic formulation of a strategy is shown in Figure 3.

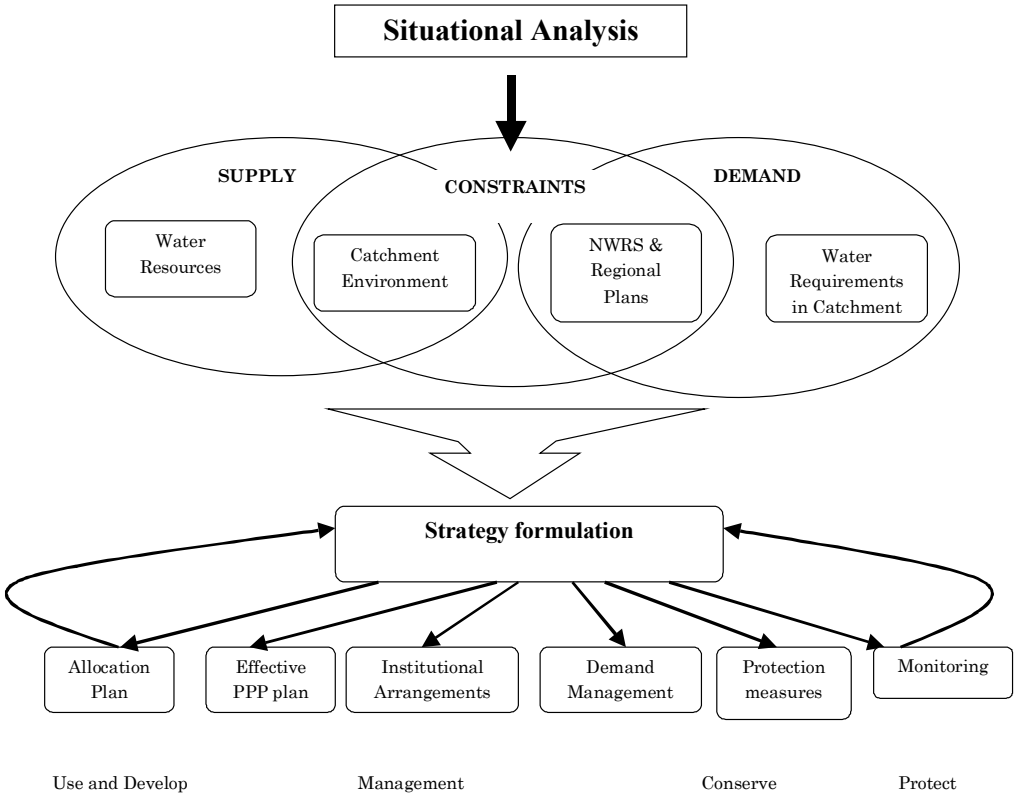


**FIGURE 3: STRATEGY FORMULATION: PREREQUISITES AND OUTPUTS**

### 3.2.2 Pre-requisites for a Catchment Management Strategy

The formulation of a strategy for catchment management should happen early in the catchment management process and provide overall goals and guidance on how to achieve these goals. However, the strategy itself is dependent on information from national and local sources. Some of the main pre-requisites for a CMS are not available for this outline and assumptions about these pre-requisites are listed below. To a certain extent the strategy development becomes iterative, as more information becomes available to fine-tune the directions given.

| | |
|---|---|
| **Catchment Management Agency** | It is the duty of each CMA to formulate a CMS, therefore they will be established before the strategy is worked out. If the CMA is in place, many of the institutional links, roles and responsibilities will be determined. In this hypothetical model we do not have a CMA, but we will follow the principle that form should follow function, and focus on the 'what' and give a broad indication of the 'who'. |
| **State of the Environment** | The strategy should be based on a sound understanding of the constraints and opportunities of the local environment as well as information on the demand for water services. A full strategy should be based on a thorough situational assessment. |
| **Effective stakeholder participation** | The strategy should represent the needs and wishes of all stakeholders in its catchment. However, an aim of the strategy is to ensure that effective public participation is achieved and mechanisms for full representation may not be in place during the strategy formulation. |
| **National Water Resources Strategy (NWRS)** | The NWRS will guide the CMS in its obligations to neighbouring catchments, including international neighbours, and give a rapid assessment of the Reserve, resource classification, RQOs and allocatable resources. In turn, the NWRS should be receptive to guidance from the CMAs on strategy directions. |

### 3.2.3 Development of the CMS

**In summary, the strategy should tell us…**

| | |
|---|---|
| Where are we now? | *The situational analysis.* |
| Where do we want to be? | *The vision and objectives.* |
| How will we get there? | *Procedures and action plans.* |
| How will we know when we are there? | *The objectives and KPIs.* |

This has been summarised as 3 main components:

1. **Situation assessment** to establish the characteristics of the WMA, covering demographics, a profile of water resources, physical characteristics, hydrological and hydro-geological characteristics, vegetation and land-use profile, water use profile and economic overview. The situation assessment is generally done at catchment level, and then combined to describe the WMA as a whole.

2. **Foundation strategies** that provide the over arching framework for managing water resources in the WMA but do not deal with specific aspects of water resource management. These strategies create the framework for human and financial resources and the institutional development necessary to involve and deal with stakeholders as well as to implement the strategies. This is why the term “foundation” has been used because these strategies provide the enabling framework (i.e. a basis to work from) to get from the situation assessment (“where we are now”) to the water management strategies (“where we would like to be”).

3. **Supporting strategies** to protect, use, develop, conserve, manage and control water resources. These strategies are viewed as the minimum requirements for covering as many aspects as possible of water resource management of the WMA.

The current capturing of the Internal Strategic Perspective (ISP) process identifies strategies in each Water Management Area that’s need to be addressed and the prioritisation thereof will also aid in the development of the supporting strategies for the CMS.

## 3.3 GROUNDWATER COMPONENTS IN THE CMS

### 3.3.1 Foundation Strategies

The foundation strategies provide the structure and enabling framework within which the water management strategies can be implemented. The strategies are inherently interrelated in that collectively they form part of the overall CMS for the WMA, but are separated for ease of preparation and development (DWAF, 2001).

The groundwater components to be incorporated in the foundation strategies (as defined in DWAF, 2001) are summarised below.

