REPORT No. PWMA 19/000/00/0304

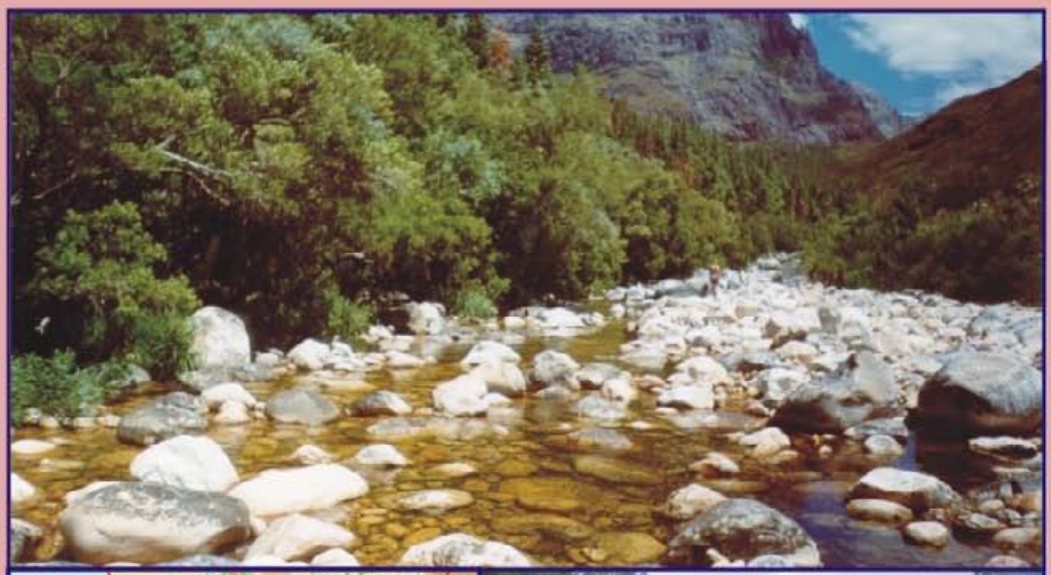
DEPARTMENT:WATER AFFAIRS AND FORESTRY

DIRECTORATE: NATIONAL WATER RESOURCES PLANNING

BERG
WATER MANAGEMENT AREA

INTERNAL STRATEGIC PERSPECTIVE

VERSION 1 : JANUARY 2004



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DEPARTMENT OF
WATER AFFAIRS
& FORESTRY

DEPARTMENT OF WATER AFFAIRS AND FORESTRY

BERG WATER MANAGEMENT AREA

INTERNAL STRATEGIC PERSPECTIVE

Version 1

January 2004

Department of Water Affairs and Forestry
Directorate National Water Resource Planning

DEVELOPMENT OF INTERNAL STRATEGIC PERSPECTIVE
FOR THE
BERG WATER MANAGEMENT AREA (WMA No 19)

APPROVAL

Title	:	**Berg Water Management Area: Internal Strategic Perspective**
DWAF Report No	:	P WMA 19/000/00/0304
Consultants	:	Ninham Shand in association with Umvoto Africa, Jakoet & Associates, and Tlou & Matji
Report Status	:	Version 1, January 2004
Version Controller	:	Mr B van Zyl (Catchment Manager Berg WMA)
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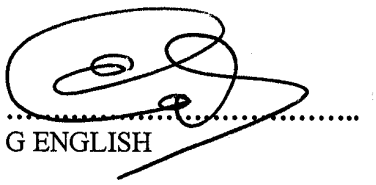

G ENGLISH

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INVITATION TO COMMENT

This report will be updated on a regular basis until it is eventually superceded by the Catchment Management Strategy. Water users and other stakeholders in the Berg River WMA and other areas are encouraged to study this report and to submit any comments they may have to the Version Controller (see box overleaf).

ELECTRONIC VERSION

This report is also available in electronic format as follows:

- DWAF website:
  - Intranet: http://dwaf-www.pwv.gov.za/documents/
  - Internet: http://www.dwaf.gov.za/documents/
- On CD which can be obtained from DWAF Map Office at:
  157 Schoeman Street, Pretoria (Emanzini Building)
  +27 12 336 7813
  mailto:apm@dwaf.gov.za

  or from the Version Controller (see box overleaf)

The CD contains the following reports (all available on DWAF website)

- Berg WMA Internal Strategic Perspective (*This Report*)
  (Report No: P WMA 19/000/00/0304)
- The National Water Resource Strategy, First Edition, 2004
- The Berg WMA - Overview of Water Resources Availability and Utilisation
  (Report No: P WMA 19/000/00/0203)
- The Berg WMA – Water Resources Situation Assessment
  (Report No: P WMA 19/000/00/0101)

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BERG WATER MANAGEMENT AREA

INTERNAL STRATEGIC PERSPECTIVE

EXECUTIVE SUMMARY

1. INTRODUCTION

The Berg Water Management Area (WMA) is situated in the extreme southwest corner of South Africa and falls entirely within the Western Cape Province. It derives its name from the largest river within its boundaries, namely the Berg River. The WMA borders on the Olifants/Doring WMA to the north and on the Breede WMA to the east. It borders on the Atlantic Ocean and Indian Oceans to the west and south respectively.

2. WATER LEGISLATION AND MANAGEMENT

The **National Water Act** of 1998 (NWA) is the principal legal instrument relating to water resource management in South Africa. It is now being incrementally implemented. The NWA introduces far-reaching concepts such as the **National Water Resource Strategy** (NWRS), the First Edition of which will be published in the first quarter of 2004. This NWRS is being progressively developed to set out policies, strategies, objectives, plans, guidelines, procedures and institutional arrangements for the protection, use, development, conservation, management and control of the country's water resources.

The delegation of water resource management from central government to catchment level, as provided for in the NWA, will be achieved by establishing a Catchment Management Agency (CMA) for each WMA and each CMA will progressively develop a Catchment Management Strategy (CMS), within the general framework set by the NWRS. Until such time as the CMA is established and is able to manage the water resources within the WMA according to its CMS, the Regional Offices (ROs) of the Department of Water Affairs and Forestry (DWAF) will continue to manage water resources according to the Internal Strategic Perspective (ISP).

3. INTERNAL STRATEGIC PERSPECTIVES

This document presents DWAF's Internal Strategic Perspective (ISP) or view on how it intends managing the water resources within the Berg WMA during the period leading up to the establishment of a CMA and the development of a CMS by the CMA. The ISP will inter alia provide a consistent basis for the Western Cape Regional Office to process requests for new water use licences.

After internal approval, the Department will obtain comment on the ISP from local authorities, Water User Associations (WUAs), other water related organisations and the public. This will take place through the RO's established liaison structures (forums) and through normal contact with water users in the execution of its duties. This ISP document will be updated periodically

until the CMA for the Berg WMA is fully functional and has prepared a CMS. All updates to the document will be authorised by the RO, and the task of managing version control will be the function of the Catchment Manager for the Berg WMA.

The ISP has been compiled by referring to policy documentation, legislation, regional planning, departmental guidelines and relevant water related studies, and is also based on interviews and communications with DWAF's regional managers, as well as staff in relevant Head Office directorates.

The yield balances quoted in this report are the same as those contained in the First Edition (2004) of the NWRS. More detailed figures appear in Report No P WMA 19/000/00/0203, Berg Water Management Area, which was compiled as part of the NWRS process.

The ISP does not assume to address all possible issues. This is a living document and further improvements will be made and strategies developed as new issues arise.

4. INTEGRATED WATER RESOURCE MANAGEMENT

As part of the implementation of Integrated Water Resource Management (IWRM), in line with the requirements of the NWA, DWAF is following a process that will include:

- development of the ISPs;
- verification of existing lawful use;
- determination of water availability at acceptable confidence levels; and
- determination of Ecological Reserves at high confidence levels.

An iterative and interactive process will also follow where public participation will play a role in determining water resource and water use reconciliation options. This will be handled by DWAF until the CMA can take over.

The following aspects of water resource management will be encompassed within the broad process of IWRM:

- caring for the environment and where possible, enhancing ecological integrity;
- keeping society at the forefront of all decision making;
- affording the correct level of attention to addressing water quality issues in relation to both surface and groundwater;
- managing groundwater as an integral part of the total water resource;
- taking cognisance of the recreational and social use of dams and rivers; and
- forging ways to improve co-operative governance with other authorities towards more effective water resource management.

5. SUB-AREAS OF THE BERG WMA USED IN THE NWRS

For the purposes of reviewing the available yield, the Berg WMA was divided into three sub-areas. These correspond with the so-called areas of interest used in the NWRS, namely the Upper Berg, Lower Berg and Greater Cape Town sub-areas (see Figure iii).

Figure iii – The Areas of Interest of the Berg WMA as defined in the NWRS
(Ref**:** National Water Resource Strategy – Appendix D19 – Berg WMA)

The further sub-division of the WMA into eight sub-areas was necessary to facilitate the identification of issues and concerns that would require detailed strategies. This is discussed in Chapter 3 of this report and summarised in Paragraph 21 of this Executive Summary.

6. TOPOGRAPHY, RAINFALL AND LAND USE

The topography of the Berg WMA varies considerably, with consequential impact on the climate of the region. Rainfall is highest in the southern mountain ranges where the mean annual precipitation is as high as 3 000 mm per annum, whilst the north-west part of the WMA immediately inland of the coast, receives as little as 300 mm per annum. There is intensive irrigation in the Upper Berg River and Lower Berg River sub-areas and in parts of the Greater Cape Town sub-area (Eerste River and Lourens River catchments).

7. ECONOMIC ACTIVITY

The Berg WMA is the economic hub of the Western Cape, with the dominant commercial and industrial activities taking place in Cape Town and the developing West Coast (Saldanha/ Vredenburg in the Lower Berg sub-area). Approximately 12% of the Gross Domestic Project (GDP) of South Africa originates from within this WMA, mainly in the Greater Cape Town sub-area.

8. POPULATION

Of the total Berg WMA population, estimated at 3 247 000, 95% reside in urban areas, with 87% concentrated in the Greater Cape Town sub-area (Ref: Berg WMA - Overview of Water Resources Availability and Utilisation)

9. WATERWORKS

The Berg WMA is predominantly supplied with water via the Western Cape Water Supply System (WCWSS). Paragraph 12 of this Executive Summary describes the integrated operation of the WCWSS. In addition to supplying the City of Cape Town (CCT), the system also augments the local supply schemes of the towns of Paarl, Wellington, Stellenbosch, Saron and the West Coast District Municipality. The system also supplies water to irrigators along the Berg and Eerste Rivers.

Bulk water supply infrastructure is mostly owned and operated by the CCT. DWAF however also own and operate some of the infrastructure within the WCWSS, whilst some local authorities own and operate local supply schemes themselves. Wastewater treatment works (WWTWs) are largely owned and operated by the CCT, other local authorities and the Department of Public Works (WWTWs at prisons).

10. WATER QUALITY

The natural geology (shales) and agricultural return flows introduce elevated salinities in the middle and lower reaches of the Berg River and in the Diep River. This impacts on industrial water use and on crop selection. Many of the urban rivers of Cape Town serve as conduits for discharging treated effluent to sea and whilst they cannot be rehabilitated, their condition should at least be maintained at levels that will not introduce adverse health and social impacts.

11. GROUNDWATER SITUATION

Groundwater resources are available from primary aquifers along the coastal plain as well as from deeper rock-fractured and confined aquifers, of which the TMG holds the most potential for development. Groundwater is currently utilised from the primary aquifers near Atlantis and on the Cape Flats as well as from deeper aquifers in the Swartland. Monitoring networks to facilitate monitoring of aquifer systems and in particular the interaction between the surface and groundwater resource, are inadequate.

12. THE WESTERN CAPE WATER SUPPLY SYSTEM (WCWSS)

The WCWSS supplies the CCT and other water service providers (WSPs) and WUAs (irrigators) in the Berg and Eerste River catchments. Existing storage dams and the future Berg Water Project form part of this integrated system, operated in such a manner that spills from the storage dams are minimised. The Berg Water Project, comprising the Berg River Dam (formerly known as Skuifraam Dam) and Supplement Scheme, a run of river pumping scheme, has been approved and will be completed by 2007. The WCWSS is co-operatively managed by the CCT and the Department's RO. The majority of towns in the Berg WMA are either wholly or partially supplied with water from this integrated scheme.

A committee comprising DWAF and all major stakeholders reviews the system storage and projected demands annually on 1 November and decides whether or not restrictions need to be recommended for the following year. Other operational challenges include the need for close co-operation with authorities such as Eskom, varying water quality, and the operation of the Riviersonderend–Berg River Tunnel system which provides the means of transferring water from the Breede WMA into the Berg WMA.

The main schemes currently supplying water into the WCWSS include the Palmiet River Government Water Scheme (Breede WMA), the Upper and Lower Steenbras Dams, Wemmershoek Dam and the off-channel Voëlvlei Dam. The latter is filled by diverting water out of the Klein Berg River, the Leeu River and the Twenty-Four Rivers. Theewaterskloof Dam in the Breede WMA is the largest dam within the WCWSS and water from it is transferred into the Berg WMA via the Riviersonderend-Berg River Tunnel System. This dam will also store water pumped from the Berg River Dam during winter, for transfer back into the WCWSS during summer.

13. FUTURE WATER DEMANDS ON THE WCWSS

Through the Western Cape Planning Model Committee, historical and projected future demands on the WCWSS have been determined, based on operating rules established by that same Committee. Whilst these do not reflect the total water requirement for the entire Berg WMA, the projections for the WCWSS are nevertheless consistent with the future water requirement projections contained in the NWRS. The CCT will soon embark on a new requirements study in collaboration with DWAF. It is evident that even with significant water conservation and demand management (WC/DM) measures planned by the CCT, the existing supplies to the region are likely to come under pressure of restrictions until the Berg Water Project is completed and additional interventions to augment the supply may be required soon after 2010.

14. FUTURE RECONCILIATION INTERVENTIONS FOR THE WCWSS

All studies undertaken to date by DWAF and the CCT recommend that WC/DM should be implemented before any other reconciliation interventions are considered. Furthermore it is recommended that increased re-use of treated effluent should be seriously considered as an option. Both surface and groundwater schemes have been studied at varying levels of detail, including the development of schemes in the adjacent Breede WMA, for supplying water into the WCWSS.

The Table Mountain Group Aquifer appears to have potential and the CCT has commissioned a study leading towards the establishment of a pilot wellfield. Augmenting the supply of water into Voëlvlei Dam appears to be a favourable future option within the Berg WMA. The Breede River Basin Study has identified the Michell's Pass Diversion and the Upper Molenaars Diversion as the most favourable options for augmenting the WCWSS out of the Breede WMA.

15. LOCAL SUPPLY SCHEMES

The majority of urban users are supplied through the various regional schemes encompassed within the WCWSS. Smaller schemes at local level supplement the supply to certain towns such as Paarl and Wellington. A few small towns rely on local sources only (Tulbagh and Porterville, for example). The supply to Tulbagh is particularly stressed in summer, due to insufficient run of river yield from the Moordenaarskloof. Strategies for reconciling supply and demand for the small towns are discussed in Section 1 of Part 2 of this report.

16. WATER REQUIREMENTS AND USE FOR THE YEAR 2000

The water requirements in the Berg WMA, at 98% of assurance of supply, are shown below. The urban requirement constitutes approximately 57% of the total and irrigation approximately 41%. The remaining 2% is the rural requirement. The NWRS currently reflects a negligible impact of afforestation on the 1:50 year yield. The requirements are shown in the following table:

WATER USER SECTOR	2000 REQUIREMENTS – 1:50 YEAR LEVEL OF ASSURANCE (x 10^6 m^3/a)			
	GREATER CAPE TOWN	UPPER BERG	LOWER BERG	TOTAL
Irrigation	46	202	53	**301**
Urban	343	23	23	**389**
Rural	5	4	5	**14**
Afforestation	0 (2)	0 (4)	0	**0 (6)**
TOTAL	**394**	**229**	**81**	**704**

Quantities in brackets are suggested changes to the NWRS figures and refer to impact on yield only. Total streamflow reduction is 26 million m^3/a.

17. CURRENT YIELD BALANCE FOR THE BERG WMA (YEAR 2000)

The best estimate of yield balance is contained in the NWRS and given below:

COMPONENT	YIELD BALANCE (YEAR 2000)			
	GREATER CAPE TOWN	UPPER BERG	LOWER BERG	TOTAL
Local yield	108	322	52	**482**
Transfers in	269	32	18	**194**
Transfers out	0	125	0	**0**
Local requirements	394	229	81	**704**
Balance	**(17)**	**(0)**	**(11)**	**(28)**

Brackets around numbers indicate a negative balance (shortfall).

The results indicate an overall shortfall of 28 million m^3/a for the WMA with a shortfall of 17 million m^3/a for the Greater Cape Town area. It is recommended that a further reduction in yield of 8 million m^3/a be allowed, to take account of the impact on yield of alien plant infestation (2 million m^3/a) and of afforestation (6 million m^3/a). These impacts are considered to be more realistic than the negligible (zero) impacts currently used in the NWRS yield balance. The overall shortfall will then increase to 36 million m^3/a. This in no way alters the conclusions drawn and recommendations made in the NWRS, but it will remove the erroneous notion that invasive alien plants and afforestation have virtually no impact on yield.

18. PROJECTED FUTURE YIELD BALANCE SCENARIOS

The NWRS has developed two scenarios with respect to future requirements:

- A *Base Scenario* with projected water requirements in the Year 2025 of 830 million m^3/a resulting in a shortfall of 68 million m^3/a. This is based on a high scenario of population growth, increased standards of water services and no general increase in irrigation requirements.
- A *High Scenario* with projected water requirements in the Year 2025 of 1 306 million m^3/a resulting in a shortfall of 510 million m^3/a. This is based on a high scenario of population growth, high standards of water services (socio-economic development), a strong increase in the economic requirements for water and no general increase in irrigation requirements.

The impact of HIV/AIDS, future economic growth trends and changes in sectoral requirements all impact on the estimate of future requirements. Further requirement scenarios will have to be revisited and real time monitoring will be necessary to determine the growth scenario that actually develops.

19. OTHER UNCERTAINTIES INFLUENCING THE YIELD BALANCE OF THE BERG WMA

A number of uncertainties exist which may impact on the reconciliation of availability and requirements. These include:

- Hydrology - the system analysis is currently based on a mix of hydrology, some as old as 1988. Since then there has been a significant increase in irrigation usage which has impacted on present day runoff. It is therefore necessary that the system yield be confirmed for planning purposes, by utilising the most up-to-date data.

- Irrigation use - the taking up of currently unexercised allocations by farmers would place further stress on the system and capping limits for irrigation have been introduced to the system model. However approximately 50% of the irrigation requirement in the Berg WMA, lies outside of the system (farmers own sources and run of river) and is more difficult to control. Future scenarios considered in the NWRS assume zero growth in irrigation requirement and do not take cognisance of currently unexercised water allocations. The legal status and extent of unexercised allocations, as well as their potential impacts on the yield balance will have to be investigated urgently.

- Reserve requirement - implementation of the Reserve would have a significant impact on the potential yields of existing and future schemes, however most estimates of the ecological component of the Reserve are provisional at this stage. It is important to do a comprehensive Reserve determination for the Berg WMA and develop an appropriate implementation strategy.

- Changes in land use – the ongoing reduction of forestry areas in the Berg WMA and the removal of invasive alien plants should result in increases in runoff which will in turn influence yields and the implementation programme of future supplementary schemes.

- Impact of WC/DM – the extent of water that may become "freed up" through WC/DM remains uncertain, particularly in the agricultural sector which is most vulnerable to the impacts of long hot summers and dry winters.

- Climate change - the effects of global warming could cause a possible 10% reduction in streamflow in the Western Cape by 2015. The actual effects of climatic change could have an influence on the implementation programme of future supplementary schemes.

Taking cognisance of the yield balance shown previously and the list of uncertainties above, it is imperative that a study to consider and develop revised reconciliation strategies for the WCWSS be undertaken as soon as possible. Thereafter the strategies should be updated at regular intervals.

20. RECONCILIATION INTERVENTIONS

Reconciliation interventions to be considered to meet the longer term growth in the water demand of the Berg WMA include:

- Increased re-use of treated effluent (only 10 to 12% of treated effluent discharged by the wastewater treatment works (WWTW) in the WMA is currently re-used).
- Water Conservation and Demand Management by local authorities and irrigators.
- Development of the groundwater resource, particularly that of the very deep confined Peninsula aquifer of the TMG. The TMG potential is currently being investigated by the CCT with the intention of developing a pilot wellfield.
- Aquifer Storage Recovery offers a zero evaporation storage option by injecting surplus surface water into an aquifer for subsequent abstraction.
- Re-allocation of water through progressive implementation of compulsory licensing, to meet the Reserve and/or equity requirements.
- Re-allocation of water through trading of existing water use authorisations.
- Improved management of the WCWSS, notably the releases from Voëlvlei Dam into Misverstand Weir.
- Clearing of invasive alien plants.
- Development of new surface water supply schemes.
- Desalination of sea water, although expensive, has unlimited potential.

With the possible exception of desalination the effect of the Reserve could be a major factor in the relative feasibility of supplementary schemes.

Early planning of future water schemes is essential to ensure an adequate supply to sustain the Berg WMA, the economic hub of the Western Cape, as it may take as long as ten years or more for schemes to be studied, approved and implemented. It is essential that all options should be

regularly reviewed or investigated in order to develop and update the most effective programme of implementation. The implementation of a Reconciliation Strategy for the Western Cape System is required so as to investigate current and future requirements and to evaluate the potential reconciliation interventions that could be implemented to meet those requirements.

21. THE EIGHT ISP SUB-AREAS

Chapter 3 presents an overview of the water resources management perspective of the Berg WMA, for each of the eight management units (sub-areas) used to identify issues and concerns that would require detailed strategies. These sub-areas are shown in Figure iv.

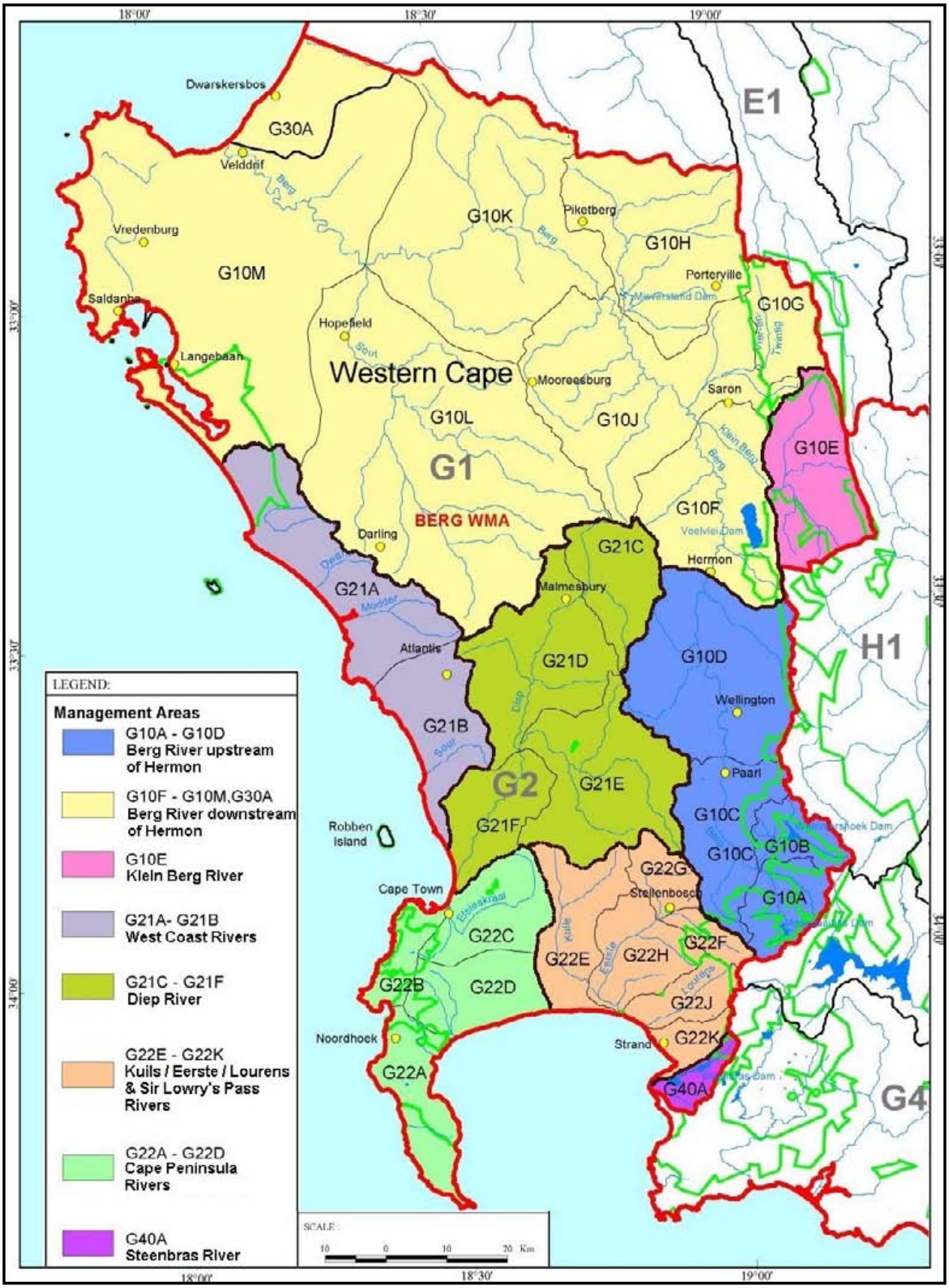

Figure iv – The Eight Management Units (sub-areas) of the Berg WMA

22. INTRODUCTION TO THE ISP STRATEGIES

The strategies contained in this document were developed to give effect to the NWA and the NWRS.

The ten broad strategy groups, referred to as **Main Strategies,** cover all currently identified water management activities of the DWAF RO and the requirements of the NWA and the NWRS. These are:

(i) Yield balance and reconciliation strategies address the need relating to the existing uncertainties and information gaps in the availability of surface water and groundwater, the possible reconciliation interventions (increased re-use of treated effluent, for example), the supply to local authorities and the potential for the development of the groundwater resource in the Berg WMA. This WMA is the economic hub of the Western Cape and as such reliable estimates of the available water resource are essential for future planning. There is therefore an urgent need to carry out an updated integrated water resource planning study in the Berg WMA. Four strategies were developed, namely:

- ⇨ Reliability of the Yield Balance
- ⇨ Reconciling Water Supply and Demand
- ⇨ Groundwater
- ⇨ Aquifer Storage Recovery and Artificial Aquifer Recharge

(ii) Water resource protection strategies address the need to achieve the protection of water resources to ensure their continuing availability for human use by leaving enough water of appropriate quality in rivers and streams to maintain their ecological functioning. This will be achieved by classification of freshwater bodies and determination of their human and environmental Reserves, setting resource quality objectives for freshwater bodies, addressing water quality management, pollution control, sanitation and solid waste management. The following four strategies were developed:

- ⇨ Reserve and Resource Quality Objectives
- ⇨ Siting of New Developments
- ⇨ Solid Waste Management
- ⇨ Water Quality

(iii) Water use management strategies address the objectives of equity of access to water, and sustainable and efficient use thereof. This will be achieved through conditions of water use imposed through authorisations. These will include general authorisations (GAs) to manage water use, verification of the legality of existing water use, processing and issuing of new water use authorisations, point source pollution control, changing land use and water pricing. It is important to note that in the absence of GAs for surface water abstraction in the Berg WMA, the administration and processing of many minor individual licence applications would be unnecessarily time consuming and costly.

Eight water use management strategies have been developed, namely:

- ⇨ Implementing Schedule 1
- ⇨ General Authorisations
- ⇨ Verification of Existing Lawful Use
- ⇨ Licensing
- ⇨ Pollution Control
- ⇨ Changing Land Use: Forestry
- ⇨ Changing Land Use: Clearing of Invasive Alien Plants
- ⇨ Water Pricing Strategy

(iv) Water conservation and demand management strategies are required as an alternative to further augmentation of water supply by developing physical infrastructure. Attention needs to be devoted to managing the demand for water, encouraging the efficient and effective use thereof, minimising loss or waste of water and creating a water conservation and demand management culture within all water management and water services institutions, and among water users. These strategies will address urban and agricultural conservation measures and water demand management as well as the potential increased use of treated effluent. The CCT has implemented a pilot project in which pressure reduction in urban supply networks has shown potential for significant savings. The following three strategies have been developed:

- ⇨ Water Conservation and Demand Management: Water Services
- ⇨ Agricultural Water Conservation and Demand Management
- ⇨ Effluent Re-use

(v) Integration and co-operative governance strategies address the establishment and nurturing of co-operative relationships with other South African Government Departments, local authorities and water service providers for co-operative data collection, information sharing, sharing of visions and plans, capacity building and support and co-operative making of joint decisions. The integrated manner in which the WCWSS is operated illustrates the important relationship between the CCT, DWAF and other stakeholders. This strategy further aims to alleviate poverty by addressing the inequities of the past relating to water, *inter alia* relating to resource poor farmers and by support rendered to water related land reform initiatives. Management of water resources must also take environmental legislation into account. Three strategies were developed, namely:

- ⇨ Support to Resource Poor Farmers
- ⇨ Co-operative Governance
- ⇨ Managing the Environment

(vi) Institutional development and support strategies address the fundamental transformation of water resources management and governance, to appropriate and representative regional and local institutions. Such institutions include any organisation or person who fulfils the functions of a water management institution. Water User Associations (WUAs) and the Berg CMA are such organisations. The current and potential future sources of supply to local authorities is described in detail in the:

- ⇨ Supply to Local Authorities Strategy

(vii) The **Social** strategy addresses various social aspects and mitigation of environmental and social impacts to ensure improved overall water management and decision-making, while complying with environmental legislation. It includes public participation issues such as education and capacity building, community awareness and public consultation and participation. It also addresses the implementation of employment equity and gender issues and communications relating to water.

(viii) Waterworks development and management strategies address the ongoing need to economically and safely manage the existing water resources infrastructure. They also address the need for integrated operation and planning of the existing WCWSS and its interface with the future Berg Water Project. Strategies for recreation relating to dams, rivers, lakes and estuaries, and for disaster management planning are addressed. The following seven strategies were developed:

- ⇨ Strategy for System Management and Reconciliation
- ⇨ The Theewaterskloof Tunnels
- ⇨ Implementing the Berg Water Project
- ⇨ Strategy for the Lower Berg
- ⇨ Operation During Extreme Drought
- ⇨ Recreation on Dams and Rivers
- ⇨ Public Health and Safety

(ix) Monitoring and information management strategies address the monitoring of, collection of and data capturing of water resource related information from surface freshwater bodies and groundwater. Resulting information will enable the introduction of water billing and will ensure compliance with water authorisation conditions and the control of all water users. Issues relating to information systems and information access and requirements are also addressed. Three strategies were developed, namely:

- ⇨ Abstraction Control
- ⇨ Monitoring Networks and Data Capture
- ⇨ Information Management

(x) Implementation strategies address the need for a consolidated approach within DWAF to the implementation and ongoing management of the ISP process. This will formalise the implementation, so that delegated responsibilities and a programme of implementation can be drawn up according to priorities set in the ISP. The ISP is a developing process and the document will be reviewed on a regular basis and strategies will be amended, updated or added so as to achieve the management objectives for the Berg WMA. One strategy was developed, namely:

⇨ ISP Implementation

Under each of these main strategy groups, the specific strategies particular to the Berg WMA have been identified and developed. Frameworks for 34 strategies have been developed. As additional strategies are identified through the implementation process (including feedback from stakeholders), this document will be updated by the Department.

For each strategy, the following aspects are addressed:

- ***Management objectives*** in terms of the envisaged solutions for the Strategy;
- ***Background information;*** stating the relevant issues, problems, uncertainties and gaps in information;
- ***Strategic Approach*** as to a correct management procedure or solution to a problem in terms of the DWAF's management perspective for the ISP-area;
- ***Actions required*** to implement the strategy and the responsible organisations or persons;
- ***Responsibility***. The responsible implementing authority and contact persons are named;
- ***Priority*** in terms of the ISP rating system (1 – 5, where 1 is of highest priority);
- ***Interfaces*** with related strategies and other WMAs and ISP management areas and the identification of other major role-players and their functions. Relevant reports and documents are listed.

BERG WATER MANAGEMENT AREA

INTERNAL STRATEGIC PERSPECTIVE

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LIST OF ABBREVIATIONS

AAR	Artificial Aquifer Recharge
ASR	Aquifer Storage Recovery
BWP	Berg Water Project
CAGE	Citrusdal Artesian Groundwater Exploration
CCT	City of Cape Town
CMA	Catchment Management Agency
CMS	Catchment Management Strategy
CNCB	Cape Nature Conservation Board
DEADP	Department of Environmental Affairs and Development Planning
DEAT	Department of Environmental Affairs and Tourism
DECAS	Department of Environment Affairs, Culture and Sport
DWAF	Department of Water Affairs and Forestry
GAs	General Authorisations
GDP	Gross Domestic Project
IAC	Irrigation Action Committee
IDP	Integrated Development Plan
IFR	Instream Flow Requirements
ISP	Internal Strategic Perspective
IWRM	Integrated Water Resource Management
ℓ/c/d	litres per capita per day
m^3/a	cubic metres per annum
m^3/s	cubic metres per second
MAP	Mean Annual Precipitation
MAR	Mean Annual Runoff
mg/*l*	milligrams per litre
NWA	National Water Act
NWRS	National Water Resource Strategy
RO	Regional Office (DWAF, Western Cape Regional Office)
SFRA LAAC	Streamflow Reduction Activities Licence Assessment Advisory Committee
SUP	Sustainable Utilisable Potential
TCTA	Trans Caledon Tunnel Authority
TINWA	Team for Implementation of the National Water Act
TMG	Table Mountain Group
WCDM	West Coast District Municipality
WC/DM	Water Conservation and Demand Management
WCSA	Western Cape System Analysis
WCWSS	Western Cape Water Supply System
WfW	Working for Water
WMA	Water Management Area
WRPM	Water Resources Planning Model
WRSA	Water Resources Situation Assessment
WSA	Water Service Authorities
WSAM	Water Situation Assessment Model
WSDP	Water Services Development Plan
WSP	Water Service Provider
WTW	Water Treatment Works
WUA	Water User Association
WWTW	Wastewater Treatment Works
x 10^6 m^3/a	million cubic metres per annum

GLOSSARY OF TERMS

AQUIFER	A saturated permeable geologic unit that can transmit significant (economically useful) quantities of water under ordinary hydraulic gradients. (Specific geologic materials are not innately defined as aquifers and aquitards, but within the context of the stratigraphic sequence in the subsurface area of interest.)
AQUICLUDE	A geologic unit that cannot transmit significant (economically useful) quantities of water under ordinary hydraulic gradients. (Very few natural geologic materials are considered aquicludes.)
AQUITARD	A saturated, relatively lower permeability geologic unit within a stratigraphic sequence relative to the aquifer of interest. (This terminology is used much more frequently in practice than aquiclude, in recognition of the rarity of natural aquicludes.)
ASSURANCE OF SUPPLY	The reliability at which a specified quantity of water can be provided, usually expressed either as a percentage or as a risk. For example "98% reliability" means that, over a long period of time, the specified quantity of water can be supplied for 98% of the time, and less for the remaining 2%. Alternatively, this situation may be described as a "1 in 50 year risk of failure" meaning that, on average, the specified quantity of water will fail to be provided in 1 year in 50 years, or 2% of time.
BASIN	The area of land that is drained by a large river, or river system.
BIOTA	A collective term for all the organisms (plants, animals, fungi, bacteria) in an ecosystem.
CATCHMENT	The area of land drained by a river. The term can be applied to a stream, a tributary of a larger river or a whole river system.
COMMERCIAL FARMING	Large scale farming, the products of which are normally sold for profit.
COMMERCIAL FORESTS	Forests that are cultivated for the commercial production of wood or paper products.
CONDENSATION	The process whereby water is changed from a gas (water vapor) into a liquid.
CONFINED AQUIFER	An aquifer that is physically located between two aquitards. The water level in a well tapping a confined aquifer usually rises above the level of the aquifer.
CONTAMINANT	Any physical, chemical, biological, or radiological substance or matter in the water.
DEFICIT	Describes the situation where the availability of water at a particular assurance of supply is less than the unrestricted water requirement.

DISCHARGE AREA	The area or zone where groundwater emerges from below the surface. The outflow maybe into a stream, lake, spring, wetland, etc.
ECOLOGICAL IMPORTANCE	A measure of the extent to which a particular species, population or process contributes towards the healthy functioning of an ecosystem. Important aspects include habitat diversity, biodiversity, the presence of unique, rare or endangered biota or landscapes, connectivity, sensitivity and resilience. The functioning of the ecosystem refers to natural processes.
ENVIRONMENTALLY SENSITIVE AREA	A fragile ecosystem which will be maintained only by conscious attempts to protect it.
FORMAL IRRIGATION SCHEME	The term applies to a scheme where water for irrigation purposes is stored in a dam controlled by DWAF or an Irrigation Board and supplied in pre-determined quotas to irrigators registered under the scheme.
GREY WATER	Any water that has been used in the home, such as water from the bath, shower, washing machine, and bathroom sink, but not from toilets and the kitchen sink, is referred to as “grey water”. Grey water can be used for other applications around the home, such as garden irrigation.
GROUNDWATER	Water in the sub-surface, which is beneath the water table, and thus present within the saturated zone. In contrast, to water present in the unsaturated or vadose zone which is referred to as soil moisture.
HYDRAULIC GRADIENT	The difference in hydraulic head between two measuring points within a porous medium, divided by the distance between the two points.
HYDRAULIC HEAD	The fluid potential for flow through porous media largely comprised of pressure head and elevation head. This satisfies the definition of potential in that it is a physical quantity capable of measurement (such as with manometers, piezometers, or wells tapping the porous medium), where flow always occurs from regions of higher values to regions of lower values.
INTERBASIN TRANSFER	Water transferred from one WMA to another.
MEAN ANNUAL RUNOFF	Frequently abbreviated to MAR, this is the long-term mean annual flow calculated for a specified period of time, at a particular point along a river and for a particular catchment and catchment development condition. In this report, the MARs are based on the 70-year period October 1920 to September 1990 inclusive.
NON-POINT SOURCE OF POLLUTION	Contaminates found in water from a source that cannot be specifically defined. For example contamination resulting from municipal runoff or agricultural infiltration.

OPPORTUNISTIC IRRIGATION	Irrigation from run of river flow, farm dams, or compensation flows released from major dams. As storage is not provided to compensate for reduced water availability in dry years, areas irrigated generally have to be reduced in dry years.
PERMEABILITY	The portion of the proportionality constant of hydraulic conductivity, which is a function of porous medium alone. Permeability is an intrinsic property, which is a function of mean grain diameter, grain size distribution, sphericity and roundness of grains and the nature of grain packing.
POINT SOURCE OF POLLUTION	Contaminants found in water that can be readily identified from a specific source such as a leaking underground storage tank.
POLLUTION	Any substance, natural or synthetic, that degrades water quality to such a degree that water is not suitable for a particular use.
POTABLE WATER	Water, which is free from impurities that may cause disease or harmful physiological effects, such that the water is safe for human consumption.
QUATERNARY CATCHMENT	The basic unit of catchment area used in the WR90 series of reports published by the Water Research Commission and also in this report. The primary drainage regions are divided into secondary, tertiary and quaternary catchments. The quaternary catchments have been created to have similar mean annual runoffs: the greater the runoff volume the smaller the catchment area and vice versa. The quaternary catchments are numbered alpha-numerically in downstream order. A quaternary catchment number, for example R30D, may be interpreted as follows: the letter R denotes Primary Drainage Region R, the number 3 denotes secondary catchment 3 of Primary Drainage Region R, the number 0 shows that the secondary catchment has not, in this case, been sub-divided into tertiary catchments, and the letter D shows that the quaternary catchment is the fourth in sequence downstream from the head of secondary catchment R30.
RECHARGE AREAS	Areas of land that allow groundwater to be replenished through infiltration or seepage from precipitation or surface runoff.
RESERVOIR	The lake formed behind a dam wall. In this report the colloquial term dam is generally used for reservoir.
RESOURCE QUALITY	The quality of all the aspects of a water resource including: (a) the quantity, pattern, timing, water level and assurance of instream flow; (b) the water quality, including the physical, chemical and biological characteristics of the water; (c) the character and condition of the instream and riparian habitat; and (d) the characteristics, condition and distribution of the aquatic biota.

RESOURCE QUALITY OBJECTIVES	Quantitative and verifiable statements about water quantity, water quality, habitat integrity and biotic integrity that specify the requirements (goals) needed to ensure a particular level of resource protection.
RIVER SYSTEM	A network of rivers ranging from streams to major rivers and, in some cases, including rivers draining naturally separate basins that have been inter-connected by man-made transfer schemes.
SALINITY	The concentration of dissolved salts in water. The most desirable drinking water contains 500 ppm or less of dissolved minerals.
SATURATED ZONE	The subsurface zone below the water table where pores within the geologic matrix are filled with water and fluid pressure is greater than atmospheric.
SUB-CATCHMENT	A sub-division of a catchment.
SURFACE WATER	Bodies of water, snow, or ice on the surface of the earth (such as lakes, streams, ponds, wetlands, etc.).
10^6 m^3/a	1 million cubic metres of water in one year.
TRANSPIRATION	The process by which plants give off water vapor into the atmosphere.
TURBIDITY	A measure of water cloudiness caused by the amount of suspended matter in the water
UNCONFINED AQUIFER	(a.k.a. water table aquifer) - An aquifer in which the water table forms the upper boundary. The water level in a well tapping an unconfined aquifer will rise only to the level of the water table within the aquifer.
UNSATURATED ZONE	(See vadose zone)
WATER IMPORTS	Water imported to one drainage basin or secondary sub-catchment from another.
WATER TABLE	The surface on which the fluid pressure in the pores of a subsurface porous medium is exactly atmospheric.
WATER TRANSFERS	Water transferred from one drainage basin or secondary sub-catchment to another. Transfers in are synonymous with water imports.
YIELD	The maximum quantity of water obtainable on a sustainable basis from a dam in any hydrological year in a sequence of years and under specified conditions of catchment development and dam operation.

PART 1 – INTRODUCTION AND OVERVIEW

CHAPTER 1: BACKGROUND TO THE BERG WMA INTERNAL STRATEGIC PERSPECTIVE

1.1 LOCATION OF THE BERG WMA

Figure 1.1 shows the location of the Berg WMA, which falls within the Western Cape Province.

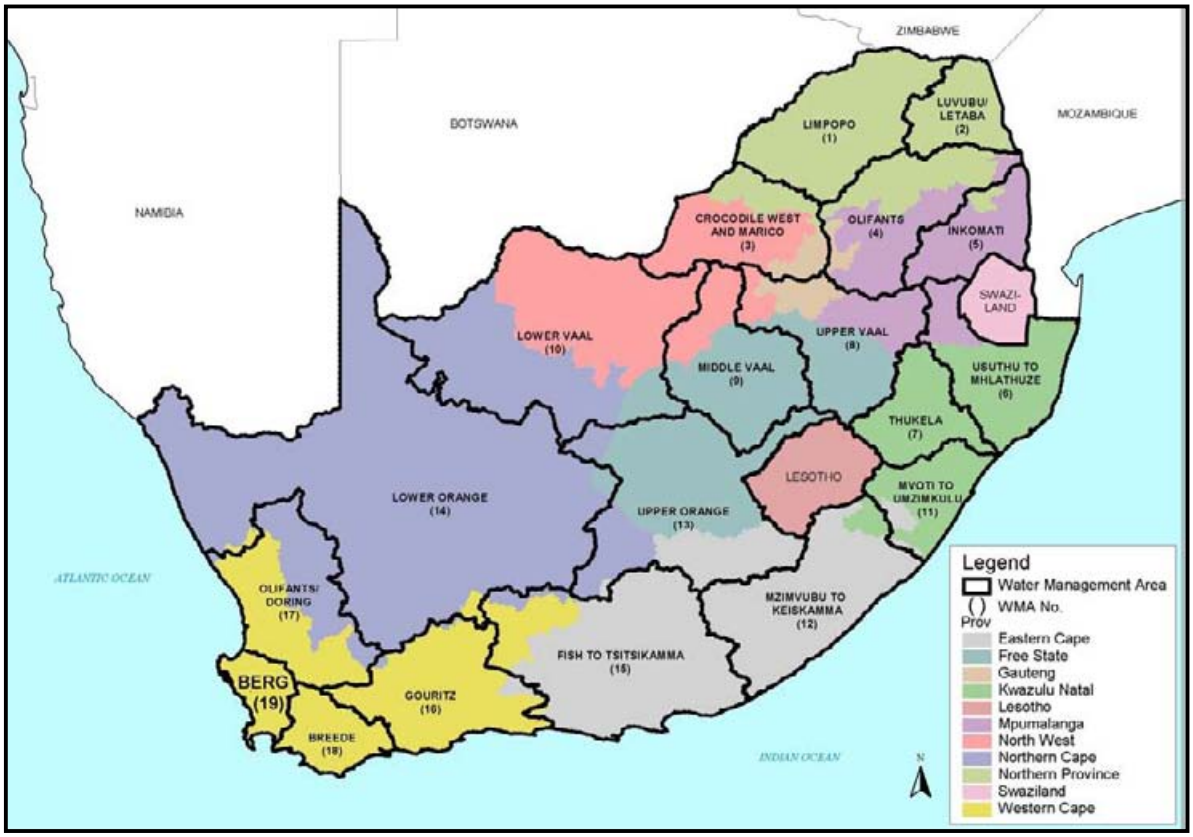

Figure 1.1: Location of the Berg WMA

1.2 WATER LEGISLATION AND MANAGEMENT

Water is one of the most fundamental and indispensable of all natural resources. It is fundamental to life and the quality of life, to the environment, food production, hygiene, industry, and power generation. The availability of affordable water can be a limiting factor for economic growth and social development, especially in South Africa where water is a relatively scarce resource that is distributed unevenly, both geographically and through time, as well as socio-politically.

Prosperity for South Africa depends upon sound management and utilisation of our many natural and other resources, with water playing a pivotal role. South Africa needs to manage its water resources optimally in order to further the aims and aspirations of its people. Current government objectives for managing water resources in South Africa are set out in the National Water

Resources Strategy (NWRS) as follows:

- **To achieve equitable access to water.** That is, equity of access to water services, to the use of water resources, and to the benefits from the use of water resources.
- **To achieve sustainable use of water**, by making progressive adjustments to water use to achieve a balance between water availability and legitimate water requirements, and by implementing measures to protect water resources and the natural environment.
- **To achieve efficient and effective water use** for optimum social and economic benefit.