#### 3.3.1.1 NWR strategy:

| | |
|---|---|
| Purpose | To meet the requirements of the NWRS |
| Content | Strategies to meet requirements of Reserve, water availability (allocatable portion), water balance, transfers, international obligations and strategic uses |
| Ground-water | The importance of the interaction of groundwater and surface water in sustaining ecosystems means that the approval of groundwater abstraction in most environments would have to be accompanied by an assessment of possible environmental impacts. In other words, a reserve determination of the total water resource should be undertaken if a license application for water allocation is processed. Where aquifers have minimal connection with the aquatic ecosystems, the groundwater Reserve would refer to the basic human needs component (Xu, et al., 2001). |

#### 3.3.1.2 RDM strategy:

| | |
|---|---|
| Purpose | To develop strategies for management classes and resource quality objectives |
| Content | Database of and strategies for resource classification and RQOs of all resources |
| Ground-water | The RQOs are seen to be particularly important for groundwater resources as it is not restricted to aquatic systems, so that the full ecosystem functioning of groundwater may be recognised and protected where necessary (Xu, et al., 2001). The RQOs may relate to water levels, storage volumes and quality parameters, aquifer parameters such as permeability, storativity and recharge, and aquatic biota in features dependent on groundwater baseflow. |

#### 3.3.1.3 Stressed catchments strategy:

| | |
|---|---|
| Purpose | To develop strategies for stressed **and** unstressed catchments |
| Content | • Identify and prioritise stressed catchments in WMA<br>• Develop strategy for catchment management plans (stressed and unstressed catchments)<br>Develop strategy for more detailed catchment assessments |
| Ground-water | Catchments may be stressed in terms of water quantity, quality or the environment. In such cases remedial action should be taken in accordance with the severity of the stress. The proposed remedial action should be incorporated into the Catchment Management Plan (CMP). An understanding of the relation between systems (hydrological and environmental) is necessary to effect successful remediation. |

#### 3.3.1.4 Institutional development strategy:

| | |
|---|---|
| Purpose | To deal with existing and develop new institutional framework |
| Content | • Evaluate existing institutions<br>• Strategise for new institutional structure<br>• Clarify roles and relationships between institutions<br>• Establish communication mechanisms<br>• Prioritise activities for institutional development strategy |
| Ground-water | It is expected that the groundwater coordinator will form a key link in the chain, integrating not only with other water resource managers, but also with land-use and development planners and user groups. In order to operate effectively groundwater coordinators will need to understand their local groundwater systems and the local institutional systems that interact with the resource. (See Volume 1, Chapter 1) |

#### 3.3.1.5 Spatial/land-use planning strategy:

| | |
|---|---|
| Purpose | To influence water related aspects of land-use planning |
| Content | • Identify existing land-use and mix of political/catchment boundaries<br>• Spatial compatibility between development and water locality<br>• Liase/interact with land-use planning institutions to influence water related aspects of planning<br>• Identify and integrate development initiatives with CMS |
| Ground-water | It should be recognised that groundwater is susceptible to impact from land-use activities. As such land-use planning should form part of the water resource protection strategy of the catchment; with input from the groundwater coordinator to highlight possible impacts on groundwater resources. An effective resource protection strategy should aim to attain or preserve the desired RQOs of the resource. |

#### 3.3.1.6 Human resource strategy:

| | |
|---|---|
| Purpose | To establish policy on human resource requirements and development |
| Content | • Establish management philosophy (“lean’ versus “fully fledged”)<br>• Develop policy on human resource requirements and development<br>• Identify management roles and responsibilities |
| Ground-water | The specialised skills necessary for effective groundwater management within the IWRM paradigm, makes human resource development an imperative. It is likely that many of the groundwater management functions (such as monitoring, remediation, development, etc.) will be outsourced. |

#### 3.3.1.7 Co-operative governance strategy:

| | |
|---|---|
| Purpose | To strategise for effective co-operative governance |
| Content | • Identify "Government" role players in catchment management<br>• Develop communication strategy for joint planning |
| Ground-water | Effective groundwater management is dependent on appropriate land-use planning and control of such activities. The control and assessment of such activities are often prescribed by legislation other than the National Water Act. Other regulatory authorities assume responsibility for the administration of these acts. The CMAs and DWAF would thus be expected to achieve the desired level of control through consultation and coordination with other government departments through the use of appropriate legislation, before reverting to the NWA (DWAF, 2000). |

#### 3.3.1.8 Public involvement / interaction strategy:

| | |
|---|---|
| Purpose | To optimise the process of reaching stakeholders for their meaningful participation<br>To facilitate effective public participation in the development and implementation of the CMS |
| Content | • Identify all stakeholders<br>• Develop information dissemination strategies aimed at meaningful participation<br>• Develop mechanisms for interaction with stakeholders<br>• Refer to Public Participation guidelines produced by Directorate: Catchment Management |

#### 3.3.1.9 Data collection and information management strategy:

| | |
|---|---|
| Purpose | To develop centralised, relevant, and updated database for planning and strategy formulation |
| Content | • Develop/acquire appropriate hardware and software to support databases, GIS, information management, monitoring, reporting<br>• Develop strategy to organise and regularly update WRSAS database, and characteristics of additional data to be collected (sources, scale, accuracy)<br>• Develop strategies for making data accessible to stakeholders and DWAF |
| Ground-water | Availability of timely, adequate, relevant and valid hydrogeological information will be crucial for the future management of South Africa's groundwater resources. It is imperative, therefore, that collection of new general hydrogeological and monitoring data be accompanied by the development of powerful and robust information tools such as databases, information systems, maps, reports and booklets. These are to be used to convey the relevant information to hydrogeological specialists; water resource managers; decision makers and the public, and can greatly support groundwater awareness and promotion campaigns. |

#### 3.3.1.10 Capacity building/education strategy:

| | |
|---|---|
| Purpose | To improve the level of participation through appropriate capacity building |
| Content | • Develop profile of existing capacity and community involvement<br>• Develop strategies for adding to existing and building new capacity<br>• Investigate education and training programmes at various levels |
| Ground-water | A need exists to cultivate an understanding and appreciation of the role and functioning of groundwater. Such an understanding is necessary if resource protection strategies are to be effective. It is also a requirement for stakeholder buy-in to water conservation/water re-use strategies that use groundwater. |

#### 3.3.1.11 Auditing and review plan:

| | |
|---|---|
| Purpose | To strategise for internal and external auditing of CMS activities |
| Content | • Identify CMS aspects to be audited<br>• Identify audit standards, frequency, type of reporting and feedback, corrective action |

#### 3.3.1.12 Conflict management plan:

| | |
|---|---|
| Purpose | To strategise for conflict anticipation and resolution |
| Content | • Appoint advisory committee to identify potential dispute issues and advise on legal matters<br>• Develop dispute resolution strategy in relation to role of Water Tribunal |
| Ground-water | The regionally extensive nature of aquifers, the fact that groundwater is largely hidden, its inter-connectedness with other systems, and the fact that it has a history of private ownership make the development of conflict situations especially likely where groundwater is used. |

#### 3.3.1.13 Financial strategy:

| | |
|---|---|
| Purpose | To develop a strategy to ensure financial viability and growth |
| Content | • Prepare overall annual business plan<br>• Investigate income potential and likely expenditure (per annum)<br>• Strategise for financial growth |

### 3.3.2 Supporting Strategies

Existing, supporting strategies are deemed to be essential for all WMAs in order to effectively manage water resources in these regions (DWAF, 2001). These strategies should address current management issues in the WMA, and reflect future (desired) conditions agreed to through the public participation processes.

DWAF (2001) outlines each strategy in terms if its respective components. The level of detail required per component by each WMA will vary depending on its particular circumstances.

Existing and developing strategies that will give direction and add value to the different CMSs include the following and can be obtained from DWAF:

**Water Resource Management Strategies**

- Overall management strategy for quantity management
- Overall management strategy for quality management
- Overall strategy for ecological sustainability and reliability
- Overall strategy for financial viability
- Strategy for integration of protection, use, development, conservation and control of water resources

The groundwater coordinator will need more than a simple water balance understanding of hydrological processes in the WMA in order to determine what and where groundwater resources are available for licensed allocations. The classification process (part of the RDM, Volume 2, Chapter 3) advises the development of an integrated conceptual model of surface and groundwater resources within the WMA and a full inventory of groundwater uses. These uses should include inherent environmental uses such as groundwater fed baseflow and supporting vegetation during dry periods. An inventory of uses should be followed by a valuation of those uses, or goods and services provided, by the catchment stakeholders. Important uses/services will require a higher level of protection. This is afforded by the RQOs, which should be articulated to protect key attributes of the aquifer (e.g. – water levels for basic human needs from shallow wells). The RQOs along with other monitoring requirements will then form the basis for license conditions. (Volume 2, Chapter 2)

**Water Resource Protection strategies**

- Strategy for maintaining desired RQOs
- Strategy for designing, implementing, reviewing Source Directed Controls
- Strategy for dealing with point and non-point sources of pollution
- Economic incentives for reduction in pollution
- Strategy for dealing with hazardous spills, import & disposal of toxic waste
- Strategy for dealing with ecosystem components under stress or threat
- Co-operative governance strategy for land-use planning, impact assessment.

Volume 2, Chapter 3 outlines existing strategies for groundwater quality management in South Africa. These strategies exist at varying levels of detail, but should all be realised with the implementation of IWRM at a catchment level.

**Water Use Strategies**

- Strategy for over-allocated catchments
- Strategy for under utilised catchments
- Water allocation strategy (for allocatable volume) – this must stem from water allocation principles and should incorporate suitable time frames to allow for evaluating actual use against allocated use, and for review of activities associated with initial allocation
- Water pricing strategy
- Strategy for general authorisations
- Strategy for licence application (individual and compulsory)
- Strategy for trading water rights
- Strategy for upliftment programmes
- Strategy for future demands.

Guidelines for groundwater allocation within IWRM are discussed in Volume 2, Chapter 2. Prediction of the impact of groundwater allocations and determination of optimal use are a key challenge to the groundwater coordinator. Water allocation managers need to understand available volumes, water quality and assurance of supply. The groundwater coordinator needs to understand how aquifer characteristics that influence these values vary within the resource, what are the critical thresholds (RQOs) and to what degree of certainty is the necessary data known. A key challenge facing the groundwater coordinator is converting the intrinsic heterogeneity and unpredictability of hidden groundwater systems into a reliable resource for supply.

**Water Resource Development Strategies**

- Assessment of existing water supply schemes – efficiency and financial viability
- Strategy for evaluating new development proposals
- Strategy for future and potential transfers
- Strategy to integrate land development initiatives (SDI, LDO etc)

The development of groundwater resources and assessing groundwater resources are discussed in Volume 2, Chapter 1.

**Water Resource Conservation Strategies**

- Establish demand management strategies for user sectors
- Identify and prioritise catchments where water is not efficiently and effectively used, and strategise how WDM/WC measures should be implemented

The DWAF-DANCED IWRM project is developing guidelines for water conservation and water demand management. Conjunctive use and the artificial recharge of groundwater are among the water saving/re-use options available to water managers.

**Water Resource Control Strategies**

- Establish and evaluate status of existing quantity and quality monitoring in WMA
- Develop strategy to upgrade and maintain monitoring system to satisfactory levels and to possibly introduce new monitoring systems (e.g. biomonitoring).
- Develop appropriate strategies for flood, drought and pollution disaster management
- Establish database of dam safety reports and maintain regular safety inspections.
- Develop risk management strategies for reliability of supply, major disasters etc.

Volume 2, Chapter 4 gives guidelines on the establishment of monitoring networks in the WMAs. Sound management of all water resources depends on decisions being based on facts rather than beliefs and assumptions. For this reason, monitoring and information systems are critical for successful resource management.

**Integration of Strategies**

As stated earlier, the foundation strategies are not totally independent of the supporting strategies but that they were kept separate to facilitate preparation of the CMS. The CMA must bear in mind the potential linkages before preparing the individual strategies so that duplication can be avoided and streamlining optimised.

With regard to the foundation strategies, the following grouping shows linked strategies (additional linkages may be included as appropriate):

| | | | | |
|---|---|---|---|---|
| Situation assessment | ★ | RDM strategy | ★ | Response to NWRS strategy |
| Situation assessment | ★ | Stressed catchments strategy | | |
| Institutional development strategy | ★ | Co-operative governance strategy | ★ | Public participation strategy |
| Spatial/land use planning strategy | ★ | Data collection and information strategy | ★ | Co-operative governance strategy |
| Communication and public relations strategy | ★ | Public participation strategy | ★ | Capacity building and education strategy |
| Human resources strategy | ★ | Finance strategy | ★ | Auditing and review strategy |

The supporting strategies concerning water resource protection, use development, conservation, and control are inherently linked through optimum benefit in the public interest through economic efficiency, ecological sustainability and social equity. Note that Water Resource Management Strategies have been omitted from this list as they merely reflect the underlying management philosophy that applies to the WMA as a whole.