The NWRS also lists important proposals to facilitate achievement of these policy objectives, such as:

- Water will be regarded as an indivisible national asset. The Government will act as the custodian of the nation's water resources, and its powers in this regard will be exercised as a public trust.
- Water required to meet basic human needs and to maintain environmental sustainability will be guaranteed as a right, whilst water use for all other purposes will be subject to a system of administrative authorisations.
- The responsibility and authority for water resource management will be progressively decentralised by the establishment of suitable regional and local institutions, with appropriate community, racial and gender representation, to enable all interested persons to participate.

1.2.1 The National Water Act (NWA)

The NWA of 1998 is the principal legal instrument relating to water resource management in South Africa. The Act is now being implemented incrementally. Other recent legislation which supports the NWA includes the Water Services Act (Act 108 of 1997) and the National Environmental Management Act (Act 107 of 1998).

1.2.2 The National Water Resource Strategy (NWRS)

The NWRS is the implementation strategy for the NWA and provides the framework within which the water resources of South Africa will be managed in the future. All authorities and institutions exercising powers or performing duties under the NWA must give effect to the NWRS. This strategy sets out policies, strategies, objectives, plans, guidelines, procedures and institutional arrangements for the protection, use, development, conservation, management and control of the country's water resources. The purpose of the NWRS is to provide the following:

- The National framework for managing water resources;
- The framework for preparation of catchment management strategies in a nationally consistent way;
- Information, in line with current legislation, regarding transparent and accountable public administration; and
- The identification of development opportunities and constraints with respect to water availability (quantity and quality).

1.2.3 Catchment Management Strategies (CMS)

The country has been divided into 19 Water Management Areas (WMAs). The delegation of water resource management from central government to catchment level will be achieved by establishing Catchment Management Agencies (CMAs) at WMA level. Each CMA will progressively develop a Catchment Management Strategy (CMS) for the protection, use, development, conservation, management and control of water resources within its WMA.

The Department's eventual aim is to hand over certain water resource management functions to CMAs. Until such time as the CMAs are established and are fully operational, the Regional Offices (ROs) of DWAF will have to continue managing the water resources in their areas of jurisdiction.

1.3 INTERNAL STRATEGIC PERSPECTIVES (ISPs)

1.3.1 The Objectives of the ISP Process

The objective of the ISP will be to provide a framework for DWAF's management of the water resources in each Water Management Area, until such time as the Regional Offices can hand over the management functions to the established CMA. This will ensure consistency when answering requests for new water licences, and informing existing water users (including authorities) on how the Department will manage the water resource within the area of concern. Stakeholders must be made aware of the bigger picture as well as the management detail associated with each specific water resource management unit.

1.3.2 Approach Adopted in Developing the ISP

The ISP for the Berg WMA was developed in five stages as follows:

i) Determining the current status of water resource management and relevant water resource management issues and concerns in the Berg WMA. This was achieved through interviews with individual members of DWAF's RO in Bellville and by collating information from the NWRS, WMA reports, Water Resource Situation Assessment (WRSA) reports and other catchment study reports. The following topics were discussed with Regional Office staff and their issues and concerns documented:

- Water Situation
- Resource Protection
- Water Use
- Water Reconciliation
- Water Infrastructure
- Monitoring and Information
- Water Management Institutions
- Co-operative Governance
- Planning Responsibilities.

A starter document of the identified issues and concerns was produced as a discussion document for the first workshop.

ii) The first workshop was held with attendees from the Regional Office, the Integrated Water Resource Planning (IWRP) Chief Directorate of the Department as well as the consulting team. The workshop focussed on the lists of general issues in the WMA as well as area-specific issues. The issues were clarified and refined during the workshop. Strategies were discussed and developed to address the issues.

iii) The third stage involved the preparation of the second workshop document to be used for refining strategies to address the various issues and concerns, during the second workshop.

iv) The fourth stage was the second workshop. During this workshop the overall management of the water resources in the catchment was discussed along with the ISP management strategies and the relevant issues and concerns. The priorities and responsibilities for carrying out the strategies were identified. First workshop attendees were again involved, as were representatives of several DWAF Head Office directorates.

v) The fifth stage was the finalisation of the ISP document.

As can be deduced from the above this Berg ISP was prepared internally within the Department, and captures the Department's perspectives. Once approved by DWAF Management, it is intended that the Regional Office will make the ISP available to Water User Associations

(WUAs), Water Service Providers (WSPs), Water Service Authorities (WSAs) and other forums for discussion and comment. These comments will be considered and worked into later versions of the ISP. By adopting this procedure this ISP becomes a working document, which will be progressively updated and revised by DWAF. Public participation forms part of the CMS process, for which the ISP serves as a foundation (see Paragraph 1.6).

The ISP does not formulate all the details pertaining to every strategy but provides a suggested framework for each strategy around which the details will be developed by the responsible authority. Where relevant and readily available, certain details have been included in the strategies. The responsible authority for the further development of each strategy is indicated. This is predominantly the Regional Office, which remains responsible for involving the relevant DWAF directorates.

1.3.3 Updating of the ISP Report

The ISP strategies should not lag behind national developments, become outdated or differ from related ISPs regarding trans-boundary management. There is therefore a need to have a standard process for updating strategies, and to prevent strategies becoming outdated by ensuring adequate feedback from national developments. Furthermore, the proposal and introduction of new strategies needs to be accommodated. It is suggested that each strategy has a version-control system. The following is necessary:

- Keep abreast of changes in national legislation and policy changes or refinements by keeping a list of all relevant legislation and supporting documents relevant to the ISP;
- Ensure consistency between the ISP strategies and national strategies through a regular review-and-update procedure;
- Annually review and ensure consistency and agreement regarding trans-boundary ISP management issues by liasing with the responsible managers of other areas and updating relevant ISP strategies if necessary;
- Annually review the priorities of required management actions and align budgets accordingly;
- Monitor the implementation of the ISP (review actions, progress, implementation and stumbling blocks);
- Incorporate feedback from stakeholders;
- Rigorously apply ISP version control.

Updating and Version Control

The actual frequency of ISP revision will be determined by the number and extent of revisions to management approaches as reflected in Strategy amendments. All updates to this report, particularly with respect to amendment to the Strategies, need to be passed on to and vetted by the Catchment Manager for the Berg WMA. The current incumbent is Mr B van Zyl, who has been delegated the task of managing version control.

1.3.4 The Authority of Information Contained in the ISP

The NWRS is a statutory document, subject to a high level of public scrutiny and input, and signed off by the Minister. The information contained in the NWRS is the best information and knowledge available at the time. The information in Chapter 2 and Appendix D of the NWRS Strategy on water requirements, availability and reconciliation was updated with comments received from the public participation process in the second half of 2002. To enable the finalisation of the NWRS, these figures were "closed" for changes in February 2003.

Underlying the figures in Chapter 2 and Appendix D is a set of 19 reports "Overview of Water Resources Availability and Utilisation", one for each WMA. These reports contain more detailed information on each WMA than was summarised for the NWRS and are referred to, in short, as "WMA Reports". The WMA reports were also finalised with the February 2003 information.

Still deeper in the background lies another set of reports (one per WMA), the so-called Water Resource Situation Assessment Reports. These reports contain a wealth of information on each WMA, but the figures on requirements, availability and reconciliation have been superceded by the WMA report and the NWRS.

The ISPs for all WMAs used the information contained in the NWRS and WMA reports as the point of departure. However, an inevitable result of the ISP process has been that better information has emerged in some cases. The reason is that the level of study is more detailed and intense for the ISP. This included very close scrutiny of the numbers used in the NWRS, and in some cases a reworking of base data and some re-modelling. Where the ISPs contain yield balance data which differs from the NWRS, these discrepancies are carefully explained. Where other differences from the NWRS are necessary these are also detailed in the ISP, with accompanying explanations.

It is required that the Department work with the best possible data so that the best possible decisions can be taken. Where the ISPs have improved upon the NWRS then this is the data that should be used. The new data contained in the ISP will also be open to public scrutiny as the ISP reports will be published on the Internet and in hardcopy, and will be presented and discussed at WMA forums. Comments received will be considered and worked into subsequent versions of the ISP on a regular (yearly) basis. The NWRS will be updated to reflect the latest understanding in each new edition.

1.4 INTEGRATED WATER RESOURCE MANAGEMENT (IWRM)

It is imperative that the natural, social, economic, political and other environments and their various components are adequately considered when conducting water resources planning and management. Water as a strategic component also interacts with other components in all environments. For example, human activities such as the use of land, the disposal of waste, and air pollution can have major impacts on the quantity and quality of water which is available for human use and for proper life support to natural biota.

Taking an even broader view, water must also be managed in full understanding of its importance for social and economic development. It is important to ensure that there is conformity between the water-related plans and programmes of the CMAs, and the plans and programmes of all other role players in their management areas. The CMAs must therefore establish co-operative relationships with a wide range of stakeholders, including other water management institutions, water services institutions, provincial and local government authorities, communities, water users ranging from large industries to individual irrigators, and other interested persons.

This integrated planning and management approach is intended, through co-operative governance and public participation, to enable water managers to meet the needs of all people for water, employment, and economic growth in a manner that also allows protection and, where necessary, rehabilitation of aquatic ecosystems. Above all, Integrated Water Resource Management (IWRM) will enable water managers to use our precious water resources to assist us in poverty eradication and removal of inequity.

One of the big opportunities to formally integrate a large number of actions in water resource management presents itself during the compulsory licensing process.

Compulsory licensing is identified in the NWRS as a very important action for implementing the NWA. However, it is not a simple action of issuing licences but a complex process of closely related and interdependent activities that will in itself formalise IWRM to a great extent. The process of IWRM is diagrammatically depicted in Figure 1.2.

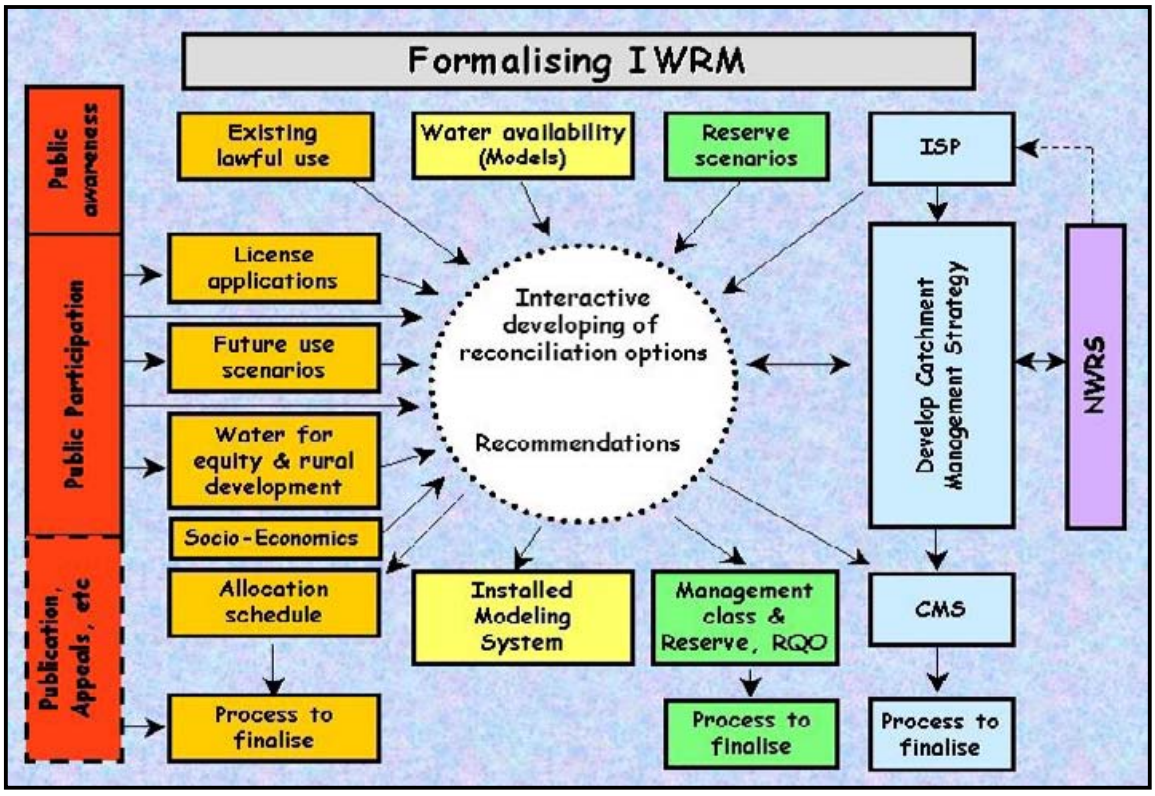

Figure 1.2: Diagram showing DWAF Integrated Water Resources Management approach

Before an allocation schedule can be determined and the legal steps followed to finalise compulsory licensing (through the issuing of licences to all users), many other aspects must be addressed:

- Existing use and the lawfulness of that use must be verified, all users (existing and new) must apply for licences, a good understanding of future use scenarios must be developed and water required for equity purposes and rural development must be clearly understood.

- Water availability must be understood as thoroughly as possible with "best available" existing information used to model all possible reconciliation options.

- Reserve scenarios must be developed for all significant resources in the catchment, for instance, the river flow requirements for all possible classes that may be considered.

- The development of strategies for implementing the licensing (abstraction controls, for example), the Reserve and Resource Quality Objectives (i.e. incrementally over time) must go hand in hand with the rest of the processes to ensure that practical, workable solutions are found.

The processes will then enter a very intensive, interactive phase of developing realistic reconciliation options. This would entail, for example, the selection of a specific management class to be scrutinised for its impact on the number of licences that could be issued for use, with its concomitant impacts on the social and economic structure of the catchment.

The active participation of stakeholders in this process will then hopefully crystallise clear recommendations on an allocation schedule, management classes for the various reaches of the rivers and the resultant ecological Reserve and Resource Quality Objectives, as well as strategies for the implementation.

Although the Department will play a very strong role in guiding this process, it is extremely important to have the CMA actively involved. Preferably, at least the Board of the CMA must be in place to drive the public participation for the process.

1.5 CARING FOR THE ENVIRONMENT

DWAF is responsible for water resource development and management in terms of the NWA, and within the broader framework of other environmental legislation. The Department also strongly reflects the will to make sound decisions which ensure the development of society and the economy whilst maintaining, and where possible enhancing, ecological integrity. The concept of management of the environment has evolved from the exclusivity of protection of plants and animals to balancing the complex interaction of society, the economy, and ecology. “Environmental management is the integration of social, economic and ecological factors into planning, implementation and decision-making so as to ensure that development serves present and future generations” (NEMA).

The key legislative Acts to which DWAF is required to refer are the National Environmental Management Act (NEMA, Act 107 of 1998) and the Environment Conservation Act (ECA, Act 73 of 1989). DWAF has prepared a Consolidated Environmental Implementation and Management Plan (CEIMP) as a requirement of NEMA. This describes the Department's functions, policies, plans and programmes, and states how these comply with environmental legislation. Through the CEIMP the Department has committed itself to developing and implementing an integrated Environmental Management Framework (EMF) to ensure that its approach is aligned with the principles prescribed in NEMA and the ECA. The EMF will inform the Department at a strategic decision-making level, bring about environmental legal compliance, and help in achieving environmental sustainability through the promotion of sound environmental management practices. Integrated Environmental Management is a co-operative governance effort with DWAF as a full partner in the process.

This ISP has the responsibility of raising and maintaining the environmental consciousness of the Department's water resource planners and managers. The control over water has a very broad range of influence and impact for which strategies and planning need to account. Impacts come from many different angles.

Some of these angles of impact which are considered through this ISP are noted below:

- The direct impact of physical structures (environmental constraints to construction e.g. of weirs or dams)
- The implications of allocating and licensing water for use. Forestry and irrigation are examples of users where development based on water can mean the transformation of extensive areas of otherwise 'natural' environments.
- The allocation of water for equity. Here we can include approaches towards the application of Schedule 1 Use, General Authorisations, the revitalisation of irrigation schemes, etc.
- Failure to support equity, or appropriate development – noting the consequential impacts of poverty.
- Sanitation systems and the impacts on groundwater quality.
- The implementation of the Reserve.
- The ability to monitor and manage compliance, thus protecting the resource and with it the environment.

All decisions regarding water are critical to the environment. Decisions must be made on a balance of social, economic and ecological costs and benefits, considering both the immediate and the long-term, and always with an eye out for the unintended consequence. It is the intention of the ISP to provide the basis for integrated decision-making. The principles of environmental management underpin every strategy developed in this document.

There are a number of strategic areas with a particularly strong biophysical/ ecological emphasis. These include:

- The Reserve (groundwater, rivers, wetlands and estuaries)
- Water quality - surface and groundwater
- The approach towards the clearing of Invasive Alien Plants
- The management of wetlands
- Land degradation. Erosion and sedimentation (land care)
- Land use and especially how this is impacted by land reform and the re-allocation of water.

The roles of Co-operative Governance and the need for awareness raising and capacity building are key strategic elements of many strategies.

In reality all strategies and all aspects of management have a strong interaction with the biophysical environment. This ISP endeavours to capture all of these concerns in discussion and through a strategic approach which emphasises the will of the Department to manage the environment to the best benefit of the country and its people.

The approach set out above applies to all Water Management Areas and associated ISPs, and is not repeated within the Strategy Tables (Part 2 of this ISP). It reflects the way the Department views Integrated Water Resource Management and the importance of the biophysical aspects of decision-making. There may nevertheless be specific ecological and biophysical aspects of management which require specific attention and which may not be captured in the above-mentioned or other strategies. The ISP therefore still includes an Environmental Strategy which serves to make pertinent those issues of the environment which might not otherwise be covered.

1.6 THE SOCIAL ENVIRONMENT

The utilisation of water resources is aimed at the benefit of society, and at society through the economy. As noted in Section 1.5 this should not be at undue cost to ecological integrity.

Impacts on society are a core element of this ISP, and decisions are often complicated by the risk of unintended consequence. As a typical example the over-zealous implementation of the ecological Reserve may benefit the river, to the intended benefit of society, but the cost of lack of use of that water to employment and to livelihoods may lead to other strains on natural resources that undo the benefits.

The implementation of the NWA requires that society be kept at the forefront of all decision-making. This principle is now deep-seated within the Department and is integral to all strategies. Water resource allocation and use has critical social impact, as does water quality management. But pivotal to the social component is the question of equity. What can be done and what is being done to redress past inequities? Within this, strategies have been developed to consider the provision of water to Resource Poor Farmers, the use of water under Schedule 1, Licensing and

General Authorisations, etc. Whilst water supply and sanitation are not part of the brief of the ISP, the provision of water to meet these needs most certainly is. The urban poor, and the poor in rural villages, are as important in the consideration of the distribution and use of water resources as are the rural subsistence poor, and this should not be forgotten in the urgencies of land reform and the enthusiasm to establish a substantial class of farmers from amongst the previously disadvantaged.

This ISP aims to see water benefiting society. This can be through access to water in livelihood strategies, through small-farmer development programmes, through water supply and sanitation and especially the provision of good quality drinking water, and through the maintenance and growth of income-producing, job creating, and tax paying agricultural, commercial and industrial strategies.

Consultation and public participation are cornerstones of the social component of any strategic document. These requirements are repeatedly stressed throughout the National Water Act. This ISP has been prepared as DWAF's position statement with respect to the management of water resources and, although strategies and plans have been captured without consultation with the stakeholders, it remains an open and transparent document where the understanding of the Department, its visions and its principles are made clear for all to see and to interact with. This is amplified in the Implementation Strategy (Part 2: Strategy no 10) of this ISP.

1.7 WATER QUALITY MANAGEMENT

Much of the emphasis in water resource management has revolved around ensuring that users have sufficient quantities of water. However, as more water gets used and re-used, as quantities get scarce and feedback loops get even tighter, it is quality that begins to take on a dominant role.

Water availability is only as good as the quality of that water. Both quantity and quality need to be considered at the correct level of detail, and this can mean that at times they should be considered with similar emphasis and with similar expenditure of resources. Too often we have failed to integrate the issues of quantity and quality – both with regard to surface water and groundwater. The concept of Available Assimilative Capacity, the ability of the water resource to absorb a level of pollution and remain 'serviceable', is as important in water resource management as is the concept of Systems Yield.

Quantity and quality can no longer be managed in isolation of each other. Not that this isolation has ever been total. The importance of releasing better quality water from Brandvlei Dam for freshening the saline water in the lower reaches of the Breede River, and of the addition of freshening releases from Vaal Barrage to bring water back to an acceptable quality has, inter alia, long been standard practice. The consequences of irrigation, the leaching of fertilisers, and more importantly the leaching of salts from deeper soil horizons can render both the lands themselves and the receiving rivers unsuitable for use. Diffuse agricultural 'effluent' may be less visible than direct discharges of sewage or industrial effluent, but are no less pernicious.

Direct discharges to rivers are licensed and managed on the basis of assimilative capacities of those rivers, and on Receiving Water Quality. Where these limits are exceeded, often through the cumulative impact of diffuse discharges, water becomes unavailable to some, or even all, users downstream. DWAF will licence users to take water, and again to discharge it in recognition that there is generally a cost to the resource in terms of a reduction in quality and a reduction in its further assimilative capacity. It is for this reason, and in order to bring about additional management and a strong incentive, that the Waste Discharge Charge System is being developed. Discharge users will be obliged to pay, depending on the quantity and quality of their discharge.

Surface water quality is affected by many things including sediment and erosion, the diffuse discharges from irrigated farmland (both fertilisers and salinity through leaching), domestic and urban runoff, industrial waste, and sewage discharges. Of these, industrial waste and sewage discharges are the easiest to licence and control, but this does not mean that this is problem-free. The Department has found that the situation with regard to sewage discharges often far exceeds the standards and conditions demanded by licences. There is a problem of compliance with regard to Local Authorities and private operators responsible for waste management systems. Diffuse discharges only compound the problem by reducing the assimilative capacity until the water becomes unfit for use, very expensive to purify, and a danger to human health.

Groundwater quality requires equal attention, and more so as we recognise the importance of groundwater in supplementing our meagre resources, and providing water to remote communities. Although our groundwater resources are for the most part to be found at a relatively deep level (50-100m is quite typical) this water can easily be polluted by surface activity. The leaching of fertilisers is one such problem but of greater concern is the influx of nitrates, primarily a consequence of human habitation and sanitation. Pit latrines are on the one hand so necessary, and have the huge advantage of not requiring volumes of water, but disposal is ‘on-site’, and often responsible for the longer-term pollution of the underlying aquifers which feed and water the communities above.

Water quality is a very important aspect of strategy within this ISP – considered primarily within the Water Quality Strategy and also under Groundwater. Industrial wastewater discharge, diffuse agricultural discharges, wastewater treatment works, the location and management of solid waste disposal sites, the siting of new developments, informal settlements and the impacts of sanitation systems, are all elements considered with great concern in this and other ISPs. Despite this attention it may be that Water Quality has still not taken its rightful place in the integrated management of the water resource. But the Department is moving towards IWRM and the integration of quantity and quality issues. Managers have now been given crosscutting responsibilities that will ensure a far more integrated approach in future.

Actions recommended within the Department include:

- The need to actively workshop the integration process. Resource Management, Planning and Allocations of Groundwater and Surface Water Quantity and Quality.
- The review and incorporation of knowledge from recent Water Research Commission Studies on both radioactivity and nitrates (groundwater quality issues).
- A review of all water quality literature reflecting situational knowledge and understanding within this WMA (and each and every WMA).
- Ensure that Water Quality monitoring is fully integrated into WMA water resources monitoring.

Refer particularly to strategies 2.2, 2.3, 2.4 and 3.5 in Part 2 of this ISP

1.8 GROUNDWATER

The ISP process in all of the Water Management Areas of South Africa has highlighted the role and importance of groundwater as part of the total water resource. Although groundwater has always been important in some areas this overall vision is a significant advance on our previous understanding of the potential for groundwater use. With the surface water resources in many WMAs now fully utilised, almost the only opportunity left for further development lies in the exploitation of groundwater. More particularly it is recognised that many of the more remote towns and villages, far from surface supplies, can in fact supply or supplement existing sources through groundwater, and that this must become a priority option. So, too, many small communities and subsistence farmers can avail themselves of groundwater when it would otherwise be impossible or impractical to lay on piped supplies. This can also reduce the pressure on existing users and perhaps even circumvent the need for Compulsory Licensing. The Department will be developing its capacity to explore and encourage the use of groundwater.

Of obvious concern is the likelihood of an interaction between groundwater and surface water. If the interaction is strong then additional use of groundwater may simply be reducing the surface water resource already allocated to someone else. In some instances (such as in the case of dolomitic aquifers) this interaction can indeed be very strong, whilst across many areas of the country it is so weak as to be negligible. In these circumstances groundwater comprises a huge pool of available water which is only of benefit if it is utilised. Care must always be taken with the issuing of licenses to ensure that both the Groundwater Reserve and other downstream users do not end up being the losers.

The realisation in this and other ISPs is that groundwater offers a huge resource of water which can be tapped, and that this can be a very significant supplement to the national water resource. The Table Mountain Group Aquifer which underlies much of the Berg WMA is being specifically researched for its utilisation potential.

See also the Groundwater Strategy No 1.3, in Part 2 of this ISP.

1.9 PUBLIC RECREATION - THE USE OF DAMS AND RIVERS

The use of water for recreational purposes is one of the 11 water uses regulated in terms of the NWA (Section 21 j). The Department is developing a national policy towards 'Recreation on Dams and Rivers' and this should, in the first instance, be adhered to. Recreational use can take many forms and only occasionally has any direct impact on the water resource. Most obvious are activities such as power-boating, sailing and swimming which can have quality / pollution impacts. Far more significant in terms of both quantity and quality is the release of water to allow for canoeing and other water sports downstream (The Berg, Dusi and Fish River canoe marathons being prime examples). These activities can bring very significant economic benefits to the WMAs concerned, and where water releases can be accommodated, particularly through alignment with the needs of the ecological Reserve or other downstream users, then so much the better.

It is noted in this ISP that water resources offer a very significant recreational outlet and that recreation is an important public and social asset necessary for national health and productivity. A central philosophy is that recreational opportunity should not be unreasonably and unnecessarily denied to users, and that the implementation of policy should ensure that disadvantaged and poor people should also be able to avail themselves of opportunities.

The Department has already transferred responsibility for the management of many public waters to Local Authorities and will continue with this process. Responsibility will therefore devolve upon these Authorities, but within the broad principles as laid down by the Department.

In this ISP refer to Strategy 6.1.

1.10 CO-OPERATIVE GOVERNANCE – the place of the ISP

The ISP is DWAF's approach to the management of water resources within the WMA. This will, in the longer term, be replaced by a fully consultative Catchment Management Agency. What is most important, in the medium term is that the ISP has a good fit with the Provincial Growth and Development Plan, with regional and other Environmental Management Plans, with plans and expectations of the Departments of Agriculture, Land Affairs, the Environment and others. It must also be aligned with the Integrated Development Plans and Water Services Development Plans now required for each District Municipality. Water is very often a constraining feature in development and co-operative governance planning and implementation is essential in matching what is wanted with what is possible.

CHAPTER 2: BROAD OVERVIEW OF THE BERG WMA FROM A WATER RESOURCE MANAGEMENT PERSPECTIVE

2.1 INTRODUCTION

The purpose of the Broad Overview is to provide background information with respect to water resource management of the Berg WMA. One of the most important factors in the water environment of the Berg WMA is the Western Cape Water Supply System (WCWSS). It plays a dominant role in water supply to a large section of the Berg WMA and is first described, and dealt with in detail before introducing the overall Berg WMA yield balance. The current sources of supply to towns are described and potential future sources of supply are suggested.

As mentioned in Chapter 1, the current water reconciliation of demands and existing supply infrastructure and of future development scenarios are reviewed in Chapter 2 and Appendix D19 of the NWRS, as well as in the Berg WMA Report: Overview of Water Resources Availability and Utilisation, Report No P WMA 19/000/00/0203. These (nineteen) WMA reports were issued in 2003 in support of the NWRS, and contain more detailed information. The water reconciliation figures currently used in the NWRS have been reviewed in the ISP process and any suggested changes are motivated. Uncertainties that still remain regarding the current estimate of the yield balance in the Berg WMA are also discussed in this chapter.

Reconciliation interventions, including water conservation and demand management, effluent re-use and the future development of water resource infrastructure are outlined.

2.1.1 Location and Sub-areas

The Berg WMA is situated in the south-western corner of South Africa and falls entirely within the Western Cape Province.

The NWRS makes use of three sub-divisions within the WMA, as shown on Figure 2.1.1. These so-called areas of interest are used for the purposes of describing the broad overview of the WMA and for assessing the reconciliation of water availability and requirements. They are:

- The ***Upper Berg*** sub-area, consisting of 8 quaternary catchments (G10A – G10H). This area extends from the source of the Berg River in the Franschhoek Mountains to Misverstand Dam, south of Piketberg.
- The ***Lower Berg*** sub-area, consisting of 10 quaternary catchments (G10K – G10M, G21A – G21F and G30A). The area includes the Berg River catchment between Misverstand Dam and the Berg River mouth. It includes the smaller rivers which drain some West Coast catchments direct to the sea, and the catchment of the Diep River.
- The ***Greater Cape Town*** sub-area, consisting of 11 quaternary catchments (G22A-G22K and G40A). This area includes the urban rivers in the Cape Town Metropolitan area, the Kuils, Eerste, Lourens and Sir Lowry's Pass Rivers, as well as the Steenbras River

catchment.

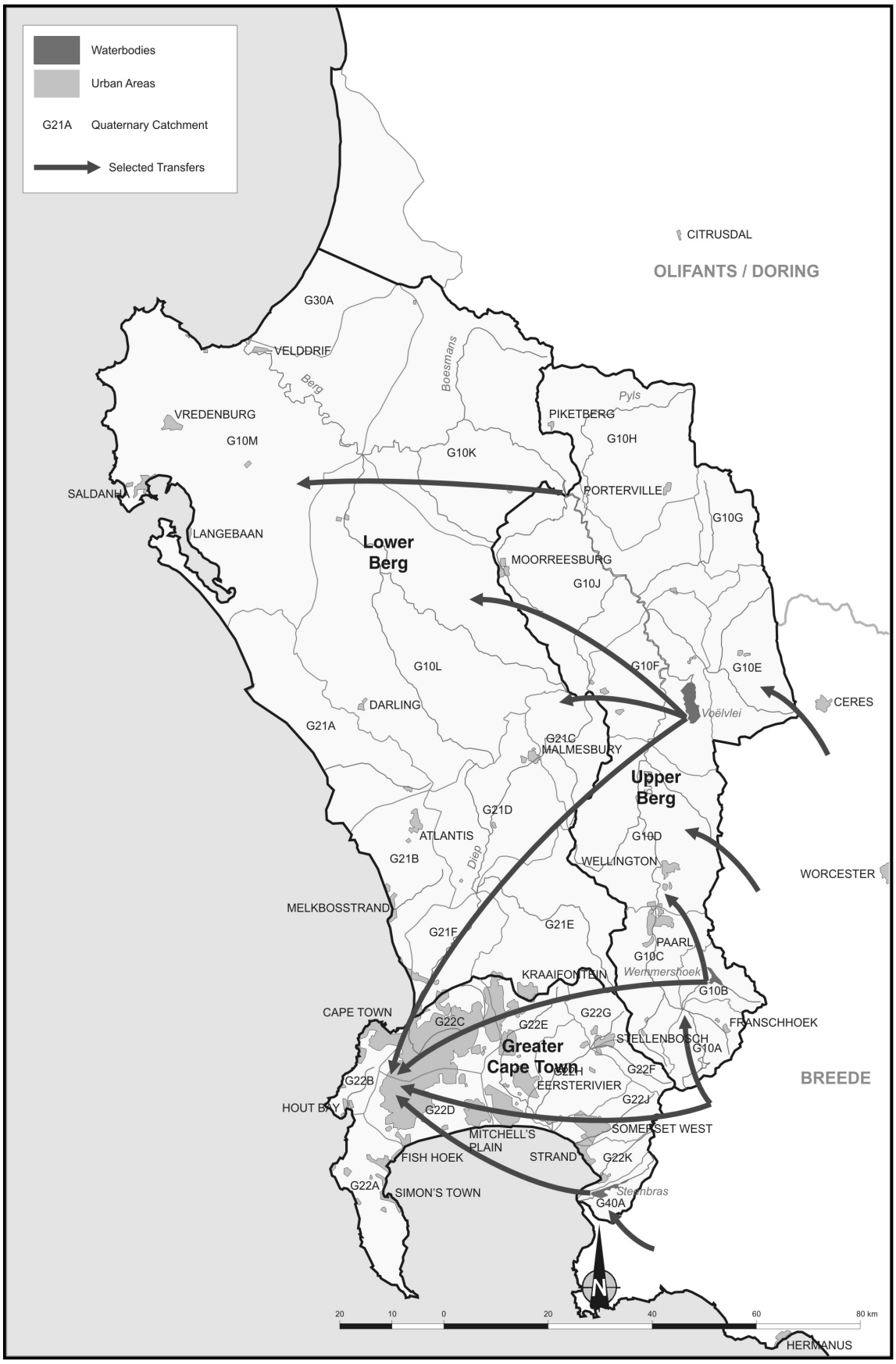

Figure 2.1.1: Base map of the Berg WMA
(Ref**:** National Water Resource Strategy – Appendix D19 – Berg WMA)

2.1.2 Topography, Rainfall and Land Use

The variation in topography results in a climate which varies considerably within the WMA. The mean annual temperature varies between 16°C in the east to 18°C along the West Coast, with an average of 16°C for the whole WMA. Maximum temperatures are experienced in January (average daily max = 29,4°C) and minimum temperatures usually occur in July (average daily min = 4,5°C). Temperatures along the coast are a few degrees cooler than in the interior.

The majority of the rainfall occurs between the months of May and September and hence it is referred to as a winter rainfall region. Rainfall is of a frontal nature, generally moving from the Atlantic Ocean to the north-west over the Western Cape. The orographical influence of the high mountain ranges in the Cape Peninsula and on the eastern side of the WMA, introduces a large spatial variability in the mean annual precipitation (MAP). In the high lying areas of the Upper Berg River, the upper reaches of the Eerste River and the Steenbras River, the maximum MAP exceeds 3 000mm per annum. In the lowlands, the precipitation is between 600mm and 400mm per annum, being greater in the small mountain outcrops and hills and reducing to 300mm per annum in the north-west of the WMA, where the Berg River flows into the sea. The average potential mean annual evaporation (measured by S-pan) ranges from 1 400mm in the south to 1 700mm in the north of the WMA.

Intensive irrigation takes place in the Upper and Lower Berg River valleys from the Berg River, its tributaries and from private dams, as well as in the Eastern region of the Greater Cape Town sub-area (along the Eerste and Lourens Rivers), with small pockets of irrigated land within the Cape Flats. Dry land cultivation of wheat is dominant in both the Upper Berg and Lower Berg sub-areas (including the Diep River), with some dry land vineyards in the hills.

2.1.3 International and National

The Berg WMA does not border on any neighbouring country and is not directly linked to any other country through the transfer of water. Water is transferred between the Breede WMA and the Berg WMA, with a net transfer into the Berg WMA of some 194 million m^3/a (in 2000). This is made up as follows:

- Transfers via the Riviersonderend – Berg River Tunnel:
  - 22 million m^3/a from Theewaterskloof to the Upper Berg sub-area.
  - 139 million m^3/a from Theewaterskloof to Greater Cape Town sub-area.
  - 9,6 million m^3/a to the Upper Berg sub-area from minor transfers.

- 23 million m^3/a from the Palmiet River (Breede WMA) to the Greater Cape Town sub-area, via the Palmiet Pumped Storage Scheme.

2.1.4 Economic Activity

A strong and diversified economy exists in the Berg WMA, which is dominated by the commercial trade and industrial activities in the Cape Town Metropolitan area, the towns of Stellenbosch, Paarl and Wellington and in the developing West Coast area of Saldanha Bay. Approximately 12% of the Gross Domestic Product (GDP) of South Africa originates from within the Berg WMA. The Berg WMA Report indicates an unemployment rate of 19% for 1994, which was well below the official national average of 29% (unofficially 40%). Of those formally employed, the government sector and the manufacturing and trade sectors account for approximately 70% of the employment. Agriculture, although one of the smallest sectors in terms of its contribution to the Gross Geographical Product (± 2,5%), has strong linkages to other sectors of the regional economy and provides livelihood to a large proportion of the rural population.

2.1.5 Population

All population estimates referred to in this ISP report are based on the "*Berg WMA - Overview of Water Resources Availability and Utilisation*" Report, 2003. The total population of the Berg WMA was estimated to be 3 247 000 at the 1995 level of development. 95% of the total WMA population resides in urban areas, with 87% concentrated in the Greater Cape Town sub-area, where they are attracted by employment opportunities. Population in the winelands (Stellenbosch, Paarl, Wellington, Franschhoek) is moderate as is the case in the north and west (Darling, Saldanha, Vredenburg and Velddrif). The population density reduces in the areas where towns are more widely spaced (Tulbagh, Saron, Porterville, Malmesbury, Moorreesburg and Piketberg).

2.1.6 Conservation Features

Both the Berg River Estuary and the Rietvlei Wetland (Diep River mouth) are of high conservation value and both are pending recognition as Ramsar sites. The Cape Peninsula National Park extends along the mountainous belt of the Cape Peninsula, from Cape Point to the City. Various other protected natural areas, including most of the mountain catchments, and natural heritage sites occur within the Berg WMA.

2.1.7 Waterworks

The main waterworks in the WMA are as follows:

The WCWSS comprises a system of diversion canals, dams, tunnels and pipelines which serve the City of Cape Town (CCT) and irrigators in the Berg, Eerste and Riviersonderend valleys (as described in Paragraph 2.2).

- The WCWSS also supplies the following towns:

  - Paarl/Wellington which have other minor supplies.
  - Stellenbosch, which utilises water from the WCWSS during summer to supplement shortfalls from its own sources.
  - Saron.
  - The West Coast District Municipality (WCDM), which has its own limited surface water supplies, and is the Water Service Provider (WSP) for Malmesbury, Moorreesburg, Piketberg and Vredenburg/Saldanha. The WCDM also abstracts water from the primary aquifer in the vicinity of Vredenburg/Saldanha.
- Yzerfontein relies on groundwater abstracted from a primary aquifer.
- Porterville has its own spring supply.
- Many of the irrigators in the Berg River Valley have developed their own diversion schemes and/or farm dams on the tributaries of the Berg River as well as off-channel dams which are filled from the Berg River during the winter months.

The CCT, DWAF and local authorities each own components of the bulk water supply infrastructure within this WMA. Both the CCT and DWAF are involved in the operation of the infrastructure comprising the WCWSS. Local authorities operate and maintain their own infrastructure. Details pertaining to the ownership of the main dams in the Berg WMA are presented in Appendix 11.

Wastewater treatment works (WWTWs) are largely owned and operated by the CCT, other local authorities and the Department of Public Works (WWTWs at prisons). Details pertaining to the WWTWs in the Berg WMA are presented in Appendix 3.

2.1.8 Water Quality

Most of the rivers in the ISP area rise in the Table Mountain Group (TMG) mountain catchments which provide very good quality water with total dissolved solids (TDS) concentrations of about 60 mg/*l*. The quality of the water generally deteriorates further downstream as described below:

- The middle reaches of the Berg River receive effluent from various wastewater treatment works as well as agricultural return flows and occasionally naturally high salinity runoff from tributaries underlain by Malmesbury shales of marine origin. This leads to water quality problems in the lower Berg River. Industrial users (steel manufacturers) in the Saldanha area need to pre-treat this water before being able to utilise it in their industrial processes. Irrigators are limited to the types of crops they can cultivate, due to increased salinity levels.

- Effluent return flows and stormwater washoff from Stellenbosch enters the Eerste River. This will have an impact on the costs associated with treating water if the Eerste River Diversion scheme is implemented.

- Runoff in the lower reaches of the Diep River arising from the Malmesbury formation is also naturally saline and wastewater is discharged into the river from two of the CCT's wastewater treatment works. The Rietvlei wetland is a highly valued ecosystem and the potential impact, particularly from treated effluent being discharged into it is of concern.

- The Lourens River, most of the Peninsula rivers and the Cape Flats rivers and vleis have been impacted by urban runoff. The Kuils River and Salt River are also impacted by large, wastewater return flows that have changed these seasonal rivers into perennial rivers. These urban rivers cannot be rehabilitated but their condition must at least be maintained at levels that will not introduce social, health and aesthetic problems.

2.1.9 Groundwater Situation

Groundwater resources are available form three different aquifer systems:

a. Intergranular aquifers consisting of unconsolidated sediments along the coastal plan. These are the sole or supplementary supply to resort developments, coastal towns and local agriculture.
b. Fractured-and-weathered ("regolith") aquifers of Malmesbury and Cape Granite bedrock underlying the Swartland and areas of the coastal aquifer are primarily used for domestic supply and stock watering on farms.
c. Deep fractured-rock aquifers of the Table Mountain Group (TMG) around the Berg River headwater supply and/or supplement the water demands of small and larger towns from perennial springs and /or pumped boreholes.

Poor perception of groundwater is exacerbated by the failure of groundwater supply schemes to deliver predicted yields, often due to a lack of co-ordination between private and public users abstracting from the same aquifer, or to poor monitoring and management practice.

The resource potential of the Berg WMA aquifers is a function of recharge potential and storage potential. The underground storage is an evaporation-free reservoir, the volume of which is relatively easily estimated in the case of aquifer types (a) and (b) above, but requires a more sophisticated reservoir-characterisation approach in the case of the confined TMG aquifers.

The main schemes are described below:

- A pilot groundwater extraction scheme has been initiated at Saldanha, but there is considerable concern about the sustainability and environmental impact of the scheme.
- Until recently, Atlantis was dependent on groundwater from these primary aquifers together with a stormwater and effluent aquifer recharge scheme.
- Groundwater is also extensively used by smallholdings on the West Coast.
- On the Cape Flats the Philippi market garden area utilises groundwater and a scheme to augment the water supply to Cape Town, the so-called Cape Flats Aquifer Scheme, has been investigated at pre-feasibility level.

- The rural areas of the Swartland utilise groundwater from the Malmesbury formation which tends to be saline but at particular localities provides good quality water and moderate yields.

The following specific issues and concerns were identified:

- Too little is known about the potential use of groundwater for local supply and/or improvement of assurance of supply to towns and rural users.
- The groundwater monitoring network for the different aquifer systems is inadequate.
- Spatial and temporal recharge and discharge patterns between aquifers and the surface water system at quaternary catchments level and WMA level (between the Breede and Olifants-Doring) are unknown.
- Unquantified risks of pollution threat and seawater intrusion to vulnerable aquifers.
- Poor management of groundwater resources
- Unknown spatial distribution of potentially toxic trace elements in groundwater derived from older rock, viz., granites and Malmesbury bedrock.
- There is no practical definition of Groundwater Protection Zones and Groundwater Exclusion Zones. There is also a lack of awareness about the importance of these zones.
- Lack of co-ordination between groundwater specialists and the authorities responsible for disaster and risk management planning. Typically in relation to possible catastrophic disruption of water supply lifelines (e.g. major earthquake impact on the Theewaterskloof tunnel system) and temporary or standby emergency provision of water to Cape Town. Groundwater specialists could assist in sourcing emergency supplies.
- Uncertainty regarding groundwater contributions to Tulbagh's future sources of supply.
- The underlying aquitard character of deeper Malmesbury bedrock and currently increasing levels of abstraction in excess of recharge in these relatively poor quality aquifers, raises uncertainties about the potential use of groundwater for local supply to small towns and rural users.
- Threats of pollution from landfill sites, industrial plants (e.g. Swartklip waste site and former munitions factories), wastewater treatment plants, uncontrolled stormwater discharges, and seawater intrusion into vulnerable aquifers.
- There are contaminated landfill sites in this area, but no official guidelines for the rehabilitation of contaminated land.
- It is thought that there are strong active discharges to the sea along the Kogelberg coastline from NE/SW-trending major faults cutting the Peninsula Aquifer. There may be an important relationship in terms of the maintenance of key elements in the marine ecosystem.

2.2 THE INTEGRATED OPERATION OF THE WESTERN CAPE WATER SUPPLY SYSTEM (WCWSS)

Within the Berg WMA, the WCWSS supplies the CCT and other water user associations (irrigators) in the catchments of the Berg and Eerste Rivers. The WCWSS also supplies water to irrigators in the Riviersonderend catchment area of the Breede WMA. The scheme is operated in an integrated manner so as to reduce spillage and make optimum use of the limited available yield in the region. As mentioned in the introduction the WCWSS is so dominant in the Berg WMA that it is dealt with in detail before dealing with the rest of the Berg WMA.

2.2.1 Main Schemes

The main storage dams are the DWAF dams, Theewaterskloof (in the Breede WMA, which also serves irrigators in the Riviersonderend valley) and Voëlvlei, the Wemmershoek, Upper Steenbras and Lower Steenbras Dams owned by CCT and the future Berg River Dam that will initially be owned by the Trans Caledon Tunnel Authority (TCTA) and later transferred to DWAF. These dams are operated in an integrated manner to minimise spillage during the wetter years and thus to maximise the stored water available for essential uses during droughts. The effects of droughts are mitigated by progressively restricting supplies during droughts, with less essential users provided at lower assurance of supply, being more severely restricted.

As the WCWSS is situated in a winter rainfall area which is characterised by wet winters and dry summers, the dams are filled during the wet winter months (April to September) when about 90% of the annual runoff occurs and water demands comprise only about 30% of the annual demand.

During the dry summer months (October to March) inflows to the dams are small and irrigation demands and garden watering demands in the urban areas are large. Approximately half of the storage in the dams is required to store water during the winter in order to meet the high water demands during the summer. The other half of the dams' storage is required to provide long-term carry over storage for droughts.

The main schemes that constitute the WCWSS are listed in Table 2.2.1 and shown graphically on Figure 2.2.1.

TABLE 2.2.1: MAIN SCHEMES OF THE WESTERN CAPE WATER SUPPLY SYSTEM

MAIN DAM	GROSS CAPACITY (10^6 m^3)	NET SYSTEM YIELD (1:50 Year) (10^6 m^3/a)	OWNER	USER
Palmiet				
Kogelberg	(17)*	22	DWAF/	CCT/
Rockview	(17)*		Eskom	Eskom
Upper Steenbras	32**	40	CCT	CCT
Lower Steenbras	34			
Wemmershoek	59	54	CCT	CCT/Drakenstein
Voëlvlei	172	105	DWAF	CCT/W Coast/ Irrigators
Theewaterskloof	480	219	DWAF	CCT/Stellenbosch/ Irrigators
TOTAL EXISTING	**777**	**440**		
Berg Water Project				
Berg River Dam	127	56	TCTA (DWAF)	CCT/Others/
Supplement Scheme		25		Irrigators/Overberg
TOTAL	**904**	**521**		

* Storage utilised by Palmiet Pumped Storage Scheme.