## 3.4 REFERENCES

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# CHAPTER 4

# STRATEGIES TO DEVELOP, CONSERVE AND ENHANCE AVAILABLE WATER RESOURCES IN A CATCHMENT

## EXECUTIVE SUMMARY

### Context

The National Water Act clearly states in Chapter 2, Section 5 that:

*(3) The water resources of the Republic must be protected, used, developed, conserved, managed and controlled in accordance with the national water resource strategy.*

This issue of conservation is raised again in Chapter 4, Section 26, stating that:

*(4) When making regulations, the Minister must take into account all relevant considerations, including the need*

*to -*

*(a) promote the economic and sustainable use of water;*

*(b) conserve and protect water resources or, instream and riparian habitat;*

This chapter outlines strategies and approaches to ensure that the responsibility of conserving and enhancing groundwater resources are taken up in the management process already. These approaches start with complying to the reserve, identifying opportunities to conserve water and finally discuss a few methods for resource enhancement.

### The role of the groundwater coordinator

In order to realise the effective management of groundwater resources, the groundwater co-ordinator within the CMA will need to have a broad understanding of:

- Aquifer characteristics (including vulnerability and interactive processes between surface water, strata and groundwater)
- Potential advantages/disadvantages if implementing these in different areas

The groundwater coordinator will have to ensure that these conservation and resource enhancement approaches are reflected in the CMS.

### Recommendations

Conservation of groundwater resources is accepted and practised more widely than enhancement. This is probably due to the lack of experience in enhancement procedures, but should not necessarily be seen as risky or inefficient. These methods are encouraged and should be investigated and implemented were possible.

## 4.1 INTRODUCTION

In the White Paper on a National Water Policy for South Africa, it is stated that: “new approaches to water management will be needed. These will have to focus on the way in which water is used (efficiency, effectiveness and demand management) in each user sector, rather than on simply predicting, planning and supplying water needs.”

Optimal development of groundwater resources requires the most efficient and effective use of the resource in a sustainable manner. This means that the long-term integrity of the aquifer is preserved and the water, once abstracted, is used with minimal losses for the greatest benefit of the stakeholders in the catchment. Catchment management presents an opportunity for innovative improvements in efficient groundwater use and greater consideration of aquifers in the conservation of the WMA resources.

This chapter deals with ways in which groundwater resources can be conserved through efficient use and best practices of demand management.

Broader integrated water resource conservation protocols for municipalities and urban areas are dealt with in a complementary set of guidelines on water demand management and water conservation in this series.

Groundwater resources may also be enhanced, typically through managing recharge for maximum rates of infiltration in catchments where underground storage is preferable to storage in surface water dams. Responsible development of a groundwater resource requires an understanding of factors that limit its sustainable use in order to manage its optimum utilisation. These factors may be defined as the Resource Quality Objectives and are discussed further in Volume 2, Chapter 3. Monitoring is an integral part of good management practice and is dealt with in Volume 2, Chapter 4.

## 4.2 DEVELOPMENT OF RESOURCES

Strategic sustainable development of groundwater resources is key to the optimal use of aquifers. The overall plan for the development of an aquifer will need to draw on all elements of these guidelines, and are illustrated in Figure 4.

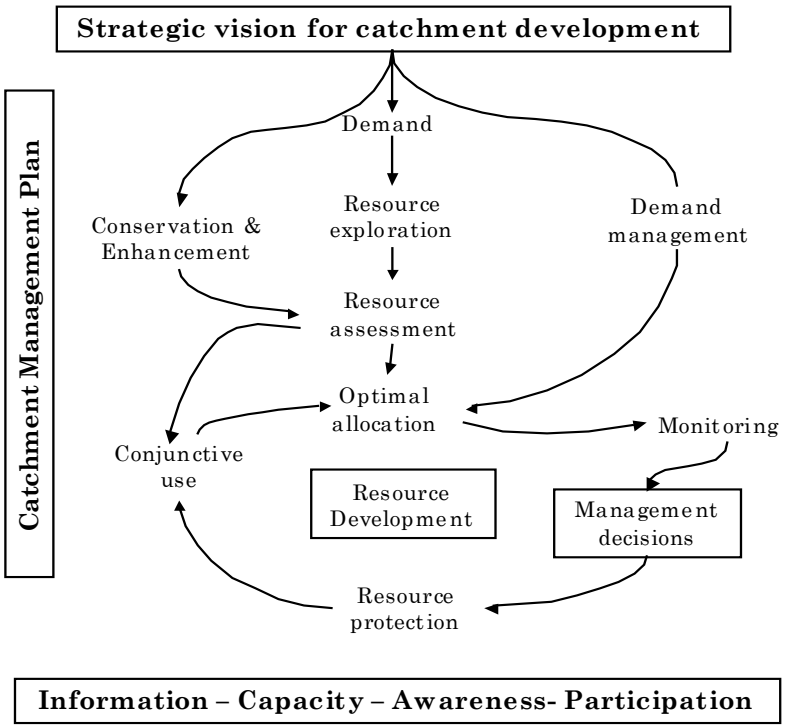


**FIGURE 4: DEVELOPMENT OF RESOURCES**

In most cases of current aquifer development, sustainable use is aimed for. This means that the abstraction of groundwater and other activities impacting the aquifer are managed within the limits of the integrity of the system. Sustainable resource development is described in Volume 2, Chapter 3 and forms the basis of groundwater classification and resource quality objectives. The latter may typically include the following:

- Water levels should not fall below their annual range,
- Land/surface subsidence should not occur, and
- Water quality parameters should remain within the functional range of the unmodified system.

The NWA aims to achieve IWRM through catchment management, with an optimal balance of protection and use. Development of the resource should ensure that groundwater is used sustainably and optimally for the benefit of stakeholders in the WMA (Figure 5). The Irish hydrogeologist, Burdon, excellently summed up the need for this balance:

"*An aquifer that is almost always full is almost as badly managed as one that is almost always empty*."

(Foster et al, 2000).

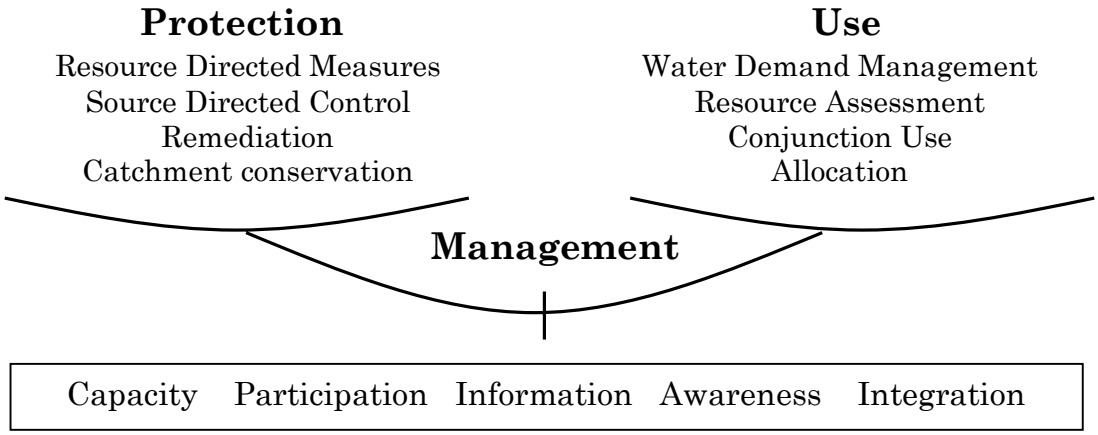


**FIGURE 5: THE BALANCE OF PROTECTION AND USE**

It is important to emphasise the need for integration with all components of groundwater management, IWRM and catchment management. Plus, the results of integration, such as management decisions feeding back from information system capture of monitoring results, must be obvious.

The groundwater coordinator needs to draw on the following tools and processes to ensure that development of resources is aligned with the objectives of the NWA.

**Strategic:**

The demand for water resources should be aligned to the strategic vision for development in the WMA. The CMA needs to participate in a Strategic Environmental Assessment as well as link to the IDP process for the catchment and its urban areas.

The potential for water available from the implementation of WC/WDM and catchment conservation initiatives, such as the Working for Water Programme, should be understood.

**Beneficial:**

The use of water resources in the WMA should aim to achieve optimal economic and social benefits for the stakeholders in the catchment. The participative processes of establishing WUAs and catchment forums should indicate to the groundwater coordinator where examples of inequitable distribution of rights to use exist. These should be addressed as a priority with the allocation of new resources.

**Optimisation:**

Various resource economic tools exist to determine the optimal economic use of water in the WMA. Typically, the groundwater coordinator should liase with a resource economist to compare cost benefits of alternate uses of groundwater resources for specific examples.

Table 2 in this chapter summarises some of the opportunities and constraints offered by groundwater resources in comparison with the development of other water resources. These need to be considered and communicated to decision makers and stakeholders alike.

**Sustainability**:

Water resources in South Africa are developed within the context of the classification system in section 6 of this chapter. Once a significant resource has been classified, the limits for acceptable impacts are set. Even if significant modification is experienced through the use of groundwater, the resource needs to be managed within sustainable limits that will not permanently compromise the aquifer and lead to a collapse of the resource.

The groundwater coordinator needs to link the resource assessment to the resource class and estimate the impact of the known uses of groundwater, particularly abstraction volumes, for allocations which do not receive an individual license. These include Schedule 1 uses, General Authorisations, Existing Lawful Uses and the Reserve as well as allocations for International Obligations. (See Volume 2, Chapter 2.)

The maintenance of sustainable use is reliant on effective monitoring of the resource (Volume 2, Chapter 4), reliable information storing and retrieval (Volume 2, Chapter 5) and management actions in response to this information. In order to prepare for the potential range of management actions required, it would be useful for the groundwater coordinator to prepare management scenarios for different outcomes under uncertainty. In other words, to address the “If this happens, then these are the appropriate responses…”

The concept of sustainability is broader than the traditional hydrogeological estimation of safe yield.

## 4.3 USING THE INTERNAL STRATEGIC PERSPECTIVES AS FOUNDATION FOR THE DEVELOPMENT OF STRATEGIES

In line with the National Water Act one of the initial tasks of the CMA will be to develop a Catchment Management Strategy (CMS), which will become a strategic management framework within which water use will be managed at the WMA level. Until such time as the CMAs have been established and have developed their CMSs, it is an imperative requirement of good governance that the DWAF Regional Offices develop an interim strategy to manage water resources.

DWAF therefore embarked on a process of developing Internal Strategic Perspectives (ISPs) for the selected catchments in all 19 Water Management Areas. The Directorate: National Water Resource Planning is spearheading the process, and can be contacted for information in this regard. Each ISP document reflects DWAFs existing knowledge in regard to a specific WMA. It addresses, and provides answers to the questions such as:

- Who needs water?
- Why do they need it?
- How much do they need?
- What are the resource options? Etc.

The ISP's fall within the framework of the NWRS, which takes into account new initiatives to promote rural development and poverty alleviation.

The ISP documents therefore contain a range of strategies, including Water Balance and Water Resource Reconciliation, Water Resources Protection, Water Use Management, Monitoring and Information and other. These strategies should be incorporated in the CMS and it is suggested that each CMA then prioritises its strategies in accordance with the ISP to ensure efficiency and optimal use of funding and capacity.

## 4.4 THE RESERVE AS THE FIRST STEP IN WATER RESOURCE DEVELOPMENT AND CONSERVATION

The Reserve is a concept that is enshrined in Part 3, Chapter 3 of the NWA (1998). Together with classification of water resources and resource quality objectives, it forms that part of a strategy for the protection of water resources collectively known as Resource Directed Measures (RDM). It is evident; therefore, that RDM has a key role to play in conserving and protecting water resources.

The first string in the RDM bow, the Reserve, essentially looks after the water quantity and water quality requirements needed to supply in the essential needs of humans (for drinking, food preparation and personal hygiene) on the one hand, and for the needs of aquatic ecosystems on the other. These two components represent the **basic human needs Reserve** and the **ecological Reserve** respectively. The basic human needs Reserve is set at a minimum of 25 litres per person per day but may, under certain conditions such as where a higher level of service is indicated, be set at a higher level of consumption, e.g. 60 litres per capita per day. The ecological Reserve as far as groundwater is concerned, considers primarily the contribution of springs and/or base flow to the discharge of streams. This contribution is most evident in surface water drainages that flow throughout the dry season, i.e. perennial streams and rivers. A less obvious demand in this regard is that of vegetation ecosystems that depend to some or other degree on groundwater.

The second string in the RDM bow is that of water resource Classification. The ecological Reserve is described on the basis of six distinct ecological management categories (EMCs), labelled A (best) through to F (poorest). These categories are also used to describe the present ecological status category (PESC), which may differ from the desired EMC. The state of water resources, on the other hand, is described on the basis of four classes, namely "natural", "good", "fair" and "poor". The symbiotic relationship between the EMC/PESC and the water resource class in defining a water resource management class is illustrated in Table 1.