** 3 x 10^6 m^3 of storage utilised by Steenbras Pumped Storage Scheme.

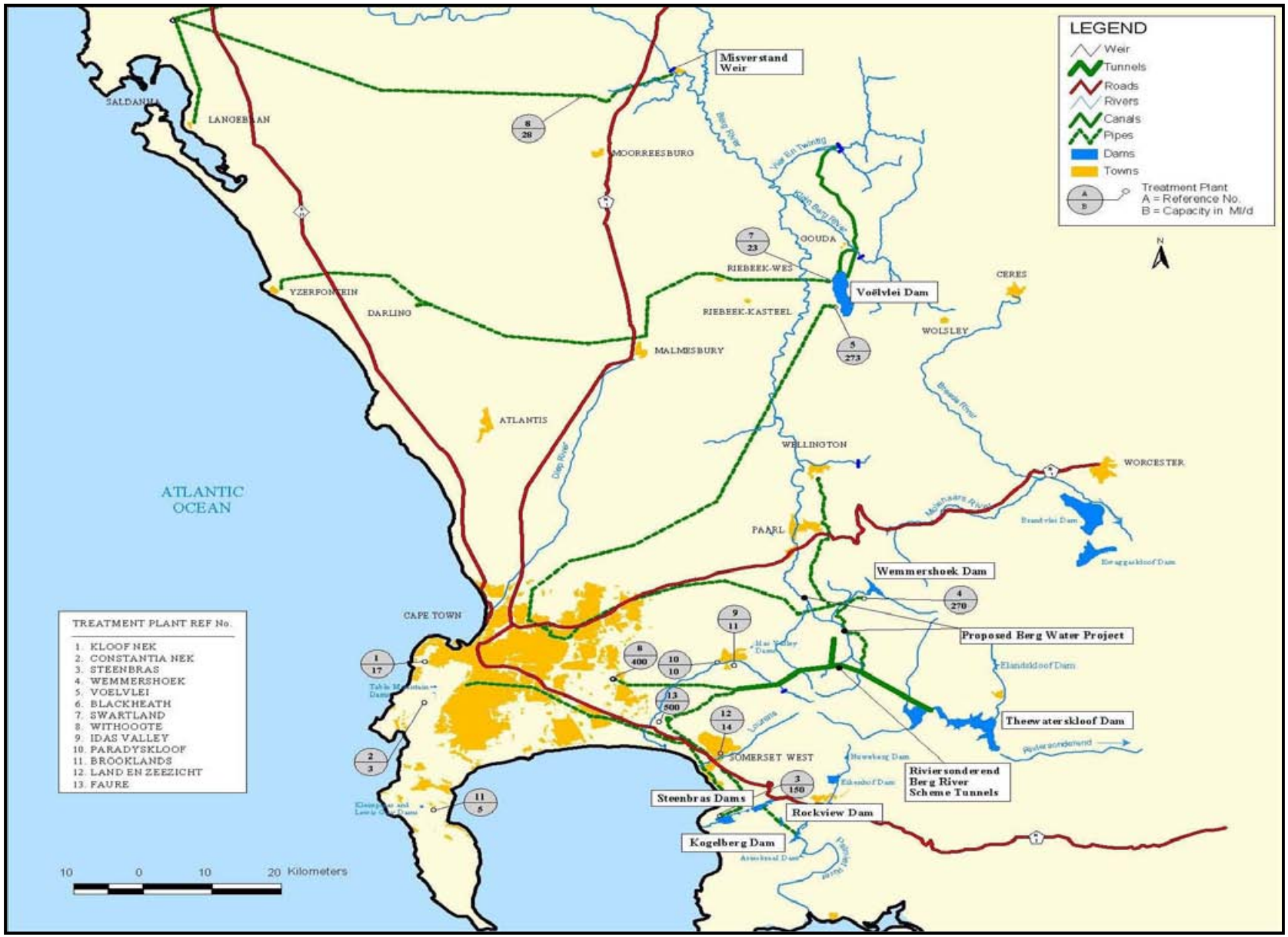

Figure 2.2.1 : Western Cape Water Supply System

2.2.2 Minimise Spillage

During the winter filling of the dams, the demands of the CCT are shifted onto those dams that appear more likely to spill. This minimises the occurrence of the situation where one dam spills while there is storage available in another dam.

The CCT has co-operated to help minimise spillage by:

- Introducing additional capacity in its water treatment works and bulk water pipelines to enable flexibility in the allocation of the demands on the different dams and to provide interconnectivity between the various sources.
- Reducing the demands on their own dams (Wemmershoek and Steenbras), although there might be short-term benefits for them to use water from their own dams preferentially, and only use the other dams as backup during drier periods. However, this would increase spills and reduce the system yield.

DWAF has also introduced one system tariff for the CCT which also allows the City greater flexibility.

2.2.3 Water Restrictions During Droughts

The water storage in the system is evaluated towards the end of the wet season (September to November), to assess whether supplies must be restricted to ensure that sufficient water remains for the more essential uses such as basic human needs and industry, were a drought to occur.

The Water Resources Planning Model (WRPM) (DWAF 1994) of the WCWSS is run annually in November using the 1 November system storage and the latest demand projections, to determine if restrictions will be necessary in the coming summer. The model also forecasts a set of storage trajectories for the coming year under different inflow scenarios (median and above/below average inflow conditions) and indicates the different levels of restrictions that should be imposed.

If restrictions seem likely the matter is discussed at a meeting of the Western Cape Planning Model Committee, comprising DWAF, the CCT and all other major urban and agricultural stakeholders. If the Committee agrees that it is necessary to impose water restrictions, it will make recommendations to the Minister who finally decides on the imposition of restrictions. DWAF is responsible for informing all users what their allocations will be from the various Government Water Schemes and for ensuring that all users comply with the restricted allocations imposed on them. Such restrictions apply until the Committee deems that they can be lifted, where after the Minister decides on the lifting of restrictions. This decision is conveyed to the users by DWAF.

The levels of restrictions to be imposed on the various users depend on the allocations and assurances of supply i.e. 97% for domestic and industrial users (100% for 90% of the time and

70% for 10% of the time) and 91% for irrigation (100% for 70% of the time and 70% for 30% of the time). Demands are progressively curtailed during droughts to correspond with these average levels of assurance of supply.

2.2.4 Operation and Supply from System Schemes

(a) Palmiet River Government Water Scheme

When there is adequate flow in the Palmiet River (Breede WMA) to meet the instream (environmental) flow requirements and also to transfer water, then DWAF and CCT may request Eskom to extend the pumping hours of the Pumped Storage Scheme to deliver up to 3 million m^3 of additional water per week from Kogelberg Dam into Rockview Dam from where it is released into the Upper Steenbras Dam.

(b) Steenbras Scheme

The Upper Steenbras Dam stores water from its own catchment as well as water transferred by the Palmiet Pumped Storage Scheme. Water from the Upper Steenbras Dam can be released to the Lower Steenbras Dam or conveyed to the City's Faure Water Treatment Works via the 160 Megawatt Steenbras Pumped Storage Scheme which is owned by the CCT's Electrical Engineering Department, and the City's Faure Pump Station. Water from the Lower Steenbras Dam is treated at the Steenbras Water Treatment Works and piped to Cape Town.

(c) Wemmershoek Dam

Water from Wemmershoek Dam is treated at the Wemmershoek Water Treatment Works and supplied to Cape Town. A branch pipeline from the Wemmershoek pipeline supplies water to Paarl and Wellington.

(d) Voëlvlei Dam

Voëlvlei Dam is an off-channel dam with a small catchment area of only 38 km^2. Two diversion canals provide the main inflows:

- A weir on the Klein Berg River diverts water during the winter months into an 8 km long canal which has a capacity of 20 m^3/s. Water quality can be problematic at times and has resulted in algal blooms in Voëlvlei Dam, introducing unacceptable tastes and possible toxicity, which are costly to remove. Strategy No 8.4 (Lower Berg) addresses these problems.

- Weirs on the Twenty-Four Rivers and on the Leeu River divert up to 34 m^3/s into a 29 km long canal to fill Voëlvlei Dam during the winter months and supply irrigators during the summer.

Voëlvlei Dam supplies the following users:

- The CCT via the Voëlvlei Water Treatment Works and pipeline
- The West Coast District Municipality as follows:
  - *The Swartland Regional Water Supply Scheme*, abstracts water from Voëlvlei Dam, after which it is treated at the Swartland Water Treatment Works, to supply Darling, Moorreesburg, Yzerfontein, Riebeek-Wes, Riebeek-Kasteel, Koringberg, Hermon and Gouda. It also supplements Malmesbury which also has its own source of supply.
  - *The Saldanha Regional Water Supply Scheme* via releases into the Berg River, abstraction at Misverstand Dam, treatment at the Withoogte Water Treatment Works and reticulated to Saldanha Bay, Langebaan, Paternoster, Laaiplek, Velddrif, Vredenburg and Hopefield.
  - Saron from the Twenty Four Rivers canal.
  - Piketberg from Misverstand Dam.
  - The Lower Berg irrigators, also via releases from Voëlvlei Dam.

(e) Misverstand Dam

Water is released from Voëlvlei Dam into a canal which flows into the Berg River to supply water to irrigators during the summer months. The West Coast District Municipality abstracts water from Misverstand Dam to the Withoogte Water Treatment Works, as described under the Saldanha Regional Water Supply Scheme, above. High salinities are occasionally experienced at Misverstand Dam due to local runoff and a strategy is required to address this. Refer to the Water Quality Strategy (No 2.4) and the Strategy for the Lower Berg River (No 8.4).

(f) Theewaterskloof Dam

Theewaterskloof Dam in the Breede WMA is the largest storage dam of the WCWSS. It is filled by runoff from its own catchment and by the diversions during the winter months of the Wolwekloof and Banhoek Rivers into the Riviersonderend-Berg River Tunnel System (Berg WMA to Breede WMA transfer).

In future the Theewaterskloof Dam will also receive water pumped during the winter months from the Berg River Dam.

Theewaterskloof Dam supplies the following:

- Irrigators in the Riviersonderend Valley via abstractions and releases from the dam.
- The Upper Berg River Irrigators (upstream of Sonquasdrift) via releases from the tunnel at the Berg River Syphon.
- Water can also be released to the Wemmershoek Water Treatment Works.
- Irrigators in the Eerste River Valley via the Kleinplaas Dam and via the Stellenboschberg tunnel outlet.
- Also via the Stellenboschberg tunnel outlet:
  - The CCT's Blackheath and Faure Water Treatment Works

- Stellenbosch during the peak summer months when the town's own sources cannot meet the demand.

(g) Berg Water Project

This project consists of the Berg River Dam which will impound runoff from the Upper Berg River as well as water abstracted and pumped by the Berg River Supplement Scheme at Bien Donne (DWAF 1997 and DWAF 1999). At Wolwekloof, upstream of the Berg River Dam, winter flows (April to September) will normally be diverted into the Theewaterskloof Tunnel before reaching the Dam. The Berg Water Project will be implemented by the TCTA on behalf of DWAF which will operate the project. The CCT will pay for the full cost of the scheme via DWAF to TCTA. However the Berg Water Project will be fully integrated into the WCWSS and water withdrawn by the CCT which is in excess of its allocation from government water schemes, will be deemed to be supplied from the Berg Water Project.

The Berg Water Project will supply:

- **Upper Berg River Irrigators** (scheduled out of Theewaterskloof Dam) using the multilevel release structure and the Supplement Scheme pipeline to ensure that the summer flow in the river below the dam is reduced as far as possible to comply with the Environmental Instream Flow Requirements. To minimise wastage, DWAF will continue to monitor the summer flows in the river and adjust releases to limit the streamflow past Sonquasdrift (the last point on the river that will normally be supplied by the Berg River Dam).

- **The Instream Flow Requirements (Riverine Reserve)** immediately downstream of the Berg River Dam and at the Supplement Site have been defined. The releases from the dam will comprise low flow releases as well as freshet (65 m^3/s) and flood (160 m^3/s up to 200 m^3/s) releases from the proposed multi-level release structure.

- **The System Usage** of water from the Berg River Dam will require that spillage be minimised by pumping from the Dam into the Riviersonderend-Berg Tunnel system via the Dasbos Branch Tunnel. Pumping will take place in accordance with the needs of the integrated system so as to minimise spillages.

- **The CCT** will continue to withdraw water from Theewaterskloof Dam, via the Riviersonderend-Berg Tunnel system, at the Stellenboschberg Tunnel Outlet, and possibly in the future also at the Dasbos Tunnel Outlet, if a new water treatment works is constructed in this vicinity.

2.3 FUTURE WATER DEMANDS ON THE WESTERN CAPE WATER SUPPLY SYSTEM

The WCWSS supplies water to the CCT, the West Coast District Municipality and to irrigators in the Berg and Eerste River valleys. It also supplies water to irrigators in the Riviersonderend catchment of the Breede WMA. The integrated nature of the system and ownership of the infrastructure within it has necessitated an integrated management approach. Through the Western Cape Planning Model Committee, operating rules have been developed for managing the system

in the most efficient way. Through this same Committee historical and projected future water demands were determined for developing the operating rules and are shown in Figure 2.3.1 and Table 2.3.1. The demands (406 million m^3/a at 98% level of assurance) reflect the latest (2003) available estimates and are based on actual allocations from the WCWSS. These do not reflect the total water requirement for the entire Berg WMA, but only those on the WCWSS itself. Table 2.6.2 shows the total estimate for the Berg WMA (704 million m^3/a at 98% level of assurance). This includes the demands on the WCWSS in addition to the requirements of areas not supplied from the System, of which irrigation from farmers' own sources constitutes the greatest component. The WCWSS projections are based on the following:

- That water demand management (WC/DM) will have a significant impact on the growth of water usage and that savings of 20% will be achieved within 10 years in accordance with the City's WC/DM Policy and Strategy.

- That the growth of irrigation demands will also reduce as allocations from existing government water schemes become fully utilised.

- That urban and industrial growth along the West Coast will result in substantial growth in demand in spite of WC/DM.

It is important to note that the projected demands used for WCWSS operation and planning are within the envelope of the projected future water requirement scenarios contained in the NWRS. The CCT will soon embark on a new requirements study in collaboration with DWAF. This study will probably use revised methodology for future estimates.

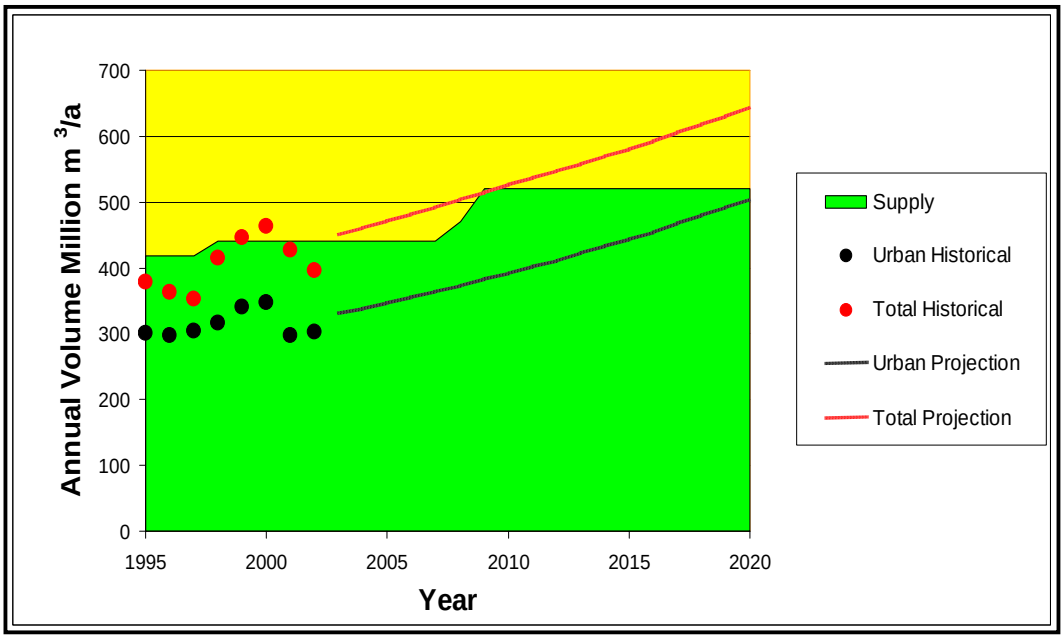

Figure 2.3.1: Historical and Projected Water Demands on the Western Water Supply System

Figure 2.3.1 and Table 2.3.1 show that even with the significant WC/DM measures planned by the CCT, the existing supplies to the region are likely to come under increasing pressure of restrictions until the Berg Water Project is completed and that additional interventions to augment the supply, after the Berg Water Project, may be required soon after about 2010.

TABLE 2.3.1: COMPARISON OF FUTURE DEMANDS AND SUPPLIES (WESTERN CAPE WATER SUPPLY SYSTEM)

YEAR	SCHEMES	SYSTEM DEMANDS IN THE BERG WMA (10^6 m^3/a)	SYSTEM DEMANDS IN THE BREEDE WMA (10^6 m^3/a)	TOTAL DEMANDS ON WCWSS (10^6 m^3/a)	WCWSS YIELD (10^6 m^3/a)	POTENTIAL SHORTFALL (10^6 m^3/a)
2000	Existing	405	47	452	440	-(12)
2003	Existing	406	47	453	440	-(13)
2005	Existing	427	47	474	440	-(34)
2007	Existing	446	48	494	440	-(54)
2009	Existing and Berg Water Project	468	48	516	521	Nil
2010	Existing and Berg Water Project	479	48	527	521	-(6)
2012	Existing and Berg Water Project	500	48	548	521	-(27)
2014	Existing and Berg Water Project	522	48	570	521	-(49)
2016	Existing and Berg Water Project	546	48	594	521	-(73)
2018	Existing and Berg Water Project	571	49	620	521	-(99)
2020	Existing and Berg Water Project	596	49	645	521	-(124)
2022	Existing and Berg Water Project	623	49	672	521	-(151)
2024	Existing and Berg Water Project	652	49	701	521	-(180)
2025	Existing and Berg Water Project	668	49	717	521	-(196)

2.4 FUTURE RECONCILIATION INTERVENTIONS FOR THE WESTERN CAPE WATER SUPPLY SYSTEM

2.4.1 Introduction

A number of studies have been undertaken by DWAF and CCT to identify options for reconciling the potential future shortfalls in supply with the growing demands of the WCWSS as described above. All studies determined that water demand management should be implemented before any other reconciliation options and that increased re-use of effluent should be seriously considered as an option. These and other more likely potential reconciliation options identified by the various studies are described below and the potential yields and comparative unit reference values are shown in Table 2.4.1

TABLE 2.4.1 : POSSIBLE INTERVENTIONS TO AUGMENT THE SUPPLIES TO THE BERG WMA
(Ref: City of Cape Town Integrated Water Resource Management Study; Breede River Basin Study; Western Cape System Analysis).

POTENTIAL SCHEMES	POTENTIAL YIELD (10^6 m^3/s)	UNIT REFERENCE VALUE (R/m^3)
BERG WMA		
Water demand management (1)	70+	0,15 - 0,50
Surface Water:		
Lourens River	19	0,46
Voëlvlei Phase 1	35	0,53
Eerste River	8	1,06
Groundwater:		
Cape Flats Aquifer	18	1,13
TMG Aquifer	80?	1,00
Effluent Re-use		
Local Irrigation and Industrial	11+	0,80
Irrigation Exchange	5+	1,62
Potable	40+	3,10
Desalination	Unlimited	8,59
WCSA		
Raise Steenbras + Palmiet	±45	Unknown
Voëlvlei Phase 2	30?	Unknown
Raise Misverstand	30?	Unknown
Transfer of water user rights	Uncertain	Unknown
BREEDE WMA		
Breede River Basin Study		
Michell's Pass Diversion	53	0,11
Upper Molenaars Diversion	27	0,82
Brandvlei Augmentation - Theewaterskloof Tunnel	41	1,14
TMG Aquifer	Unknown	1,00

1) Actually a reduction in demand, just expressed as a yield for comparison purposes.

2.4.2 Western Cape System Analysis (WCSA)

In the early 1990s the WCSA (DWAF Study) identified some thirty options for augmenting the water supply to users in the Berg WMA. These options were evaluated by a task group representing the public who selected the eleven options shown in Figure 2.4.1 for further investigation. The Berg Water Project comprising the Berg River Dam and Supplement Scheme (formerly referred to as the Skuifraam Dam and Supplement Scheme) have been approved and are being implemented.

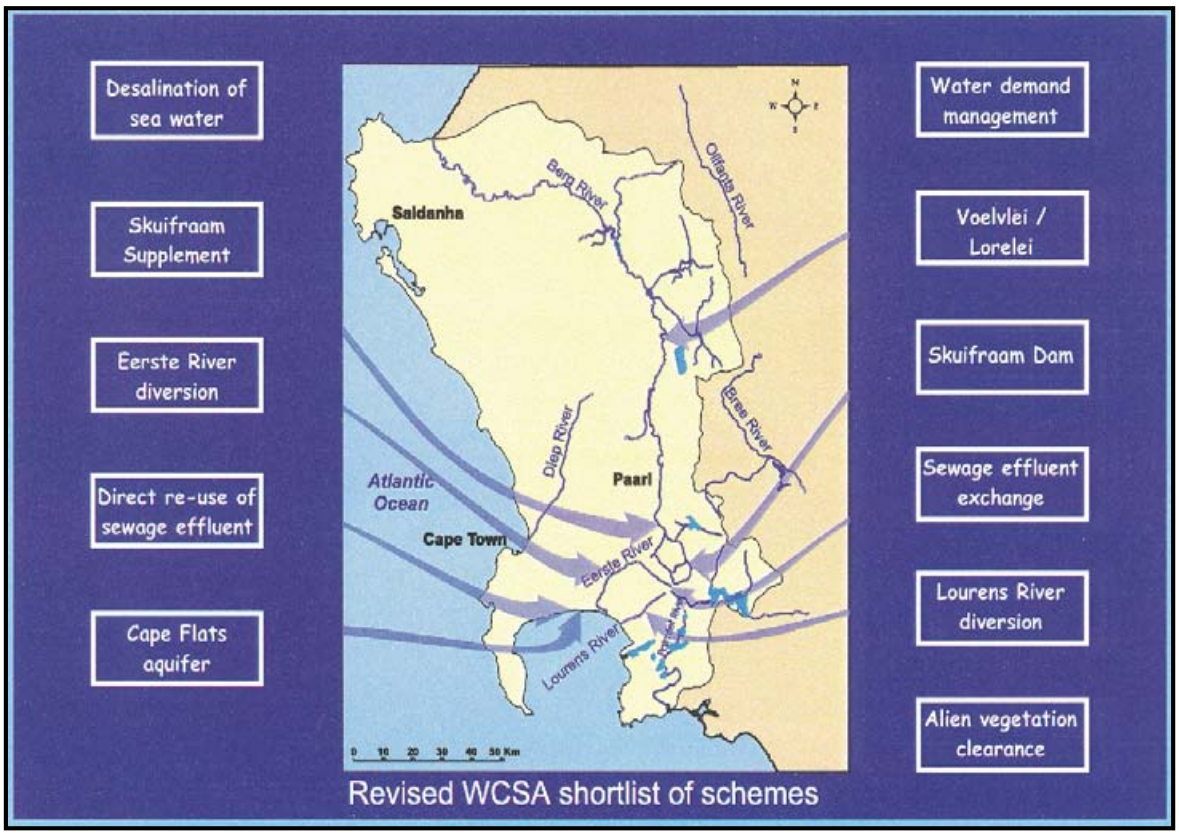

Figure 2.4.1 : Western Cape Water Supply System : Selected Conservation and Supply Options

These and other favourable options identified by the WCSA are described hereafter.

2.4.3 Reconciliation Options in the Berg WMA

Integrated Water Resources Planning Study

The CCT's Integrated Water Resources Planning Study of 2002 comprised reconnaissance level assessments of some selected WCSA options which had not been investigated further by DWAF or by Working for Water (WfW). In addition, a reconnaissance level investigation of the TMG Aquifer was undertaken.

Some of the conclusions of this investigation are summarised in Table 2.4.1 and briefly discussed below:

- Water Demand Management measures such as pressure management, user education, elimination of automatic flushing urinals, leakage repair, tariffs, metering and credit control, and water efficient fittings are highly cost effective.

- The development of private boreholes, and grey-water use by private individuals, is less cost effective, and grey-water has potential health hazards.

- Two aquifer options were investigated:

  - The Cape Flats Aquifer wellfield would be sited in an urban area with possible pollution risks and operating problems.

  - The TMG Aquifer appears to have potential and CCT has commissioned a study leading to the establishment of a pilot wellfield. The main concerns are that major abstractions might impact on the riverine and wetland environments of the main catchment areas and on other sources of supply. Potential target wellfield sites have been identified in both the Berg and the Breede WMA.

- Three surface water options were examined:

  - The Voëlvlei Phase 1 Augmentation Scheme was investigated by DWAF in 2001 and reassessed by CCT in 2002, and appears to be a favourable option.

  - The diversion of Lourens River flood water into Paardevlei and thence to Faure Water Treatment Works appears to be cost effective and viable.

  - The Eerste River flood diversion to the Faure Water Treatment Works would be a less viable and cost effective option.

  - All these options would have implications for the riverine and estuarine flow requirements as well as some direct environmental impacts, although the latter should not be significant.

  - None of these surface water options provide additional storage.

- Three options for reusing treated wastewater were examined:

  - Re-use for local urban irrigation or industrial use is cost effective and should be expanded although health issues are of concern. At present the CCT wastewater totals about 180 million m^3/a of which it is estimated that at least 40% could be re-used at viable cost. A comprehensive study would be required to determine the maximum practical re-use potential and associated costs.

  - Reclamation to potable standard would be relatively expensive. Health risks would also be of concern as well as possible social and religious objections.

  - The exchange of treated wastewater for fresh water from irrigators would be viable, but would require buy-in by irrigators and might pose health risks and cause adverse international perceptions. It might also be detrimental to the soil in the long term.

- The transfer of irrigation water use rights for urban and industrial use may also be a favourable option.

- Desalination is still very expensive relative to other options.

Other Options in the Berg WMA

The following are some of the other options in the Berg WMA which were identified by the WCSA and might still be considered in the long-term future:

- The raising of the Lower Steenbras Dam would provide significant additional storage in the Berg WMA and some improvement in yield, but is likely to be costly and would have some environmental impacts, particularly if additional water is abstracted from the Palmiet River.

- The raising of Misverstand Dam would have impacts on the riverine and estuarine flow requirements. Water quality might also be of concern.

- The Voëlvlei Phase 2 Scheme would entail the raising of Voëlvlei Dam and increasing diversions into the dam. Potential additional algal problems might impact on the viability of this scheme.

Options to Supply the West Coast

DWAF's Directorate of Options Analysis has recently commissioned a study to investigate options to augment and improve the quality of supplies to the West Coast. This is a two-phase study, the first phase comprising the screening of a number of options and the second a pre-feasibility level investigation of a shortlist of options. Any option that is ultimately selected must be integrated into the operation of the WCWSS. Some of the more promising options identified under Phase 1are:

- Alien plant infestation clearing along the lower Berg River.
- Michell's Pass Diversion from the Breede WMA into the Klein Berg River, from where it is diverted into Voëlvlei Dam, via the existing diversion works.
- Increased efficiency of the existing Twenty-Four Rivers Diversion scheme, feeding Voëlvlei Dam.
- Low level pumps at Misverstand Dam to improve the abstraction and take maximum advantage of the available storage.

2.4.4 Options from the Breede WMA

The Breede River is the largest river in the Western Cape Province with a Mean Annual Runoff (MAR) of about 1800 million m^3/a. The Breede River Basin Study shows that 770 million m^3/a (43% of MAR) is currently utilised including transfers to the Berg WMA and usage by local water service authorities, but the majority is utilised for local irrigation (DWAF 2003). Assessments of the instream and estuarine flow requirements of the Reserve indicate that some 900 million m^3/a may be required for the environment which would only leave some 90 to 140 million m^3/a

(depending on storage and invasive alien plant removal) available for further development in the Breede WMA or for transfer into the Berg WMA.

The study also identified a number of schemes for developing this exploitable remaining yield for transfer into the Berg WMA. Further investigations and consultations would be necessary to decide where this exploitable yield could best be utilised for the benefit of the whole region.

The Breede River Basin Study indicated that if transfers were to take place then the following options should be considered:

- The most favourable options from financial, socio-economic and environmental perspectives are:

  - The Michell's Pass Diversion which would comprise a low weir and a canal to the Klein Berg River. Winter flows would be diverted via this canal to the Klein Berg River and then through the existing diversion works into Voëlvlei Dam. This scheme appears to be one of the most favourable options.

  - The Upper Molenaars Diversion which would comprise a pump station adjacent to the Molenaars River at the Huguenot Tunnel, and would utilise the existing pipeline laid through the tunnel. Water would be delivered into the Berg River Dam or into Wemmershoek Dam. This scheme would be more expensive, but might still be viable.

  - The Brandvlei-Theewaterskloof Scheme which would augment the inflow into Brandvlei by increasing the capacity of the existing Papenkuils pump station. A canal, pipeline and pump stations would deliver the water into Theewaterskloof Dam.

  - All the above schemes would have some impact on the instream flows and on the environment, but this should not preclude their implementation.

2.4.5 Conclusion

The ongoing application of water demand management measures is essential in order to suppress the future demands of this potentially water scarce region so as to extend the life of existing schemes and defer the high capital cost of new schemes.

It is also essential that the future re-use of treated sewage effluent be thoroughly investigated as this is potentially a large exploitable fresh water source.

As the implementation of large projects can take up to 10 years or more from feasibility study to completion, it is essential that potential future sources of supply be confirmed as soon as possible in order for CCT and other Water Service Providers to be able to plan future bulk infrastructure for the conveyance and treatment of water. For this reason, and to facilitate efficient systems

management, the Directorate: NWRP plans to undertake a Western Cape Reconciliation Strategies study, to commence in the 2004/05 financial year.

2.5 LOCAL SUPPLY SCHEMES IN THE BERG WMA

2.5.1 Supplementing Local Urban Supply Schemes from the WCWSS

A number of local supply schemes are supplemented from the WCWSS. These include:

- *Table Mountain and Southern Peninsula Schemes* supply local areas of the Cape Town Metropolitan area and Simon's Town, supplementing the supply from Theewaterskloof, Steenbras and Wemmershoek Dams as well as that from the Palmiet transfer.
- *Atlantis Groundwater Scheme* supplies the towns of Atlantis and Mamre from two well fields at Witsand and Silverstroom. This area is also supplied from Voëlvlei Dam.
- *Paarl* supplements its water via winter pumping from the Berg River into two off-channel storage dams (Nantes and Bethel), in addition to that supplied from Wemmershoek Dam.
- *Wellington* supplements the supply from Wemmershoek Dam, from winter water in Antoniesvlei (Bain's Kloof area), which is stored in two small dams.
- The CCT's supply to *Somerset West* and *Strand* from the Lourens River is being used progressively less due to the poor water quality obtained from the local purification works. The current allocation from the Lourens River is likely to be piped to the Faure Purification Works in the future.
- *Stellenbosch* abstracts from the Eerste River in Jonkershoek into the town service reservoirs. Excess winter water is abstracted from the Eerste River and stored in the two Idas Valley Dams for use during summer. During dry summers, Stellenbosch is supplemented from Theewaterskloof Dam.
- The villages of *Pniel and Kylemore* divert water from mountain streams and this supply can be supplemented during seasonal shortfalls by Stellenbosch. These perennial mountain streams are maintained by baseflow from the springs above the TMG basal unconformity.
- *Piketberg* receives treated water from the Withoogte WTW, supplied out of Misverstand Dam and supplements this with water from a local spring emerging from the base of the TMG aquifer.
- *Saron* abstracts raw water from the Twenty-four Rivers canal which feeds Voëlvlei Dam.
- *Franschhoek* abstracts water from a stream in the Perdekloof, with recent augmentation via a pipeline from Wemmershoek Dam.
- *Malmesbury* is supplied from Voëlvlei Dam and supplements its requirement from the municipal dam (Paardeberg Dam)

2.5.2 Individual Town Supplies not associated with the WCWSS

Certain small towns in the Berg WMA rely exclusively on local water resources. These resources are primarily groundwater from the TMG and/or perennial streams supplied by baseflow contribution via springs discharging from the TMG. These include:

- *Porterville* utilises groundwater from two local springs which daylight at the base of the mountain. (Potential exists to augment this source by strategically placed wellheads and directional drilling from locations on the higher mountain slopes).
- *Tulbagh* abstracts water from the Moordenaarskloof stream and makes use of groundwater from springs emerging from the base of the TMG.
- *Aurora* utilises groundwater from 6 boreholes in the Nardouw aquifer on Grootkloof Farm. The spring that emerges from the Nardouw aquifer has traditionally supplied Aurora.

2.5.3 Stressed Towns

The Supply to Local Authorities Strategy (No 6.1) provides details of the current and potential sources of supply for the towns in the Berg WMA. Some towns are considered to be stressed, as noted below:

- *Tulbagh*. Water shortages are experienced during summer. The Water Services Development Plan (WSDP) for the town has not yet been submitted. Consequently, the exact problems are not well documented. However, it is known that shortfalls do occur and water has had to be trucked in on occasions. The implementation of water conservation and demand management needs to be addressed by the local authority. Thereafter the potential for developing the local groundwater resource should be considered. Two licence applications by the local authority are pending (one for groundwater abstraction and one for raising of a small municipal storage dam). The operation and management of the local WWTW is not satisfactory. Spillages pose a pollution risk to shallow alluvial groundwater resources in the area.
- *Yzerfontein* on the west coast receives water from the West Coast District Municipality. The supply line to Yzerfontein has a diameter of 200 mm, and may become a limiting factor in meeting future requirements, at which stage the conveyance capacity would need to be increased. The coastal intergranular aquifer is currently developed for some domestic supply and this initiative could be expanded and better co-ordinated.

2.5.4 Irrigation Schemes

Many irrigators in the Berg, Eerste and Lourens River valleys have developed irrigation schemes on their farms, comprising the following:

- run of river diversions on tributaries;
- run of river diversions on tributaries into farm dams;
- farm dams on tributaries;
- off channel storage dams on tributaries but filled during the winter months by pumping from the Berg River. Some of these off channel “storage schemes” receive allocations from the Riviersonderend Berg River Government Water Scheme and others do not.

In addition, farmers in the Philippi area of the Cape Flats abstract groundwater from the Cape Flats primary aquifer for vegetable farming.

2.6 CURRENT YIELD BALANCE FOR THE BERG WMA (YEAR 2000)

As mentioned in the Introduction in Section 2.1 the yield balance of the WCWSS was first dealt with in detail as set out in paragraphs 2.2 to 2.5. This section covers the yield balance for the whole the Berg WMA, which includes the WCWSS.

2.6.1 Water Resources Availability

The natural MAR and the ecological component of the Reserve are shown in Table 2.6.1 and are as reflected in the NWRS.

TABLE 2.6.1 : MEAN ANNUAL RUNOFF AND ECOLOGICAL RESERVE (million m^3/a)

COMPONENT/ SUB-AREA	NATURAL MAR (1)	PROVISIONAL ECOLOGICAL RESERVE (1, 2)
Greater Cape Town	373	61
Upper Berg	849	124
Lower Berg	207	32
TOTAL FOR WMA	**1 429**	**217**

1) Quantities are incremental, and refer to the sub-area under consideration only.
2) Total volume, based on preliminary estimates. The impact on the yield will only be a portion of this amount.

The estimated available yield at 98% assurance of supply is given in Table 2.6.2. The yield consists of both surface and groundwater yields, transfers into the Berg WMA as well as the estimated return flows which could be re-usable.

The provisional ecological Reserve requirement in Table 2.6.1 shows the total requirement. A large portion of this is supplied by floods that are not used otherwise. The actual impact on yield from the provisional Reserve requirement is estimated to be 23 million m^3/a, as shown in Table 2.6.2.

The ecological Reserve shown in Tables 2.6.1 and 2.6.2 may be too low, as the intermediate Reserve determination for the Breede River has shown that the original desktop methodology for the determination of Provisional Reserves, underestimates the requirements in this winter rainfall region.

It should also be noted that the deficit of 28 million m^3/a shown in Table 2.6.2 for the year 2000 will progressively get worse until the implementation of the Berg River Dam in 2007. This means that the CCT will be experiencing water restrictions on a more frequent basis than it has in the past.

TABLE 2.6.2 : YIELD BALANCE FIGURES (YEAR 2000) AS REFLECTED IN THE NWRS

YIELD COMPONENT	GREATER CAPE TOWN			UPPER BERG			LOWER BERG			WATER MANAGEMENT AREA		
LOCAL YIELD												
Major dams			66			159			5			230
Minor dams and run of river			9			145			25			179
Urban return flows			22			15			0			37
Irrigation return flows			0			8			0			8
Urban run-off			2			2			0			4
Groundwater [6]			20			15			22			57
Yield Reductions												
River losses			0			10			0			10
Impact on yield : invasive alien plants [8]			0			0			0			0
Impact on yield : provisional Reserve			11			12			0			23
TOTAL LOCAL YIELD			108			322			52			482
TRANSFERS [7]												
Transfers In			269 [1]			32 [2]			18 [4]			194 [5]
Transfers Out			0			125 [3]			0			0
TOTAL YIELD			377			229			70			676
LOCAL REQUIREMENTS	**From W Cape System**	**From Other Sources**	**Total**	**From W Cape System**	**From Other Sources**	**Total**	**From W Cape System**	**From Other Sources**	**Total**	**From W Cape System**	**From Other Sources**	**Total**
Irrigation	20	26	46	62	140	202	41	12	53	123	178	301
Urban	307	36	343	19	4	23	16	7	23	342	47	389
Rural	0	5	5	0	4	4	0	5	5	0	14	14
Afforestation [9]	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL REQUIREMENTS	327	67	394	81	148	229	57	24	81	465	239	704
BALANCE			**(17)**			**0**			**(11)**			**(28)**

1) Made up of 139 million m^3/a from Theewaterskloof, 67 million m^3/a from Voëlvlei, 40 million m^3/a from Wemmershoek and 23 million m^3/a from Palmiet transfer = 269 million m^3/a. (The available yield from the two Steenbras River Dams (40 million m^3/a) is accounted for in the local yield).
2) Made up of 5 million m^3/a from the Wit River (Breede WMA), 4 million m^3/a from Witbrug (Breede WMA), 0,6 million m^3/a from the Breede WMA for Franschhoek, and 47 million m^3/a from Theewaterskloof Dam = 56,6 million m^3/a - 25 million m^3/a winter water from the Berg River stored in Theewaterskloof Dam = 31,6 million m^3/a.
3) Made up of 67 million m^3/a from Voëlvlei to Cape Town, 40 million m^3/a from Wemmershoek to Cape Town, 14 million m^3/a to Lower Berg via Vredenburg/Saldanha and Swartland Schemes, and 4 million m^3/a from Voëlvlei to catchment G10K for irrigation = 125 million m^3/a.
4) Made up of 14 million m^3/a imported for Vredenburg/Saldanha and 4 million m^3/a for irrigation = 18 million m^3/a.
5) Made up of 22 million m^3/a from Theewaterskloof to Upper Berg, 139 million m^3/a from Theewaterskloof to Greater Cape Town and 9,6 million m^3/a to the Upper Berg from minor transfers and 23 million m^3/a from Palmiet transfer = 194 million m^3/a.
6) The groundwater yield accounts for existing use from groundwater and does not reflect the potential yield from primary aquifers or from the TMG.
7) Transfers into and out of sub-areas may include transfers between WMAs. Addition of the transfers per sub-area therefore does not necessarily correspond to the total transfers into and out of the WMA.
8) The impact on yield of invasive alien plants has been estimated in the NWRS as being negligible (0). It is however a recommendation of this ISP that an impact on yield of 2 million m^3/a would be more realistic.
9) The impact on yield of afforestation has been estimated in the NWRS as being negligible (0). It is however a recommendation of this ISP that an impact on yield of 6 million m^3/a would be more realistic.

2.6.2 Comments on the Year 2000 Yield Balance

The NWRS figures reflect a shortfall in this WMA of 28 million m^3/a. This is based on a zero impact of invasive alien plants and a zero impact of afforestation, on the yield. It is recommended that this be increased to 36 million m^3/a to allow for a 2 million m^3/a impact of invasive alien plants and 6 million m^3/a for afforestation. These impacts are considered to be more realistic than the negligible impacts shown in the current version of the NWRS. The reasons for this statement and how the new figures were arrived at are given in section 2.8.

The overall deficit of approximately 28 million m^3/a (or 36 million m^3/a) means that if a dry season is experienced the system could go into deficit, and restrictions will have to be applied.

The uncertainties in respect of the yield balance are described in Paragraph 2.8. The most significant of these are the irrigation requirements from other sources (outside of the WCWSS) and the impact on yield of the provisional Reserve requirement. In respect of the latter, it is anticipated that the provisional Reserve determinations (desktop; low confidence level of determination) are likely to be less than those to be determined through more comprehensive methods. Consequently, the deficit in the Berg WMA may be more, once the Reserve requirements are determined at a higher confidence level. This is addressed in the Reserve and Resource Quality Objectives Strategy (No 2.1).

2.7 PROJECTED FUTURE YIELD BALANCE SCENARIOS

2.7.1 The Year 2025 Base Scenario

Within the spectrum of population and economic growth scenarios, a base scenario was selected for estimating the most likely future water requirements. This is built on the high scenario of population growth and more equitable distribution of wealth leading in time to higher average levels of water services. The ratio of domestic to public and business (commercial, communal, industrial) water use for urban centres in the year 2000, for the respective centres, is maintained. The yield balance and potential development of additional yield is shown in Table 2.7.1.

TABLE 2.7.1 : RECONCILIATION OF WATER REQUIREMENTS AND AVAILABILITY FOR THE 2025 BASE SCENARIO (million m^3/a)

COMPONENT	YIELD BALANCE (YEAR 2025)			
	GREATER CAPE TOWN	UPPER BERG	LOWER BERG	TOTAL
Local yield	111	405	52	**568**
Transfers in	350 (1)	32 (2)	18 (4)	**194 (5)**
Transfers out	0	206 (3)	0	**0**
Local requirements	508	235	87	**830**
Balance	(47)	(4)	(17)	**(68)**
Potential for development	27 (6)	100 (7)	0	**127**

1) Made up of 139 million m^3/a from Theewaterskloof, 67 million m^3/a from Voëlvlei, 40 million m^3/a from Wemmershoek, 81 million m^3/a from the Berg Water Project, and 23 million m^3/a from Palmiet transfer = 350 million m^3/a. (The available yield from the two Steenbras River Dams (40 million m^3/a) is accounted for in the local yield).
2) Made up of 5 million m^3/a from the Wit River (Breede WMA), 4 million m^3/a from Witbrug (Breede WMA), 0,6 million m^3/a from the Breede WMA for Franschhoek, and 47 million m^3/a from Theewaterskloof Dam = 56,6 million m^3/a - 25 million m^3/a winter water from the Berg River stored in Theewaterskloof Dam = 31,6 million m^3/a.
3) Made up of 67 million m^3/a from Voëlvlei to Cape Town, 81 million m^3/a from the Berg Water Project, 40 million m^3/a from Wemmershoek to Cape Town, 14 million m^3/a to Lower Berg via Vredenburg/Saldanha and Swartland Schemes, and 4 million m^3/a from Voëlvlei to catchment G10K for irrigation = 206 million m^3/a.
4) Made up of 14 million m^3/a imported for Vredenburg/Saldanha and 4 million m^3/a for irrigation = 18 million m^3/a.
5) Made up of 22 million m^3/a from Theewaterskloof to Upper Berg, 139 million m^3/a from Theewaterskloof to Greater Cape Town and 9,6 million m^3/a to the Upper Berg from minor transfers and 23 million m^3/a from Palmiet transfer = 194 million m^3/a.
6) Based on 19 million m^3/a from the Lourens River diversion scheme and 8 million m^3/a from the Eerste River diversion scheme.
7) Based on raising of Voëlvlei Dam.

2.7.2 The Year 2025 High Scenario

A possible upper scenario of future water requirements, is also given, based on the assumption of high population growth and high standard of services (socio-economic development); together with a strong increase in the economic requirements for water, where the public and business use of water would increase in direct proportion the gross domestic product. It assumes no general increase in irrigation requirements from those in 2000 and no adjustments have been made for reflecting the impacts of increased water use efficiency. The yield balance and potential development of additional yield is shown in Table 2.7.2.

TABLE 2.7.2 : RECONCILIATION OF WATER REQUIREMENTS AND AVAILABILITY FOR THE 2025 HIGH SCENARIO (million m^3/a)

COMPONENT	YIELD BALANCE (YEAR 2025)			
	GREATER CAPE TOWN	UPPER BERG	LOWER BERG	TOTAL
Local yield	124	422	56	**602**
Transfers in	350 (1)	32 (2)	18 (4)	**194 (5)**
Transfers out	0	206 (3)	0	**0**
Local requirements	913	270	123	**1 306**
Balance (6)	(439)	(22)	(49)	**(510)**
Potential for development	27 (6)	100 (7)	0	**127**

1) Made up of 139 million m^3/a from Theewaterskloof, 67 million m^3/a from Voëlvlei, 40 million m^3/a from Wemmershoek, 81 million m^3/a from the Berg Water Project, and 23 million m^3/a from Palmiet transfer = 350 million m^3/a. (The available yield from the two Steenbras River Dams (40 million m^3/a) is accounted for in the local yield).
2) Made up of 5 million m^3/a from the Wit River (Breede WMA), 4 million m^3/a from Witbrug (Breede WMA), 0,6 million m^3/a from the Breede WMA for Franschhoek, and 47 million m^3/a from Theewaterskloof Dam = 56,6 million m^3/a - 25 million m^3/a winter water from the Berg River stored in Theewaterskloof Dam = 31,6 million m^3/a.
3) Made up of 67 million m^3/a from Voëlvlei to Cape Town, 81 million m^3/a from the Berg Water Project to Cape Town, 40 million m^3/a from Wemmershoek to Cape Town, 14 million m^3/a to Lower Berg via Vredenburg/Saldanha and Swartland Schemes, and 4 million m^3/a from Voëlvlei to catchment G10K for irrigation = 206 million m^3/a.
4) Made up of 14 million m^3/a imported for Vredenburg/Saldanha and 4 million m^3/a for irrigation = 18 million m^3/a.
5) Made up of 22 million m^3/a from Theewaterskloof to Upper Berg, 139 million m^3/a from Theewaterskloof to Greater Cape Town and 9,6 million m^3/a to the Upper Berg from minor transfers and 23 million m^3/a from Palmiet transfer = 194 million m^3/a.
6) Based on 19 million m^3/a from the Lourens River diversion scheme and 8 million m^3/a from the Eerste River diversion scheme.
7) Based on raising of Voëlvlei Dam.

2.7.3 Comments on Future Requirement Projections and Yield Balance for the whole WMA

The population growth rate and economic development scenario used to estimate water requirements and availability for year 2025 (NWRS) are based on many assumptions. These future projections are best estimates and should be interpreted as such, taking cognisance of the large variance shown in comparison of the 2025 Base (-68 million m^3/a) and High Scenarios (-510 million m^3/a). As stated before the reason for these variances is the way in which the public and business use of water would increase to ensure a strong economic linkage. The purpose of this was to ensure an upper scenario in order to identify the possible occurrence of an unexpected water shortage. It is important that we monitor the growth in the use of public and business water together with the associated growth in the economy.

Furthermore, the CCT and DWAF have also estimated the future water requirements to 2025 from the WCWSS for input to the Planning Model of some 668 million m^3/a (Table 2.3.1), which would result in a substantial deficit (-196 million m^3/a), even with the implementation of the Berg Water Project. As such, there are effectively three future scenarios being considered with the WCWSS projections forming the median of the Base and High scenarios as presented in the NWRS. Estimates of future demands will be improved by ongoing "real time" monitoring of actual water use so as to determine the true scenario being played out together with updated projections of water use by the various sectors, (see Monitoring Strategies, Chapter 9) so as to establish the appropriate interventions necessary to provide additional water to meet these requirements.

The main uncertainties in terms of future demand projections include, but are not limited, to:

Population related
- normal growth
- impact of HIV/AIDS
- influx to cities (in turn dependant on conditions for rural livelihoods)

Economic related
- future economic growth trends
- socio economic improvement
- type and number of industries
- changes in sectoral water requirements

Behavioral
- success of water conservation
- payment / non payment of water accounts

The commitment and capacity of local authorities to undertake water conservation and demand management also has a huge impact on water requirements.

2.8 OTHER UNCERTAINTIES INFLUENCING THE YIELD BALANCE OF THE BERG WMA

In addition to the uncertainty about the future water requirements discussed in Section 2.7.3, a number of other uncertainties exist which directly impact on the reconciliation of availability and requirements in the Berg WMA. These are addressed under the Reliability of the Yield balance Strategy (No 1.1) and outlined below.

2.8.1 Hydrology

The flow gauging stations and their available records are listed in Appendix 12. The calibration and evaluation of flow gauging stations in the Berg WMA is described in the WCSA Report (1994). Although this report concludes that the Western Cape gauging stations have relatively long record periods and the stations are well distributed, this is relevant only to that portion of the WMA which was modelled. Calibrated modelling of the Berg River downstream of Misverstand Dam is not possible, as there are no gauging stations between the dam and the estuary. Consequently the lower third of the Berg River is ungauged and calibrated modelling of flows into the estuary is therefore not possible. In view of the ecological importance associated with the estuary, long term monitoring is required for the Lower Berg River, so as to monitor the instream and estuarine flow requirements.

In some catchments of the Berg WMA, the hydrology used in the WCSA dates back as far as 1988. As such, the system analysis currently used is based on a mix of hydrology. Subsequent modelling has taken place in certain catchments for the Berg River Dam Feasibility Study (DWAF, 1997), the Voëlvlei Augmentation Study (DWAF, 2002) and the Lourens and Eerste River Diversion Schemes (CCT, 2001). During the period November 2000 to November 2001, restrictions were imposed on the domestic and agricultural allocations from the WCWSS. The impact of this drought period on the overall yield determinations (possible reduction) for the Berg WMA, should be determined. To do so, all hydrology within the Berg WMA needs to be upgraded and the overall system yield re-determined, using latest available information. This is addressed under the Reliability of the Yield balance Strategy (No 1.1).

The rainfall records are of particular concern in the upper most (high rainfall) regions of the Berg River. It was highlighted in the Berg River Dam Feasibility Study that the spatial distribution and number of rain stations in this area is insufficient for reliable modelling purposes. Furthermore the effect of snow melt on surface water runoff and groundwater recharge (thus also groundwater discharge and contribution to base flow) has yet to be determined in this WMA.

The improvement of the rain gauging at higher altitudes in this part of the Berg WMA is important for understanding the recharge to the TMG aquifers, and the proper separation of baseflow contributions from shallow and deep TMG sources. However, DWAF's RO is arranging for additional raingauges to be sited at higher elevations and the results of these should be utilised.

The NWRS shows no reduction in yields due to afforestation and invasive alien plants in the Berg WMA. However there are a number of forestry plantations and extensive invasive alien plant infestation, particularly in riparian zones. No up to date information on these reductions in yield was available from DWAF or from WfW. Consequently estimates of the areas of infestation were determined from the assessments prepared for the WCSA, the Skuifraam Dam (Berg River Dam) Feasibility Study and the West Coast Study (currently in progress). Estimates of the effects on yield were made by applying typical estimates of water utilisation by alien plants and afforestation, and then adjusted to represent the impacts on yield. These estimates are therefore approximate and should be confirmed.

All of the above hydrological uncertainties impact on the reliability of the system yield.

2.8.2 Irrigation Water Use

There are many farmers who have not yet exercised the water allocations that they have been assigned. If these irrigation allocations were fully exercised, then the Berg WMA would be further stressed and the level of assurance of supply, impacted upon.

The irrigation water used from the Government Water Schemes is accurately known. The latest available agricultural demand projections for the WCWSS show very small increases in the allocations to irrigation. Capping limits have been agreed to between DWAF and the CCT (Berg River Dam Agreement) in terms of allocations to irrigation from the WCWSS. Table 2.8.1 reflects the agreed irrigation demand projections for the Berg WMA, as used in the Western Cape System Planning Model.

TABLE 2.8.1 : AGRICULTURAL DEMAND PROJECTIONS IN THE BERG WMA ON THE WESTERN CAPE WATER SUPPLY SYSTEM

YEAR	SUB-AREA			
	GREATER CAPE TOWN	UPPER BERG	LOWER BERG	TOTAL
2003	22	67	38	**127**
2005	23	70	38	**131**
2010	24	77	38	**139**
2015	26	77	38	**141**
2020	28	77	38	**143**
2025	28	77	38	**143**

These figures only represent the allocations to agriculture from the System. As shown in the above table, there is a very limited allowance for increased irrigation from the system.

The "zero" allowance in the NWRS for increased irrigation at the 2025 level of development may not be entirely representative, in terms of the WCWSS. Although limitations have been defined in terms of the system, more than 50% of the total irrigation requirement in the Berg WMA is from other sources. This is supplied from excess winter water abstracted from the rivers, as well as farmers' own sources. Irrigation estimates (outside of the WCWSS) are based on aerial photography, local knowledge input from RO officials and previous reports. The actual quantity of water used for irrigation is therefore uncertain, as is the extent of currently unexercised allocations. The RO is currently in the process of improving the information relating to water use

through compulsory registration of irrigation use and streamflow reduction activities. This will have to be followed up with a full verification of existing lawful use. Only then will a more accurate estimate of actual water use by irrigation and streamflow reduction, be possible. This is further addressed under the Verification of Existing Lawful Use Strategy (No 3.3) and the Licensing Strategy (No 3.4).

2.8.3 Reserve Requirement

Current estimates of the ecological component of the Reserve are provisional and will eventually be superceded by the requirements identified through a comprehensive Reserve determination. To date, the majority of Reserve determinations in the Berg WMA have been based on the desktop and rapid methods. As such these are considered to be provisional. These have been done on an ad-hoc basis, as and when an authorisation application is required to be processed. It should also be noted that the Rapid Reserve Determination procedure utilised for the NWRS has subsequently been revised, and if implemented, the Reserve will be substantially increased and the available yield correspondingly reduced.

An intermediate level of Reserve determination was carried out for the Berg Water Project Feasibility Study. The results suggest that Reserve requirements based on more comprehensive methods than desktop or rapid, may exceed these provisional estimates (for the same class of river). Until the Reserve is determined at a high confidence level, the impact of the Reserve requirement on the yield (and the resulting yield balance) within the WMA cannot be accurately determined and as such, remains uncertain. It is important that a comprehensive determination be done and an implementation strategy developed for the Berg WMA. This is addressed under the Reserve and Resource Quality Objectives Strategy (No 2.1).

Ad hoc estuarine flow requirement determinations have been undertaken on the Berg, Eerste and Lourens River estuaries for various studies. The results of the Breede River Basin Study indicate that the estuarine Reserve requirements may exceed the riverine Reserve requirements and therefore impact further on potential yields. This is also addressed under the Reserve and Resource Quality Objectives Study.

2.8.4 Changes in Land Use

The on-going reduction of SAFCOL's commercial forestry enterprise in the Western Cape will result in large areas of state owned land becoming available for alternative land use purposes. The initial impact is likely to be less water use, with resulting increased runoff. However, future land use may introduce new demands.

The removal of invasive alien plants through the WfW programme is active in the upper reaches of the Berg River, where the priority is to increase surface water runoff by removing invasive alien plants.

These changes in land use will impact on the availability of water and need to be included in the analysis of the system yield. This is discussed in the strategies dealing with afforestation (No 3.6) and the clearing of invasive alien plants (No 3.7).

2.8.5 Impact of Proper Water Conservation and Demand Management Measures being Implemented

The volume of additional water likely to be "freed up" through water conservation and demand management remains uncertain. This is particularly relevant in the agricultural sector, where weather conditions (long hot summers and dry winters) have a significant impact on water availability to, and use by farmers.

The saving achieved through water conservation and demand management will vary between water use sectors. Smaller local authorities will require technical assistance from DWAF in implementing appropriate water conservation and demand management measures. This is addressed under the Water Conservation and Demand Management Strategies (No 4.1 and 4.2).

2.8.6 Climate Change

Ongoing global warming may result in a decrease in rainfall over the Western Cape region. This could cause substantial reductions in streamflow with concomitant impacts on the recharge of aquifers. Studies to date suggest a possible 10% reduction in streamflow by 2015, in the Western Cape. Increased temperatures in the Western Cape would further result in increased evaporation, as well as an increase in irrigation requirements. The impacts of climate change must therefore be taken into consideration when developing planning scenarios for future water requirements.

2.9 RECONCILIATION INTERVENTIONS

There are a number of possible reconciliation intervention options. All of them will have to be studied to greater levels of detail to enable decisions to be made on which of them, or which combinations of them should be implemented. It will further be necessary to determine the most economical options and the sequence and programme for their implementation.

2.9.1 Effluent Re-use

Effluent re-use is currently taking place but only a relatively small portion of the available treated effluent is re-used. The CCT's WWTWs currently generate approximately 180 million m^3/a of treated effluent, of which 22 million m^3/a is re-used. The remainder is discharged to sea. It has been estimated that at least a further 56 million m^3/a could be treated to standards suitable for potable, industrial and irrigation use. Over and above this, the potential to further utilise treated effluent does exist, but at increased cost (for additional treatment, reticulation to remote areas, artificial aquifer recharge, etc). It has become clear from the ISP process that the CCT is in a water stressed area and that in the future it will be necessary to seriously look at all available options to supplement water availability. Taking this planning reality into account it is evident that effluent re-use may become an attractive option that will yield in excess of the

56 million m^3/a mentioned above. This is a relatively large quantity of water available in close proximity to users and it warrants serious investigation and consideration.

The 2025 base and high scenarios of the NWRS allows for some increase in useable return flows, as a result of the growth in water requirements. From studies undertaken by the CCT the extent of the re-use is largely dependent on the source of the effluent and particularly domestic or industrial (which usually contains heavy metals), and on the level of treatment (and cost thereof) for each water use sector. These findings need to be tested against a planning reality of desalination. This is further addressed under the Effluent Re-use Strategy (No 4.3).

2.9.2 Water Conservation and Demand Management

Water Conservation /Demand Management is generally accepted as the most favourable and particularly the most cost effective means of improving the yield balance. In the urban sector, the CCT has implemented a water conservation and demand management policy in which a 20% reduction in projected consumption by 2010 is being targeted. A pilot study undertaken by the CCT in a section of the Khayelitsha reticulation network, has shown encouraging results, using pressure reduction methods. An equivalent reduction from 22 million m^3/a to 16 million m^3/a (27%) was achieved through the installation of standard pressure reducing valves. Through more advanced systems, requiring technical expertise in operation, a saving of 40% was achieved. Other interventions implemented by CCT include user education, the development of appropriate by-laws to curb wasteful usage and eliminate automatic flushing urinals, tariffs, metering, credit control and targeted plumbing repairs. CCT is also making strong representation to SABS to draft National Performance Standards for water fittings, appliances and devices.

Similar efforts need to be encouraged at other local authorities, to ensure that best practices are adopted, before new local supply schemes are considered. Realistic water conservation and demand management targets need to be identified in the WSDPs of local authorities and progress needs to be closely monitored to establish its success. Technical assistance should be made available by DWAF to those local authorities where adequate technical resources are not available. Granting of new licences for local schemes could be made conditional such that users are required to prove that they have successfully implemented appropriate water conservation and demand management measures. This is further addressed under the Water Conservation and Demand Management: Water Services Strategy (No 4.1).

Water conservation and demand management in the agricultural sector has been implemented in all but a few areas, by introducing drip and microjet irrigation systems, soil moisture monitoring and weather predictions. However, significant losses occur through releases into river systems of up to 80 km in length, on account of evapotranspiration from invasive alien riparian plants and scheduling difficulties. Therefore, there are steps such as the installation of more efficient irrigation systems, clearing of invasive alien plants, appropriate water pricing and improved scheduling that could be taken to reduce the demands in this sector. This is further addressed under the Agricultural Water Conservation and Demand Management Strategy (No 4.2).

Implementation of water conservation and demand management remains more cost effective than the development of new schemes and needs to be entrenched, at all user levels through technical support, public awareness and education.

2.9.3 Development of Groundwater Resources

The exploitation of groundwater in the Berg WMA previously focussed mainly on the development of the primary aquifers located on the Cape Flats and the West Coast. The main schemes in these areas include abstractions by the Philippi vegetable farmers on the Cape Flats, the Atlantis aquifer scheme which includes artificial recharge, the pilot abstraction scheme in Saldanha and numerous small private abstractions. In addition, water for stock watering and domestic supply is abstracted from the Malmesbury formation. The unconfined Nardouw aquifer of the TMG rock formations is developed for agricultural and domestic supply.

The potential to exploit the very deep confined Peninsula aquifer of the TMG was only recently appreciated. It is envisaged that a wellfield could be developed to substantially augment the supply of the WCWSS with individual boreholes yielding between 25 *l*/s and 80 *l*/s.

Based on the outcome of studies carried out to date, the following potential groundwater schemes in the Berg WMA have been identified:

(1) *TMG* feasibility study with the development of a pilot wellfield to yield 5 million m^3/a is in progress. The study is scheduled for completion in 2008. Development of the aquifer will be in both the Berg and Breede WMAs and provisional estimates indicate a potential yield of 80 million m^3/a. The CCT is currently implementing the TMG Aquifer Feasibility study and Pilot Scheme project to assess the potential for large-scale abstraction of groundwater for augmentation of the WCWSS. DWAF are represented on the Study Management Committee by the Directorate: NWRP, as well as representation from the RO. DWAF also participates on the Key Stakeholder Forum.

Uncertainties about the mass balance in the G10G (Twenty-four Rivers), G10H and G10J (east) catchments with regard to possible inter-basin groundwater transfer within TMG aquifers crossing the Olifants-Doring River divide. The TMG may offer potential to augment the Porterville supply by TMG groundwater development on the higher mountain slopes.

It is believed that there are significant discharges of good quality groundwater directly into the ocean (i.e. freshwater springs beyond the coastline). These have not been adequately explored and documented. This knowledge would give important clues as to the groundwater to surface interaction of the TMG aquifer.

The potential for groundwater augmentation from TMG aquifers to meet seasonal demand, in particular areas of the South Peninsula (G22A), has been recognised but must still be quantified

There is potential for groundwater augmentation of the Steenbras scheme through conjunctive use of the deep groundwater storage in the confined synclinal part of the TMG aquifer system.

(2) *The Cape Flats Wellfield* would be located within the urban areas of the Cape Flats. It may be well suited to local product use, such as greening of the Cape Flats, local subsistence food gardens, emerging market gardeners or disaster management and/or prevention.

(3) *The Malmesbury Bedrock* underlying the Cape Flats Aquifer could well contain a local supply of potable water where it is associated with intrusive or structural features. The potential is currently little known and warrants further investigation.

Uncertainty exists in relation to the actual yield and storage of the groundwater resource in general. Furthermore, the extent to which aquifer storage recovery techniques could be beneficially used, particularly in the drier regions of the WMA, is not well established.

Historically, there has been limited investment in quantifying the groundwater resource from storage as well as a yield potential. The spatial and temporal variations in surface-groundwater interaction in the different aquifers, the lateral recharge and discharge relationships between different aquifers are not formally documented and quantified. Limited monitoring data is available and datum conditions not known. A significant investment is required to establish the relevant knowledge and database in order to prepare suitable monitoring protocols (quality and quantity) and to devise an appropriate management and resource planning and implementation strategy in detail. Currently, the pollution of surface waters and management of waste (domestic, industrial, human) at the coastal resorts poses a threat to the intergranular aquifers that are, in places, the sole supply. Aquifer protection and wellhead protection measures are urgently required, both in small schemes, private developments and individual landowners. Recharge catchment protection is required throughout the WMA.

2.9.4 Aquifer Storage Recovery (ASR)

This aquifer management and conjunctive use approach essentially allows for available storage within aquifers to be used for storing surplus water, which is injected into the aquifer through various techniques. The potential exists for increased re-use of treated effluent via ASR techniques in the primary aquifers along the West Coast.

The potential for further enhancement of Artificial Recharge schemes (e.g. at Atlantis) and development of new ASR Schemes using treated water in the intergranular aquifers has not been given enough attention.

2.9.5 Re-allocation of Water

It can be expected that re-allocation of water under existing authorisations (via the compulsory licensing process) will need to be progressively implemented to make allowance for the Reserve. Furthermore, re-allocation of authorisations will be necessary to ensure equitable distribution of water to all users and to correct imbalances. Policy and specific area strategies need to be developed to give effect to this process while being balanced by the need to achieve the most beneficial use of water in the national interest. The capacity building amongst resource poor farmers and the distribution of land must also be accommodated. This is further addressed under the Support to Resource Poor Farmers Strategy (No 5.1).

Re-allocation via trading of existing authorisations is a further possibility as opposed to issuing of new authorisations. It may be important to trade unexercised existing rights as soon as possible as this will not have a negative impact on current users. Trading between different water use sectors, such as irrigation to urban should be cautiously managed if the current nature of economic activity in the region is to be preserved. A strategy for Trading of Authorisations in the Berg WMA needs to be developed (See Part 2, Section 11 – Additional Strategies to be Developed).

2.9.6 Improved System Management

The introduction of telemetry and improved control of releases from the Berg River Dam and between Voëlvlei and Misverstand Dams will allow for a reduction in wasteful spills at Misverstand Dam. This would be in line with the current operation of the WCWSS in which minimising spills is a priority. The Voëlvlei/Misverstand issue is further addressed under the Strategy for the Lower Berg (No 8.4). Further improvement and optimisation of operating rules could also increase system yield.

2.9.7 Clearing of Invasive Alien Plants

One of the main objectives of the clearing of invasive alien plants is to increase water availability. Clearing of invasive alien plants is currently focused in the uppermost regions of the Berg River catchment, however the possible removal of riparian invasive alien plants is also under consideration. The increased surface water runoff arising from these efforts will need to be determined through ongoing monitoring (see Strategy No 3.7: Changing Land Use – Clearing of Invasive Alien Plants).

2.9.8 Development of New Surface Water Supply Schemes

Based on the outcome of studies carried out to date, the following possible schemes in the Berg WMA have been identified:

(1) *The Voëlvlei Augmentation Scheme* has already undergone a detailed feasibility study (2001). (Yield = + 35 million m^3/a). This excludes the further possibility of raising Voëlvlei Dam.
(2) A reconnaissance level study (2001) of the *Lourens River Diversion* indicates that this is a relatively favourable development option although the scheme is situated in a protected natural environment area. (Yield = 19 million m^3/a).
(3) The *Eerste River Diversion* site lies downstream of the discharge point for effluent from the Stellenbosch WWTW, into the Eerste River. The discharge would need to be rerouted to a point downstream of the abstraction site, so as to reduce the costs of purification. The need for additional civil engineering adds to the unit cost of the water and as such, the scheme is ranked last. This was studied as part of the CCT's Integrated Water Resource Planning Study (2001). (Yield = 8 million m^3/a).
(4) *Raising of the Lower Steenbras Dam* would provide significant additional storage and some improvement in yield, but is likely to be costly and will have environmental impacts, particularly if additional water is to be abstracted from the Palmiet River.
(5) *Raising of Voëlvlei Dam* would need to be accompanied by increasing the diversions into the dam. This option may not be viable due to the potential additional algal problems.
(6) *Raising of Misverstand Dam* would have impacts on the riverine and estuarine flow requirements. Water quality might also be of concern.

Details pertaining to these schemes are given in Appendix 10.

Possible schemes in the Breede WMA which would augment the supply in the Berg WMA include:

- The Michell's Pass Diversion (Yield = 53 million m^3/a).
- The Upper Molenaars River Diversion (Yield = 27 million m^3/a).
- Brandvlei Augmentation to Theewaterskloof (Yield = 41 million m^3/a).
- Development of the TMG Aquifer (80 million m^3/a, but uncertain).

2.9.9 Desalination of Sea Water

The potential for desalination was investigated by the CCT in their Integrated Water Resources Planning Study. The yield potential is unlimited, but the unit costs, as reflected in the CCT study, are high relative to other options:

- 15 to 60 times the cost of water conservation and demand management.
- 8 times the cost of developing the TMG.
- 8 to 15 times the cost of surface water development.

Notwithstanding these findings the Department believes that the CCT should plan to commission a pilot desalination plant. This is because the introduction of this technology into a large supply system would enable the CCT to gain the necessary skills in operation and to select the appropriate technology when the time comes to provide desalinated water on a large scale. Although the cost of supplying water at the high assurance level of supply is much higher than at

a lower assurance of supply, the desalination plant should be integrated into the system to exploit this cost differential by providing high assurance water and freeing up the system yield to supply at a lower assurance (see Strategy No 1.2: Reconciling Water Supply and Demand).

CHAPTER 3: WATER RESOURCES MANAGEMENT PERSPECTIVE OF THE BERG WMA

The sub-division of the Berg WMA into three sub-regions as defined in the NWRS and as shown on Figure 2.1.1, proved sufficiently detailed to adequately evaluate the yield balance and identify stressed areas. It was therefore not deemed necessary, to further disaggregate the yield balance figures into smaller catchments, say to quaternary level detail. However, to facilitate the identification of issues and concerns that would require detailed strategies (see Figure 3.1) the WMA was further sub-divided into eight management units (sub-areas).

3.1 DESCRIPTION OF ISP SUB-AREAS

A brief overview of each of the eight sub-areas is provided, together with the main issues and concerns identified in each region. The strategies (in Part 2) addressing these issues and concerns should be referred to for detail.

A description of each of the eight sub-areas follows.

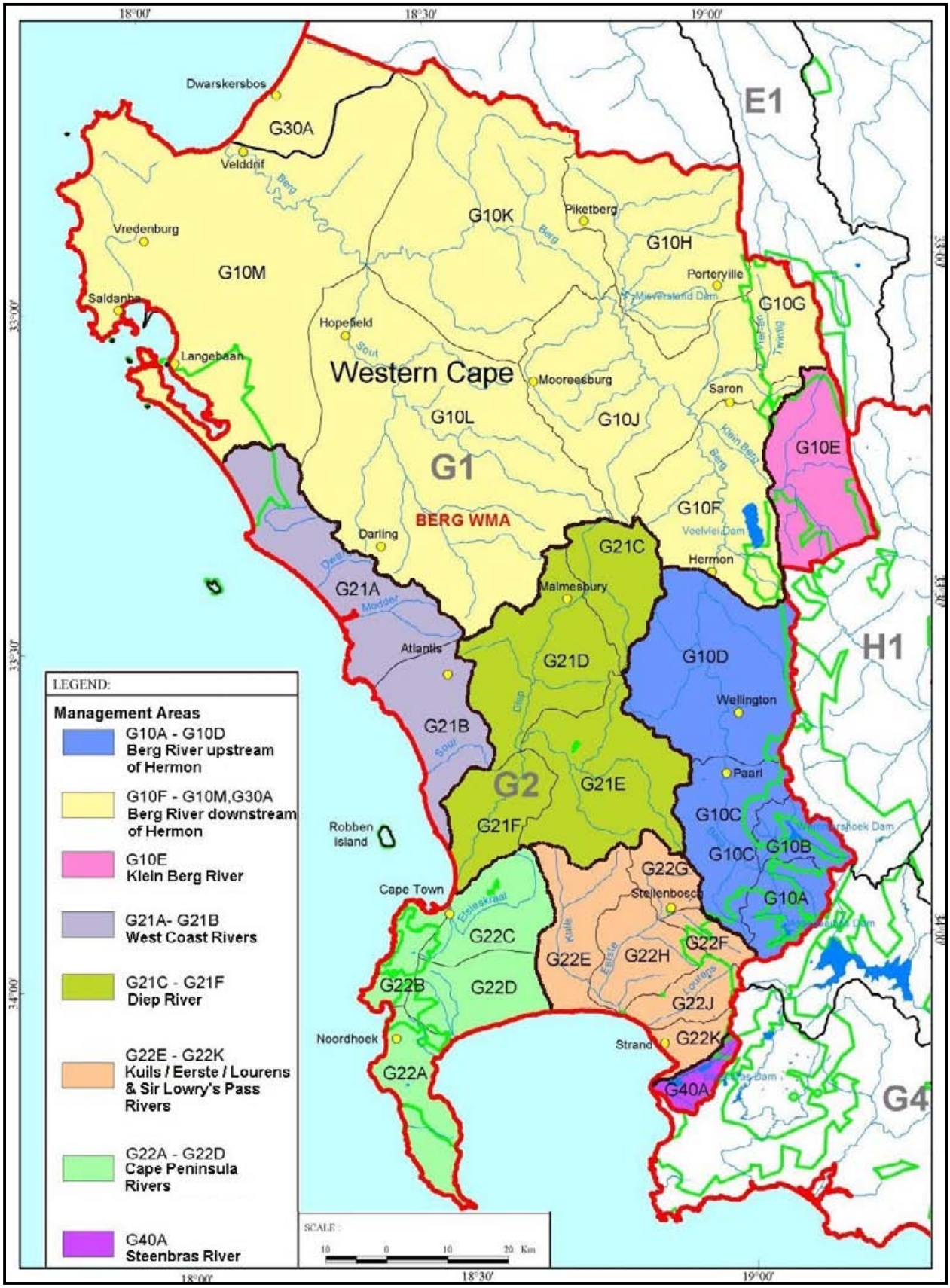

Figure 3.1: The Eight Management Units (sub-areas) of the Berg WMA

3.1.1 The Berg River Upstream of Hermon

(a) Topography and rainfall

This sub-area consists of four quaternary catchments (G10A - G10D) and extends from the source of the Berg River in the Groot Drakenstein Mountains, to the flow gauging station (G1H036) at the bridge near the town of Hermon. It covers an approximate area of 1 310 km^2. The topography is characterised by high mountain ranges in the south and east which drain towards the Berg River. The maximum mean annual precipitation (MAP) in the high lying southern areas reaches 3 200 mm. This declines to approximately 600 mm at the town of Hermon.

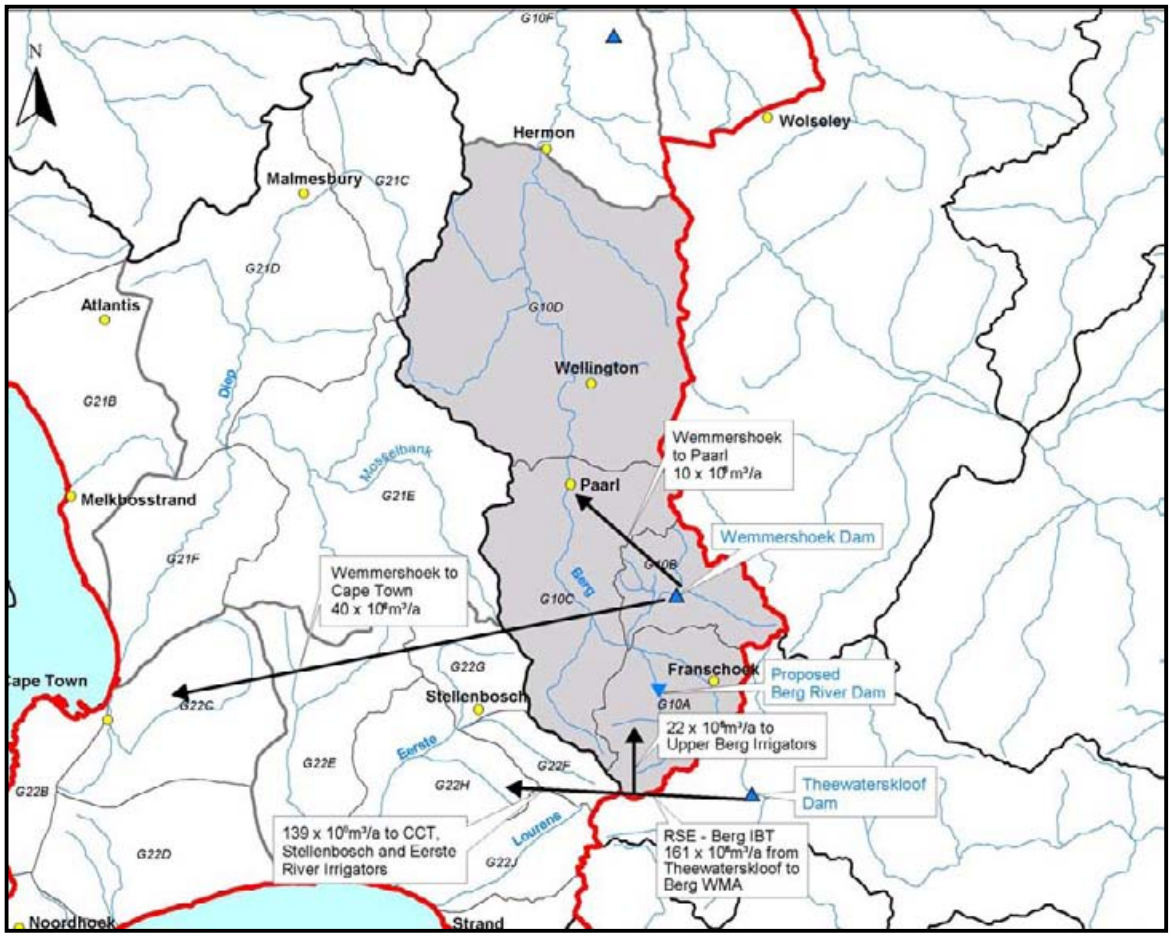

Figure 3.1.1: Berg River upstream of Hermon

(b) Main water resource infrastructure

Wemmershoek Dam (59 million m^3 storage) near Paarl is the largest dam in the area. It is owned by the CCT and supplies the Cape Town Metropolitan area as well as Paarl (under an agreement with the CCT). The Nantes (0,8 million m^3) and Bethel (0,5 million m^3) Dams on Paarl Mountain, form part of the local supply to Paarl. Water is abstracted from the Berg River in winter and stored in these two off-channel storage dams. A pipeline from the Theewaterskloof tunnel system to the water purification works at Wemmershoek Dam allows for additional water to be supplied from the Riviersonderend/Berg River Government Water Scheme. Improvements to the de-watering methods currently used on the tunnel system are required. The tunnel system conveys excess winter water from the Banhoek and Wolwekloof weirs (Upper Berg River tributaries) into Theewaterskloof Dam, for storage and use during summer. The Berg River Dam is to be constructed near Franschhoek (G10A).

(c) Population

Population estimates are based on the figures presented in the *"Berg WMA – Overview of Water Resources Availability and Utilisation"* Report.

In 1995, it was estimated that approximately 199 600 people resided in this area. 21% of those were estimated as the rural population. The total population constituted approximately 6% of the overall population in the Berg WMA.

(d) Land Use

Land use is centred around irrigated agriculture of grapes, deciduous fruit, lucerne and pasture as well as dryland vineyards, grain crops, olives, etc. In 1995 the estimated area under irrigation was 245 km^2 but there is uncertainty regarding actual water use by irrigators (from own sources and run of river) notwithstanding the fact that the substantially completed process of registration, which it was hoped would enable more reliable estimates of irrigation water use, did not improve on estimates. Changing land use is taking place due to the demobilisation of SAFCOL's commercial forestry operation and the removal of invasive alien plants, through WfW. The corresponding effect on surface water runoff needs to be determined.

(e) Water quality

The water quality of this section of the Berg River catchment is better than that of the lower reaches of the Berg River, where salinity problems occasionally occur. Certain of the headwaters of the Berg River are normally acidic and coloured brown as a result of dissolved humic substances. Although this has some impact in terms of treatment required to reach potable standards, it is not considered to be a significant problem. There are concerns that pesticide residues washed into the rivers through irrigation and the leaching of fertilizers as a result of irrigation, are impacting on water quality of the Berg River and its tributaries. The potential impact of aquaculture activities on water quality is a further concern.

The existing WWTWs at the towns of Paarl and Wellington are under pressure due to the increased load being placed on them as a result of industrial and urban growth. The existing facilities at both towns consist of closed systems (evaporation ponds) and these pose a risk of

spillage into the Berg River, particularly during winter months. The ponds at Wellington are unlined and seepage occurs from them.

The WWTWs managed by the Department of Public Works include those at the La Motte forestry residential village, and the WWTWs at the Paardeberg and Drakenstein prisons. At the latter, upgrading of the existing works has been proposed by DWAF but lack of funding within Public Works appears to be a constraint.

At present only those users irrigating with more than $10m^3/d$ of effluent, need to register with DWAF. Whilst the larger wineries make an effort to re-use their effluent for irrigation, over-irrigation in close proximity to rivers has an impact on water quality. Smaller wineries, which are more difficult to monitor, may be discharging directly into rivers however the cumulative impact of this problem is not well established.

(f) Yield balance

The yield balance shown in Section 2.6 represents a larger region than this sub-area. Nevertheless it can be deduced from those results that there is no surplus water available for further allocation to the irrigation sector in this sub-area. Potential water resource supply schemes in the Berg WMA (see Appendix 10) are not intended to be used for further irrigation development.

(g) Future for this sub-area

Through the Berg Water Project Agreement (between DWAF and CCT) limits have been introduced in terms of the future development of irrigation supplied from the WCWSS. These effectively allow for very little further development of irrigation within the system.

A recent authorisation has been recommended by the RO for approval, in which the conditions of an existing authorisation were changed. The authorisation involves a change in operation through the use of an off-channel storage dam, to abstract excess winter water from the Spruit River, rather than on the existing run of river basis. As such there is no impact on the quantity of water used in this case.

The trading of existing authorisations is an option open to any user to obtain water. The extent of existing irrigation (outside of government schemes) and the extent of unexercised rights need to be determined. This must then be verified and the lawfulness established before such trading can be appropriately managed.

(h) Summary of main issues and concerns

The following issues and concerns are noted:

- Changing land use through reduction of afforestation and removal of invasive alien plants may result in additional surface water runoff, the extent of which is dependant on any new demands resulting from new land uses (*Strategy No 3.6 and 3.7 - Changing Land Use*).
- Management of aquaculture activities from a water quality perspective need to be considered and appropriate charges considered for this water use. (*Strategy No 3.5 – Pollution Control*).
- Operation and maintenance of the Theewaterskloof tunnel inlet shafts requires attention (*Strategy No 8.2 – The Theewaterskloof Tunnels*).
- An *Agricultural Practises Strategy* is required to address the impact on water quality from agricultural methods and irrigation return flows (See Part 2, Section 11 – Additional Strategies to be Developed).

3.1.2 The Klein Berg River

(a) Topography and rainfall

The sub-area consists of only one quaternary sub-catchment, namely G10E which has an approximate area of 390 km^2. The Tulbagh Valley is bounded in the east by the Witzenberg Mountains and in the north by the Groot Winterhoek Mountains. The mean annual precipitation for the catchment is 640mm, with the highest rainfall being recorded along the south-east boundary, where the MAP reaches 1000 mm.

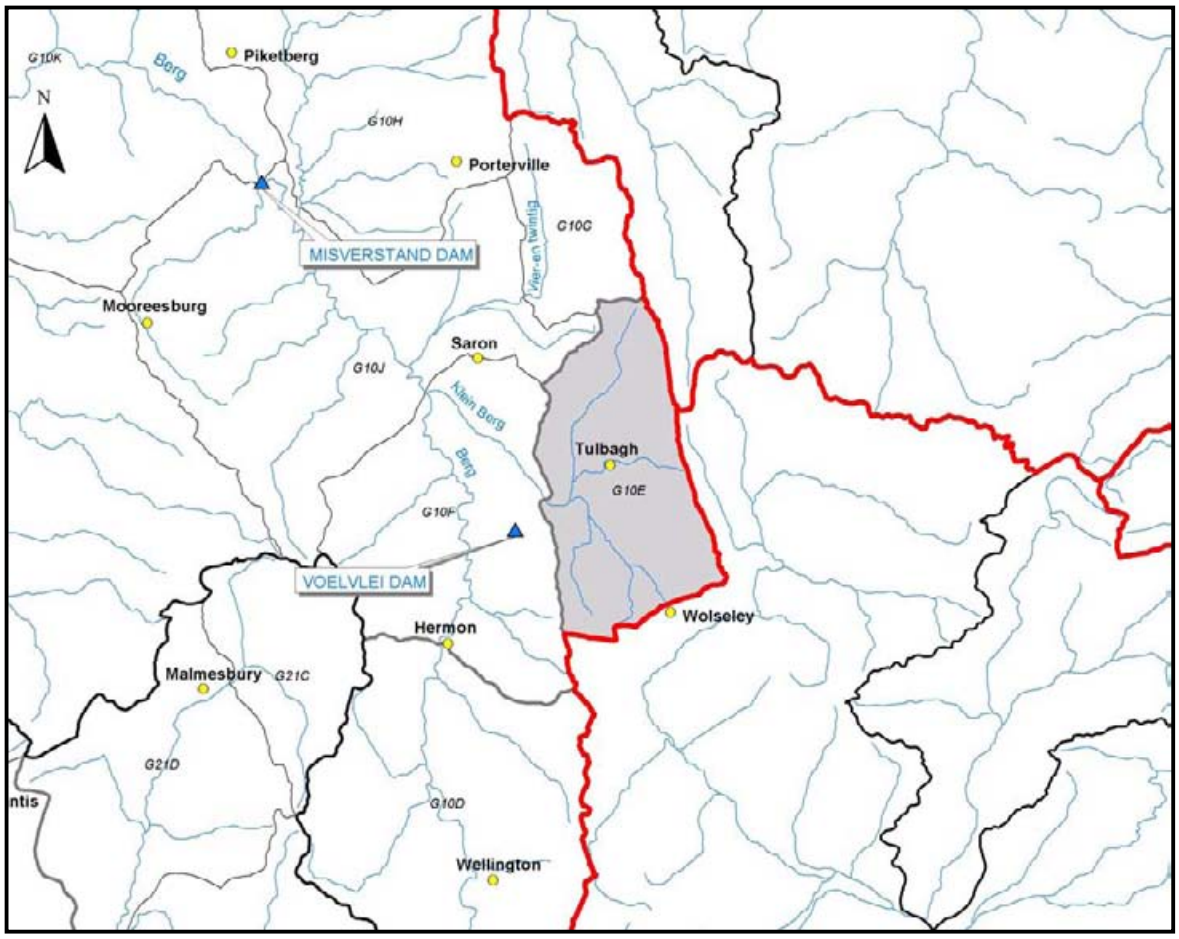

Figure 3.1.2: The Klein Berg River

(b) Main water resource infrastructure

The sub-area contains no major dams or water resource infrastructure. Tulbagh is the main town and it relies on water from the Moordenaarskloof stream as well as groundwater from local springs.

(c) Population

Population estimates are based on the figures presented in the *"Berg WMA – Overview of Water Resources Availability and Utilisation"* Report.

In 1995, it was estimated that approximately 10 900 people lived in this area of which approximately 57% were rural (mostly farm workers). The total population was less than 0,5% of the total for the Berg WMA.

(d) Land Use

Approximately 3 600 ha is under irrigation, most of which is scheduled under the Klein Berg and Dwars River Irrigation Boards. As is the case for all irrigation boards in the Berg WMA, these two have also yet to be officially transformed into WUAs.

(e) Water quality

Poor quality effluent discharged from the Tulbagh WWTW, winery effluent discharged into the Klein Berg River, and pollution from informal settlements contributes to the poor water quality in this river. The extent of the direct discharge from the wineries into the river is not well established but may have a considerable cumulative effect. Similarly, the impact on water quality of the return flows arising from over-irrigation (with winery effluent) in close proximity to the river, is also of concern. The Tulbagh WWTW is designed for domestic effluent, however traces of fruit waste are common. Vandalism and pipe blockages in the reticulation system cause spills from manholes into the stormwater system.

The water quality problem in the Klein Berg River is exacerbated at the start of winter due to diffuse pollution being washed into the river from adjacent informal settlements. As a result it is desirable that the runoff from the first winter rains is not diverted into Voëlvlei Dam, so as to minimise the impact on the water quality in Voëlvlei Dam as discussed in the strategy for the Lower Berg River (No 8.4). The management of the diversion in accordance with water quality has not yet been formerly implemented, on account of the impacts of the potential loss of yield on the supply until the Berg Water Project is completed. Therefore there is an urgent need to attend to the pollution risks in the catchment.

(f) Yield balance

This catchment is severely stressed. The Moordenaarskloof stream and local springs that supply water to Tulbagh provide insufficient yield. It has been necessary for water to be trucked in, during dry years.

(g) Future for this sub-area

Water conservation and demand management measures need to be defined by the local authority in their WSDPs and then implemented. Lei-water exchange so as to augment the municipal supply is one possible augmentation option. The further possibility also exists for providing water to Tulbagh, from a potential interbasin transfer from the Breede WMA (Michell's Pass). This would primarily be implemented to augment the inflow to Voëlvlei Dam. The TMG aquifers in

the SW part (Waterval stream) of the Klein Berg region, and TMG sources - springs along the NNWQ/SSE-trending Tulbagh Road Fault, are a potential source that is being investigated in the TMG project, for possible transfers to the Voëlvlei scheme.

Two authorisation applications have been submitted by the local authority. One is for increased groundwater abstraction and the other for raising the local storage dam and diverting water from a local mountain stream.

(h) Summary of main issues and concerns

The following issues and concerns are noted:

- Water conservation and demand management measures need to be implemented by the local authority (Witzenberg Municipality) should feature prominently in WSDPs (*Strategy No 4.1 - Water Conservation and Demand Management: Water Services).*
- Seasonal water shortages at Tulbagh and uncertainty regarding the towns current and future sources of supply (*Strategy No 6.1 – Supply to Local Authorities*).
- Poor management of the municipal WWTW and the diffuse pollution into the Klein Berg River from informal settlements and agricultural activities (*Strategy No 5.2 – Co-operative Governance and Strategy No 2.4 – Water Quality*)
- Maintenance requirements of Voëlvlei Dam feeder canals may impact on the operation of the system (*Strategy No 8.4 – Lower Berg*).
- Poor water quality in the Klein Berg River (which feeds Voëlvlei Dam) at the start of winter makes it preferable that the first winter runoff is bypassed (*Strategy No 3.5 - Pollution Control and Strategy No 2.4 – Water Quality*).
- A specific strategy to deal with water supply to Tulbagh needs to be developed (See Part 2, Section 11 – Additional Strategies to be Developed*).*

3.1.3 Berg River Downstream of Hermon

(a) Topography and rainfall

The sub-area consists of quaternary catchments G10F - G10M, as well as G30A. It covers an approximate area of 7 450 km^2. The MAP in the most easterly quaternary (G10G) is approximately 1 300 mm (Groot Winterhoek Mountains). The average MAP over the remainder of the sub-area ranges from 450 mm (G10J) to as low as 300 mm (G10M), towards the coast.

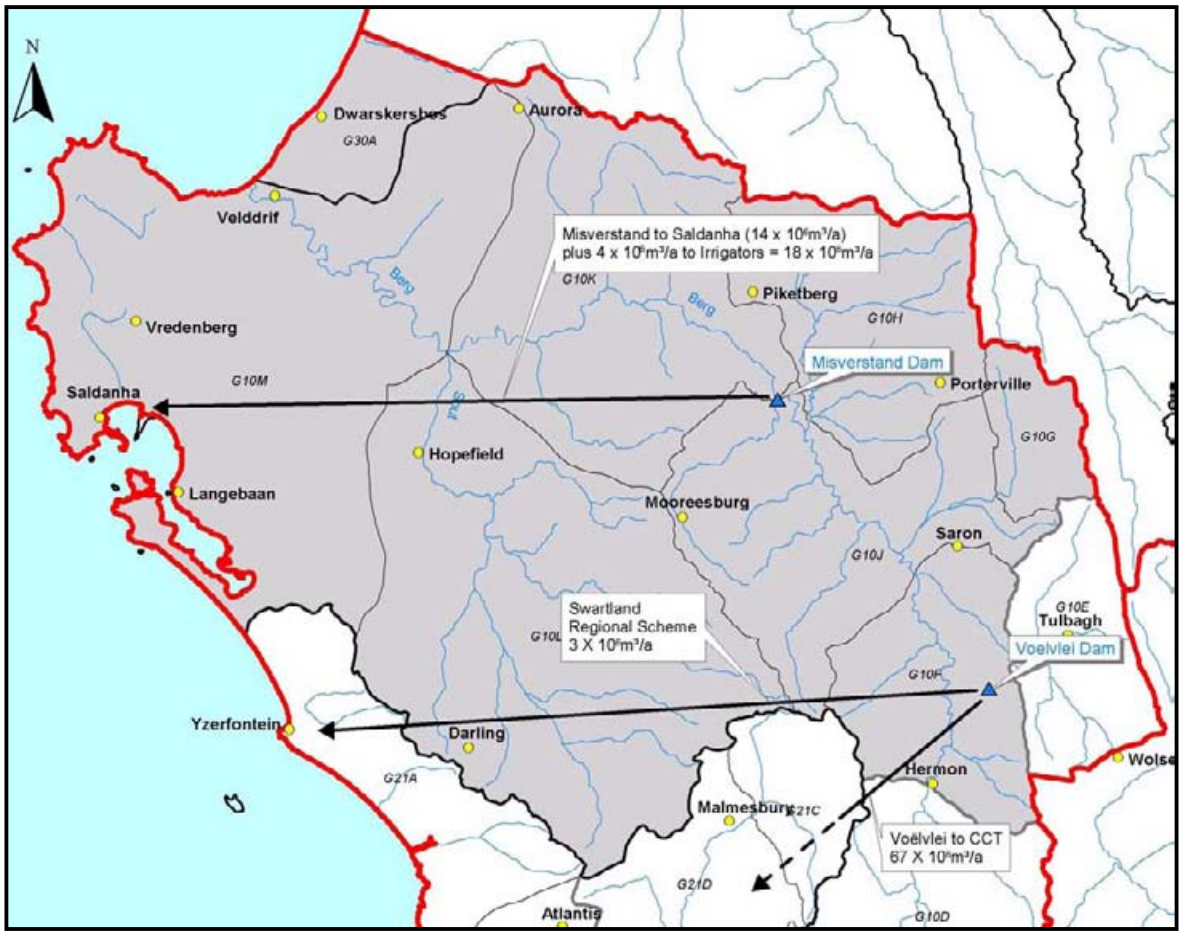

Figure 3.1.3: Berg River downstream of Hermon

(b) Main water resource infrastructure

Voëlvlei Dam (164 million m^3) and Misverstand Dam (6 million m^3) are the two main dams in this sub-area. Voëlvlei Dam is an off-channel storage dam, fed from diversion canals leading from the Klein Berg, Leeu and Twenty-Four Rivers. The dam supplies the Cape Town Metropolitan area and the Swartland Regional Scheme (see Paragraph 2.2.4). Releases from Voëlvlei are stored in Misverstand Dam and abstracted to supply the Saldanha Regional Scheme (see Paragraph 2.2.4).