**TABLE 1: ILLUSTRATION OF THE SYMBIOTIC RELATIONSHIP BETWEEN EMC/PESC AND WATER RESOURCE CLASS (AFTER DWAF, 2002).**

<table>
<tr><th>MANAGEMENT CLASS</th><th>EMC/PESC</th><th>WATER RESOURCE CLASS</th></tr>
<tr><td>Excellent</td><td>A<br>(Unmodified/natural)</td><td>Natural</td></tr>
<tr><td rowspan="2">Good</td><td>B<br>(Largely natural)</td><td rowspan="2">Good</td></tr>
<tr><td rowspan="2">C<br>(Moderately modified)</td></tr>
<tr><td rowspan="2">Fair</td><td rowspan="2">Fair</td></tr>
<tr><td>D<br>(Largely modified)</td></tr>
<tr><td rowspan="2"></td><td>E<br>(Seriously modified)</td><td rowspan="2">Poor</td></tr>
<tr><td>F<br>(Critically modified)</td></tr>
</table>

Resource Quality Objectives (RQOs) represent the third string in the RDM bow, and establish the framework of conditions and requirements needed to meet the following two basic water resource management objectives.

- Maintaining the water resources in their present state, i.e. allowing no further degradation from their assessed PESC.
- Improving the state of the (ground)water resources, i.e. to a higher EMC than their PESC, provided that no RQO that is set represents an improvement on the natural value or character of the specific parameter or characteristic that it targets.

It is important to note that section 13(4) of the NWA makes it a legal requirement that the process of determining the Class of a water resource and its RQOs must provide for the participation of interested persons, and consider all comments received before finally determining the Class and RQOs. In conclusion, it is clear that RDM represents potentially the most powerful weapon in the arsenal of strategies aimed at protecting and conserving the water resources in a catchment.

The implementation of the Reserve is disussed in further detail in Volume 2, Chapter 3.

## 4.5 CONSERVATION OF GROUNDWATER RESOURCES

South Africa is a relatively dry country, with irregular rainfall across the country and from year to year. The average annual rainfall is 500mm compared with the global average of 800mm. Water scarcity is further aggravated by the fact that 60% of the river flow arises from only 20% of the land area (Schreiner, 1998).

The total natural runoff in South Africa is estimated at 55 billion $m^3$ per year, of which only 33 billion $m^3$ is utilizable. It is estimated that water use will increase from the estimated 1996 level of 18 billion $m^3$ to 30 billion $m^3$ in 2030. From this it is apparent that a strategy is urgently needed to ensure the wise supply and use of water. The first step in such a process should be to ensure more efficient and productive use of current water resources. The Department of Water Affairs and Forestry (DWAF) has embarked upon a process to develop sectoral action plans for improving water use efficiency and productivity. These plans are generically referred to as Water Conservation & Water Demand Management (WC/WDM) Strategies (DWAF, 2000).

One of the requirements of the National Water Resource Strategy (Section 6 of NWA, Act 36 of 1998) is that the strategy must set out principles relating to water conservation and water demand management. “Conservation” in relation to a water resource is defined in the Act as the efficient use and saving of water, achieved through measures such as water saving devices, water-efficient processes, water demand management and water rationing.

Water conservation should be an integral part of any catchment management strategy and CMAs should actively promote conservation in their catchment areas. In our water scarce country, it is important that the control of water demand be prioritised above the development of new schemes for the augmentation of water supply. All water conservation and demand management strategies will require a participatory approach with water service providers and water users in the catchment. Some powers and duties assigned to the CMA under Schedule 3 of the NWA are the following:

- Conserve and protect the water resources and resource quality within its water management area;
- Make rules to regulate water use relating to, amongst others,
  - the times when,
  - the places where,
  - the manner in which, and
  - the waterwork through which water may be used;
- Require water users to establish management systems; and
- Place water restrictions on users if a water shortage is believed to exist, including the power to,
  - limit or prohibit the use of water,
  - require any person to release stored water under that person's control,
  - prohibit the use of any waterwork (including boreholes and wellfields), and
  - require specified water conservation measures to be taken.

The power to perform these actions is generally subject to adequate notification and public participation and taking due consideration of the conditions of the Water Services Act as detailed in Schedule 3 of the NWA.

Currently the DWAF Unit: Water Use Efficieny is coordinating Water Conservation and Water Demand Management within IWRM and have produced a suite of guidelines for each sector as indicated in Figure 6 below. These guidelines will provide very useful information regarding conservation management.

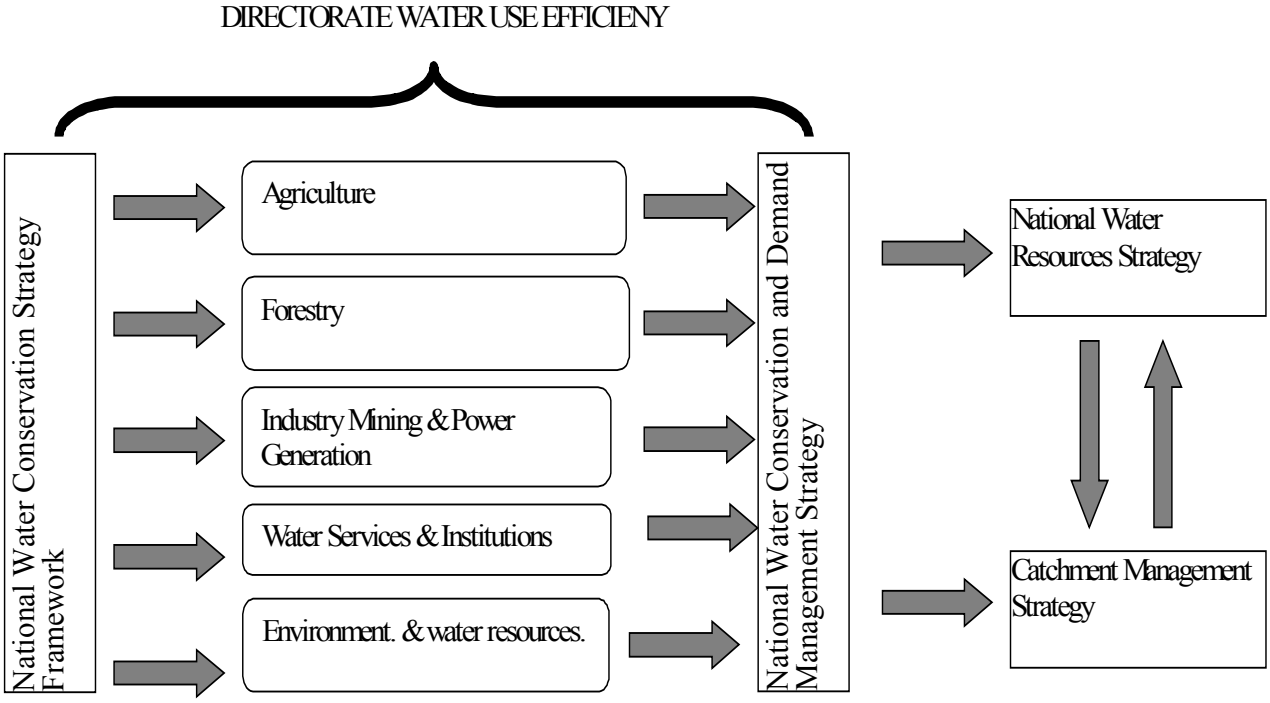


**FIGURE 6: DEVELOPMENT OF SECTORAL WATER CONSERVATION AND DEMAND MANAGEMENT GUIDELINES**

Land care, soil and biological conservation programmes may also have a beneficial impact on water resources. Although these typically aim to remediate the negative impacts of development, their effect is also to conserve and enhance resources within the WMA, therefore these programmes are dealt with in Section 3.3 in this Chapter.