(c) Population

Population estimates are based on the figures presented in the *"Berg WMA – Overview of Water Resources Availability and Utilisation"* Report.

Although this is the largest sub-area within the Berg WMA, it had an approximate population (1995) of only 121 500, of which 26% were rural. The population constituted only 4% of the total for the WMA, although the region occupies 57% of the total land space within the WMA. Rapid economic growth in the Saldanha/Langebaan region is expected. As such, the population concentration in those areas is anticipated to increase.

(d) Land Use

Approximately 11 500 ha were estimated to be under irrigation in 1995, with lucerne and mixed pastures the main crop types. This is mainly concentrated within the Riebeek-Wes and Riebeek-Kasteel (G10F) irrigation boards as well as the Twenty-four Rivers (G10J) and Lower Berg (G10F, G10J, G10K) irrigation boards. Dryland grain farming, with wheat predominating in the Swartland, occurs on a large scale. Releases from Voëlvlei Dam supply water to irrigators in the middle and lower reaches of the Berg River.

(e) Water quality

In the Berg River, downstream of Voëlvlei Dam, water quality during the summer months is generally good because water is released from Voëlvlei to supply downstream irrigators and regional water supply schemes. The water quality deteriorates further downstream on account of high salinity return flows and cannot be utilised for the environment and the estuary. However, nutrient rich inflows from the Klein Berg River together with the releases of nutrients in the dam sediments due to wave action, has resulted in algal blooms which cause taste and odour problems and must be removed at high cost by utilising activated carbon.

Occasionally during the winter months natural runoff from the more saline Malmesbury shale soils may result in salinity at Misverstand Dam exceeding 400 mg/*l* for periods of up to three weeks which is apparently detrimental to the processes at Saldanha Steel. Salinity concentrations and their duration will increase after the Berg Water Project is implemented and strategies for dealing with this are currently being investigated by DWAF Option Analysis. As one moves further downstream, the water quality becomes more saline, due to the further influence of the geology and return flows (Malmesbury shale). At the lowest reach of the river, the tidal impact, together with the effect of the geology, results in a high salinity. Nutrients from upstream return flows and agricultural return flows annually result in extensive water hyacinth growth in the upper reaches of the Berg River Estuary.

The Riebeek-Wes and Voorberg prisons have their own WWTWs. These fall under the Department of Public Works and are generally not well managed. The municipal WWTWs operated by the local authorities do not appear to be posing any significant problems in this sub-area.

(f) Yield balance

Whilst there is currently a sufficient quantity of water available to the Saldanha area to meet existing demands (released from Voëlvlei Dam), the quality of water (occasionally of high salinity during winter months) supplied out of Misverstand Dam, is the primary concern. Furthermore, with the anticipated expansion along the West Coast (industrial development and economic growth) further stress will be placed on Voëlvlei Dam to meet projected future demands. This expansion is stimulated by the Saldanha-Sishen railway line, the Saldanha Steel mill and the potential offshore gas reserves. Water conservation and demand management needs to be implemented through local authorities. Consideration should also be given to the possible use of artificial aquifer recharge during the winter using water abstracted at Misverstand Dam, treated at Withoogte Water Treatment Works and conveyed via the existing pipeline to Vredenburg / Saldanha. Augmentation schemes are, however, likely to be required to meet the future requirements in this sub-area.

(g) Future for this sub-area

The anticipated industrial growth in the Saldanha area and subsequent increase in water requirement is the scope of a study currently being carried out by the West Coast District Municipality. The study will present estimates of future growth in requirement as well as potential reconciliation interventions, including surface and groundwater development schemes. A specific strategy relevant to the provision of water to the West Coast area needs to be developed.

The major industry in the region is Saldanha Steel which has an authorisation to abstract 1,5 million m^3/a water from the Langebaan Road lower aquifer. Farmers are suggesting that this is impacting on the upper aquifer from which they abstract. Saldanha Steel have indicated that their proposed expansion will require a further 2 to 3 million m^3/a.

Options include artificial aquifer recharge, the possible use of alternative aquifers, such as Adamboerskraal and the development of additional surface water yield. The latter would involve augmenting the yield of Voëlvlei Dam via pumping of excess winter water from the Berg River or the possible transfer of water from the Breede WMA into Voëlvlei.

(h) Summary of main issues and concerns

The following issues and concerns were noted:

- Water Conservation and Demand Management at towns is to be encouraged *(Strategy No 4.1 – Water Conservation and Demand Management: Water Services).*
- Potential use of groundwater yield, aquifer storage and recharge both for local supply to and improvement of assurance of supply to towns and rural users, needs to be investigated *(Strategy No 6.1 – Supply to Local Authorities and Strategy No 2.4 – Aquifer Storage Recovery and Artificial Aquifer Recharge).*
- Implementation of reconciliation options to meet anticipated increasing demands from industrial development, especially in the Saldanha area, is required. A *Water Supply Options to the Saldanha Area Strategy* needs to be developed (See Part 2, Section 11 – Additional Strategies to be Developed).

- There is no flow gauging of the Berg River, close to the estuary *(Strategy No 9.2 – Monitoring Networks and Data Capture).*
- Groundwater monitoring design and protocol for the different aquifer systems warrants urgent review. Monitoring spatial and temporal recharge and discharge patterns, evaluating of lateral recharge and discharge between aquifers and the surface water system, between quaternary catchments as well as between the Breede and the Olifants Doring WMA. Groundwater quality, aquifer vulnerability and seawater intrusion are of particular concern in the coastal plain. Headwater protection is imperative. (*Strategy No 1.3 – Groundwater*).
- Measures to investigate the occasional periods of high salinity abstractions from Misverstand Dam should be developed *(Strategy No 8.4 – Lower Berg and Strategy No 2.4 - Water Quality).*

3.1.4 The West Coast Rivers

(a) Topography and rainfall

The sub-area consists of two quaternary sub-catchments, namely G21A and G21B, covering an area of approximately 830 km^2. The MAP of the region is approximately 410 mm and as a result, surface water resources are limited and recharge of the groundwater resource is not high.

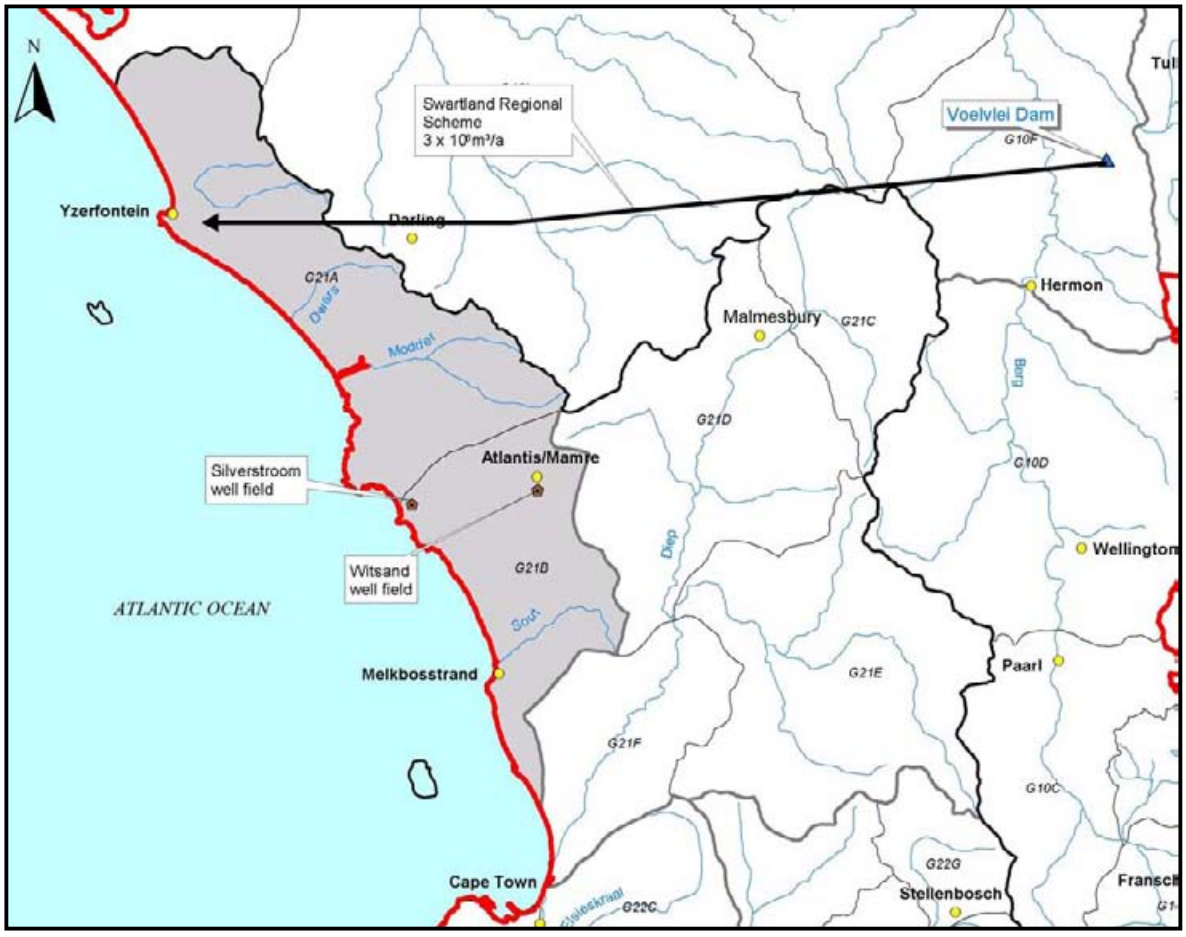

Figure 3.1.4: West Coast rivers

(b) Main water resource infrastructure

There are no major dams in this region. The wellfields at Silverstroom and Witsand supply water to the towns of Atlantis and Mamre. Atlantis is supplemented from Voëlvlei Dam. The town of Yzerfontein is supplied through the West Coast District Municipality via the Swartland Regional Scheme.

(c) Population

Population estimates are based on the figures presented in the *"Berg WMA – Overview of Water Resources Availability and Utilisation"* Report.

This sub-area had a total population of 64 600 at the 1995 level of development, of which 14% were estimated as rural inhabitants and the remainder as urban. The total population in this sub-area was 2% of the total for the Berg WMA.

(d) Land Use

There is no irrigation of any significance due to the low rainfall and sandy soils which are characteristic of this sub-area. Much of the region consists of coastal dunes and nature reserve areas.

(e) Water quality

There is a strong reliance in this sub-area on groundwater. The main concern is the extent of the impact on groundwater quality from the effects of land sub-division. This is primarily due to the increased abstraction by poor small-scale users under Schedule 1, coupled with the increased use of pit latrines in the absence of proper services. As a result, the primary coastal aquifers may be at risk. No specific problems have been identified with regard to the operation of WWTWs in this sub-area. Aquifer Storage Recovery is effectively utilised near Atlantis, by recharging with stormwater runoff and injecting treated effluent from the Wesfleur WWTW into the aquifer.

Monitoring of the intrusion of seawater, as a result of groundwater abstraction, is required.

Surface runoff from the short coastal rivers is very erratic and of relatively high salinity.

(f) Yield balance

It was estimated in 1995 that the area experiences a small shortfall of 0,2 million m^3/a.

(g) Future for this sub-area

There is no opportunity for irrigation development. At a 1:50 year level of assurance there is essentially no surface water yield available. Existing urban requirements are those at Atlantis, Mamre and small rural communities. These are supplied from groundwater out of the Witsand and Silverstroom wellfields. Atlantis is also supplemented from Voëlvlei Dam.

Land restitution at Atlantis and Mamre and the associated small-scale irrigation practises which may arise, will require water. These requirements are likely to be small but need to be considered by DWAF, Dept Land Affairs and Dept Agriculture to ensure provision is made for these people, whilst protecting the existing resource.

(h) Summary of main issues and concerns

- The potential for enhanced recharge and Aquifer Storage Recovery (ARS) needs to be investigated *(Strategy No 1.4 – Aquifer Storage Recovery and Artificial Aquifer Recharge).*
- Potential use of groundwater, from both the intergranular and the fractured-and-weathered aquifers of the Cape Granite Suite for local supply to towns and rural users needs to be investigated *(Strategy No 6.1 – Supply to Local Authorities and Strategy No 1.3 - Groundwater).*
- The existing pipeline delivering water to Yzerfontein is only a 200mm dia. pipe and may require upgrading to meet future requirements. (*Strategy No 6.1 - Supply to Local Authorities*).
- Coastal resort developments require that aquifer protection and wellhead protection measures are implemented immediately, particularly in view of the fact that groundwater is, in the smaller towns, the sole source of supply. (*Strategy No 1.3 – Groundwater*).
- Approval of land sub-divisions and development of agricultural land requires co-operative governance between DWAF and Dept Land Affairs and the Department of Environmental Affairs and Development Planning (DEADP) *(Strategy No 5.2 – Co-operative Governance).*
- The extent of water requirements arising out of land restitution is not well established. (*Strategy No 5.2 - Co-operative Governance*).

3.1.5 The Diep River

(a) Topography and rainfall

The region consists of four quaternary sub-catchments (G21C - G21F) covering an area of approximately 1 500 km^2. The Diep River drains south-west from the Riebeek-Kasteel Mountains in the north-east of the sub-area, through the wheat producing areas of the Swartland, to enter the sea at Milnerton, via the Rietvlei wetland. The Mosselbank River drains the south-eastern portion of the region, and is the main tributary of the Diep River. The MAP ranges from 530 mm in the east to 480 mm in the west.

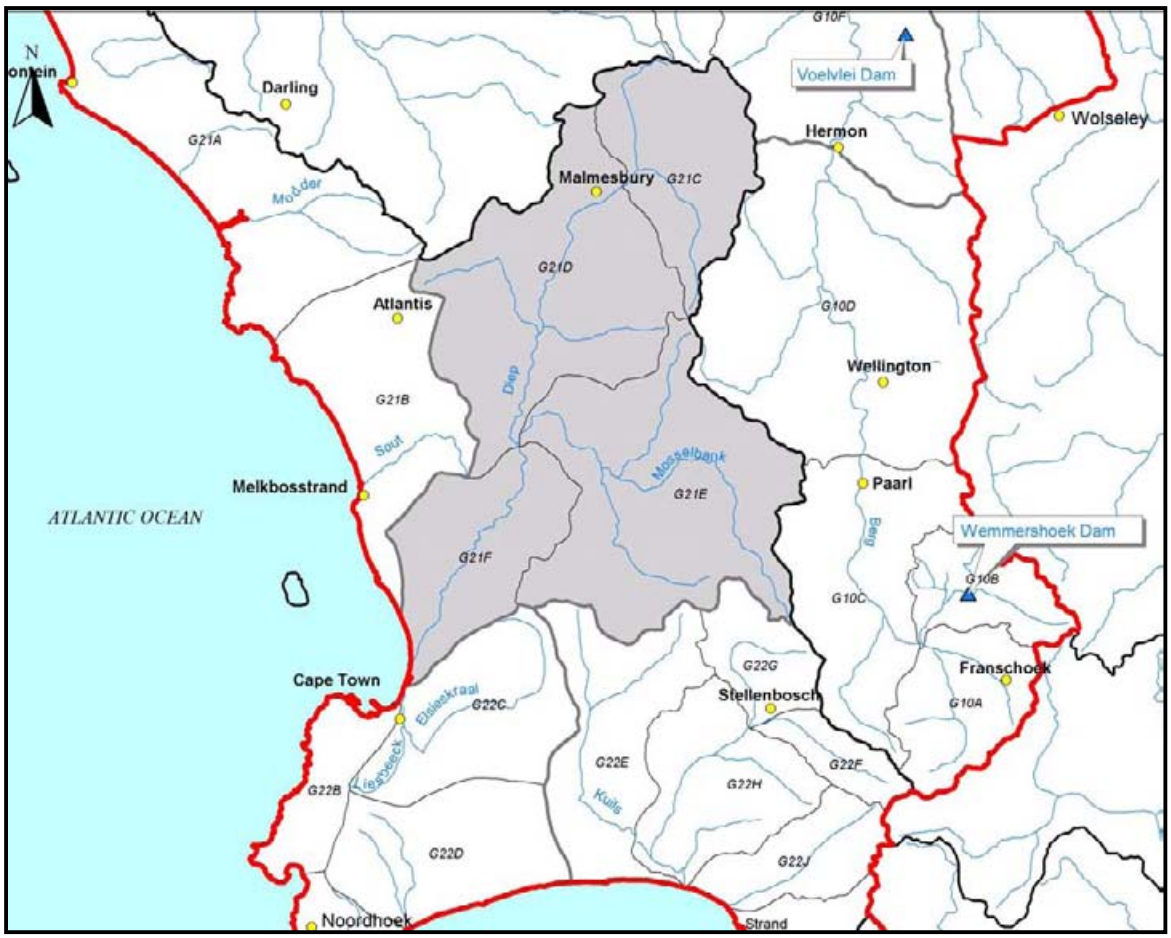

Figure 3.1.5: The Diep River

(b) Main water resource infrastructure

There are no major dams in this sub-area. Malmesbury has a small dam (Paardeberg) which supplements the supply received from Voëlvlei, through the Swartland Regional Scheme.

(c) Population

Population estimates are based on the figures presented in the *"Berg WMA – Overview of Water Resources Availability and Utilisation"* Report.

The population was estimated in 1995 to be in the order of 54 600 with approximately 63% being rural. The total population for this sub-area was slightly less than 2% of the total for the Berg WMA.

(d) Land Use

Approximately 6 700 ha of irrigated land use was estimated in 1995. This was predominantly for the cultivation of lucerne and pasture (6 000 ha) as well as grapes (700 ha). The remainder consists of small areas of deciduous fruit and vegetables. Approximately 59 000 ha of dryland crops are cultivated, of which the predominant crop type is wheat. Dryland vineyards are also found in the vicinity of Klipheuwel.

(e) Water quality

The water quality in the Diep River is relatively poor, largely on account of the local geology (Malmesbury shale formations), resulting in salinity. As a result, the cultivation of high value crops in this area is limited. Treated effluent discharged from the Malmesbury and Kraaifontein WWTWs is abstracted by irrigators, from the Diep and Mosselbank Rivers respectively. The Potsdam WWTW (Milnerton) discharges treated effluent into the lower reaches of the Diep River which feeds the ecologically important Rietvlei wetland. The works is currently scheduled for upgrading by the CCT and the new permit will require that the effluent be treated to the Special Standard.

An estimated 13 million m^3/a of developed groundwater yield suggests that this sub-area relies extensively on groundwater supply out of the primary coastal aquifers. Land sub-division is increasing the abstraction of groundwater under Schedule 1. This introduces the same risk of aquifer pollution as identified in the West Coast Rivers sub-area, namely from the use of pit latrines

(f) Yield balance

The Diep River catchment represented one of the key incremental areas of interest in the Water Resource Situation Assessment Study. That report provided a yield balance for the catchment at the 1995 level of development, as shown in Table 3.1.5. It should be noted that the urban requirements of those areas of the City of Cape Town, situated within the Diep River catchment are accounted for in the requirements of the Cape Peninsula Rivers (Section 3.1.6).

TABLE 3.1.5: YIELD BALANCE IN THE DIEP RIVER CATCHMENT (1995 LEVEL OF DEVELOPMENT, 1:50 Year)

COMPONENT	($x10^6 m^3/a$)
Local surface yield	3
Local groundwater yield	13
Total Yield	**16**
Transfers in	0
Transfers out	0
Irrigation requirement	19
Rural requirement	2
Urban requirement	5
Total Requirement	**26**
BALANCE	(10)

The yield balance indicates a shortfall of 10 million m^3/a, at the 1995 level of development. A significant portion of the overall irrigation requirement is supplied from groundwater (estimated at 8 million m^3/a). However, the remaining 11 million m^3/a, estimated as being supplied from surface water, appears to be a possible over-estimation and needs to be confirmed. Furthermore, the preliminary Reserve determination for this catchment is currently in progress and the impact thereof on the yield also needs to be taken into account. These uncertainties result in a low level of confidence in the above yield balance figures. In order to evaluate the yield balance at a higher level of confidence and add support to the assessment of applications for new authorisations, it is necessary to re-determine the yield balance for this catchment.

(g) Future for this sub-area

A number of authorisation applications for small storage dams, in the upper reaches of the Mosselbank River tributaries (north of Durbanville) have been submitted to the RO. Similarly there have been applications for small dams near Malmesbury. At Riverlands, land sub-division, increasing groundwater abstraction (Schedule 1) and the increasing number of pit latrines may be impacting the groundwater quality. A groundwater quality Reserve determination has yet to be carried out.

A preliminary Reserve determination for the surface water resource in the Diep River catchment is in progress, so as to support the assessment of the above mentioned licence applications. In view of the uncertainty regarding the yield balance in this catchment, applications for surface water and groundwater abstraction should not be considered, until the Reserve has been determined and the yield balance for this sub-area reviewed.

(h) The main issues and concerns

The following issues and concerns are noted:

- Water Conservation and Demand Management at towns needs to be encouraged *(Strategy No 4.1 –Water Conservation and Demand Management: Water Services).*
- Potential use of groundwater for local supply to towns and rural users needs to be investigated, but is likely to be limited because it is largely underlain by Malmesbury bedrock which is variably productive *(Strategy No 6.1 – Supply to Local Authorities).*
- There is potential pollution of groundwater resources in the area by irrigation return flow. Chemical use in farming practise is a threat to the quality of groundwater abstracted from shallow, weathered Malmesbury bedrock (*Agricultural Practices Strategy – Section 11*).
- Land sub-division, increased groundwater use under Schedule 1 and the use of pit latrines in the Riverlands area may be impacting on groundwater quality (*Strategy No 3.5 – Pollution Control*).
- Groundwater abstraction is increasing and exceeds recharge in the poor yielding parts of the aquifer. Recharge to the fractured rock bedrock is unknown. (*Strategy No 1.3 - Groundwater*).
- There is little understanding of the impacts of current irrigation practises and return flows, on water quality *(Strategy No 2.1 – Reserve and Resource Quality Objectives).*
- There are contaminated solid waste sites in this area but no official guidelines for rehabilitation of such sites are available *(Strategy No 2.3 – Solid Waste Management).*
- Siltation of the Diep River is taking place due to development and sand mining activities *(Strategy No 3.2 – General Authorisations and Strategy No 3.5 – Pollution Control).*
- Due to the low level of confidence in the yield balance in this sub-area, applications for abstraction authorisations cannot be appropriately evaluated. (*Strategy No 1.1 - Reliability of the Yield balance and No 3.4 - Licensing*).

3.1.6 The Cape Peninsula Rivers

(a) Topography and rainfall

This sub-area consists of the four quaternary sub-catchments in the Cape Peninsula, namely G22A - G22D. This includes the Liesbeeck and Elsieskraal Rivers as well as smaller streams draining Table Mountain and the Peninsula. Quaternary G22B lies in the high rainfall area of Table Mountain and has a MAP of approximately 920 mm. The remaining three quaternary catchments, namely G22A, G22C and G22D have MAPs of approximately 680 mm, 600 mm and 740 mm, respectively.

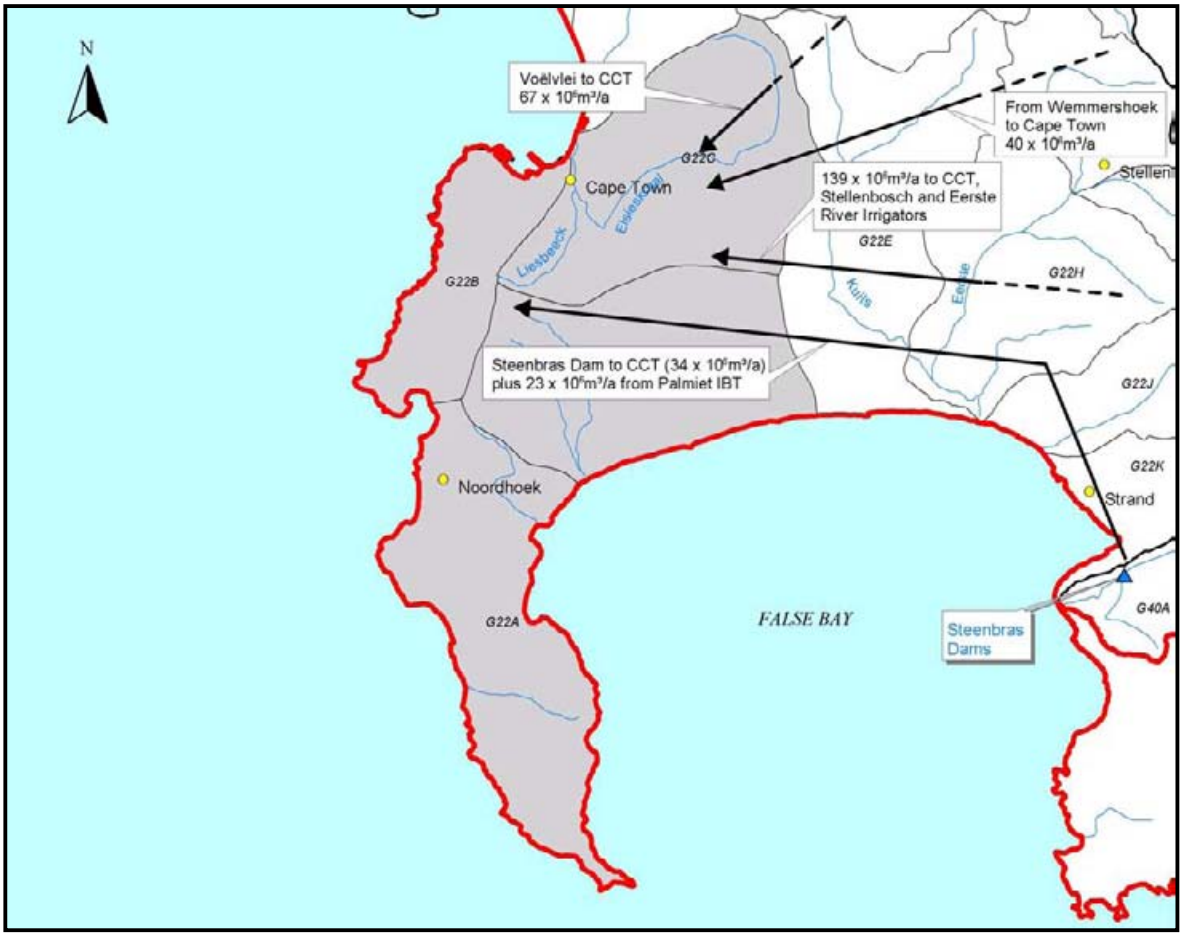

Figure 3.1.6: Cape Peninsula Rivers

(b) Main water resource infrastructure

There are no major dams in this sub-area. Small dams on Table Mountain and above Simon's Town provide small quantities of water for local use. The main source of supply to this area is the WCWSS.

(c) Population

Population estimates are based on the figures presented in the *"Berg WMA – Overview of Water Resources Availability and Utilisation"* Report.

In 1995, the population was estimated to be in the order of 2 664 500 (all urban inhabitants). Approximately 82% of the total population in the Berg WMA resided in this sub-area.

(d) Land Use

Land use is dominated by urbanisation apart from areas comprising the Cape Peninsula National Park and adjacent vineyards, as well as local parks, golf courses, river corridors and vleis. The total sub-area comprises 847 km^2 of which approximately 38% (325 km^2) consists of developed urban areas.

An estimated 1400 ha of cultivated land is under irrigation on the Cape Flats (vegetables). The vegetables grown on the Cape Flats are of significant importance in terms of feeding the City. Other crop types include lucerne and pasture. The Cape Flats Aquifer provides water for irrigation. The extent of the current abstraction from the aquifer is not known as there is inadequate monitoring of this resource. Treated effluent is used to irrigate certain golf courses.

(e) Water quality

Local water quality is highly variable ranging from the pristine mountain streams arising in the Cape Peninsula Mountains, to the severely modified urban rivers that serve as conduits for stormwater, and treated effluent from WWTWs.

Many of the WWTWs currently discharge into severely modified rivers and the question needs to be asked as to whether or not it is acceptable to allow further degradation of these rivers, such as the Salt / Black River. Table 3.1.6 shows the current points of discharge, and effluent quality compliance at each of the nine WWTWs. There are three marine outfalls operated by the CCT in this sub-area.

TABLE 3.1.6: WWTWs IN THE CAPE PENINSULA RIVERS SUB-AREA

PLANT	POINT OF DISCHARGE	EFFLUENT COMPLIANCE
Athlone	Black River to Table Bay	On average, General Standard is met
Cape Flats	To sea (False Bay)	NH_4 and total solids failure in summer
Mitchells Plain	To sea (False Bay)	Meets General Standard
Wildevoëlvlei	Into Atlantic ocean via vlei	High Phosphate concentration can cause algal blooms in the vlei
Simons Town	To sea (False Bay)	COD and NH_4 sometimes exceed the Standard
Llandudno	To sea (False Bay)	Meets relaxed General Standard
Oudekraal	To sea via Camps Bay outfall	Small biodisc plant – not monitored
Millers Point	To sea (False Bay)	Small biodisc plant – not monitored
Borcherds Quarry	Black River to Table Bay. Also golf course irrigation.	Extensive upgrade to plant in 2002/3.
Green Point marine outfall	To sea	Satisfactory
Camps Bay marine outfall	To sea	Satisfactory
Hout Bay marine outfall	To sea	Discharge rate requires increasing

(Ref: City of Cape Town Strategic Evaluation of Bulk Wastewater)

In summary, the works are generally well operated and those rivers serving as conduits to sea are already severely degraded. Investigations by the CCT to remedy the high phosphate concentration in the Wildevoëlvlei are currently in progress.

Limited monitoring of the Cape Flats Aquifer takes place and as such, the impacts of surface activities on the water quality of the aquifer are not well documented.

(f) Yield balance

The yield balance for this sub-area has not been determined as the proportion of the usage from the integrated WCWSS is not known and as such, a yield balance to sub-area level is not readily determined. The water demand in this area has long since exceeded the local resources and is reliant on transfers in from other areas.

There is no further potential for any significant development of the surface water resource in this sub-area. However, small local groundwater development schemes are possible out of the Cape Flats aquifer for local irrigation supply (see (g) below).

(g) Future for this sub-area

The whole CCT had an urban water requirement of approximately 330 million m^3/a in 2000. Through water restrictions being regularly imposed in dry years, and the implementation of water demand management, the requirement has been reduced to approximately 300 million m^3/a in subsequent years. The projected growth in requirement is approximately 3% per annum (see Figure 2.3.1). Large potential water resource schemes are at various stages of planning (see Paragraph 2.9.8 and Appendix 10). The implementation of the Berg Water Project will serve to provide the CCT (amongst other users) with additional water. Surplus surface water is available in the urban rivers, which serve as conduits for discharging treated effluent. As an alternative to discharging effluent to sea, there is potential for increased direct use of treated effluent. This option is discussed in Section 2.9.1 and in Strategy No 4.3 (Effluent Re-use).

The potential exists for the use of water from the Cape Flats Aquifer for greening of the Cape Flats, local subsistence food gardens, the Philippi vegetable growers, emerging market gardeners, or disaster reduction and risk management (e.g. borehole hydrants for township fire hazard). This form of use would reduce the risks associated with infrastructure operation, if the Cape Flats aquifer were used to augment the WCWSS.

(h) Summary of main issues and concerns

The following issues and concerns are noted :

- There are no GAs for surface water abstraction and, as such, even abstractions from degraded urban rivers serving as conduits for effluent discharge to sea, require authorisation applications *(Strategy No 3.2 – General Authorisations).*
- The use of the Cape Flats Aquifer for local irrigation purposes needs to be optimised and a strategy developed (*Use of the Cape Flats Aquifer Strategy – Section 11).*
- Large quantities of effluent are flowing unutilised to the sea. Utilisation of this needs serious and urgent investigation. *(Strategy No 4.3 – Effluent Re-use).*
- A monitoring protocol (recharge and water quality) of the Cape Flats aquifer is required and aquifer head protection is inadequate *(Strategy No 9.2 – Monitoring Networks and Data Capture).*
- Potential may exist for groundwater use from TMG aquifers in particular areas of the South Peninsula (*Strategy No 1.3 – Groundwater*).
- Potential may exist for increased local development of the fractured Malmesbury bedrock (*Strategy No 1.3 – Groundwater*).

3.1.7 The Kuils/Eerste/Lourens and Sir Lowry's Pass Rivers

(a) Topography and rainfall

This sub-area includes six quaternary sub-catchments, namely G22E - G22K. It includes the catchments of the Kuils and Eerste Rivers, as well as that of the Lourens and Sir Lowry's Pass Rivers. The quaternary catchments in the extreme east (G22F and G22J) border on the Hottentots Holland Mountains and have MAPs of 1 400 mm and 1 000 mm, respectively. The MAPs reduce towards the west. Quaternary G22E has an MAP of 570 mm. The upper reaches of the Eerste River receive the country's highest recorded rainfall of 4 000mm per annum.

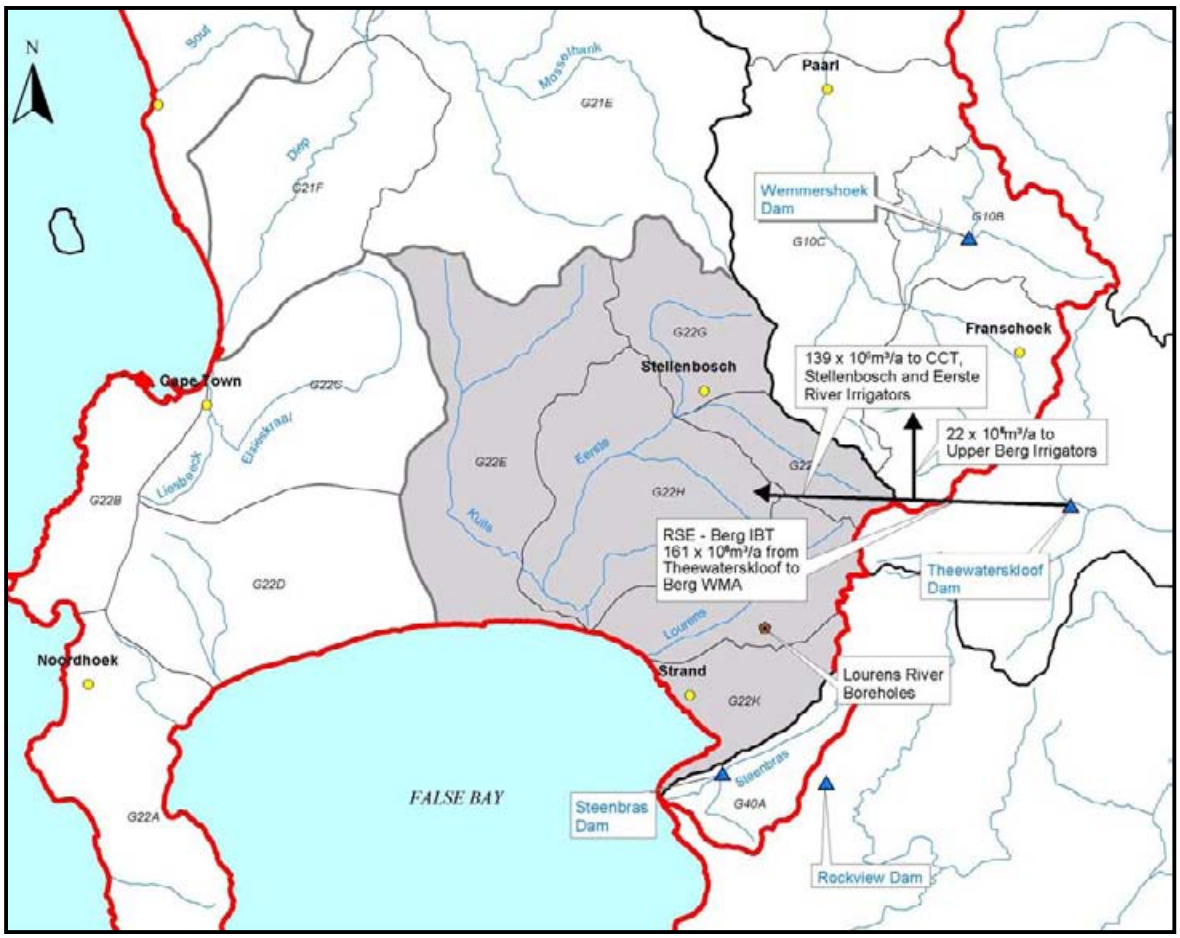

Figure 3.1.7: Kuils/Eerste/Lourens/Sir Lowry's Pass Rivers

(b) Main water resource infrastructure

There are no major storage dams in this sub-area. Kleinplaas Dam (G22F) on the Jonkershoek tributary of the Eerste River acts as a balancing dam along the tunnel transfer system between Theewaterskloof Dam and the Stellenboschberg Tunnel outlet which supply water to irrigators and to CCT's Blackheath and Faure water treatment works. The Faure works can also be supplied from the Upper Steenbras Dam. A small off-channel storage dam (Land-en-Zeezicht) in

quaternary G22J, stores water abstracted from the Lourens River for supply to Somerset West. Two municipal dams in Stellenbosch (Idas Valley Dams) store excess winter water abstracted from the Eerste River in Jonkershoek. During dry summers, the Stellenbosch supply is supplemented from the Riviersonderend-Berg River Scheme via a pipeline leading from the Stellenboschberg Tunnel outlet to the Paradyskloof Treatment Plant. There are a number of farm dams in the area.

(c) Population

Population estimates are based on the figures presented in the *"Berg WMA – Overview of Water Resources Availability and Utilisation"* Report.

In 1995, the population was estimated to be in the order of 130 800 of which 27% were estimated to be rural inhabitants. Approximately 4% of the total population in the Berg WMA resided in this sub-area.

(d) Land Use

The catchment of the Kuils River is highly urbanised, as are the middle and lower reaches of the Eerste, Lourens and Sir Lowry's Pass River catchments. An estimated 8 700 ha of cultivated land is under irrigation, of which 8 300 ha is under vine. The rest is under deciduous fruit, lucerne and pasture. Forestry plantations include Lourensford and Jonkershoek and cover an approximate area of 20 000 ha.

(e) Water quality

The Eerste River is classified as having good quality water upstream of Stellenbosch. The Plankenbrug River has a high pollutant load arising from the informal settlement at Khayamandi which impacts on the quality of water in the Eerste River, downstream of the confluence with the Eerste River, where effluent from the Stellenbosch WWTW is also released into the river. The Kuils River has poor water quality due to urban impacts and the use of the river as a conduit for discharging treated effluent from the Bellville, Scottsdene and Zandvliet WWTWs. The Kuils River joins the Eerste River near the estuary into which the Macassar works discharges. The Lourens River water quality is high in the upper reaches but decreases downstream, probably as a result of urban impacts, as is the Sir Lowry's Pass River quality impacted.

Table 3.1.7 shows the current points of discharge and effluent quality at each of the seven WWTWs in this sub-area.

TABLE 3.1.7: WWTWs IN THE KUILS / EERSTE / LOURENS / SIR LOWRY'S PASS SUB-AREA

PLANT	POINT OF DISCHARGE	EFFLUENT COMPLIANCE
Kraaifontein	Mosselbank River to Diep River to Table Bay	Occasional COD and NH_4 problems.
Scottsdene	To Kuilsriver then False Bay	Complies with permit requirements
Macassar	To Eerste River then False Bay	Required standards are met
Bellville	To Kuilsriver then False Bay	Required standards are met
Parow	Irrigation of golf course and sports fields	General Standards are met, except occasionally for e-coli.
Zandvliet	To Kuilsriver then False Bay	Occasional summer peaks of NH_4.
Stellenbosch	To Eerste River then False Bay	Required standards are met.

In summary, the works are all generally well operated. Rivers serving as conduits to sea are already degraded, downstream of the treatment works.

(f) Yield balance

The 1995 reconciliation figures indicate that the sub-area was in balance at that time. This means that there is no surplus water available for additional irrigation development. If infrastructure is put in place, then the yield potential of the Eerste and Lourens Rivers can be increased by pumping water during high flow events to the CCT via the Faure water treatment works.

(g) Future for this sub-area

The irrigation within this catchment is largely from allocations out of Theewaterskloof Dam which are managed through the WCWSS. The RO does not anticipate that there will be applications for further irrigation development outside of the system.

The Lourens and Eerste Rivers have been identified for the potential development of schemes to augment the WCWSS. These schemes are not intended to support additional irrigation development.

(h) Summary of main issues and concerns

The following issues and concerns are noted:

- Spillages from industry and wineries may be reaching the rivers due to inadequate first line of protection, such as bund walls and cut-offs *(Strategy No 3.5 – Pollution Control).*
- Diffuse pollution into the Plankenbrug River, particularly after heavy rains, is taking place in the Stellenbosch area. Khayamandi residential area has an effluent spill problem *(Strategy No 3.5 – Pollution Control).*
- Operation and maintenance of the valves and the inlet shaft at Kleinplaas Dam is of concern *(Strategy No 8.2 – The Theewaterskloof Tunnels).*
- No low flow gauging takes place on the Sir Lowry's Pass River *(Strategy No 9.2 – Monitoring Networks and Data Capture).*
- Opportunities for re-use of effluent from WWTWs *(Strategy No 4.3 - Effluent Re-use).*

3.1.8 Steenbras River

(a) Topography and rainfall

This quaternary sub-catchment is situated between the Hottentots Holland and Kogelberg Mountains. It is an area of high rainfall and experiences an MAP in excess of 1 100 mm.

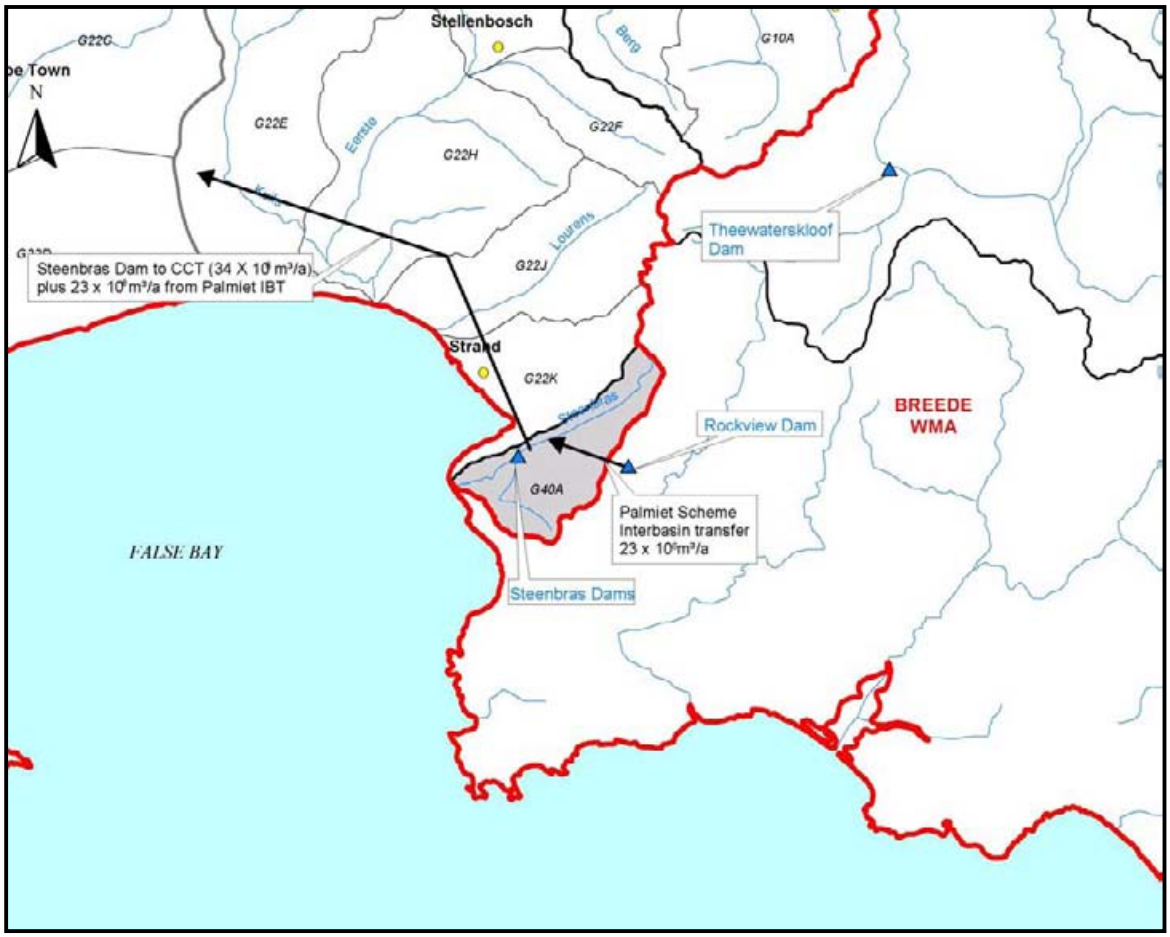

Figure 3.1.8: Steenbras River

(b) Main water resource infrastructure

The resource infrastructure in this sub-area forms part of the WCWSS. There are two major dams, both located on the Steenbras River. These are the Upper Steenbras and Lower Steenbras Dams, with capacities of 32 million m^3 and 34 million m^3 respectively. These have a combined yield of 40 million m^3/a (1:50 year level of assurance), excluding the inter-basin transfer from the Palmiet River. A canal leading across the boundary between the Breede and Berg WMAs, delivers an inter-basin transfer of 23 million m^3/a (1:50 year level of assurance) via the Palmiet Pumped Storage Scheme from Rockview Dam into Upper Steenbras Dam. The transfer scheme has a maximum capacity of 50 million m^3/a and most of the water is conveyed via the Steenbras Pumped Storage Scheme and the Firlands pipeline and pump station to the CCT's Faure Water Treatment Works. The Steenbras Dam, treatment plant and reticulation infrastructure is owned by the CCT.

The main Peninsula Aquifer of the TMG is folded into a deep synclinal structure beneath this catchment, and is transacted by generally NE/SW-trending major faults which show strong active

discharges to the sea along the Kogelberg coastline. Potential augmentation of the Steenbras scheme through conjunctive use of the deep groundwater storage is being investigated in the TMG project.

(c) Population

This sub-area is undeveloped. A small rural population of approximately 500 was estimated in 1995.

(d) Land Use

There is no cultivated land use in this sub-area. An estimated 860 ha of commercial forestry is found, which is likely to be removed as is the case for other commercial plantations in the Western Cape. Alien plant infestation is a problem in this catchment.

(e) Water quality

With the exception of forestry, the Steenbras River catchment is relatively undeveloped. In terms of water quality, the most significant factor is that of the Palmiet River (Breede WMA), from which inter-basin transfers into Upper Steenbras Dam, take place. This currently involves an average annual transfer of 23 million m^3/a (of a maximum capacity of 50 million m^3/a) via the Palmiet Pumped Storage Scheme. The point of abstraction in the Palmiet River (Kogelberg Dam) is downstream of the urban and industrial area of Grabouw, which has an impact on the Palmiet River water quality. Furthermore, the agricultural development in the Palmiet catchment, upstream of Kogelberg dam is significant, and this can have a diffuse runoff type impact on the water quality of the Palmiet River. The dilution effect on the water transferred from the Palmiet River into the Upper Steenbras Dam plays a role in mitigating the extent of the impact on the Steenbras water. Normally, volumes transferred range from 2 to 3 million m^3 per transfer into a receiving volume of between 10 and 20 million m^3 in Upper Steenbras Dam. Information on the water quality of the Steenbras River needs to be assembled. There is only one monitoring point in the catchment and that is in the dam itself.

(f) Yield balance

In 1995, this sub-area was determined as being in balance.

(g) Future for this sub-area

The future land use is to some extent uncertain due to decreasing afforestation and fluctuations in overseas markets. Where afforestation is eventually removed land use may revert to either catchment or apple orchard. Furthermore, the catchment offers some tourism potential.

(h) Summary of main issues and concerns

The Steenbras catchment is relatively undeveloped, except for some forestry. The following issues and concerns are noted:

- Changing land use due to the possible removal of afforestation from the catchment may initially result in increased surface water runoff but the net effect will be dependant on the subsequent land use and possible new water demands. *(Strategy No 3.6 – Changing Land Use - Forestry).*
- There is significant invasive alien plant infestation in this catchment, which should be included in the WfW prioritisation process to define clearing priorities within the WMA *(Strategy No 3.7 – Changing Land Use – Clearing of Invasive Alien Plants).*
- There is no monitoring of water quality in the Steenbras River. Future monitoring will be required for the purposes of the Reserve. *(Strategy No 9.2 – Monitoring Networks and Data Capture).*

CHAPTER 4: INTRODUCTION TO ISSUES AND STRATEGIES IN THE BERG WMA

In the preceding chapters most aspects of the water situation in the Berg WMA, as well as likely future scenarios were identified and analysed. A number of issues and concerns were revised regarding the general management of water resources in the WMA, and in particular regarding such matters as estimating future requirements, identifying and evaluating available resources (particularly groundwater), reconciling requirements and availability of water, the Reserve, water quality issues, licensing decisions and many more. It became clear that a number of guiding strategies would be required to facilitate proper management. Such strategies would in the first place be of invaluable assistance to the Department (RO) in the execution of its management responsibilities until such time as a CMA can take over, and would create a sound foundation for that CMA to in due course develop its own Catchment Management Strategy.

Some of the issues raised for the Berg WMA proved to be the same as those raised for the other WMAs. These issues should lead to strategies which are national in nature and which could inform future versions of the NWRS.

Following interviews with members of the Western Cape RO, and two workshops with Regional and Head Office staff, frameworks for a number of strategies were identified as being required for development in the Berg ISP. The actual strategies are given in Part 2 of this report. The following actions give an indication of how the strategies are structured.

4.1 STRATEGIES DEVELOPED IN THE BERG ISP DOCUMENT

There are ten broad strategy groups under which the individual strategy frameworks have been developed. These are:

- Yield Balance and Reconciliation
- Water Resource Protection
- Water Use Management
- Strategies for Water Conservation and Demand Management
- Integration and Co-operative Governance
- Institutional Development and Support
- Social
- Waterworks Development and Management
- Monitoring and Information Management
- ISP Implementation

The individual strategies are listed below. A brief motivation is provided for each strategy.

4.1.1 Yield Balance and Reconciliation Strategies

The yield balance in the Berg WMA indicates that this WMA is stressed. An overview of the WMA is provided as an introduction to the Yield balance and Reconciliation Strategies and reference is made to the strategies in the ISP which address the issues relating to the following:

- The Resource
- The Requirement
- The Reconciliation Options

– ***Reliability of the Yield balance***
  - The accuracy of the data and the methods used to determine water availability has a major influence on decisions regarding future schemes, capital investment and management of water systems. Clarifying uncertainties, improving assumptions and utilising latest available information are important factors that influence the reliability of yield balance estimates.

– ***Groundwater***
  - Groundwater offers a significant resource and almost the only opportunity for expansion of many small towns and some farming enterprises. This strategy is considered necessary in view of the need to identify the location, aerial distribution and quality of groundwater resources, their Sustainable Utilisable Potential, and where and how they can best be utilised.

– ***Reconciling Water Supply and Demand***
  - To match the demand requirements in the Berg WMA with adequate supply in such a way that growth is not unreasonably constrained nor the environment and long-term future of the WMA in any way compromised. Supply is not infinite and the matching of supply to demand also requires that growth in demand be constrained within reasonable limits. This may impact particularly sectors that are particularly demanding of water.

– ***Aquifer Storage Recovery and Artificial Aquifer Recharge***
  - These techniques allow for aquifers to be replenished through injection with surplus surface water and for advantage to be taken of available storage within aquifers. For example, surplus winter water from the Berg River could be pre-treated and injected into the primary aquifers of the coastal plain, for subsequent abstraction during summer, to supply the developing West Coast region.

4.1.2 Water Resource Protection Strategies

– ***Reserve and Resource Quality Objectives***
  - This strategy is essential to implement the requirement for a Resource-Directed Measures approach for the protection of water resources.

- ***Siting of New Developments***
  - There is a risk of groundwater resource pollution due to inappropriate siting of new developments, excessive sub-division of land, and lack of adequate aquifer protection, headwater protection, and wellhead protection measures and regulation.
- ***Solid Waste Management***
  - Solid waste sites are generally poorly managed and there are no official guidelines for the rehabilitation of contaminated land. This situation poses a pollution threat to the groundwater resources, particularly the intergranular aquifers in the coastal plain.
- ***Water Quality***
  - Water quality needs to be appropriately managed to ensure that there is water of acceptable quality available to meet the needs of the environment and of all users in the WMA. Salinity concentration and nutrient content must be reduced to the most practically manageable levels.

4.1.3 Water Use Management Strategies

- ***Implementing Schedule 1***
  - Abstraction of water under Schedule 1 by growing numbers of users, especially on sub-divided land, is of concern in terms of both quantity and quality impacts. Land sub-division and small-scale abstraction is increasing, particularly in the Diep River and West Coast catchments, with concomitant risks of polluting the primary aquifers, through the use of pit latrines.
- ***General Authorisations***
  - It is necessary to reduce the administrative requirements for processing licences, prior to the availability of the Reserve determination and implementation of compulsory licensing. The introduction of General Authorisations for surface water abstraction on already degraded rivers should be considered.
- ***Verification of Existing Lawful Use***
  - This is an essential preliminary step towards compulsory licensing to improve the knowledge about water use and enable water pricing to be implemented.
- ***Licensing***
  - There is a backlog of authorisation applications as a result of the individual Reserve determinations required to evaluate each application. It is necessary to have a formal water use authorisation strategy that will describe the process to impose limits and restrictions on water use and advise on the setting of conditions to be attached to each authorisation. Managers need to know whether water is still allocable or not for each sub-area of the WMA
- ***Pollution Control***
  - Certain point source polluters, as well as poorly managed WWTWs, are discharging effluent into the rivers and impacting negatively on water quality.

- ***Changing Land Use : Forestry***
  - The reduction of commercial forestry, largely associated with the decommissioning of SAFCOL in the Western Cape, opens up significant areas currently under afforestation, for alternative land use. Water is also freed up and this additional availability needs to be put to optimal use.
- ***Changing Land Use : Clearing of Invasive Alien plants***
  - WfW is removing invasive alien plants from the Berg WMA and prioritisation of clearing is required to make optimum use of limited budget. In addition to being a cost-effective augmentation option, other benefits include conservation of bio-diversity, job creation and reduced fire risk.
- ***Water Pricing***
  - Pricing provides the revenue stream to finance the provision of water resource management services and the development of water resources, as well as financial and economic measures to support the implementation of strategies aimed at water resource protection, conservation and the beneficial use of water.

4.1.4 Water Conservation and Demand Management Strategies

- ***Water Conservation and Demand Management: Water Services***
  - The stresses experienced in the Berg WMA emphasise the need for more efficient and beneficial use of water. Integrated planning must allow for demand management initiatives to relieve the stress on current water supply schemes and possibly delay the need for implementing new schemes.
- ***Agricultural Water Conservation and Demand Management***
  - The stresses experienced in the Berg WMA emphasise the need for more efficient and beneficial use of water. Integrated planning must allow for demand management initiatives to relieve the stress on current water supply schemes and possibly delay the need for implementing new schemes, provide water to the Reserve, and make water available to equity users.
- ***Effluent Re-use***
  - The Berg WMA is under stress and water from all sources needs to be efficiently used. Increased effluent re-use has associated financial benefits such as the extension of the implementation dates of new capital works and reduced water costs. Significant quantities of treated effluent from the Berg WMA are being discharged to sea and re-use is currently not being optimised.

4.1.5 Integration and Co-operative Governance Strategies

- ***Support to Resource Poor Farmers***
  - A strategy is required to provide upliftment of previously disadvantaged societies and to identify sources of water from which to supply resource poor farmers. There is no surplus water available in the Berg WMA for the development of resource poor farmers

and as a result, re-allocation through Compulsory Licensing is most likely, unless WC/DM and other strategies can be implemented and this water made available.

- ***Co-operative Governance***
  - The many role-players and decision makers involved in water-related activities, necessitates a co-operative approach between them to facilitate improved overall governance, integrated planning, liaison and decision-making.
- ***Managing the Environment***
  - The strategy aims at the compliance of Integrated Water Resource Management with the relevant requirements of environmental legislation.

4.1.6 Institutional Development and Support Strategies

- ***Supply to Local Authorities***
  - Local Authorities need to take a more structured approach to the future planning of their water use. Local Authorities must understand the constraints of possible future sources of supply and the need for water conservation and demand management. DWAF can facilitate improved water management by Local Authorities, and the Department can provide guidance regarding development of local schemes. Local authority WSDPs (and ultimately IDPs) must define their undertaking to implement water conservation and demand management, as well as where they anticipate their future sources of supply to come from.
- ***Water User Associations***
  - The transformation of existing irrigation boards and the inclusion of all other users (outside of municipal areas), into WUAs is necessary. This to ensure the transformation of water resources management to appropriate, representative, local institutions. To date none of the irrigation boards in the Berg WMA have undergone transformation into WUAs, although draft constitutions for some of them have been developed for review. There is no specific strategy as yet.
- ***Establishing the Catchment Management Agency***
  - The implementation of the Berg CMA is a requirement of the NWRS. It is necessary to implement the regional transformation of water resources management and governance, through decentralisation of the responsibility and authority to the CMA as the appropriate, representative, regional management institution. The CMA process in the Berg WMA is still at an early stage of development. There is no specific strategy as yet.

4.1.7 Social Strategy

There is a need to create awareness and build capacity of stakeholders at various levels for their meaningful participation and appropriate involvement in the development and implementation of the ISP strategies. Public awareness of groundwater potential and the benefits of groundwater use is a particular requirement.

4.1.8 Waterworks Development and Management Strategies

- ***Strategy for System Management and Reconciliation***
  - The Berg WMA lies within the WCWSS consisting of infrastructure which is owned, operated and maintained by more than one authority. The strategy is to ensure that the system is optimally operated and maintained.
- ***The Theewaterskloof Tunnels***
  - These tunnels form an integral part of the bulk water supply system to Cape Town. The current maintenance and disaster management procedures applicable to the tunnel system need to be upgraded.
- ***Implementing the Berg Water Project***
  - The implementation of the Berg Water Project (dam and supplement scheme) needs to be optimally integrated within the existing system.
- ***Strategy for the Lower Berg***
  - Improved operation and maintenance of Voëlvlei and Misverstand Dams is required to address the growing needs of the areas supplied from this system.
- ***Operation During Extreme Drought***
  - Over and above implementing standard water restrictions, the development of drought specific operating rules for the WCWSS is required.
- ***Recreation on Dams and Rivers***
  - The Berg River WMA includes a major metropolitan region and is therefore particularly important from a recreational perspective. The operation of the river system and the dams within it, need to maximise recreational opportunities for the large and growing urban population.
- ***Public Health and Safety***
  - Effective implementation of disaster management planning in relation to flood management, dam safety and hazardous spills is required.

4.1.9 Monitoring and Information Strategies

- ***Abstraction Control***
  - To ensure compliance with authorisations and to control over-abstraction through licensing or other intervention measures.
- ***Monitoring Networks and Data Capture***
  - To meet the requirement for integrated information so as to facilitate appropriate water resource planning.
- ***Information Management***
  - The high value and cost of good quality data and information systems requires a structured approach towards information storage, manipulation, backup, archiving and dissemination to avoid duplication of effort and improve productivity.

4.1.10 Implementation Strategies

– ***ISP Implementation***
  - To ensure a consolidated approach to the ongoing development of the ISPs.

4.2 ASPECTS ADDRESSED UNDER EACH STRATEGY

Within each strategy, the following aspects are addressed:

- ***Management objectives*** in terms of the envisaged solutions for the strategy;
- ***Background information*** provides an introduction to the generic need for the strategy and places it in perspective in terms of Integrated Water Resource Management, the NWA and the NWRS. The situation and major issues within the WMA and its key areas are described;
- ***Actions*** required to implement the strategy***;***
- ***Responsibility*** identifies the responsible implementing authority*;*
- ***Priority*** in terms of the ISP rating system, explained in Paragraph 1.7***;***
- ***Interfaces*** with the encompassing IWRM picture, with related strategies and other WMA and ISP management areas will be identified. Similarly, other major role-players and their functions will be identified. Relevant reports and documentation will be listed.

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PART 2 – THE STRATEGIES

SECTION 1: YIELD BALANCE AND RECONCILIATION STRATEGIES

The Broad Overview described in Chapter 2 of this report, concludes that the Berg WMA is in deficit in terms of its overall yield balance. Greater Cape Town and the developing West Coast regions are of particular concern. Anticipated economic growth coupled with the need for urban expansion will place further stress on the water resources of the Berg WMA.

a) The Resource

Hydrology

The natural MAR from all the catchments in the Berg WMA is at present estimated at about 1 430 million m^3. This figure is based on available hydrological information, which for some of the catchments, dates back to 1988. Estimates of yields for the Berg WMA are therefore based on a mix of hydrology. This is one of the uncertainties relating to the yield balances.

Yield (1:50 year level of assurance)

The yield within the WMA (as reported in the NWRS) at the Year 2000 level of development is summarised as follows (Refer to Chapter 2, Table 2.6.2 for details):

Area	Local Surface Yield ($10^6m^3/a$)	Groundwater Yield ($10^6m^3/a$)	Total Local Yield ($10^6m^3/a$)	Transfers In ($10^6m^3/a$)	Total Available Yield ($10^6m^3/a$)
BERG WMA	**425**	**57**	**482**	**194**	**676**

River losses (10 million m^3/a), the impact of invasive alien plants (0,1 million m^3/a according to the NWRS) and the impact of the provisional Reserve (23 million m^3/a), have been accounted for in the above figures. It is a recommendation of this ISP that the NWRS figure for impact on yield of invasive alien plants is too low and that the actual impact should be determined. In the mean time a figure of 2 million m^3/a can be adopted in the next revision of the Strategy. Also the impact of the Reserve on yield is greater than 23 million m^3/a and should be revised, as this does not reflect the most recent Reserve determination approach. The effect of afforestation on yield should be about 6 million m^3/a and not zero as shown in the detailed figures. Efforts should be made to confirm the 6 million m^3/a estimate.

The Reserve

The impact that the Reserve has on the yield of the WMA is currently estimated at 23 million m^3/a, but this is based on provisional Reserve determinations only. As discussed in Paragraph 2.8 of Part 1, the eventual Reserve requirements may exceed those of the provisional estimates and as such, may further impact on the available yield within the WMA.

b) The Requirements

The requirements (as reported in the NWRS) at the Year 2000 level of development in the Berg WMA are as summarised below (Refer to Chapter 2, Table 2.6.2 for detail):

Area	Irrigation ($10^6 m^3/a$)	Urban ($10^6 m^3/a$)	Rural ($10^6 m^3/a$)	Afforestation (Impact on Yield) ($10^6 m^3/a$)	Total Requirement ($10^6 m^3/a$)
BERG WMA	**301**	**389**	**14**	**0,2**	**704**

A comparison of the requirements and available yield shows a shortfall in the Berg WMA of some 28 million m^3/a, at the Year 2000 level of development. It is a recommendation of this ISP that the impact on yield of afforestation is too low and that a figure of 6 million m^3/a be adopted until such time that the figure can be confirmed. The actual figure should be adopted in the next revision of the NWRS.

Urban Growth

Two future scenarios for the Year 2025 are presented in Paragraph 2.7 of Part 1. Actual growth must be carefully monitored so that resource planning can be adapted to meet realistic needs. What does seem certain is that there will be significant growth in urban water requirements through economic growth and industrial expansion in the Saldanha (West Coast) area. There can be no doubt that resource management interventions will be required if future needs are to be met.

Irrigation Requirements

DWAF is currently implementing the registration process and all users are required to register their use. A verification process will follow to determine the "correctness" of the registration, where after the lawfulness of the use will be verified. This will give a much more reliable determination of the extent of current irrigation water use, which is quite uncertain outside of the Government Schemes. Irrigation from farmers' own sources and from run of river constitutes more than 50% of the total irrigation requirement in the Berg WMA, emphasising the importance of this process.

Capping limits on further allocations of water to irrigation out of the Western Cape Water Supply System (WCWSS) have been introduced into the Western Cape System Planning Model (refer to Paragraph 2.2.3 of Part 1). There is insufficient water available to support any substantial growth in the agricultural sector.

c) Reconciliation Interventions

The implementation of the Berg Water Project is in progress and will provide an additional yield of 81 million m^3/a to the Berg WMA, through the WCWSS. It is anticipated that this water will become available by 2007 and that by 2010 the system will once again be in deficit. Additional water will then be required to sustain further growth. Possible interventions are listed below (refer to Paragraph 2.9 of Part 1 for details):

- *Re-allocation through Compulsory Licensing*
  The re-allocation of water will need to be progressively implemented to make allowance for the Reserve. This would be through the Compulsory Licensing process. Re-allocation through Compulsory Licensing will also allow for a more equitable distribution of water, correcting

imbalances in past allocations. The details of this strategy have yet to developed in the Berg ISP (See Part 2, Section 11 – Additional Strategies to be Developed).

- *Water Trading*
  The re-allocation of water via the trading of existing authorisations allows for a change of ownership without having to find additional water and issue new authorisations. Refer to the Licensing Strategy (No 3.4).

- *Water Conservation and Demand Management*
  Encouraging results have been achieved through the CCT's Water Conservation and Demand Management strategy. The implementation of water services water conservation and demand management needs to be entrenched in all local authorities, with DWAF providing technical assistance to those local authorities where adequate technical resources are not available. Refer to the Water Conservation and Demand Management: Water Services Strategy (No 4.1).

  Both the pricing of water and the installation of more efficient irrigation systems are measures that can be used to reduce the demands in the Agricultural sector. Refer to the Agricultural Water Conservation and Demand Management Strategy (No 4.2).

- *Strategy for System Management and Reconciliation*
  The current management approach to the operation of the WCWSS is focused on minimising spills from dams. Spills at Misverstand Dam can be better managed through the installation of telemetry, allowing releases from Voëlvlei Dam into Misverstand Dam to be more appropriately timed, so as to minimise wasteful spillage. Refer to the Strategy for the Lower Berg (No 8.4).

- *Clearing of Invasive Alien plants*
  Clearing of invasive alien plants is currently focused in the uppermost regions of the Berg River catchment. This will bring increased surface water runoff although monitoring is required to improve quantification. What is most important is the prevention of increased losses by containing the spread of invasive alien plants. Refer to the Changing Land Use - Clearing of Invasive Alien plants Strategy (No 3.7).

- *Effluent Re-use*
  The volume of treated effluent currently re-used can be significantly increased. This includes industrial use and local commercial irrigation use. Artificial aquifer recharge using treated effluent is a further possibility. Refer to the Effluent Re-use Strategy (No 4.3).

- *Aquifer Storage Recovery (ASR)*
  This essentially allows for available storage within aquifers to be used for storing surplus water. There are various ways in which this water can be fed into these aquifers. The potential exists for increased re-use of treated effluent via ASR techniques. ASR is addressed under the Aquifer Storage Recovery and Artificial Aquifer Recharge Strategy (No 1.4).

- *Development of New Surface and Groundwater Supply Schemes*
  The choice of interventions and order of implementation needs careful consideration. It must be recognised that the above interventions may not alone be sufficient to meet requirements into the longer term. In addition to the implementation of the Berg Water Project (yield = 81 million m^3/a), further water projects must be part of the picture. The planning of such schemes is a lengthy procedure and studies should be implemented sooner rather than later. This is further addressed under the Reconciling Water Supply and Demand Strategy (No 1.2).

  Paragraph 2.9.8 of Part 1, and Appendix 10 provide details of the following schemes that have been identified as potentially viable.

  - Voëlvlei Augmentation Scheme
  - Lourens River Diversion Scheme
  - Table Mountain Group Aquifer
  - Cape Flats Well Field
  - Eerste River Diversion
  - Breede WMA to Berg WMA transfers
  - Desalination

In addition to the implementation of water conservation and demand management, the potential for effluent re-use, and the proposed development of new schemes, there are a number of uncertainties regarding the resource availability, the quantities of actual water use and the requirements of the ecological component of the Reserve. These are discussed in Paragraph 2.8 of Part 1. Local authorities must be encouraged to implement water conservation and demand management. They must also be given assistance in the planning of the development of local water resources, rather than being reliant on the provision of additional water through major schemes (Strategy No 6.1).

While a greater reliance must be placed on groundwater within the Berg WMA, there remains too little understanding of the potential impacts of utilisation of this resource. This calls for increased monitoring. See Strategies No 1.3 (Groundwater) and No 9.2 (Monitoring Networks and Data Capture).

Four Yield balance and Reconciliation strategies have been identified for development, namely:

1.1 Reliability of the Yield Balance
1.2 Reconciling Water Supply and Demand
1.3 Groundwater
1.4 Aquifer Storage Recovery and Artificial Aquifer Recharge

1.1	RELIABILITY OF THE YIELD BALANCE
Management objective:	This strategy addresses the uncertainties, assumptions and unknowns of the two components that impact on the reliability of the yield balance determination, namely the availability of water (yield) and the water requirements. The objective is to improve on our knowledge and understanding of both components, which in turn improves the reliability of the yield balance.
Background information:	Yield Balance = Availability of Water - Water Requirements **Availability of Water (Yield)** The accuracy of estimates of water availability (or yield) is dependant on the reliability of the available hydrological information used as input to the water resource models. Land use changes may also have a significant impact on the yield. *Reliability of Hydrological Information Base Data* Rain gauge data (reliability, record length and spatial distribution) and flow gauge data form an integral part of the determination of yield. In the Berg WMA, the yield of the Western Cape Water Supply System (WCWSS) and the yield of catchments lying outside of that system (the Diep River catchment for example) is based on hydrology dating back as far as 1988. More recently, hydrological modelling has been updated in those catchments forming part of proposed schemes for which feasibility studies have been conducted. These include the Berg Water Project and the Voëlvlei Augmentation Scheme. However, the yield of the entire WCWSS, taking the revised hydrologies into account, has not been re-determined. Another factor influencing the reliability of availability estimates is the question of the Reserve. The following specific issues and concerns relating to the reliability of the hydrology have been identified: • The rainfall gauging network is inadequate for accurate modelling purposes and yield analysis, particularly in the high rainfall areas of the Berg River catchment. A number of long term rain gauges have been closed. • The interaction between surface water and groundwater resources in the WMA is not well understood. • The impact of climate change on surface water runoff and groundwater recharge, has not been taken into account in the analysis of yield determinations. *Land Use Changes* In the Berg WMA land use changes such as the removal of forestry and the removal of invasive alien plants may also impact on the availability of water (Refer to Strategies No 3.6 and 3.7). **Water Requirements** Currently in the Berg WMA, urban water use is predominantly supplied from the WCWSS, as is approximately 50% of the total irrigation requirement in the WMA. As such, supply to these users is well monitored through the system. However the remaining irrigation requirement is supplied from farmers' own sources, run of river and from groundwater. It is this component of current water use that is most uncertain throughout the Berg WMA. The Diep River catchment is identified as one of particular concern in this regard. Clarity regarding agricultural use will eventually be provided through registration and verification and the licensing of additional usage (if any). Refer to the Verification of Existing Lawful Use Strategy (No 3.3). Methodologies used to estimate future water requirements produce demand figures that are only as accurate as the input information used. Future urban use will depend on population numbers, on the actual economic growth of the various urban and industrial sectors, and also on the efficiency of future water use (WC/DM). These factors will all impact on the reliability of future requirement estimates. As such there is uncertainty as to the exact water requirement scenario that will ultimately unfold. This is reflected in the significant difference between the base and high requirement scenarios (Year 2025) for the Berg WMA as contained in the NWRS. Ongoing monitoring of actual water use will allow for estimates of future water use to be continually improved.

1.1	RELIABILITY OF THE YIELD BALANCE (cntd)
Background information (cntd):	It is nevertheless important to note that the projected demands used for the WCWSS operation and planning are within the envelope of the projected future water requirement scenarios contained in the NWRS. The City of Cape Town (CCT) will soon embark on a new requirements study in collaboration with DWAF. This study will probably use revised methodology for future estimates.
Strategic approach:	Until better information becomes available regarding the availability of water in the WCWSS, the NWRS figures, as tabled in Section 2.6 (Part 1) of this ISP will be used in supporting management decisions in this WMA. The approach is however to improve our knowledge of availability and of requirements and to make use of improved information as and when it becomes available, so as to continually improve our estimates of the yield balance. Revised hydrological studies and water yield modelling need to be implemented to obtain a more reliable understanding of the availability of water. The Western Cape System Analysis model should be extended to include the full extent of the Berg River downstream of Misverstand Weir. The model should be rerun on a regular basis, as more reliable hydrological information becomes available from which to improve the yield estimate. On the requirements side, improved estimates of current irrigation water requirements will be possible through the verification process. Future water requirement scenarios will largely be influenced by population change, economic development, the Reserve requirement and efficiency of water use. Estimates of future scenarios of water requirements will be possible through improved methodologies, supported by ongoing monitoring of actual water requirements. It is likely that once the Reserves for the rivers and Berg River Estuary have been determined and implementation begins, the Berg WMA will be even more stressed than is currently the case. An accurate measure for the Reserve will improve the level of confidence for all our estimates of water availability. As such more informed planning and management of the system will be possible. The impacts of climate change need to be considered in future water resource planning.
	MANAGEMENT ACTIONS
Required actions:	Develop a detailed strategy for improving the reliability of the yield balance in the Berg WMA. The following general actions are required: a. Address the diminishing rainfall gauging network. The Regions should indicate needs and propose improvements to the network, along with an implementation plan. The problem of declining networks must also be addressed at National level. b. Identify required improvements to flow gauging immediately. List and implement these on an ongoing basis. c. Establish additional rain stations in the high rainfall areas of the Berg River catchment. d. Update the hydrology at regular intervals and allow for the impacts of climate change. e. Re-determine the yield of the WCWSS. f. Re-determine the yield balance of the Diep River catchment. g. Research the interaction between surface water and groundwater. h. Update the requirements at regular intervals using best available information. i. Keep a watchful eye on water use trends through monitoring and ensure that all observations are brought to the attention of the resource planners. j. Improve methodology for future requirement estimates by incorporating elements such as population, standard of living (as reflected in individual water use), economic activity, etc.
Responsibility:	The implementation of the **Reliability of the Yield Balance Strategy** is the responsibility of the RO, in consultation with the Directorate: NWRP.
Priority:	Priority 2 – High. Implementation over the medium term.

1.1	RELIABILITY OF THE YIELD BALANCE (cntd)
MANAGEMENT ACTIONS (cntd)	
Interfaces (cntd):	**a. Relevant documentation:** a1: NWRS: Chapter 2 a1: NWRS: Chapter 2 a2: Berg WMA Report: Chapter 5 a3: Berg Water Resource Situation Assessment Report: Chapter 7 a4: Western Cape System Analysis a5: Skuifraam Dam Feasibility Study Hydrology a6: CMA Integrated Water Resource Planning Study a7: Voëlvlei Augmentation Scheme a8: Appendix 10: Possible Future Bulk Water Supply Schemes. **b. Linked ISPs / WMAs:** Breede WMA. **c. Other role players and their functions:** CCT, West Coast District Municipality and Irrigators: participate on the Western Cape Planning Model Committee and undertake future water requirements studies. **d. Strategies Related to the Reliability of the Yield Balance Strategy:** 1.2 Reconciling water supply and demand 1.3 Groundwater 2.1 Reserve and resource quality objectives 3.3 Verification of existing lawful use 4.1 Water conservation and demand management : Water Services 4.3 Effluent re-use 9.2 Monitoring networks and data capture **e. Linked mapping:** None

1.2	RECONCILING WATER SUPPLY AND DEMAND
Management Objective:	To match the demand requirements in the Berg WMA with adequate supply in such a way that growth is not unreasonably constrained nor the environment and long-term future of the WMA in any way compromised. Supply is not infinite and the matching of supply to demand also requires that growth in demand be constrained within reasonable limits. This may impact more on sectors that are particularly demanding of water.
Background information:	The Berg River System is currently in overall deficit of 28 million m^3/a. This requires the joint actions of reducing demand and increasing supplies. A range of interventions is available. The completion of the Berg Water Project in 2007 will provide an additional 81 million m^3/a, but soon after 2010 the system will again be in deficit. Some water demand scenarios show a slight improvement in the demand situation up to 2010 - after which the situation worsens again. Other potential surface water schemes in the Berg WMA include the Voëlvlei Augmentation Scheme (30 million m^3/a), and the Lourens (19 million m^3/a) and Eerste River (8 million m^3/a) Diversion Schemes, as well as a number of other options including the raising of Voëlvlei Dam. There are also options for further development of yield in the Breede WMA, for transfer into the Berg WMA. The most favourable appear to be the Michell's Pass Diversion (53 million m^3/a) and the Upper Molenaars Diversion (27 million m^3/a). The very long lead times before any major project comes on stream (often 10-15 years from conceptualisation to completion) require that infrastructure development planning be commenced as soon as a requirement is visualised. The next scheme planned is the Voëlvlei augmentation (providing about 30 million m^3/a), which will take us up to 2012. However, these dates can change depending on the success of water demand management, which is now making inroads into the water requirement figures of Cape Town. This ISP should focus strongly on Water Demand Management to stretch the next scheme development date. There are very large uncertainties in water resource projections (see Reliability of the Yield balance Strategy, No 1.1). It has been the practice of the Department to engage in very detailed and intense planning studies for major supply systems every 15 years or so. The most recent Western Cape Systems Analysis was based on hydrology dating as far back as 1988. Many aspects of this analysis now need to be updated - but the planning urgency is such that the Department cannot wait for a full-scale study which might take five years to complete. A recently proposed approach is that the Reconciliation Strategies Study for the Western Cape Water Supply System (WCWSS) and also for other large systems elsewhere, should be updated on a regular, almost continuous basis, with smaller but more frequent research and information inputs. The Directorate National Water Resource Planning is preparing a Reconciliation Strategies Study which should be completed by the end of 2005. The study will inter alia review requirements, availability, reconciliation interventions and draw up an implementation strategy.

1.2	RECONCILING WATER SUPPLY AND DEMAND (cntd)
Background information (cntd):	There are a very large number of reconciliation interventions available to reconcile demand with supply. These are all covered in greater or lesser detail within this ISP and include: • Increased re-use of treated effluent, • Water Conservation and Demand Management - leakage control, abstraction control (monitoring), urban and industrial savings, agricultural savings, • Water pricing (in demand management), • The increased utilisation of groundwater - notably the Cape Flats Aquifer and the TMG Aquifer, • Licensing and the Verification of Existing Lawful Use (this includes the prosecution of unlawful users and return of this water to the common pool), • Water Trading - moving water out of less profitable sectors, • Compulsory Licensing (to reduce existing allocations in order to meet the demands of both Equity and the Reserve, • Improved operations management - seeking optimal efficiencies in the way systems are managed and water is released for different users and purposes, • Removal of invasive alien plants, • The construction of additional storage infrastructure (water works), • The ecological Reserve factors which have impact on most reconciliation interventions (generally this will require more water if our rivers are to be adequately conserved), • Water Quality management - especially pollution control (waste discharge management), • Ultimately there is the option of desalinating seawater. Although expensive, the feasibility of this has been considered by the CCT in its Integrated Water Resource Planning Study. A small reverse osmosis plant is currently used to augment the groundwater supply on Robben Island.
Strategic approach	The Department's focus should first and foremost be to promote cost effective WC/DM measures. Develop a reconciliation strategy aimed at a priority list of reconciliation options based on our current knowledge. This should include a well-structured public participation process. Prioritise studies which improve on the uncertainties noted in this ISP. It is also necessary to improve on the cost estimates and yield figures for specific options. Test the future with a range of yield balance scenarios - ranging from the most likely to the extreme. Revise the reconciliation strategy on a regular basis in a properly structured way as new information becomes available both from directed research studies and from the monitoring of the basic drivers of demand. All of the possible reconciliation intervention options will have to be evaluated through a comparative study so as to enable decisions to be made on which of them, or which combinations of them should be implemented. It will further be necessary to determine the most economical options, the sequence and programme for their implementation and the relative benefit to this WMA, the Breede WMA and the Western Cape region as a whole. This will be part of the output of the Western Cape Reconciliation Strategy Study to be launched by Directorate: NWRP. This strategy must be flexible to deal with all the surprises that may arise. Therefore a combination of low impact schemes that can be implemented quickly (possibly the Michell's Pass Diversion), or in small increments (such as the utilisation of groundwater) is preferred to large projects (dams) and costly projects, such as desalination for high assurance users. Groundwater is regarded with such high importance that it warrants a separate strategy as dealt with in 1.3.

1.2	RECONCILING WATER SUPPLY AND DEMAND (cntd)
MANAGEMENT ACTIONS	
Required actions:	• Update the Western Cape System Reconciliation Strategy at approximately 2 yearly intervals as new information becomes available from studies and monitoring of basic drivers of demand, • Develop the Reconciliation Strategy with a well structured participation process, • Formulate scenarios for reconciling future supplies and demands, • Carry on with implementation of cost effective WC/DM measures, • Develop a priority list of reconciliation intervention options based on current knowledge, • Prioritise studies required to improve uncertainties (as listed in this ISP), as well as to improve cost estimates and yield figures for specific development options, • Investigate the benefits of supplying high assurance users out of the TMG or with de-salinated water, and lower assurance users from existing surface water resources.
Responsibility	The development and implementation of a reconciliation strategy is the responsibility of the Directorate: NWRP together with the Regional Office (RO) and the Directorate Options Analysis.
Priority	Priority 1 - Very High. Immediate implementation is necessary to enable future schemes to be planned with confidence.

1.3	GROUNDWATER STRATEGY
Management objective:	The objective of this strategy is to address the uncertainties, assumptions and critical gaps in the hydrogeological database of this WMA, and to promote the conjunctive development of ground- and surface water resources in an Integrated Water Resources Management (IWRM) framework. Central to this objective is to develop a better understanding of the groundwater - surface water interaction.
Background Information:	The current developed groundwater yield in the Berg WMA is relatively small (57 million m^3/a) in comparison to the yield available from developed surface water resources (230 million m^3/a from major dams and 179 million m^3/a from minor dams and run of river). In the future, a stronger reliance will be placed on groundwater by virtue of the fact that the surface water yield potential is reaching its exploitable limitation, whilst the demands for water in the Western Cape will continue to increase. The developed groundwater yield is used to augment the surface water supply to the West Coast, where the town of Atlantis, for example, relied on groundwater alone until fairly recently. Many smallholdings along the West Coast continue to rely on groundwater as their only source of supply. On the Cape Flats the Philippi market garden area utilises groundwater. The CCT has investigated (at pre-feasibility level) the option of increased abstraction from the Cape Flats Aquifer to augment its surface water schemes. In the Swartland, the natural geology introduces higher levels of salinity to the groundwater, than that found in the primary aquifers and the TMG. However at particular localities in the Swartland, good quality water with moderate yields are achievable.
Strategic Approach:	The Department favours conjunctive water use solutions. Towns are encouraged to investigate groundwater options where there is a shortfall in available surface water yield. DWAF will support this. A high priority will be given to improved groundwater data gathering and the design of an effective monitoring network for the WMA.
Required actions	**i. WMA** a. Verify the existing lawful use from groundwater in conjunction with a new borehole-and-spring hydrocensus survey in order to determine more accurately the current levels of groundwater abstraction and future potential from various aquifers. b. Establish data-capture networks to monitor the interactions of groundwater, surface water, and the environment (aquatic and terrestrial ecologies). c. Undertake groundwater Reserve determinations, particularly in areas where future groundwater supply/expansion to local authorities is contemplated. d. Investigate groundwater chemistry in the various aquifers, but particularly the fractured-and-weathered older bedrock, for potentially toxic trace elements (e.g. arsenic, fluorine, nitrates). Evaluate risk of groundwater toxicity due to trace elements in older rocks, viz. granites and Malmesbury bedrock. e. Establish Groundwater protection Zones (GPZs) in the active recharge areas of aquifer systems, placing limits and/or restrictions on changes in land use, the disposal of solid wastes, and the siting of new developments. f. Investigate specific point-source pollution sites (e.g. landfills, industrial plants) for potential or actual impacts on groundwater quality, with a view to the establishment of Groundwater Exclusion Zones (GEZs). (Manage polluting sites – Pollution Control Strategy). g. Determine the likelihood of sea-water intrusion into shallow aquifer systems along the coastline of the WMA - and the extent of current intrusion. h. Offer/facilitate use of groundwater skills in support of planning future emergency provision of water to Cape Town. i. Research the direct discharge of freshwater into the ocean (i.e. freshwater springs beyond the coastline) in terms of quantity, origin, and importance to the marine ecosystem. j. Investigate potential for augmentation of the Steenbras scheme through conjunctive use of the deep groundwater storage in the confined synclinal part of the TMG aquifer system. k. Compile a reference list of available groundwater documentation.

1.3	GROUNDWATER STRATEGY (cntd)
Required actions (cntd)	**ii. Berg River upstream of Hermon** a. Determine groundwater recharge and discharge in conjunction with improved rainfall gauging in uppermost (high rainfall) regions of the Berg River. b. Evaluate lateral recharge from TMG aquifer to intergranular and fractured rock aquifers bounding it. c. Monitor springs at the base of the TMG in the Groot Drakenstein Mountains in order to evaluate the baseflow contribution of the TMG on the northern side of the Groot Drakenstein Mountains.
	iii. West Coast rivers Investigate the potential use of groundwater, from both the primary and the fractured-and-weathered aquifers of the Cape Granite Suite, for local supply to towns and rural users.
	iv. Diep River Investigate the potential in the fractured and weathered Malmesbury bedrock as a source for small-scale local supply to towns and rural users but with special precautions concerning toxic trace elements such as arsenic in the Malmesbury Group.
	v. Kuils/Eerste/Lourens/Sir Lowry's Pass Rivers a. Promote the use of the Cape Flats Aquifer for the greening of the Cape Flats, local subsistence food gardens, emerging market gardeners and as an emergency resource in the event of a supply disaster affecting the CCT. b. Evaluate the potential of the Malmesbury bedrock underlying the main Cape Flats Aquifer as a potential source of local potable supply in moderate quantities but with special precautions concerning toxic trace elements such as arsenic. c. Document and further explore submarine discharges of poorer quality and nutrient rich groundwater of the Cape Flats Aquifer and their impact on the marine ecosystems.
	vi. Cape Peninsula Rivers a. Evaluate risks of pollution threat and seawater intrusion to the western part of the Cape Flats Aquifer around the Black, Elsies and Lotus River sections. b. Evaluate the potential groundwater use from TMG aquifers to augment seasonal demand in particular areas of the South Peninsula.
Responsibility	The implementation of the Groundwater Strategy is the responsibility of the RO, providing guidance to local authorities, water management institutions and individuals in co-operation with the Directorate: NWRP and Directorate: Hydrological Information.
Priority	Priority 1 - Very High. Implementation in the short term and on an ongoing basis.
Interfaces	**a. Relevant documentation:** a1: NWA: Chapter 4, Part 12 a2: NWRS : Chapter 3 a3: Berg Water Resource Situation Assessment Report: Chapter 6 a4: CMA Integrated Water Resource Planning Study a5: Appendix 5 : General Authorisations (Groundwater)
	b. Other role players and their functions: Local Authorities (groundwater monitoring, management, protection and pollution control, land zoning approvals) Department of Agriculture (land sub-division) DEADP (Environmental Control) WCNCB (Environmental Control) Local Authorities

1.4	AQUIFER STORAGE RECOVERY AND ARTIFICIAL AQUIFER RECHARGE
Management objective:	To integrate the option of Aquifer Storage Recovery (ASR) techniques in the planning of water resource management in the Berg WMA.
Background information :	Aquifer Storage Recovery (ASR) and Artificial Aquifer Recharge (AAR), both involve pumping surface water into aquifers and reusing that water at a later stage. The inherent difference between the two is that recharge is associated with replenishing water in an aquifer from which water is currently utilised. ASR on the other hand makes use of recharge techniques to take advantage of available storage within aquifers (that may or may not be currently tapped) akin to the use of available storage in a dam. The same boreholes can be used to pump surplus surface water into the aquifer and to abstract water from that aquifer during the dry season. It is estimated that approximately 32 million m^3/a is lost from dams in the Berg WMA to evaporation. Of this, the evaporation from Voëlvlei Dam alone, accounts for an estimated 17 million m^3/a. One of the key benefits of ASR is that there are no evaporation losses associated with it. Whilst artificial recharge is currently only utilised to a very limited degree, it does hold potential, particularly in the primary aquifers along the West Coast from which water is currently abstracted (Langebaan Road, Elandsfontein and Adamboerskraal). The Langebaan Road aquifer currently supplies the West Coast District Municipality with 4000 m^3/d and to date no artificial recharge has been implemented. AAR is currently being undertaken at Atlantis where stormwater, and treated effluent from the Wesfleur WWTW (11 Ml/d) is injected into the primary aquifer, to replenish water abstracted from it. This equates to approximately 4 million m^3/a of effluent re-use. AAR has also been considered as an option within the Cape Flats aquifer. However there are concerns that this may lead to contamination of this resource due to its location within a densely urbanised area as well as associated operating problems. The Langebaan Road aquifer holds potential for ASR by possibly making use of pre-treated, excess winter water out of the Berg River and storing that water in the aquifer for use during summer.
Strategic approach:	Implement studies to investigate the potential use of treated water for ASR and AAR techniques, particularly in the intergranular coastal plain aquifers. Such studies should be undertaken as part of integrated planning of surface and groundwater development in the Berg WMA.
Required actions:	• Evaluate the potential for further AAR schemes (e.g. Atlantis) and ASR schemes in the intergranular aquifers of the coastal plain using pre-treated water. • Assess the vulnerability of the receiving water to the quality of the injected water where ASR is considered, and take cognisance of the potential for increased use of treated effluent in this regard.
Responsibility	The implementation of this strategy is the responsibility of the RO in co-operation with the Directorate : NWRP and Directorate : Options Analysis.
Priority	Priority 3 - Medium. Implement studies to determine viable options for long term application.
Interfaces:	**a. Related Strategies:** 1.2 Reconciling water supply and demand 1.3 Groundwater 4.3 Effluent re-use

SECTION 2: WATER RESOURCE PROTECTION STRATEGIES

The NWRS defines two complementary approaches for the protection of water resources. **Resource Directed Measures** focus on the character and condition of the in-stream and riparian habitats, whilst **Source Directed Controls** focus on the control of water use at the point of potential impact, through conditions attached to water use authorisations (licences).

It is not economically viable, nor always necessary, to protect all water resources to the same degree. Each river needs to be classified in terms of the degree of protection it should be accorded. This in turn influences the allowable extent of utilisation. A classification system is being developed by the Directorate: Resource Directed Measures (RDM) to provide a protocol for the classification of rivers.

The evaluation of the ecological component of the Reserve is a requirement for processing applications for authorisations. The absence of a comprehensive Reserve determination in the Berg WMA introduces a number of challenges for water resource management by the RO. Of particular concern are (i) the backlog of authorisation applications, and (ii) the availability of resources to carry out Reserve determinations for licence applications on each and every river reach on which a Reserve has not previously been determined.

The job opportunities accompanying economic development in the Berg WMA have led to a particularly rapid increase in the urban population. The appropriate planning of residential developments, provision of water, and management of waste must take cognisance of the need to protect the water resource.

Four strategies have been identified for development, namely:

2.1 Reserve and resource quality objectives
2.2 Siting of new developments
2.3 Solid waste
2.4 Water quality

2.1	RESERVE & RESOURCE QUALITY OBJECTIVES
Management objective:	The objective of this strategy is to address the uncertainties relating to the current procedures for Reserve determination, how the authorisation of licence applications will impact on the Reserve, and how implementation of the Reserve in the WMA will affect the availability of water to other users.
Background information	The implementation of the Reserve can have a major impact on the amount of water available for allocation, with serious economic and social implications. All Reserve determinations carried out prior to classification are considered to be preliminary (Refer to Paragraph 1.2 of Part 1 – Integrated Water Resource Management) – but these nevertheless have sufficient legal standing to allow for the issuing of water use licences and for limited other decision making. It should also be noted that the Rapid Reserve Determination procedure utilised for the NWRS has subsequently been revised, and if implemented, the Reserve could be substantially increased and the available yield correspondingly reduced. The NWA requires that "consideration be given to the Reserve" when addressing applications for new water use licences. As such, the RO is required to carry out ad-hoc preliminary Reserve determinations in every river reach for which an application is received, if no preliminary Reserve has previously been determined for that river reach. This can mean a large number of determinations. These are generally done at rapid or intermediate level. There is often a backlog at the RDM office, which delays approval. Furthermore, the RO does not have the necessary resources to ensure that the preliminary Reserves are actually implemented, according to the conditions attached to the licence. A strategy is required to resolve this with respect to resourcing. Projected demand figures suggest that even with the Berg Water Project in place, the WCWSS will need to be augmented again, soon after 2010. As the planning of new schemes can take up to 10 years and more, such planning should be implemented sooner rather than later. Without comprehensive Reserve determinations, authorities such as the CCT are not able to implement effective planning. In view of the approved Berg Water Project and of the potential scheme to utilise excess water for augmenting Voëlvlei Dam, a comprehensive Reserve determination for the Berg River should receive higher priority than the other river systems in this WMA. In particular, the Reserve requirement of the estuary must be determined. New schemes should be developed in such a way that they have the least detrimental effect on the environment. Appropriate operating rules should be put in place to make provision for the Reserve. The Berg Water Project, for example has been planned to provide releases of between 65 and 200 m^3/s in order to create floods to meet particular ecological requirements in the river. Although a procedure for determining the groundwater Reserve requirement is available, the lack of supporting data to facilitate the determination is a limiting factor. Adequate information is essential for all Reserve determinations. Information pertaining to the groundwater resource is particularly scant. This needs to be addressed by acquiring information through appropriate monitoring. The lack of information to support Reserve determinations for estuaries and wetlands needs to be addressed at national level. The need for a Reserve determination on severely modified rivers is also questioned and must be taken up with the RDM Directorate.