### 4.5.1 Identify opportunities for groundwater conservation

The groundwater coordinator, together with managers responsible for IWRM and WC/WDM, should assess opportunities for groundwater conservation from the point of abstraction to the point of use. Typical questions that can be asked include the following:

Are there leaks which are leading to long term significant losses? Leaks at the wellhead may be due to an inadequacy in design for the operating conditions (corrosive water chemistry, high pressures, high temperatures, large abstraction volumes). If leaks are evident, characterise the known operating conditions and repair the wellhead to the necessary standard. Flow metering at the abstraction point as well as at the point of delivery can detect leakage losses in the reticulation system?

Is the pump operating optimally, or is groundwater often pumped to waste or overflow? This might require the application of appropriate technology to regulate pumping, or the re-training of pump attendants to be able to schedule abstraction better to meet actual water requirements?

Is the storage of groundwater in a surface dam leading to unnecessary evaporative losses or deterioration of water quality due to contamination? Evaporation losses are common and may be reduced by covering the dam with a roof, shade cloth or even floating bottles on the surface of the water. Inevitable losses at communal taps can be channelled towards garden areas or trees?

Is water being used efficiently in households and gardens? Water use awareness campaigns have been conducted through the print media and school projects, especially during National Water Week in March each year. WSPs may go further and insist on bylaws to enforce water efficient building regulations, e.g. the installation of dual flush toilets. Sliding tariffs may be employed as a mechanism to reduce water consumption through financial incentive?

Households supplied with water in areas where shallow groundwater occurs may additionally tap groundwater through shallow boreholes for garden irrigation purposes. A greater appreciation of Water Wise Gardening (as publicised by DWAF) helps reduce inefficient use and provide public education regarding optimal irrigation scheduling and leak reduction helps to minimise losses.

Rand Water, Umgeni Water and the National Botanical Institute all provide educational material for water saving measures in urban gardening.

Is water being used efficiently by agriculture? Agriculture is the largest consumer of groundwater in South Africa. In many areas water efficiency could be improved through:

- Selection of water efficient crops,
- Use of more water efficient irrigation technology, and
- Optimal or minimal irrigation scheduling.

Much information on determining crop coefficients and implementation of WCDM for agriculture is available in the DWAF guidelines on the development of water management plans for irrigation. A key role player in the implementation of these plans is the former Irrigation Boards, who are transforming into Water User Associations.

Is water being used efficiently by industry? Industries requiring licences for groundwater use could be required to demonstrate water use efficiency in their industrial process. Environmental and water auditing of large industrial water consumers should form part of the water use license conditions. Water use efficiency should also form part of the Environmental Management Systems being adopted by many South African industries in order to obtain internationally recognised environmental accreditation under the SABS ISO 14001 code of practice (SABS, 1996).

A more detailed checklist is provided in the guidelines for WC/WDM produced as part of the IWRM project.

### 4.5.2 Implementation of groundwater conservation.

The implementation of groundwater conservation measures is most readily given effect in the form of conditions attached to a water use licence. These could include the following:

- Prescribing a maximum value for rest or dynamic water levels,
- Prescribing a maximum borehole depth, or
- Prescribing a maximum pump capacity.

## 4.6 ENHANCEMENT OF GROUNDWATER RESOURCES

Groundwater resources may be enhanced through managed recharge by means of widespread land-care projects (e.g. afforestation or soil conservation), urban design or focussed artificial recharge. Artificial recharge generally requires the conjunctive use of available surface and groundwater resources. The following resource enhancement methods should be built into the Catchment Management Strategy and futher methods investigated en implemented if encessary to ensure sustainability of the resource.

### 4.6.1 Catchment land-care

Land-care programmes in catchments typically aim to reduce the negative impacts of development and agriculture. These may include:

- Soil conservation through terracing, contour-tilling, wind-breaks, mulching, etc.,
- afforestation (stabilizing soil and increasing utilizable catchment water yields),
- Alien vegetation removal (improving biodiversity and increasing recharge to groundwater and surface water runoff).

In South Africa the Working for Water Programme is a well-established example of a land-care initiative that has been successful in creating employment and clearing alien vegetation. The programme is aimed at increasing runoff, through enhanced groundwater recharge and baseflow to streams, and uplifting local communities.

Other land-care programmes are being coordinated through the National Department of Agriculture (NDA), in particular Land Care South Africa (see web references). The groundwater coordinator should link with these programmes where they are being undertaken in recharge areas to ensure maximum positive impacts on groundwater resources, and warn against potential negative impacts.

Soil conservation programmes typically benefit groundwater resources by reducing runoff and increasing recharge. Soil conservation programmes that have been successful at local and wider scales in Africa include:

- Mulching,
- Agro-forestry techniques (e.g. planting Faidherbia albida),
- Contour farming (ridges, stone lines, organic trash lines, etc),
- Crop rotation, and
- Pitting (growing crops in depressions).

### 4.6.2 Conjunctive Use

Conjunctive use of surface and groundwater resources offers many opportunities to improve the volume and assurity of water supply, and to manage water resources effectively. Conjunctive use embodies a variety of mechanisms including the following:

- Various combinations of artificial recharge operations,
- Exchanges and transfers of surface and groundwater supplies, and
- Transfers or exchanges of water between wet and dry periods with other agencies.

In essence, conjunctive use seeks to maximize the use of surface water in wet years when it is readily available, and to preserve groundwater resources for use during dry periods and droughts. Undoubtedly some new conveyance facilities might have to be designed, built and operated to be able to convey surface water supplies to areas with groundwater overdrafts, to farm areas with major pumping zones, or to recharge sites. Subsidies and payments to provide the incentives and the compensation for these supply exchanges and reallocations will be necessary, but are likely to be cheaper than developing big projects to import, treat and distribute additional surface water.