2.1	RESERVE & RESOURCE QUALITY OBJECTIVES (cntd)
Background information (cntd)	*The following specific issues and concerns were identified in the Berg WMA:* **i. WMA** • Preliminary Reserve determinations are currently being done on an *ad hoc* basis. This is time-consuming and resource dependent. • The RO does not have the necessary resources to ensure that the preliminary Reserve requirements are actually being met (See Monitoring Networks and Data Capture – Strategy 9.2). • Many rivers in the Metro are canalised and modified. No framework or classification is available to assist in Reserve determination of modified urban rivers. • A backlog in processing authorisation applications is occurring. • The RDM Directorate requires Reserve determinations before allocations can be made, even in the case of significantly modified rivers. Some relaxation is suggested here. • Authorisations for groundwater abstraction cannot be processed without a groundwater Reserve determination. There is, at the same time, a lack of groundwater data (monitoring) to support these groundwater Reserve determinations. **ii. Berg River upstream of Hermon** • Although in progress, the Reserve determination for the Berg River is not yet available. **iii. Diep River** • Groundwater recharge in this area is not high. Pollution of groundwater from increasing land sub-division is of concern. • There is poor knowledge of irrigation practice in this area.
Strategic approach	In order to meet the future requirements in the Berg WMA, the Department must focus attention on comprehensive Reserve determinations for rivers in this WMA, with first priority being the Berg River itself. The Berg WMA is also dependent on the supply of water from the Breede WMA, via inter-basin transfers, to augment the local yield. The Reserve requirement for the Berg River is important in the planning of potential transfer schemes from the Breede WMA and will inform the development of water resources in that WMA as well. In the Lower Berg River, suitable baseline monitoring sites will be established to provide data that will be used to determine the requirements of the Berg River Estuary. The implementation of the Reserve itself will be supported through appropriate monitoring, and success in achieving the objective of a river functioning as required and classified, will be evaluated. Protocols will regulate the trading of water to ensure that water is not moved across sectors or catchments detrimentally. 'Within catchment' trading keeps the allocation constant and may negate the need for ad-hoc Reserve determinations to be carried out. Where Reserve determinations are required, these will have to be based on best available information and a conservative approach using the rapid or intermediate approach until such time as data has been accumulated to support more reliable evaluations. As a long-term solution, the rivers need to be classified and a comprehensive Reserve determination done throughout this WMA, with first priority afforded to the Berg River. This would eliminate the need for ad-hoc Reserve determinations.

2.1	RESERVE & RESOURCE QUALITY OBJECTIVES (ctnd)
MANAGEMENT ACTIONS	
Required actions:	Develop a detailed strategy for the Reserve and resource quality objectives in the Berg WMA. The following actions are required: a. Reserve determinations require additional resources and these must be assigned. In making the case for these resources it may be necessary to determine the extent of need, delays, cost of delays, what functions the Regions would be able to perform instead of head office staff, etc. b. Work within the existing RDM methodologies for streamlining authorisation applications, prior to the completion of the Reserve determination. c. Implement a river classification matrix to facilitate rapid decision making in terms of the level of Reserve determination required for rivers of varying ecological importance, such as pristine rivers and degraded urban rivers in the WMA. d. Identify and consult with the relevant local authorities where abstraction under Schedule 1 requires amendment through by-laws which can be introduced by the local municipalities. e. Prioritise the completion of the Berg River comprehensive Reserve determination. Ideally this should be synchronised with DWAF's intended Compulsory Licensing project for the Berg River, if that project is commenced within the next year. f. Abstraction under Schedule 1 should be reviewed and areas identified where abstraction is increasing significantly, particularly from the groundwater resource. The RO is to liase with the relevant local authority, through which by-laws can be implemented (if necessary) to amend the quantities of abstraction under Schedule 1. g. On account of the integration of the Riviersonderend catchment of the Breede WMA into the WCWSS, the Reserve of the Riviersonderend/Breede Rivers should be determined at the same time as the Reserve of the Berg River.
Responsibility:	The implementation of the **Reserve and Resource Quality Objectives Strategy** is the responsibility of the RO in conjunction with the Directorate: RDM.
Priority:	Priority 1 – Very high.
Interfaces:	**a. Relevant documentation:** a1: NWA: Chapter 3, Part 2 a2: NWRS: Chapter 3, Part 1 a3: National Water Quality Framework **b. Linked ISPs / WMAs:** None**.** **c. Other role players and their functions:** Local Authorities : amending by-laws relating to Schedule 1 use. **d. Related Strategies:** 1.1 Reliability of the yield balance 1.3 Groundwater 3.1 Implementing Schedule 1 3.2 General authorisations 3.4 Licensing 3.5 Pollution control 4.3 Effluent re-use 9.1 Abstraction control 9.2 Monitoring networks and data capture **e. Linked mapping:** None

2.2	SITING OF NEW DEVELOPMENTS
Management objective:	The objective of this strategy is to ensure protection of water resources by appropriate planning when siting new developments.
Background information:	This is most applicable to the West Coast where developments include both industrial and residential expansion. The West Coast Region relies heavily on groundwater resources. Increasing sub-division of land is taking place with a corresponding increase in abstraction under Schedule 1. The coastal resort areas up the West Coast are expanding rapidly and adequate services are often not available. Return flows from domestic and industrial users in close proximity to groundwater resources, is of concern in terms of the possible impacts on water resource quality.
Strategic Approach:	A system must be put in place to ensure that the siting of new developments is properly planned, with due consideration given to the potential impact on the water resource of the area. Protective measures are required for areas with a high impact risk. Mapping of sensitivities must focus first on those areas where impact is likely to be most pronounced (notably the developing West Coast region). Co-operative governance with local authorities is an essential element of this approach.
MANAGEMENT ACTIONS	
Required actions:	The following actions are required: a. Development of 'area-sensitive' mapping to prescribe the level of services that are required in the event of development within a particular area. b. Protocols must be drawn up to guide development from a water resource perspective. This includes, *inter alia*, the availability of surface water and the possible impacts on the groundwater resource. c. Groundwater monitoring networks are required for impact evaluation. d. Close liaison with local authorities is necessary in order to ensure that they are able to make informed decisions.
Responsibility:	The implementation of the **Siting of New Developments Strategy** is the responsibility the RO in conjunction with the Directorate: Waste Discharge and Disposal.
Priority:	Priority 3 – Medium. To be implemented on an ongoing basis.
Interfaces:	**a. Relevant documentation:** a1: NWA: Chapter 3, Part 5 a2: NWRS: Chapter 3, Part 1 **b. Linked ISPs / WMAs:** None**.** **c. Other role players and their functions:** Department of Land Affairs : Responsible for land sub-division approval. **d. Related Strategies:** 1.3 Groundwater 3.5 Pollution control 9.2 Monitoring networks and data capture **e. Linked mapping:** None

2.3	SOLID WASTE MANAGEMENT
Management objective:	Solid waste sites need to be correctly sited and suitably managed to ensure that there is no contamination of the water resource. Existing sites which fail to meet these criteria should either be upgraded, or closed and rehabilitated. Sites already closed need rehabilitation. This strategy aims to raise the necessary awareness with respect to solid waste management, to ensure that licences are not issued for unsuitable sites, that licence conditions are met, and that sites which continue to contaminate the water resource, whether closed or operational, are rehabilitated.
Background information:	Solid waste sites are generally poorly managed in the Berg WMA. There are some exceptions which include Malmesbury, Vissershok, Coastal Park and Stellenbosch. In some cases, industrial solid waste has been stored, dumped or stockpiled in close proximity to the specific industry. Many industrial operators are taking the initiative in rehabilitating previously contaminated land. These include AECI and SOMCHEM in the Kuils/Eerste River catchment as well as KYNOCH and CALTEX in the Diep River catchment. In the absence of official guidelines, the scope within which rehabilitation is undertaken is largely dependent on the recommendations of service providers and consultants. The absence of a remediation strategy for contaminated land is discussed in Section 6.2.3 of the draft National Water Quality Framework Policy (June 2002). This highlights that present rehabilitation efforts are not consistent and are sometimes inadequate. *The following general issues and concerns have been identified:* • There is no policy in place for the rehabilitation of contaminated land. This is of particular concern in view of the possible impact on local surface and groundwater bodies in close proximity to these contaminated areas. Some industries have appointed consultants to offer guidance. • Rehabilitation is done on an ad-hoc basis without guidelines as to what is required and who is responsible. • Pollution of ground and surface water resources is ongoing. *Along with the above, the following were specific issues*: **i. Diep River** • KYNOCH fertilizer manufacturer and CALTEX refinery have had industrial waste stored on their grounds. The possible contamination of Rietvlei from CALTEX needs to be considered. Both industries have marine outfalls. KYNOCH are rehabilitating old disposal sites. CALTEX have appointed consultants to investigate the impact on the groundwater. Malmesbury and Vissershok solid waste sites are well managed. **ii. Kuils/Eerste/Lourens/Sir Lowry's Pass Rivers** • Stellenbosch solid waste site is well managed. • AECI and SOMCHEM have undertaken rehabilitation of contaminated land at their premises. **iii. Cape Peninsula rivers** • Coastal Park solid waste site is well managed.
Strategic Approach:	The siting of new solid waste sites will be considered in the same light as that of new developments. Priority must be given at National level for the development of strategic guidelines that will be used to define the requirements for rehabilitation of contaminated land. In the interim, the recommendations of the Remediation Working group must be implemented until a formal strategy is in place.

2.3	SOLID WASTE MANAGEMENT (cntd)
MANAGEMENT ACTIONS	
Required actions:	The following general actions are required: a. Development of a protocol for rehabilitation of contaminated land, taking the recommendations of the National Water Quality Framework Policy into account. b. Liaison with the Remediation Working Group, established at a National level, and on an interim basis, to advise on the application of remedial measures. c. Development of area sensitive mapping to classify areas in which solid waste sites may be extended and new sites developed. d. A detailed Solid Management Strategy must be developed.
Responsibility:	The implementation of the **Solid Waste Management Strategy** is the responsibility of the RO, together with the Directorate: Waste Discharge and Disposal, taking cognisance of the National Water Quality Framework Policy.
Priority:	Priority 3 - Medium.
Interfaces:	**a. Relevant documentation:** a1: NWRS: Chapter 3, Part 1 a2: National Water Quality Framework a3: Appendix 4: Solid Waste Disposal Sites **b. Linked ISPs / WMAs:** None**.** **c. Other role players and their functions:** *Department Land Affairs :* To be consulted in the development of official rehabilitation guidelines. *Remediation Working Group :* Acts as an interim advisory forum in the absence of official guidelines on rehabilitation. *Local Authorities* : Responsible for siting of solid waste sites and local land use. **d. Related Strategies:** 1.3 Groundwater 3.5 Pollution control 5.2 Co-operative governance **e. Linked mapping:** Figure 3.5.1 - Municipal Boundaries and Waste Disposal Sites

2.4	WATER QUALITY
Management objective:	Water quality needs to be appropriately managed to ensure that there is water of acceptable quality available to meet the needs of the environment and of all users in the WMA. Salinity concentration and nutrient content must be reduced to the most practically manageable levels. This strategy aims to address the problems associated with water quality in the Berg WMA and to recommend steps that can be taken to improve the quality where problems currently exist.
Background information:	Water quality in the Berg WMA, varies not only between the individual river basins but also within individual river systems, such as the Berg River system. The natural geology, agricultural practises and point source polluters all play a role in determining the quality of water in this WMA. **<u>Berg River Catchment</u>** The most significant water quality problem in the Berg River catchment is the salinity of the water in the middle and lower reaches of the Berg River. The causes of this problem are two-fold, namely: • leaching from the natural geology, which to the north of Paarl and extending to the Berg River mouth, consists of Malmesbury shale; and • the agricultural practises and the wash-off of salts from irrigated and dryland agricultural lands. The problem is exacerbated during the first winter rains, when accumulated salts are washed into the river and result in elevated salinity in Misverstand Dam. Water diverted into Voëlvlei Dam from the Klein Berg, Leeu and Twenty-four Rivers does not pose a salinity problem to the quality of water in the dam. The Swartland WTW is supplied directly from the dam via a canal and as such, is not exposed to the same salinity problems as Withoogte WTW. A final TDS of 75mg/*l* is typical out of the Swartland WTW. Withoogte WTW treats the water abstracted from Misverstand Dam for use by the West Coast region. The final average TDS concentration is approximately the same as that of the abstracted water, as the works cannot remove salinity. This fluctuates around 200mg/*l* but has on occasions (as recently as 2001) risen to concentrations in excess of 400mg/*l* for periods of up to 3 weeks on account of local high salinity runoff. There is concern that the concentrations and durations of the higher salinity events may increase after the construction of the Berg Water Project. Whilst adequate for domestic and some industrial users, the steel and mineral processing industries along the West Coast pre-treat this water to TDS concentrations of less than 80 mg/*l* and are apparently not able to cope with the higher concentrations. This sector is likely to experience increased water demands through the anticipated industrial expansion in the region. The supply of water of high quality is an important factor in their production costs. Other water quality concerns in the Berg River include nutrient enrichment as a result of the discharge of treated sewage effluent from WWTWs, irrigation with winery effluent and the direct discharge of winery effluent. Refer to the Pollution Strategy (No 3.5) and the General Authorisation Strategy (No 3.2) for detail. Diffuse pollution from informal settlements in the Klein Berg catchment impacts on the quality of water diverted into Voëlvlei Dam. This is further addressed under the Strategy for the Lower Berg (No 8.4).

2.4	WATER QUALITY (cntd)
Background Information (cntd)	**The Urban Catchments** Certain of the urban river systems serve as conduits for treated effluent discharged to sea. Bellville, Scottsdene, Kraaifontein, Zandvliet, Stellenbosch and Macassar WWTWs discharge treated effluent into the Kuils/Eerste River system. Borcherds Quarry and Athlone WWTWs discharge into the Black/Salt River and the Potsdam WWTW discharges into the Diep River, which feeds Rietvlei. The Cape Flats WWTW discharges into the canal downstream of the Zeekoevlei outlet control weir. These rivers no longer display seasonal flow patterns, and some, notably the Black/Salt and Kuils Rivers have become severely modified. High residual nutrients can lead to eutrophication related problems such as nuisance algal growth and excessive growth of aquatic weeds. Other problems associated with urban rivers include leaking sewers, contaminated stormwater runoff, litter, oil and toxic spills. Refer to the Pollution Control Strategy (No 3.5).
MANAGEMENT ACTIONS	
Strategic Approach:	The Department has commissioned studies at various levels of feasibility to address the salinity problems in the middle and lower reaches of the Berg River. In the interim, prior to any future interventions (by the Department) and potential water quality improvements, those industrial users requiring reduced salinity concentrations will have to continue pre-treating water themselves. Certain WWTWs are not treating to the quality standards required under their authorisations. Co-operative governance between the Department and local authorities must be focussed on this problem, to ensure that the local authorities accept responsibility for the quality of effluent from all WWTWs in their areas of jurisdiction. The severely degraded rivers such as the Black/Salt and Kuils Rivers cannot be rehabilitated. Such rivers must however not be considered as entirely sacrificial and their condition should, at worst, be maintained at current levels. Further degradation will result in undesirable social, health and aesthetic impacts. The required standards for treated effluent discharged into such rivers should be appropriate to at least maintain the current condition. The focus on improved operation and management of WWTWs must be on those works that are discharging into river systems that are not already severely degraded (the Eerste River and Berg River for example) and those feeding highly sensitive wetlands and estuaries (the Diep River). The pollution problem in the Klein Berg catchment must be addressed with the local authority.
Required actions:	The following general actions are required: a. Investigate options for improved salinity management of water in the middle and lower reaches of the Berg River taking account of the future Berg Water Project and the needs of urban and agricultural users. b. Determine the extent of reduced salinity that may be achieved if releases of the first winter run-off water (high salinity) from Misverstand Dam were implemented. c. Investigate the benefit of using alternative abstraction points within Misverstand Dam. d. Investigate the options of diverting the small local tributaries (Moorreesburgspruit and Nogospruit) around Misverstand Dam, so as to reduce the salinity concentration in the dam itself. e. Investigate the potential to desalinate water for sensitive needs, such as Saldanha Steel. f. Implement the actions referred to in the Pollution Control Strategy (No 3.5) and the Effluent Re-use Strategy (No 4.3). g. Implement the actions referred to for managing water quality in Voëlvlei Dam which are addressed under the strategy for the Lower Berg (No 8.4)

2.4	WATER QUALITY (cntd)
MANAGEMENT ACTIONS (cntd)	
Responsibility:	The implementation of the **Water Quality Strategy** is the responsibility of the RO, together with the Directorate: Water Resource Planning Systems, taking cognisance of the National Water Quality Framework Policy.
Priority:	Priority 2 - High.
Interfaces:	**a. Relevant documentation:** a1: NWRS: Chapter 3, Part 1 a2: National Water Quality Framework **b. Linked ISPs / WMAs:** None. **c. Related Strategies:** 1.3 Groundwater 3.2 General Authorisations 3.5 Pollution control 4.3 Effluent Re-use 5.2 Co-operative governance **d. Linked mapping:** None

SECTION 3: WATER USE MANAGEMENT STRATEGIES

Chapter 4 of the NWA describes the provisions by which water use may be progressively adjusted to achieve the Act's principle objectives of equity of access to water, and sustainable and efficient use of water. Many of the Act's sustainability and efficiency related measures will be applied through conditions of use imposed when authorisations to use water are granted. Formal water use authorisations (licences) will also facilitate administrative control of water use by water management institutions, form the basis upon which charges for water use may be made, and provide for the collection of water-related data and information.

Compulsory licensing will be carried out through a long-term programme based on both the local and national requirements for re-allocation. Areas where water has been fully allocated or over-allocated (and which are therefore under stress), and areas where there is a clear equity demand and therefore require a re-allocation of existing resources, have been prioritised. The ISP is a tool to help in evaluating the need for compulsory licensing in the Berg WMA, and can carry this information forward to the national office.

Changes in water use are anticipated in the Berg WMA, as water becomes available through the removal of invasive alien plants and through changes in land use.

Eight water use management strategies have been identified for this ISP, namely:

3.1 Implementing Schedule 1
3.2 General authorisations
3.3 Verification of existing lawful use
3.4 Licensing
3.5 Pollution control
3.6 Changing land use – forestry
3.7 Changing land use – Clearing of Invasive Alien Plants
3.8 Water Pricing

3.1	IMPLEMENTING SCHEDULE 1
Management objective:	The objective of this strategy is to prevent over-exploitation of limited water resources by large numbers of Schedule 1 users in areas which cannot support such use. One way of achieving this is to work with Municipalities in developing site-specific limitations on Schedule 1 abstraction.
Background information:	Water use under Schedule 1 of the NWA, is exempt from the need for authorisation. Schedule 1 deals with small volume water use for purposes including reasonable domestic use, small gardening and stock watering. Such use should not be of a commercial nature although some livelihood transactions may be expected and permitted. Feedlot operations are excluded from Schedule 1 water use. The NWA does not specify the quantities which may be abstracted under Schedule 1 but does allow for limitations to be introduced through by-laws of local municipalities. A maximum of 1 hectare per household is used as a practical limit in some WMAs where there is sufficient water. Land sub-divisions, in particular, introduce the potential for increased water use under Schedule 1. This is of particular concern in the expanding West Coast region of the Berg WMA, where an increasing number of boreholes are being sunk, as land parcels become sub-divided, with water used under Schedule 1. In many cases this leads to an over abstraction of the local groundwater resource and some form of control is required. The following issues and concerns are identified: • Land sub-division may be approved by local authorities, without cognisance being given to the fact that water use must be authorised or allowed for by another authority (DWAF). • We do not yet know the extent of land restitution. • Land sub-divisions in the Yzerfontein area (in particular the Rondeberg and Jakkalsfontein sub-divisions) are resulting in pressure on the Grootwater aquifer. • Inadequate monitoring of groundwater resources means that the impact on the aquifers cannot be tracked. • Abstractions under Schedule 1 from some of the Cape Metropolitan rivers could cumulatively exceed the allowance for Reserve requirements.
Strategic approach:	Schedule 1 water use plays an important role in the provision of free water to small users and will continue to do so. However it is apparent that as the population density in developing areas increases and land parcels become further sub-divided, the extent of use under Schedule 1 also increases, whilst limitations on this use are not being imposed. This is threatening the sustainability particularly of certain of the West Coast groundwater resources. The volume of water allowable through Schedule 1 has never been strictly defined and the first step would be to set a very tight limitation, governed by what the system can supply, on Schedule 1 users in areas with limited resources. The NWA allows Municipalities to place limitations on Schedule 1 use. It is important that any by-laws should not completely subvert the purposes of Schedule 1, and particularly the needs of the rural poor. DWAF should provide inputs into any restrictions imposed. Along with the use of municipal by-laws, other forms of control, and other sources of supply need to be explored. The suggested actions of this strategy should be implemented in the Berg WMA and used to provide direction towards the development of a National Strategy on Schedule 1 use.

3.1	IMPLEMENTING SCHEDULE 1 (cntd)
MANAGEMENT ACTIONS	
Required actions:	The following actions are required: a. List those areas where introduction of limitations on Schedule 1 abstractions are appropriate. b. Prioritise the West Coast area and Diep River catchments for restrictive by-laws to be introduced by municipalities. c. Assist local authorities to develop by-laws in relation to Schedule 1 use. d. Improve consultation between the RO, Department of Land Affairs and local authorities, regarding land sub-division, noting the implications for water resources.
Responsibility:	The **Implementing Schedule 1** Strategy is the responsibility of the RO.
Priority:	Priority 1 – Very high.
Interfaces:	**a. Relevant documentation:** a1: NWA: Chapter 4, Part 1 a2: NWRS: Chapter 3, Part 2 **b. Linked ISPs / WMAs:** None**.** **c. Other role players and their functions:** Department Land Affairs : Responsible for authorising land sub-division. Local authorities : By-laws may need to be considered to introduce limits on Schedule 1 abstractions. **d. Related Strategies:** 1.3 Groundwater 2.1 Reserve and resource quality objectives 3.2 General authorisations 3.3 Verification of existing lawful use 3.5 Pollution control 3.8 Water pricing 5.2 Co-operative governance 6.1 Supply to local authorities **e. Linked mapping:** None

3.2	GENERAL AUTHORISATIONS
Management objective:	Appropriate General Authorisations will simplify the management of the water resources of the Berg WMA. This strategy aims at putting such appropriate GAs in place, but also at ensuring that regular review and amendment of existing GAs should circumstances change.
Background information:	GAs have been introduced in the country for water abstraction, storage, irrigation using treated effluent, discharge of effluent and solid waste disposal. There are no GAs for abstraction of surface water and water storage in the Berg WMA given the general stressed nature of the resources and the resulting shortfall in the yield balance. This means that all prospective users (other than Schedule 1) must apply for water use licences, even if that use is relatively small. In the absence of GAs for surface water abstractions, authorisations are required for any surface water abstraction, even from severely modified rivers. Current GAs for groundwater abstraction are listed in Appendix 5 and represented graphically on Figure 3.2.1. There is at present no protocol for a GA allowing river channel modifications. This means that any modification of any river channel (including, for example, culverts required in road construction), requires a licence. The nature of GAs for river channel modification must be defined at national level before such a GA can be introduced locally. This has been identified as a matter of urgency in several ISPs. Irrigation with treated effluent is a controlled activity in terms of the NWA, but one which can, and for certain instances is, authorised through a General Authorisation. However, the actual impact from irrigation using effluent from wineries, in particular, is not well established. The RO is concerned that this activity may be having adverse impacts on river water quality, due to the many small operators, which cannot all be monitored. This is an example of a General Authorisation which should be regularly reviewed. The GA is a useful tool which reduces unnecessary management control. However the situation can change very fast and all GAs should be regularly reviewed on a catchment by catchment basis. Typically a GA for either abstraction or discharge may be fit for certain catchments and not for others. This once again highlights the need for monitoring. *The following specific issues and concerns were identified in the Berg WMA*: **i. WMA** • GAs allow for effluent volumes of up to 10 m^3/day (per user per property) to be used for irrigation purposes. A licence is required only once this rate is exceeded. • Many small operators are irrigating with treated effluent. This is difficult to monitor and there is concern at the cumulative impact on the water quality of adjacent rivers. Wineries are of particular concern. • Control and management of river channel modification is not effective given that all modifications must be applied for. This is unreasonable and the outcome is that there is much unauthorised construction. This is bolstered by the perception that GAs will eventually cater for some of these activities. **ii. Berg River upstream of Hermon** • Unauthorised channel modification (e.g. bulldozing of the river channel) is taking place where abstractors are attempting to keep their points of abstraction clear from debris and silt. **iii. Kuils/Eerste/Lourens/Sir Lowry's Pass Rivers** • The Kuils River essentially serves as conduit for effluent discharge to sea. • Many small wineries are irrigating using their treated effluent, the impact of which is not well established. **iv. Cape Peninsula rivers** • In the absence of GAs for surface water abstraction, licences are required for abstractions from the urban rivers, some of which are already severely modified (canalised) and serve as conduits for effluent discharge.

3.2	GENERAL AUTHORISATIONS (cntd.)
Strategic approach:	GAs currently play an important role in easing the burden of licensing many small users of groundwater in the Berg WMA, and can continue to do so. Given the complete absence of surface water GAs throughout this WMA, the use of relatively small volumes of surplus surface water, even from severely modified urban rivers, requires a formal licensing procedure. This in turn requires that a Preliminary Reserve determination be done in support of such an application. The introduction of GAs for abstraction from severely modified rivers needs to be considered. All the GAs in this WMA need to be reviewed annually, and steps taken to implement monitoring wherever this can lead to improved management decisions. This may require restrictive conditions to be attached to GAs in certain catchments, whilst more relaxed conditions (as described above) could be considered in others. The review must be on a catchment for catchment basis and not a blanket approach to the Berg WMA as a whole.

3.2	GENERAL AUTHORISATIONS (cntd)
MANAGEMENT ACTIONS	
Required actions:	Develop a detailed strategy for the application of GAs. The following general actions are required: a. Introduce area specific GAs for surface water abstraction, where water is available. b. Review and revise GAs on controlled activities. c. Consider withdrawing the GAs for the controlled activity of irrigation using effluent and introduce licensing for all irrigation activities where effluent is used. Implement a short term monitoring initiative to establish the actual extent and impact of irrigation using winery effluent. d. Implement GAs for river channel modification, after guidelines become available. e. Revise GAs on groundwater (consider impact of GA abstraction on surface water yield). f. Develop a programme for regularly reviewing GAs.
Responsibility:	The implementation of the **General Authorisations** Strategy is the responsibility of the RO, in conjunction with the Directorate: Water Abstraction and Instream Use.
Priority:	Priority 1 – Very high.
Interfaces:	**a. Relevant documentation:** a1: NWA: Chapter 4, Part 6 a2: NWRS: Chapter 3, Part 2 a3: Appendix 5: General Authorisations (Groundwater) **b. Linked ISPs / WMAs:** None**.** **c. Other role players and their functions:** None. **d. Related Strategies:** 1.3 Groundwater 2.1 Reserve and resource quality objectives 3.1 Implementing Schedule 1 3.3 Verification of existing lawful use. 3.4 Licensing 3.5 Pollution control 3.8 Water pricing 4.3 Effluent re-use 9.1 Abstraction control **e. Linked mapping:** Figure 3.2.1 - General Authorisations (Groundwater Abstraction)**.**

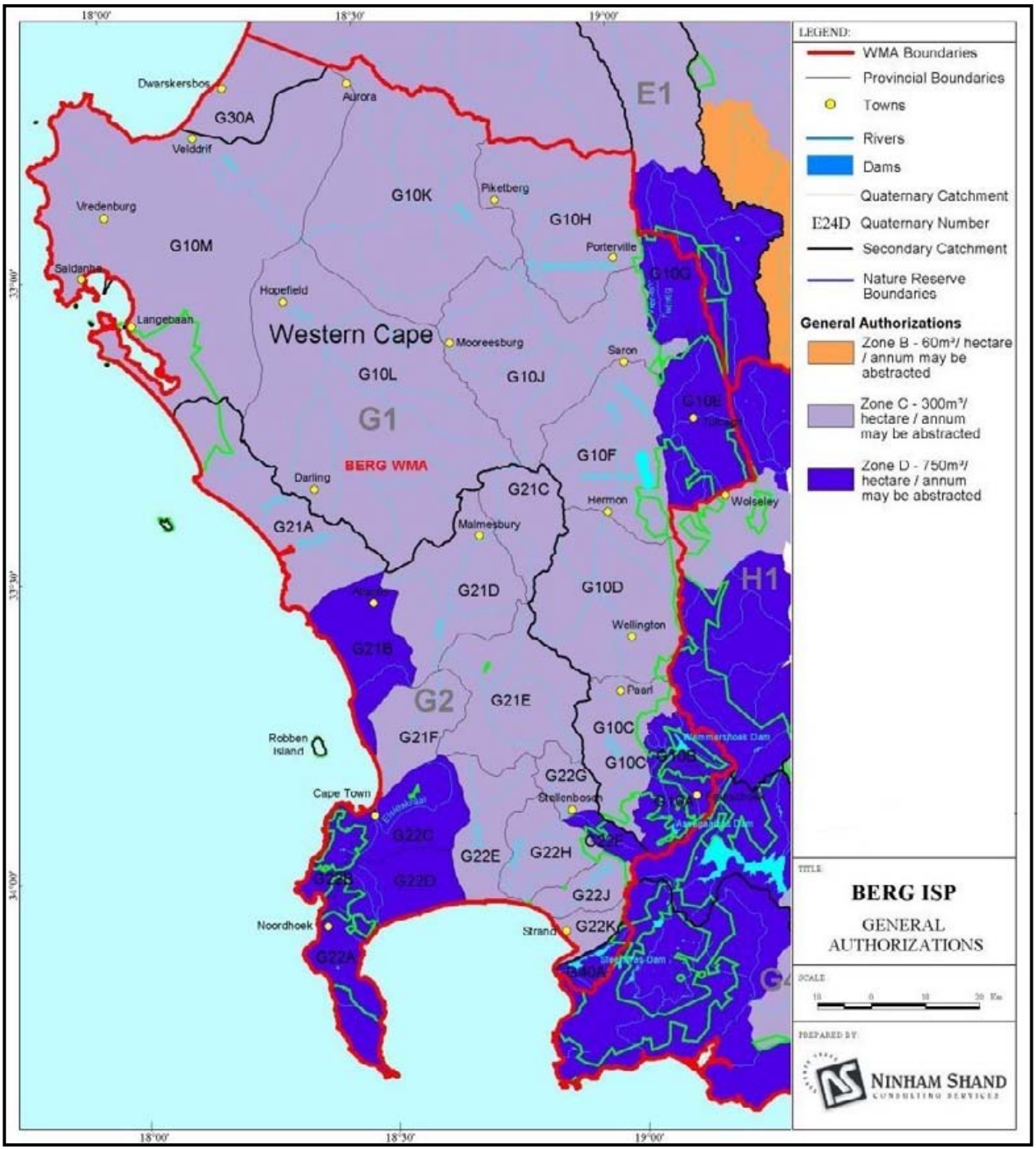

Figure 3.2.1: General Authorisations (Groundwater Abstraction)

3.3	VERIFICATION OF EXISTING LAWFUL USE
Management objective:	The objective of this strategy is to verify the extent of existing water use as registered on WARMS, and from there to determine the lawfulness of the use. Verified existing lawful use will form the basis for re-allocation during compulsory licensing.
Background information:	The Berg WMA is under stress and it is important that only lawful water use is allowed. Before abstraction (or discharge) control can be effectively managed, the existing use, and the lawfulness of that use must be established. Reliable information on existing use is also very important for updating of hydrological records and determination of yield. At the Year 2000 level of development, the total irrigation water demand (NWRS) in the Berg WMA was 301 million m^3/a. Of this, approximately 123 million m^3/a (41%) was supplied from the WCWSS. The larger component is supplied from farmers' own sources and from run of river. It is this component of the total agricultural water use which is not well established. Verification of existing lawful use is an important step to ensure that the correct volumes are registered for licensing, the actual requirements are accurately known, and no unlawful users are inadvertently licensed. All water users (excluding Schedule 1 users) must first register their use. This is a statutory obligation and a process largely completed in the Berg WMA. Registration is required of both surface and groundwater users, and includes Stream Flow Reduction Activities and those users who utilise water under GAs. Registration does not, however, serve as a check on the lawfulness of the use and checks carried out in some catchments indicate huge inaccuracies although initial indications in the Berg WMA suggest that verification of actual water use reasonably accurately reflects the use registered by farmers. Illegal users should not only be denied a license, but disallowed further use. It is expected that in this way more water may be found for the system. Verification of existing lawful use serves the following functions: • to reconcile registration, identify and correct errors • to take water out of the hands of illegal users and return this to the system • determine long-term water use • ensure lawfulness of continued water use
Strategic approach:	The verification process in the Berg WMA must be used to obtain a more reliable indication of quantities of irrigation water use and to ensure that any illegally used water is returned to the system. Through the process of registration and verification, the Department will identify illegal water users, who will be held accountable for this illegal use. Only those users who have registered a legal water use during the required registration process will qualify for the category of existing lawful use during the Compulsory Licensing process. Any current user who has not registered that use, or whose use is found to be unlawful, will have to apply for a "new" allocation during Compulsory Licensing. In the water stressed situation of the Berg it is unlikely that they will receive an allocation. The extent of currently unexercised but nevertheless 'lawful' allocations must also be determined as a priority. This will allow the regulator to assess what impact these unused allocations might have if they were to be fully exercised by the current holder, or traded for use by others.

3.3	VERIFICATION OF EXISTING LAWFUL USE (cntd)
MANAGEMENT ACTIONS	
Required actions:	The following actions are required: a. Ensure that all users currently deemed to be existing lawful users, register their use. This is an ongoing process. b. Set up a process to: • verify existing use according to guidelines made available from the Directorate: Water Abstraction and Instream Use. • determine lawfulness of use according to these guidelines.
Responsibility:	The implementation of the **Verification of Existing Lawful Use** Strategy is the responsibility of the RO in conjunction with the Directorate Water Abstraction and Instream Use.
Priority:	Priority 1 – Very high.
Interfaces:	**a. Relevant documentation:** a1: NWA: Chapter 4, Part 3 a2: NWRS: Chapter 3, Part 2 **b. Linked ISPs / WMAs:** None. **c. Other role players and their functions:** WUAs : Responsible for monitoring water use by members. SFRA LAAC (Streamflow Reduction Activities Licence Assessment Advisory Committee) Involved in assessing licences of streamflow reduction activities. Department Land Affairs : Involved in matters relating to land use change. **d. Related Strategies:** 1.1 Reliability of the yield balance 3.1 Implementing Schedule 1 3.2 General authorisations 3.4 Licensing 3.6 Changing land use – forestry 3.7 Changing land use – clearing of invasive alien plants 3.8 Water pricing 4.2 Agricultural water conservation and demand management **e. Linked mapping:** None

3.4	LICENSING
Management objective:	The objective is the implementation of a streamlined interim strategy to assist the RO in reaching decisions on licence applications and to issue authorisations, when required, with the appropriate conditions attached.
Background information	Any water use that exceeds Schedule 1 or the limits of any GA, must be authorised by a licence. A water use licence: • Replaces all previous entitlements, if any, to use water for the purpose specified in the licence; • Is specific to the user to whom it is issued and to a particular property or area; • Is specific to the uses for which it is issued; • Is valid for a specified time period, which may not exceed forty years; • May have a range of conditions attached to it and • Must be reviewed by the responsible authority at least every five years. As a transitional measure the NWA permits "existing lawful water use" to continue until such time as it is licensed through the compulsory licensing process. Potential requirements from the domestic and industrial sectors are expected to increase significantly, particularly in the Greater Cape Town and West Coast regions. The current yield balance estimate at Year 2000 level of development indicates that there is no spare water in the Berg WMA. This places an immediate constraint on the licensing of any new irrigation or Stream Flow Reduction Activity until such time as additional water can be 'found' or otherwise made available (e.g. users who construct dams to increase available yield after allowing for Reserve requirements or, perhaps, clear invasive alien plants to increase supply. The majority of the urban users in the Berg WMA rely on water supplied via the integrated WCWSS. More than 40% of the total irrigation requirement is also supplied from this system. The system is described in detail in Paragraph 2.2 of Part 1. By virtue of the integrated manner in which the system operates and the complex reticulation networks within it, the evaluation of yield balance figures for small sub-areas within the Berg WMA is not easily undertaken. Furthermore these are not representative of how the system is operated. As such it not meaningful to produce a set of yield balance tables for each of the eight management units that make up the Berg WMA. These eight sub-areas are described below, with comment on the scope for issuing new licenses. **<u>Berg River Upstream of Hermon</u>** There is little or no further water available for any additional irrigation. The system is already under stress, new dams will have to be constructed to provide any additional water and this water is likely to be extremely expensive. Allowance must also be made for the future growth that Cape Town is sure to experience. This is recognised in the Berg Water Project Agreement between DWAF and CCT. It is recommended that no further licences be issued for surface water abstraction or storage by WUAs or local authorities. Licences for major projects to supplement the WCWSS should be considered on an ad-hoc basis, within the constraints of vested interests and the Reserve. Preference should be given to TMG groundwater, particularly where there is small or no influence on surface water resources. Trading of existing authorisations, including those allocated but unexercised, should be encouraged as an alternative. This situation will be reviewed during the proposed Compulsory Licensing exercise, which is a priority and should be commenced within the next two years.

3.4	LICENSING (cntd)
Background information (cntd):	**Berg River Downstream of Hermon** The anticipated expansion of the urban and industrial sectors in the Saldanha area is expected to place additional demands on Voëlvlei Dam. Irrigation is mainly concentrated within the Lower Berg Irrigation Boards, as well as the Riebeek-Wes, Riebeek-Kasteel and Twenty-four Rivers Irrigation Boards. None of the existing irrigation boards in the Berg WMA have yet to be officially converted into WUAs. Groundwater is abstracted from the Langebaan Road upper aquifer for irrigation. Some farmers are of the opinion that the abstraction of water from the lower aquifer for supply to Saldanha Steel (1,5 million m^3/a) is impacting on their assurance of supply out of the upper aquifer. There is no surplus surface water available and as such, licences should not be considered for abstraction or storage of surface water. Applications for groundwater abstraction can be considered but should attach conditions for monitoring. As for the Upper Berg this situation will be reviewed during the Compulsory Licensing exercise, which is a priority and should be commenced within the next two years. **The Klein Berg** This catchment is severely stressed due to the extensive irrigation already taking place and the diversion of a high proportion of the flow from the Klein Berg into Voëlvlei Dam. This is a very important component of the WCWSS and the main source of supply to the West Coast. Of the total catchment area, approximately 10% is under irrigation. No new authorisations should be issued for surface water abstraction or storage for irrigation purposes. With no local resources available for allocation the stressed nature of this catchment would be relieved if the Michell's Pass transfer were implemented. This could be used to supplement Tulbagh. However, and in line with other strategies, Water Conservation and Demand Management, Groundwater Abstraction and other sources should first be optimised. Lei-water exchange should be immediately considered by the Tulbagh Local Authority. **The West Coast Rivers** This catchment has negligible yield from surface water and is entirely reliant on groundwater and water transfers. Uncertainties include the groundwater potential as well as the possible impacts of coastal resorts on the primary aquifers (use and pollution). Furthermore, the recharge of these aquifers is poor due to the low precipitation in the area. Saline intrusion from over abstraction near the coast is a potential threat. Increased artificial aquifer recharge should be considered at the Silverstroom and Witsand wellfields. Small scale resource poor farmers are likely to emerge at Mamre through land restitution. These farmers anticipate utilising groundwater for small scale farming. There is no opportunity for authorisations to abstract or store surface water. Authorisations to abstract groundwater can be considered but monitoring conditions need to be attached to these. **The Diep River** Five applications for small storage dams have been submitted by farmers north of Durbanville. These proposed farm dams would be situated on tributaries of the Mosselbank River. Similarly there have been a number of applications for dams on tributaries of the Diep River near Klipheuwel Road, Malmesbury. The preliminary Reserve determination for the Diep River catchment has not yet been completed.

3.4	LICENSING (cntd)
Background information (cntd):	The yield balance in this catchment, determined in the WRSA study, showed a deficit of 10 million m^3/a. However, the same report concluded that the yield balance is of a very low level of confidence due to the uncertainty regarding the irrigation water requirement and the supply of water from farm dams. Once the preliminary Reserve has been determined, and Existing Lawful use verified, the yield balance for this catchment needs to be re-determined before any decisions can be made in terms of issuing licences for surface water abstraction or storage. It is estimated that 13 million m^3/a is supplied from groundwater, much of which is used for irrigation purposes. Land sub-division at Riverlands and resulting increase in groundwater abstraction under Schedule 1 is of concern, in terms of the impact on groundwater quality. Pit latrines and diffuse pollution pose a threat to surface and groundwater quality. Applications for groundwater abstraction should only be considered once a groundwater quality Reserve determination has been carried out. **The Cape Peninsula Rivers** In Philippi, there is increasing use of groundwater from the Cape Flats Aquifer. Although improved monitoring is necessary, the Cape Flats aquifer does offer potential for supporting local commercial vegetable farming enterprises – very important to Cape Town. As such applications for groundwater use can be considered, with associate monitoring conditions attached. Applications for new licences have been received for surface water abstraction out of the Shusters River in Noordhoek, for development of vineyards. Those rivers in the Peninsula which have not been severely modified or degraded, remain ecologically important. As such, no further authorisations to abstract or store water from these rivers, should be considered at least until the Reserve has been determined and local yield balances accounted. Future planning by major users (notably CCT) is of concern, as the comprehensive Reserve requirements essential to that planning, are not yet available. **The Kuils / Eerste / Lourens / Sir Lowry's Pass Rivers** There is potential for further use of the Cape Flats aquifer and provision of water to commercial vegetable farmers on the Cape Flats. As such, applications for groundwater abstraction can be considered. Surplus water is also available in those severely modified rivers serving as conduits for transporting effluent to sea. The objective here should be to see as much as possible of this effluent treated and re-used by the CCT, and not allocated to irrigation. Most irrigators utilising surface water in this sub-area, do so through the provision of water allocated to them from Theewaterskloof Dam. Therefore, it is unlikely that there will be new irrigation developments outside of the schemes. Capping limits have been set on the amount of allocable water for irrigation, supplied from the WCWSS. **The Steenbras River** A reduction in the upstream area under forestry is bringing about change in land use - either rehabilitation to natural catchment or possibly a conversion to wild flower production or fruit orchards. The preferable strategy is to capitalise on this available water by rehabilitating the catchments and meeting the growing needs of the CCT with the additional water.

3.4	LICENSING (cntd)
Strategic approach	There is very limited opportunity for issuing new licences for the abstraction and storage of surface water in the Berg WMA. Some opportunity for groundwater abstraction is possible, with appropriate monitoring conditions attached to any such licences. New licences for augmenting urban supply can be considered once WC/DM objectives have been achieved, providing that the requirements of the Reserve are met. It would be irresponsible of the Department to issue new individual licences for surface water abstraction until more reliable and updated yield information is available, on both the resource and the Reserve, on which to support decisions. Certainly there is no more water available from current sources. It is highly unlikely that the irrigation sector would pay for further augmentation but this is the only way towards further licences unless water can be found through conservation or re-use. Priority must be given to re-assessing the yield within the WCWSS by remodelling the system and extending it to cover the full extent of the Berg River, from source to the Estuary. The priority in the Berg WMA must lie with the provision of water to the urban sector so as to optimally develop the economic potential of the Western Cape. Potential augmentation schemes will rely on the construction of major infrastructure so as to primarily take advantage of surplus winter water. Schemes such as the Lourens and Eerste River Diversions and the augmentation of Voëlvlei dam, will be considered, where such schemes are required to provide water to the urban sector, whilst meeting the requirements of the Reserve. More water will also be imported from the Breede. Licences for water trades will be considered, particularly where the trades are within the same sector or from a low value to a high value sector, benefiting both society and economy. Trades within the same catchment are also more likely to be licensed.