Schemes developed under a conjunctive use management system could be used to address such problems as developing more groundwater-based urban water supplies controlling subsidence, groundwater quality deterioration and other overdraft-related problems. This way adequate water supplies could be maintained during multi-year droughts when shortages of surface water are severe.

The merits of integrating the use of groundwater resources with surface water through conjunctive use is illustrated by the comparison in Table 2 of the advantages, limitations and essential issues associated with aquifers and small and large surface water reservoirs (Keller *et al*., 2000).

**TABLE 2: COMPARATIVE ADVANTAGES, LIMITATIONS AND KEY ISSUES ASSOCIATED WITH GROUNDWATER, SMALL SURFACE WATER RESERVOIRS & LARGE DAM WATER STORAGE (KELLER ET AL., 2000).**

| | GROUNDWATER STORAGE | SMALL SURFACE WATER RESERVOIRS | LARGE DAM RESERVOIRS |
|---|---|---|---|
| **Advantages** | Little evaporation loss<br>Ubiquitous distribution<br>Operational efficiency<br>Available on demand<br>Water quality | Ease of operation<br>Responsive to rainfall<br>Multiple uses<br>Groundwater recharge | Large, reliable yield<br>Carryover capacity<br>Low cost per $m^3$ water<br>Flood control & hydro-power<br>Groundwater recharge |
| **Limitations** | Slow exchange rate<br>Possible contamination<br>Cost of extraction<br>Recoverable fraction | High evaporation loss<br>Relatively high cost<br>Absence of over-year storage | Complexity of operations<br>Siting<br>High initial investment<br>Time needed to plan and construct |
| **Key issues** | Declining water levels<br>Rising water levels<br>Management of access and use<br>Groundwater salinisation<br>Groundwater pollution | Sedimentation<br>Adequate design<br>Dam safety<br>Environmental impacts | Social and environmental impacts<br>Sedimentation<br>Dam safety |

### 4.6.3 Artificial Recharge

Stated simply, artifical recharge is a process by which excess surface water is directed into the ground – either by spreading on the surface, by using recharge boreholes or by altering natural conditions to increase infiltration – to replenish an aquifer. Artificial recharge is a way to store water underground in times of water surplus to meet demand in times of shortage.

Opportunities for artificial recharge should be considered in areas where evaporative losses from open water bodies are high. In the context of conjunctive use, excess surface water might be used to recharge aquifers following excessive groundwater exploitation.

### 4.6.4 Water Sensitive Urban Design

It is widely recognised that catchment urbanisation leads to increased losses of water from the catchment due to increased impervious surfaces and storm water run-off. Water sensitive urban design (WSUD) aims to reduce those losses by incorporating more vegetated surfaces, soakaways to maintain groundwater recharge and use of rain-harvested water within the catchment. WSUD incorporates water management systems into buildings, urban transport routes and public open spaces. It is based on the principles of water efficiency and reuse. Most importantly, water is treated as a resource rather than a waste product. At the same time there is a focus on addressing pollution problems at the source rather than through the construction of expensive engineered solutions downstream.

The role of the groundwater coordinator in a CMA in regard to WSUD includes:

- Addressing the potential for inclusion of WSUD in newly developing urban areas in aquifer recharge areas; and
- Exploring the potential for retrofitting WSUD features in urban areas where aquifer depletion or excess stormwater volumes are problematic.

The concept of WSUD is based on formulating structural plans for urban development that incorporate multiple storm water management objectives and involve a process which recognises the opportunities for urban design, landscape architecture and storm water management infrastructure to be intrinsically linked. Ecologically-based storm water management systems can be readily implemented at Greenfield sites (Wong & Eadie, 2000). The process involves multi-disciplinary inputs as illustrated in Figure 7.

The CMA can play a vital role in sensitising local government and the public to water conservation and water-use efficiency issues, so that these are included as principles for urban design when municipalities draft or review Integrated Development Plans, as required by the Municipal Systems Act (Chapter 5, Act No.32, 2000).

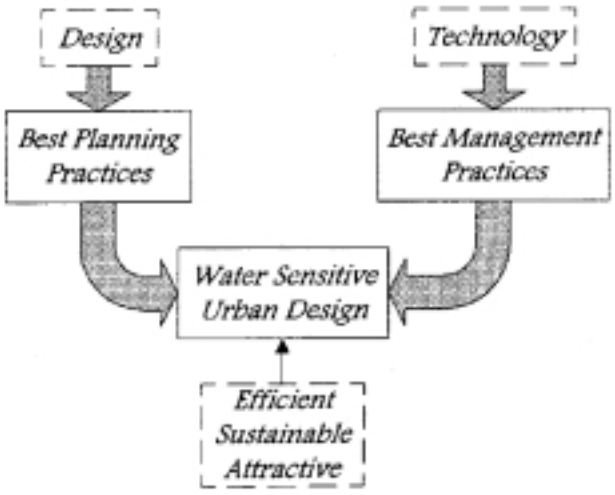


**FIGURE 7: INCORPORATION OF BEST MANAGEMENT PRACTICES AND BEST PLANNING PRACTICES IN WATER**

**FIGURE 8: GRASS SWALES IN PLACE OF THE TRADITION KERB AND CHANNEL SYSTEM FOR MANAGEMENT OF ROAD RUNOFF CAN PROMOTE BOTH WATER QUALITY IMPROVEMENT AND FLOW ATTENUATION.**

**(WHELANS ET AL., 1994).**

WSUD may include adding rainwater tanks, minimising impervious areas, the use of water efficient appliances, the design of water pollution traps, the addition of infiltration and filter strips, and on-site detention. Figure 8 illustrates the use of grass swales for the management of road runoff, resulting in both water quality and flow attenuation benefits.

The selection of appropriate Best Management Practices (BMPs) involves an assessment made within a variety of disciplines (drainage engineering, landscape architecture, ecology etc) in order to account for site specific characteristics and limitations.

**Measures to Promote Water Balance**

- detention and retention basins
- porous pavements
- infiltration measures.

**Measures to Maintain and if Possible Enhance Water Quality:**

- retention basins and wetlands
- mechanical devices, such as CDS units
- gross pollutant traps
- vegetative control measures.

**Measures to Promote Water Conservation:**

- appropriate landscaping
- water harvesting
- storm water and grey water recycling.

## 4.7 FINAL RECOMMENDATIONS

This chapter concludes the first volume in this groundwater guideline and thus over all strategies and approaches that is recommended for implementation in the CMA's. The next Volume deals in much more detail in the management actions, procedures and steps to ensure sustainable groundwater use.

## 4.8 REFERENCES

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