3.4	LICENSING (cntd)
MANAGEMENT ACTIONS	
Required actions:	The following actions are required: a. Implement the available RDM streamlining procedures for reducing the backlog of authorisation applications. The need for Reserve determinations on severely modified rivers needs to be relaxed. b. Determine additional resources required at RO for processing applications for authorisations. c. No further authorisations to be issued for surface water use along the Berg River. d. No further authorisations to be issued for surface abstraction in the Diep River catchment, until the yield balance has been more reliably determined. e. No further authorisation to be considered for surface water use in the Klein Berg catchment. f. Authorisations for groundwater abstraction can be considered, with the exception of the Diep River catchment where there is a need to first carry out a Reserve determination on the quality component of the groundwater. g. Allow the use of groundwater on the Peninsula. Reserve effluent return flows for recycling and urban/industrial use by the CCT. h. Prioritise Reserve determinations giving priority to major users for planning purposes (CCT, WCDM). i. Prioritise the processes towards compulsory licensing in the Berg WMA. WUAs to ensure compliance among its members of the conditions of their authorisations. j. Simple operating rules to be provided with each new authorisation to facilitate compliance with the Reserve requirement, for example, demarcating river water levels below which the farmer may not abstract.
Responsibility:	The implementation of the **Licensing** Strategy is the responsibility of the RO in conjunction with the Directorate: Water Abstraction and Instream Use and the Directorate: Water Allocation.
Priority:	Priority 1 – Very high.
Interfaces:	**a. Relevant documentation:** a1: NWA: Chapter 4, Parts 1 to 10 a2: NWRS: Chapter 3, Part 2 **b. Linked ISPs / WMAs:** Breede WMA**.** **c. Other role players and their functions:** Local authorities : By-laws to be considered for limitations on Schedule 1 use. **d. Related Strategies:** 1.3 Groundwater 2.1 Reserve and resource quality objectives 3.2 General authorisations 3.3 Verification of existing lawful use 3.6 Changing land use – forestry 3.7 Changing land use – clearing of invasive alien plants 3.8 Water pricing 4.2 Agricultural water conservation and demand management 8.4 Strategy for the Lower Berg 9.1 Abstraction control **e. Linked mapping:** None

3.5	POLLUTION CONTROL
Management objective:	The primary objective of the Pollution Control Strategy is improved management of: • River systems to achievable and acceptable water quality standards. • Point source pollution, diffuse pollution and spills.
Background information:	Chapter 3, Part 1 of the NWRS refers. The approach to water resource protection in the NWA includes consideration of water quantity and water quality. Water quality management deals with **point sources** (such as discharges from sewage treatment works or industrial sites), and **diffuse sources** (such as settlements without a sewerage system) of pollution through the discharge of waste, or water containing waste, into rivers or other water resources. In addition, because of their potential to impact on surface and groundwater resources, the Department is responsible for overseeing the management of sites where waste is disposed onto land. This is in terms of Section 20 of the Environmental Conservation Act, and by agreement with the Department of Environmental Affairs and Tourism. Decisions about the nature and extent of resource pollution which can be permitted are guided by a *hierarchical decision-making framework*, which takes account of the balance between the need to protect water resources for sustainable use, and the need to allow water-polluting activities in order to support social and economic development. The highest priority in the decision-making framework is to prevent water pollution through waste prevention and reduction, recovery, treatment and final safe disposal. It is however acknowledged that in many cases the discharge of pollutants into water resources is unavoidable, and in these cases the emphasis is on minimising the pollution and its effects on water resources. Where pollution has already caused degradation of water resources, or where contaminated land areas pose a threat to water quality, improvements and remediation must be effected where it is necessary and practical. Each application for authorisation to discharge wastes into water resources is preceded by an assessment of the probable impacts of the discharge on the water resource and other water users. For hazardous wastes, the aim is to prevent discharge wherever possible or, if this is not possible, to minimise the extent of the discharge and its impacts. For non-hazardous wastes the 'Receiving Water Quality Objectives' approach will continue to be used. This approach assumes that the water environment has a finite and quantifiable capacity to assimilate non-hazardous waste discharged into it without violating predetermined water quality objectives. The assimilative capacity, which will be different for each water resource and for each management class, must be equitably shared among all water users. Irrigation return flows, land use practice and reduced dilution due to upstream abstractions can also impact on salinity. This is a particular issue in the Lower Berg River at Misverstand Dam. Wherever possible, best management practices, relating to the treatment and recovery of waste, will be incorporated into licence conditions / source-directed controls, to prevent water resources being polluted. Whilst the overall intention is to prevent further degradation of the quality of the country's water resources, and to effect improvements where possible, limited and short term degradation of the water quality of specific water resources could be allowed if it can be demonstrated with confidence that the degradation will not be irreversible, and that pollution costs are not externalised to other users of the water resources. This strategy is closely related to the Water Quality Strategy (No 2.4) and should be read in conjunction with it.

3.5	POLLUTION CONTROL (cntd)
Background information (cntd):	*The following specific issues and concerns were identified in the Berg WMA*: **i. Berg River upstream of Hermon** • Aquaculture impacts on the water quality of rivers and dams (for example in the future Berg River Dam), increasing the costs of water purification.
	ii. Klein Berg River • Diffuse pollution from settlements in close proximity to the Klein Berg River, which feeds Voëlvlei Dam, is impacting on water quality in the dam. Runoff from the first winter rains is the most polluted and should preferably be allowed to bypass the dam in an attempt to reduce the impact. This however affects the yield of the dam. **iii. Berg River downstream of Hermon** • Salinity, particularly in the Lower Berg River, is experienced from time to time. **iv. Diep River** • Nitrate rich diffuse pollution occurs throughout the WMA, from feedlots, piggeries and chicken farms. The Diep River catchment is of particular concern. • Development, and sand mining in particular, are causing siltation problems in the Diep River. • Increased groundwater abstraction at Riverlands, and the use of pit latrines may be impacting on the groundwater quality. This needs monitoring. **v. Kuils/Eerste/Lourens/Sir Lowry's Pass Rivers** • Pollution in the Plankenbrug River (Stellenbosch) is impacting on water quality. The Khayamandi residential area (Stellenbosch) has inadequate services resulting in diffuse pollution, particularly after rains. Potential future schemes on the Eerste River may require pre-treatment, which has cost implications.
Strategic approach:	The disposal of pollution from both point source polluters as well as that from diffuse sources is threatening the water quality of the surface water resource in the Berg WMA. This impacts directly on the river health, on other users abstracting from the river further downstream and on the costs of treatment required to achieve potable water standards. Certain WWTWs are not treating to the quality standards required under their authorisation. Co-operative governance between the Department and local authorities must be focussed on this problem, to ensure that the local authorities accept responsibility for the quality of effluent from all WWTWs in their areas of jurisdiction. Voëlvlei Dam forms an integral part of the WCWSS, supplying the CCT and the West Coast District Municipality with water. The already stressed dam is likely to be further stressed if the quality of inflow from the Klein Berg River is so poor that this water must be made to bypass the dam at the start of the winter, with inflows only allowed once the river has flushed sufficiently. The problem in the Klein Berg catchment must be addressed with the local authority.

3.5	POLLUTION CONTROL (cntd)
MANAGEMENT ACTIONS	
Required actions:	Develop a detailed strategy for pollution control. The following actions are required: a. Dischargers are to be identified and registered. Once the waste discharge pricing strategy is in place a tariff will be imposed for discharging into rivers. b. GAs relating to the use of effluent for irrigation purposes need to be reviewed and revised as appropriate. c. Co-operative consultation between the relevant authorities is required to manage urban and agricultural diffuse pollution (co-operative governance) d. Procedures to be developed and implemented by operators of WWTW for emergency control of spillages, power failure, mechanical breakdown. e. Evaluate the existing pollution control mechanisms of wineries and industry. f. Co-operation between the RO, Departments of Agriculture and Mining, as well as local authorities, is required to manage sand mining and related rehabilitation (co-operative governance) g. The impacts of aquaculture on surface water quality need to be established. h. Aquaculture water users to be recognised as a waste discharger / polluter. i. A salinity modelling study is needed for the Berg River. j. The flushing in the Klein Berg River should be evaluated prior to the intended start of diversion, each year. Early rains that may occur in some years, might produce sufficient flushing, in which case the proposed bypass may not be necessary every year. k. Implement the dense settlement strategy (DWAF/DANIDA), drawing on co-operative governance with local authorities.
Responsibility:	The implementation of this strategy is the responsibility of the RO in conjunction with both the Water Resource Planning Systems and the Waste Discharge and Disposal directorates.
Priority:	Priority 1 – Very high.
Interfaces:	**a. Relevant documentation:** a1: NWA: Chapter 3, Part 1 a2: NWRS: Chapter 3, Part 1 a3: Appendix 3: Wastewater Treatment Works a4: Appendix 4: Solid Waste Disposal Sites **b. Other role players and their functions:** Department Agriculture : To investigate agricultural activities which impact on water quality. Department Public Works : Management and control of prison WWTW. Local authorities **c. Related Strategies:** 1.3 Groundwater 2.1 Reserve and resource quality objectives 2.2 Siting of new developments 2.3 Solid waste management 2.4 Water Quality 3.1 Implementing Schedule 1 3.2 General authorisations 3.8 Water pricing 5.2 Co-operative governance 6.1 Supply to local authorities 8.4 Strategy for the Lower Berg **d. Linked mapping:** Figure 3.5.1 - Municipal Boundaries and Waste Disposal Sites

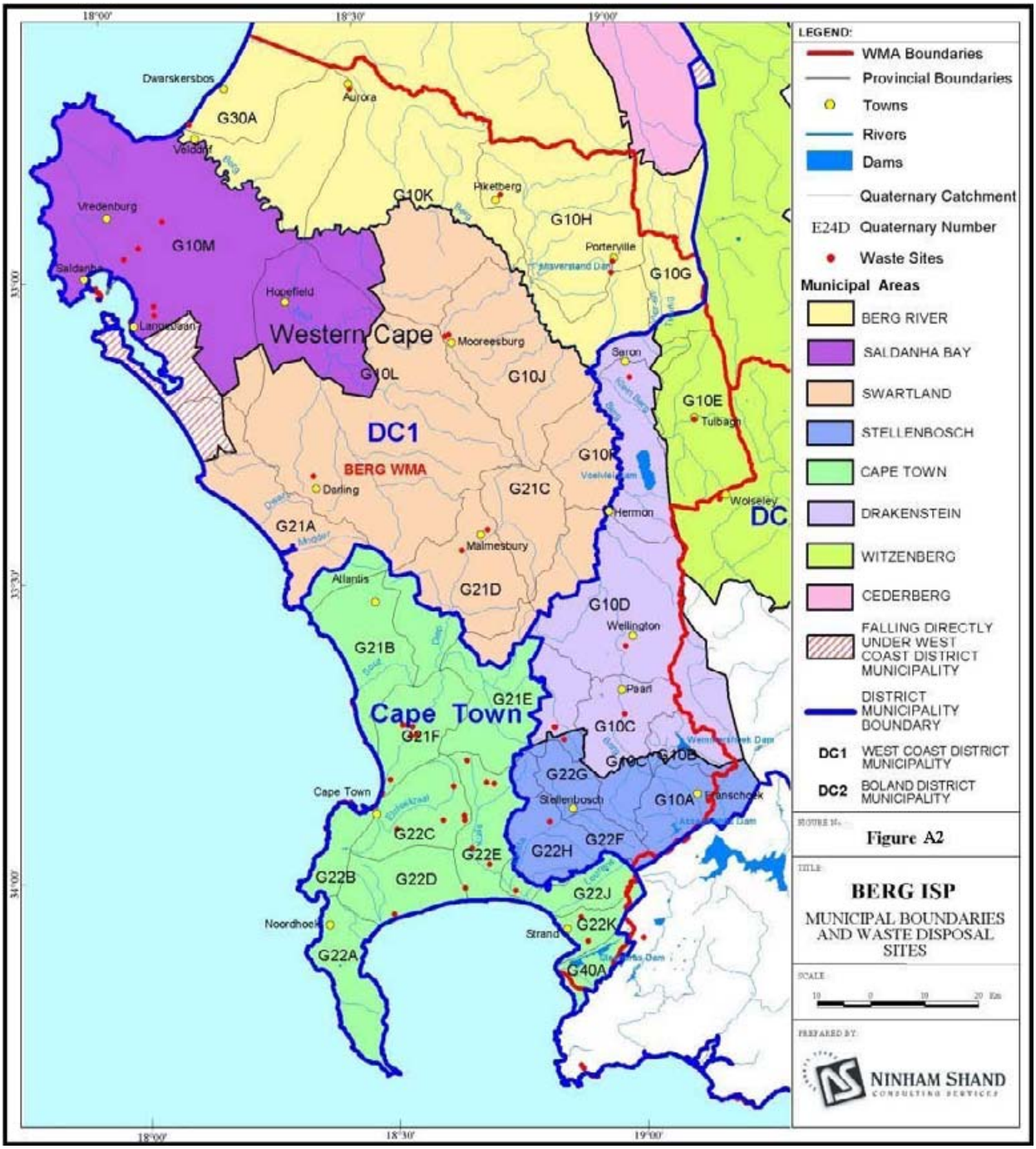

Figure 3.5.1: Municipal Boundaries and Waste Disposal Sites

3.6	CHANGING LAND USE - FORESTRY
Management objectives:	The primary objective of this strategy is to facilitate the processes required to address the decommissioning of commercial forestry operations in the Berg WMA.
Background information:	A broad policy is in place at National level for the trading of water rights. Section 25 of the NWA allows for transfer of water use authorisations, from the same resource, subject to application for such transfer. For example, a person holding an entitlement or current authorisation may surrender it (or part of it) to facilitate a licence application by another, for the use of that water (from the same resource) on other land. The recipient must, however, apply for a new authorisation. The decommissioning of much of the commercial forestry industry will release water and this may allow for trading of existing authorisations currently held by the commercial forestry operators, of which SAFCOL holds the predominant market share. The following issues/concerns have been identified: • For each proposed change in land use, a site-specific investigation is required, which is time-consuming. The core principle is that there should be no negative impact on other downstream users. • SAFCOL (existing lawful user) is decommissioning its forestry operation and felling its plantations in the Western Cape. This forestry is on State Land and its proposed future use is still uncertain. • SAFCOL should be entitled to enter into trading of their existing authorisations. This would need to be based on impact on yield, and would have to take Assurances of Supply into account. The State is also the sole shareholder in SAFCOL and could therefore presumably influence any attempt to trade water rights. • No mapping of forestry is recorded, other than that held by commercial operators. • The verification of lawful use in terms of private afforestation is difficult without mapping.
Strategic approach:	Water Resource Managers must develop a clear picture of the water resource implications of SAFCOL's exit strategy in each quaternary catchment, and of the opportunities this presents. This applies to any other operators who are also choosing to leave the forestry sector in the Western Cape. The water that will be released through the closure of plantations should be known to managers through the forestry licence. If there is no licence then the same computation used in issuing a licence, can be applied. If not licensed then this water returns straight to the State and decisions with regard to reallocation can be made on the basis of condition of the catchment, the allocations strategy for that catchment, and on special demands (such as resource poor farmers). Applications for new forestry required to compensate this loss in timber resources need to be considered sympathetically by the SFRA Licence Assessment Advisory Committee, particularly where this calls for the use of the same water that is being freed up. Should the plantations have been licensed then SAFCOL may have some claim to the water for trading purposes. Alternatively (and more likely) some water should be available for reallocation. Any water becoming available should be reallocated to poverty alleviation / rural development if at zero or low cost. Trading should be into urban use. In many cases water from deforestation could feed into the WCWSS. Only as a last resort (no other takers) should this water be allowed to go into commercial irrigation. The RO must be in possession of SAFCOL's exit strategy, and of the various plans for alternative uses suggested in that strategy. DWAF must also stay on top of any other possible closures. Possible alternatives to forestry need to be assessed and at least provisionally approved from a water resources perspective. It is important that SAFCOL be fully aware of their rights and responsibilities with regard to the water resource, particularly where the company is suggesting alternative water demanding activities in the place of existing forestry.

3.6	CHANGING LAND USE - FORESTRY (cntd)
MANAGEMENT ACTIONS	
Required actions:	The following actions are required: a. A co-operative governance decision is required regarding the decommissioning of SAFCOL and the use of the State owned land (RO in conjunction with Department of Environmental Affairs and Development Planning, Department of Agriculture and local authorities). b. Liaison with SAFCOL and the SFRA LAAC (Stream Flow Reduction Activities Licence Assessment Advisory Committee) to discuss whether there are any water use rights attached. c. The availability of water resulting from changes between certain land use types needs to be studied on an area-specific basis. d. RO to develop plans and procedures for re-allocation of water which becomes available from changing land use, taking assurances of supply into consideration. e. Registration and licensing of all commercial afforestation to be completed.
Responsibility:	The implementation of the **Changing Land Use – Forestry** Strategy is the responsibility of the RO in conjunction with the Directorate: Water Abstraction and Instream Use.
Priority:	Priority 1 – Very high. To be implemented over the medium term.
Interfaces:	**a. Relevant documentation:** a1: NWA: Chapter 4, Part 2 a2: NWRS: Chapter 3, Part 2 a3: Berg Water Resource Situation Assessment Report: Chapter 5 **b. Linked ISPs / WMAs:** None**.** **c. Other role players and their functions:** *SAFCOL* : Largest commercial forestry operator in the Berg WMA. *Department Agriculture and Department of Land Affairs:* Opportunities on converting forestry land - especially for resource poor farmers *Department Environmental Affairs and Development Planning:* To participate in the review of future land use where State owned land becomes available. *SFRA LAAC:* Licensing of new forestry to replace declining supplies of raw material. **d. Related Strategies:** 3.4 Licensing 3.7 Changing land use – clearing of invasive alien plants 3.8 Water pricing 5.1 Support to resource poor farmers 5.2 Co-operative governance **e. Linked mapping:** None

3.7	CHANGING LAND USE – CLEARING OF INVASIVE ALIEN PLANTS
Management objective:	The goal is to optimise benefits to the water resource through the clearing of invasive alien plants. The first objective is to ensure that Working for Water and other initiatives responsible for the clearing of invasive alien plants are fully aware of the extent of invasive alien plants, the water used, and the water resource management priorities. Working for Water must work closely with water resource managers in both planning and action.
Background information:	The clearing of invasive alien plants, primarily through the WfW (Working for Water) programme has site-specific impacts. There is a need to focus the clearing effort on areas in which the greatest maximum benefit may be achieved, particularly in terms of the water resource. Whilst water benefits are recognised there has been no clear strategy to maximise the impacts. The introduction of a water resource management charge (April, 2002) payable by all users will put pressure on managers to see that clearing is directed at achieving the best results. Although increased surface runoff is the primary yardstick with which to measure the impact of clearing, it is important to recognise that the groundwater resource is also impacted upon by invasive alien plants. There are also many other pressures - notably the value of biodiversity, the control of erosion of both stream banks and landscapes with water repellent soils, the reduction in fire hazard, the need to provide a social benefit (with much of the funding coming for the national poverty relief programme), and the sheer practicality of employing large numbers of workers in remote areas under difficult circumstances. The following aspects relating to clearing of invasive alien plants are relevant to the Berg WMA: • 2001 aerial photography was done for the whole WMA, but interpretation of information was focused only on areas where WfW projects are being implemented. Mapping of the aerial photography is not yet complete. • The removal of blue-gums (Category 2 IAP) upsets the bee keepers – affecting both the production of honey and the maintenance of hives necessary for fruit tree pollination. WfW in the Berg WMA has concentrated on State owned land through funding provided mainly by the DWAF trading account. Clearing has been focused on the uppermost reaches of the Berg River, 30m on either side of the river channel and in the high mountain areas where priority is on light infestations so as to reduce the spreading of seeds. The priority is firstly to provide more water, thereafter bio-diversity and job creation. The benefits of clearing can only be determined through ongoing monitoring which links to the need for mapping. Invasive alien plants are known to use significant volumes of water – dependent on biomass but not dissimilar to forestry plantations. Water use in riparian zones, where invasive alien plants are most prevalent, including much of the mainstem of the Berg River, is generally reckoned to be double that of landscape invasions. The Berg River is one of the most densely invaded, if not the most densely invaded WMA in South Africa. Water use by invasive plants must be seen as that water over and above that water which would be used by the natural vegetation it has replaced. It is also necessary to partition impact into the impact on available resources – in other words the reduction in supplies which would otherwise be available to other users (typically storage in dams) and the impact on the Reserve, which would be how the whole resource is affected – and this particularly in the dry season, low flow months.

3.7	CHANGING LAND USE – CLEARING OF INVASIVE ALIEN PLANTS (cntd)
Strategic approach:	The priority in this WMA is to provide more water, thereafter bio-diversity and job creation. The magnitude of impact of invasive alien plants on the water resource, and more importantly what would happen if there were no clearing, are numbers that should be on every water manager's desk (this includes institutions outside of DWAF). At the moment they are not! The clearing of invasive alien plants is an important water conservation and demand management strategy (Strategies 4.1 and 4.2). DWAF will not approve further infrastructure development to supply water to Local Authorities unless it is clear that all possible steps are being taken to maximize other available water through this strategy. Management of the Berg River cannot afford to lose the battle with invasive alien plants. The first strategy is that 'prevention is better than cure' and the first level of focus should be on the control of further infestations through restrictions on new sources (e.g. forestry plantations in remote areas), and through the clearing of remote, scattered and outlying invasive plants. WfW must be encouraged to take this approach. The second strategy is to ensure that clearing activity (and it can be accepted that much of this activity will be centred on densely infested areas and this is where jobs can most easily be created) is focused in those areas where the maximum benefit to the water resource can be achieved. This is dependent on both the nature of downstream use and the availability of dam storage. It is absolutely essential that the clearing operation is consistent and that WfW stick to their plans and stay up to date with their tasks, especially follow-up operations. This becomes even more important where water is estimated to have been freed up through clearing and has since been allocated to other users. Finally, impacts need to assessed through monitoring – both the mapping of the extent of invasions, and actual benefits to the resource experienced through clearing. Some small farmers have taken to clearing their own catchments and the publication of their 'success stories' could encourage other farmers in the WMA to take responsibility. It should be noted that the black wattle industry plays no part in the economy of the Western Cape, yet the wattle species (*Acacia mearnsii, Acacia decurrens, Acacia dealbata*) are major invaders, especially of riparian zones. Bio-control is an obvious solution. It is necessary to estimate the costs of wattle invasions to both water and the environment in order to encourage decision-makers that bio-control research must be pursued and bio-control implemented. One important additional strategy would be to offer incentives to private landowners for the clearing of invasive alien plants. These could include subsidies for clearing, provision of free or subsidised herbicides, and the taking of good land use practice into consideration when evaluating re-allocations. Much of this can be seen as the function of WfW and perhaps the most that Water Resource Management can do is to make sure that WATER stays on the top of the agenda.

3.7	CHANGING LAND USE – CLEARING OF INVASIVE ALIEN PLANTS (cntd)
MANAGEMENT ACTIONS	
Required actions:	The following actions are required: a. Establish a co-operative planning process together with Working for Water (and CCT and other interested parties as appropriate), to ensure that the clearing of IAPs in the Berg River is effectively prioritised, and that water resource provision plays its due role in that prioritisation. b. Improve estimates of the actual extent of invasive alien plants in the Berg WMA, and the impact on water resources – as a matter of urgency in support of planning and strategy. Estimates should include species, location (key area, and position in the landscape), and density. c. Prepare a strategy for the clearing of invasive alien plants in the Berg from a water resource management perspective. This should include priority areas, a strategy of prevention by tackling less invaded areas and thus avoiding the densification of populations and the need for later rehabilitation of these areas, and support for bio-control initiatives. d. Determine the priority areas for clearing from a water resource perspective. e. Consider the provision of incentives to private landowners for clearing invasive alien plants. These could include subsidies for manual clearing, provision of free or subsidised herbicides, and taking good land use practice into consideration when evaluating re-allocations. The biggest incentive of all would be to allow land-owners to use some or all of the water released through clearing practices on own land. f. Ensure that catchment management charges are applied equitably and effectively towards invasive alien plant clearing, with the ultimate goal being the removal of all invasive alien plants. g. Working for Water need to attend (i) to the completion of invasive alien plant mapping and interpretation from 2001 aerial photography (ii) Reconciliation of mapping with clearing data collected. h. Monitor the impacts of clearing of invasive alien plants – water yield, sedimentation and quality.
Responsibility:	The implementation of the strategy **Changing Land Use – Clearing of Invasive Alien Plants** is the responsibility of the RO in conjunction with the Directorate: Working for Water as well as the Directorate: Water Abstraction and Instream Use..
Priority:	Priority 1 – Very high. To be implemented over the medium term.
Interfaces:	**a. Relevant documentation:** a1: NWA: Chapter 4, Part 4 a2: NWRS: Chapter 3, Part 3 a3: Berg Water Resource Situation Assessment Report: Chapter 5. **b. Linked ISPs / WMAs:** None**.** **c. Other role players and their functions:** WfW : clearing of invasive alien plants. **d. Related Strategies:** 3.4 Licensing 3.6 Changing land use – forestry 3.8 Water pricing 5.2 Co-operative governance **e. Linked mapping:** None

3.8	WATER PRICING STRATEGY
Management objective:	Ensure financial sustainability and generation of funds for water resource management, whilst achieving social equity and efficient water use.
Background information:	Section 56 of the NWA provides for a pricing strategy, allowing for differentiation among geographical areas, categories of water users or individual water users. The *"Pricing strategy for raw water use"* was tabled in November 1999. Pricing requires that water use has been registered or licensed. Charges are being phased in. The pricing of waste discharge was not covered under the initial pricing strategy but is now in preparation (2003). Differential charges for geographic areas, different categories of water use, and different water users are provided for. It is aimed to eventually recover the full financial cost of 1st tier water from water users. An economic charge could eventually be introduced to reflect the relative scarcity of water. The activities of the CMAs (or DWAF in the interim) will be funded from the water resource management charges. Tariffing in a WMA will eventually be set by the CMA, and funds due will be passed on. The following relevant aspects were identified: • The CCT pays a single system tariff as it utilises three major schemes (Palmiet, Riviersonderend and Voëlvlei schemes). This brings inherent efficiency as the System is managed to maximise resources, and not cost saving. • The West Coast District Municipality currently pays no system tariff. It is reliant on the regional schemes which draw on bulk water from Voëlvlei Dam Government Water Supply Scheme. • A payment agreement has been reached with the CCT, in which they will pay the capital redemption for the Berg Water Project, whilst the scheme will be owned by the implementing agent (Trans Caledon Tunnel Authority, TCTA) for 20 years. • Catchment management charges contributed to, amongst other things, WfW. The use of these funds was aimed at benefiting the major contributors. • In April 2002, the catchment management charge was superceded by a Water Resource Management charge, which is directed at all users. • An agreement has been reached with agriculture in which that sector will pay system depreciation charges for supplies from existing government water schemes. This sector will not contribute to the capital costs existing schemes, but will pay both depreciation and capital contribution costs for water supplied from any new government water scheme. • The RO performs its own tariff calculations, contrary to the rest of the country, where the Directorate Water Abstraction and Instream Use performs that task.
Strategic approach:	Pricing is critical to the raising of catchment management funds – and therefore also to the sustainability of the resource. Pricing is also a fundamental tool in Water Demand Management. The key strategy to be adopted in tariffing in the Berg WMA is to ensure that there are no inducements to users to draw water from particular systems to the detriment of the overall management of the resource. The impact of pricing on both use and behaviour patterns needs to be closely monitored. The link between Pricing and Assurance of Supply should be clearly made. Pricing should not serve as a constraint to desirable development, or result in the unreasonable demise of any particular sector, or cause undue and unfair hardship. It is the responsibility of the Region to keep an eye on the situation and to either make internal adjustments or to advise and negotiate with the National Department should this at any time seem necessary and appropriate.

3.8	WATER PRICING STRATEGY (cntd)
MANAGEMENT ACTIONS	
Required actions:	The following actions are required: a. Incremental implementation of the *National Pricing Strategy*. Prioritise the water uses that have the most significant impact and are consumptive. b. Set charges for funding water resource management, development and use of waterworks, and for achieving the equitable and efficient allocation of water. c. Implement pricing for waste discharge as soon at this approach has been finalised. d. Prioritise implementation of tariffs for water supplied from Government Water Schemes. e. Implement effective mechanisms and structures for income generation, proportioning and accounting of funds collected from tariffing. f. Consider introducing a system tariff to the West Coast District Municipality. g. Monitor the impact of the implementation of pricing on land use, the economy, the environment and society (especially jobs). Indicate immediately should contrary effects be observed. Pricing, along with predicted and observed impacts, should be a fixed item on the agenda of local and regional water management structures.
Responsibility:	The implementation of the **Water Pricing** Strategy is the responsibility of the Directorate Water Utilisation in conjunction with the RO.
Priority:	Priority 1 – Very high. To be implemented incrementally over the medium term.
Interfaces:	**a. Relevant documentation:** a1: NWA: Chapter 5, Part 1 a2: NWRS: Chapter 3, Part 4 **b. Linked ISPs / WMAs:** None**.** **c. Other role players and their functions:** None **d. Related Strategies:** 3. Water use management strategies 4. Water conservation and demand management strategies 8. Waterworks development and management strategies **e. Linked mapping:** None

SECTION 4: STRATEGIES FOR WATER CONSERVATION AND DEMAND MANAGEMENT

The NWRS indicates that at a national level, the options for further augmentation of water supply through further physical infrastructure (particularly new dams) are limited. Attention needs to be devoted to managing the demand for water, encouraging the efficient and effective use thereof and minimisation of loss or waste of water.

The National Water Conservation / Demand Management (WC/DM) Strategy is currently being developed. This strategy is based on the reasonable premise that many water users can maintain their quality of life and achieve the desired outcomes from their water use, whilst using less water. Furthermore significant reductions in water use can be achieved by changes in behaviour and the adoption of water-saving technologies.

The National WC/DM Strategy is based on three basic principles, namely:

i. Water institutions should strive to supply water efficiently and effectively, minimise water losses, and promote WC/DM among their consumers.

ii. Users should not waste water, and should strive to use it efficiently.

iii. WC/DM should be an integral part of water resources and water services planning processes. Where future schemes are proposed, the appropriateness and cost effectiveness of demand-side solutions must be considered alongside supply-side augmentation options.

The foundation of the WC/DM Strategy is the creation of a WC/DM culture within all water management and water services institutions and among water users. The main sectoral users within the Berg WMA are the urban and the agricultural sector. The extent of consumptive bulk water use by mining, major industry and thermal power stations is not significant in the Berg WMA. As such, a stand-alone strategy for industrial water conservation and demand management has not been developed in this ISP. The water services water conservation and demand management strategy is deemed to cover industry as well.

Three strategies have been identified for development, namely:

4.1 Water Services Water Conservation and Demand Management
4.2 Agricultural Water Conservation and Demand Management
4.3 Effluent Re-Use

4.1	WATER CONSERVATION AND DEMAND MANAGEMENT: WATER SERVICES
Management objective:	The objective of this strategy is to entrench the concept of effective water conservation and demand management by local authorities, most particularly in areas of stress and where new supplies otherwise have to be developed.
Background information:	The National Water Conservation and Demand Management Strategy, currently being developed by DWAF, aims at entrenching WC/DM by insisting on efficient water management and use before additional supplies are considered. The "*Water Resource Situation Assessment Report*" for the Berg WMA, identifies the fact that despite the implementation of several water conservation and demand management programmes over time, the levels of "unaccounted for" water are growing. The implementation of water restrictions, which has been necessary in recent years, is indicative of the stressed nature of the Berg WMA. The anticipated economic growth in this region will further increase the water requirements of the urban sector. Effective water conservation and demand management may allow for improved assurances of supply as well as the postponement of new schemes – even though these may prove inevitable in the longer term. The comprehensive Reserve requirements have yet to be determined. Indications are that these may well exceed the current requirements set through initial determinations. It is likely, therefore, that the availability of water will be further reduced once the Berg WMA Reserves are finally established. The CCT has embarked on a water conservation and demand management programme and a demand management target of 20% reduction on projected demands by 2013 has been set. See also the strategy for Effluent Re-use (Strategy 4.3). The CCT has a "zero effluent" discharge plan which is looking at making optimal use of the effluent currently being discharged to sea.
Strategic Approach:	The Department will continue to entrench the importance of and encourage the implementation of WC/DM as an effective reconciliation intervention. Local authorities will be required to implement WC/DM before DWAF will permit the development of new local supply schemes. User education, and capacity building within the provider, are fundamental steps to be taken in implementing WC/DM effectively. In line with the strategy to provide degrees of technical assistance to local authorities for managing their supply schemes, support will be provided by DWAF in facilitating the implementation of WC/DM. A lot can still be achieved in terms of effluent re-use in the Berg WMA and this must be strongly encouraged. Return flows in the Peninsula rivers should not be allocated to agriculture but held over for recycling for urban and industrial use (see also Strategy 6.1). The key approach is to support the CCT and smaller Local Authorities in their endeavours, to recognise successes, and to offer support or incentives where these are appropriate.

4.1	WATER CONSERVATION AND DEMAND MANAGEMENT: WATER SERVICES (cntd)
MANAGEMENT ACTIONS	
Required actions:	The following further actions are required to improve demand management efforts in the urban sector of the WMA: a. The WSDPs of local authorities should list the water conservation and demand management initiatives that are being implemented as well the associated targets that have been set by local authorities. b. The WSDPs submitted need to be reviewed to ensure that water conservation and demand management objectives that have been included are realistically achievable. c. Water 'recovered' through demand management should be prioritised to meet the needs of urban growth and of the Reserve.
Responsibility:	The implementation of the Strategy for **Water Conservation and Demand Management : Water Services** is at National level (Directorate: Water Use Efficiency) with input from the RO.
Priority:	Priority 1 – Very high. To be implemented on an ongoing basis.
Interfaces:	**a. Relevant documentation:** a1: NWRS: Chapter 3, Part 3 a2: Berg Water Resource Situation Assessment Report: Chapter 5 a3: CMA Integrated Water Resource Planning Study – Report 6 a4: Appendix 8: Old and New Municipalities **b. Linked ISPs / WMAs:** None**.** **c. Other role players and their functions:** Local authorities : To complete and submit realistic WSDPs. **d. Related Strategies:** 3.8 Water pricing 4.2 Agricultural water conservation and demand management 4.3 Effluent re-use 6.1 Supply to local authorities 8.5 Operation during extreme drought **e. Linked mapping:** None

4.2	AGRICULTURAL WATER CONSERVATION AND DEMAND MANAGEMENT
Management objective:	To create a culture of water conservation through efficient irrigation methods and to promote equity amongst all users.
Background information:	The National Water Conservation and Demand Management Strategy, currently being developed by DWAF, aims at entrenching and insisting on efficient water management and use. The "*Water Resource Situation Assessment Report"* for the Berg WMA, identifies the fact that despite the implementation of several water conservation and demand management programmes over time, the levels of "unaccounted for" water are growing. In the agricultural sector, conveyance losses and poor efficiency contribute to the overall losses. Irrigation accounts for an estimated 41% of total consumptive water requirements (i.e. excluding the ecological Reserve) in the Berg WMA. Irrigation losses are often quite significant and it is estimated that where inefficient irrigation methods are practised, often no more than 80% of water abstracted from water resources is correctly applied to the root systems of plants. However, efficient on-farm irrigation methods are generally used in the Berg WMA. Some irrigation system losses return to the river systems but this 'Return Flow' can be of reduced quality. Irrigation methods, irrigation scheduling, soil preparation, crop selection, crop yield targets and evaporation all affect the efficient use of water. Conveyance losses can be significant and in the Berg WMA these are mainly due to riparian losses as rivers serve as the main bulk distribution system. Irrigation losses could be reduced in the Berg WMA by reducing riparian losses though the removal of invasive alien plants from the riparian zones. Procedures need to be in place to ensure that water which is made available through WC/DM is used appropriately elsewhere. This is of particular importance if the water saving has been achieved through incentives directed at farmers.
Strategic Approach:	The Department will continue to entrench the importance of WC/DM as an effective reconciliation intervention. The suite of tools comprising of Best Management Practices, water audits and benchmarks developed by the Directorate: Water Conservation will be tested and refined in specific case studies. These will be implemented through the WUAs. Water conservation and demand management, compulsory licensing, and re-allocation must be carefully synchronised. WC/DM can be aimed at (i) bringing more water into immediate production, or (ii) taking inefficiencies out of the system and recovering this water for use by others, notably in the meeting of urban, industrial and equity needs. Synchronisation with Compulsory Licensing is important so that when cuts in allocations are made (for the Reserve or for Equity) the adjustments can relatively easily be made, at least by some, through improved efficiencies. It is a concern that farmers implement WC/DM, and then promptly expand their agricultural activity to take up the water saved. If the objective is to bring this water back into the bigger system it will require that safeguards and incentives are put in place at the outset. When evaluating re-allocation options, cognisance should be given to those farmers who have conscientiously made long-standing and ongoing efforts to be more efficient in their use of water for irrigation.

4.2	AGRICULTURAL WATER CONSERVATION AND DEMAND MANAGEMENT (cntd)
MANAGEMENT ACTIONS	
Required actions:	The following actions are required: a. Synchronise the implementation of water conservation and demand management with the introduction of compulsory licensing and re-allocations. b. Consider (i) the use of subsidies for installation of efficient irrigation systems, (ii) incentives/subsidies for clearing invasive alien plants on private land, and (iii) rewards for increased efficiency, e.g. by offering a higher assurance of supply. c. Recognition of efficiency could be taken into account in the determination of re-allocations during compulsory licensing. d. Set targets with WUAs for the re-allocation, particularly to equity users, of water which can be made available through water conservation and demand management.
Responsibility:	The implementation of the strategy for **Agricultural Water Conservation and Demand Management** in the Berg WMA is a Regional responsibility, in consultation with the Directorate: Water Use Efficiency.
Priority:	Priority 1 – Very high. To be implemented on an ongoing basis.
Interfaces:	**a. Relevant documentation:** a1: NWRS: Chapter 3, Part 3 a2: Berg Water Resource Situation Assessment Report: Chapter 5 **b. Linked ISPs / WMAs:** None**.** **c. Other role players and their functions:** Department of Agriculture. **d. Related Strategies:** 3.3 Verification of existing lawful use 3.4 Licensing 3.8 Water pricing 4.1 Water conservation and demand management : water services 4.3 Effluent re-use 8.5 Operation during extreme drought **e. Linked mapping:** None

4.3	EFFLUENT RE-USE
Management objective:	To maximise the re-use of effluent rather than allowing for its discharge to the sea.
Background information :	The NWRS highlights the fact that in the inland parts of the country, water returned to rivers either directly or as seepage return flow and becomes available for re-use further downstream. In areas close to the coast, this is often not the case and the focus becomes one of direct use of treated effluent. Agricultural, industrial and domestic use each require different treatment processes, each with their own cost implications.
	The relatively low exploitation of effluent re-use has both demand management and environmental impacts. On the environmental side urban rivers are serving as conduits for ever-increasing volumes of effluent. These urban rivers have long ceased to behave according to any seasonal pattern, and remain full flowing for much of the year. Typical examples are the Black / Salt River and the Kuils River.
	Approximately 180 million m^3 of treated effluent is currently discharged annually from WWTWs in the Berg WMA. 22 million m^3/a is currently directly re-used from the CCT's WWTW.
	Clearly if all additional effluent in the Berg WMA could be re-used then the need for other augmentation could be substantially reduced and delayed. Full re-use would bring an extra 158 million m^3 in to the system, but at increased cost.
	The CCT is currently investigating the re-use of effluent as part of its Integrated Water Resources Planning Study and has an objective of achieving zero effluent discharge although precise dates for this have not been set.
Strategic approach:	Effluent from the Greater Cape Town Metropolitan Area represents a significant opportunity for re-use. This applies to all local authorities. The effort by the CCT to explore the most cost effective means of utilising this potential serves as an example to other local authorities as to what can be achieved.
	Cost effective effluent re-use must be encouraged in all cases. This particularly where there is a need to augment supplies. The development of new water resources infrastructure will not be sanctioned by DWAF until it is apparent that the potential for effluent re-use has been determined and implemented, where it is proven cost effective to do so.
	DWAF will, wherever possible, provide technical assistance to those local authorities and implementing stakeholders, where technical capacity may be a limitation.

4.3	EFFLUENT RE-USE (cntd)
Required actions:	The following actions are required: a. Promote maximum re-use of effluent. This can also be encouraged through the pricing and licensing, with licenses for additional water conditional on maximum re-use. b. Review the approaches undertaken by the CCT in terms of its objective regarding the increased use of treated effluent. c. Ensure information will be compatible with information needs, to make final decisions on best reconciliation intervention options. d. Initiate similar investigations by other local authorities, outside of the CCT. e. Identify and address gaps in planning for re-use of treated effluent. f. Identify the points of discharge for all WWTW. Only CCT WWTW discharge points have been established (see Appendix 3). g. Investigate the viability of piping treated effluent to appropriate areas for recharging aquifers. h. Determine the environmental impacts (positive and negative) that may result from a decrease of flows in the urban rivers, if direct re-use of effluent is increased.
Responsibility:	The implementation of the **Effluent Re-Use Strategy** is the responsibility of the RO in consultation with the Directorate: NWRP.
Priority:	Priority 1 – Very high. Ongoing implementation over the long term.
Interfaces:	**a. Relevant documentation:** a1: NWA: Chapter 4, Part 5 a2: NWRS: Chapter 2 a3: CMA Integrated Water Resource Planning Study a4: Appendix 3: Wastewater Treatment Works **b. Linked ISPs / WMAs:** None**.** **c. Other role players and their functions:** Local authorities : Operate and maintain WWTW in the Berg WMA. Department of Public Works : Operate and maintain WWTW at prisons in the Berg WMA. **d. Related Strategies:** 1.1 Reliability of the yield balance 1.3 Groundwater 2.1 Reserve and resource quality objectives 3.2 General authorisations 4.1 Water conservation and demand management: Water Services 4.2 Agricultural water conservation and demand management 5.2 Co-operative governance **e. Linked mapping:** None.

SECTION 5: INTEGRATION AND CO-OPERATIVE GOVERNANCE STRATEGIES

The Berg WMA has no international borders and there is therefore no interface with international authorities. However, the strategies developed for any WMA interface with those of other South African Government Departments, local authorities and water resource institutions. The task of Integrated Water Resources Management creates an inherent need for establishing co-operative relationships with those organisations.

The water resource management of the Berg WMA involves close interaction with the other major owner and operator of water resource infrastructure, namely the CCT. This relationship has developed through the need to jointly plan and manage the operation of the WCWSS. Various other initiatives have been introduced to further establish co-operative planning in terms of water resource management.

In addressing inequities of the past, the provision of an equitable share of available water to previously disadvantaged communities is being addressed. The establishment of resource poor farmers and the provision of water to areas in which land restitution is in progress must be prioritised. The water reconciliation for the Berg WMA has shown that there is no surplus water for allocation to resource poor farmers. An approach must therefore be adopted to make water available. This is likely to involve re-allocation of existing authorisations through a process of compulsory licensing. Co-operation between DWAF, the Department of Agriculture, and the Department of Land Affairs is fundamental to addressing the needs of resource poor farmers.

The National Environmental Management Act (NEMA) was gazetted in 1999. This is a ' Framework Act'. The implementation of the NWA and the management of water resources are subject to NEMA (See strategy for Managing the Environment, No 5.3).

Three strategies have been identified under Integration and Co-operative Governance, namely:

5.1 Support to resource poor farmers
5.2 Co-operative governance
5.3 Managing the environment

5.1	SUPPORT TO RESOURCE POOR FARMERS
Management objective:	The objective of this strategy is to provide a measure of equity in the allocation of water resources within the WMA and to offer further assistance to resource poor farmers. This can be achieved through the Irrigation Action Committee (IAC) and the Water User Associations (WUAs).
Background information:	The rural population in the Berg WMA constitutes only 5% of the total, hence the rural (non-commercial) water use is small when compared with urban water use. Re-addressing inequities of the past includes the needs of rural settlements and those of resource poor farmers (also referred to as "emerging farmers"). There are two aid components which need to be distinguished from one another, namely: • Assistance to resource poor farmers. • Assistance to small towns and settlements for general access to water. The latter component is the responsibility of the relevant local authority. Making water available is the key in both instances. Subsidies are available to resource poor farmers via two funding mechanisms, namely: • The pricing strategy for bulk water • Capital cost subsidies from Government. DWAF provides support to resource poor farmers through the IAC. Once WUAs are in place, they too will be able to assist resource poor farmers through subsidies from Government. Individual resource poor farmers seeking assistance are typically identified through non-governmental organisations (NGOs). The question of land availability for such farmers is addressed through the Department of Agriculture or the Department of Land Affairs. From here, the provision of water to irrigate the land is addressed through the IAC. There appears to be a relatively low demand from resource poor farmers for new agricultural land within the WMA – but this must be carefully assessed.
Strategic approach	An important part of the vision and mission of DWAF is to address past inequities with regard to the way water has been allocated. One obvious strategy is to make water more readily available to resource poor farmers. In the case of the Berg WMA there is immense pressure on the resource to meet the needs of the CCT, the West Coast, and all its people. The role that these areas play in the economy of the WMA, and in generating wealth for the bulk of its population means that any constraint to its development will contribute to the poverty of all who live there. This has meant that little or no new water can be made available to new irrigation. DWAF nevertheless has a responsibility to resource poor farmers and this can be met in the following ways: (i) If and where resource poor farmers have a requirement for water, and should that water be available, then these applications should be given priority over any other agricultural use. Where water does become available the possible use by the resource poor should be determined before any allocations are made to others; (ii) The redistribution of land out of the hands of the establishment and into the hands of the resource poor, with the concomitant water allocation, should be facilitated. Co-operation with the Department of Land Affairs is required for this; (iii) Great care should be taken to ensure that resources currently utilised by existing resource poor farmers, such as the Philippi vegetable growers, are not threatened. The Cape Flats Aquifer offers an opportunity here. (iv) Investigation and promotion of small-scale (community garden) irrigation based on groundwater resources. (v) The use of joint ventures in which established commercial farmers are teamed up with emerging farmers and receive a shared allocation.

5.1	SUPPORT TO RESOURCE POOR FARMERS (cntd)
Strategic Approach:	The re-allocation of water to the resource poor through compulsory licensing is a drastic step, which must be taken in the face of major inequity and demand. This does not appear to be the situation at all in the Western Cape, where there is no communal land and very few 'disadvantaged' farmers. Pockets of demand and any broad trends need to be identified and taken into the planning process. Close negotiations should be entered into with the Departments of Agriculture and Land Affairs to ensure that expectations are not raised amongst the resource poor, and that the capacity of the resource is not exceeded in trying to meet these development needs in the face of the overall development imperative. The limitations on the water resource must be very clear to these Departments. Together with these Departments, innovative solutions must be sought and found. The establishment of the IAC provides the platform for co-operative governance between the relevant government departments, in relation to resource poor farmers. This platform should be used to define the roles of each authority with regard to the development of these farmers.

5.1	SUPPORT TO RESOURCE POOR FARMERS (cntd)
MANAGEMENT ACTIONS	
Required actions:	The following actions are required: a. Assess the demand for equity water for agriculture (emerging farmers). Identify land reform and restitution initiatives. Assess the various projects which the Department of Agriculture has initiated or is planning and work through the water resource implications with that Department. b. Sharing of available water resources in certain areas will require re-allocation through compulsory licensing. c. Support for resource poor farmers to be a continued focus of the IAC, through co-operative governance between DWAF, the Department of Land Affairs, the Department of Agriculture and the Western Cape Nature Conservation Board (WCNCB). d. The inclusion of resource poor farmers within WUAs. e. The use of groundwater is to be evaluated in terms of a source of supply to small schemes. f. Areas need to be identified where it may be possible to develop and sustain resource poor farmers in the WMA.
Responsibility:	The implementation of the Strategy for **Support to Resource Poor Farmers** is the responsibility of the RO in conjunction with the Directorate: Water Resource Finance and Pricing and the Directorate: Water Allocation.
Priority:	Priority 2 – high.
Interfaces:	**a. Relevant documentation:** a1: NWA: Chapter 5, Part 2 a2: NWRS: Chapter 3, Part 4 a3: Appendix 6: Existing Irrigation Boards a4: Appendix 9: Resource Poor Farmers and Communities **b. Linked ISPs / WMAs:** None**.** **c. Other role players and their functions:** Department Land Affairs Department Agriculture Irrigation Action Committee WCNCB The role of the above institutions is to ensure a co-operative approach to the development and capacity building of resource poor farmers. **d. Related Strategies:** 1.3 Groundwater 3.6 Changing land use – forestry 5.2 Co-operative governance **e. Linked mapping:** None

5.2	CO-OPERATIVE GOVERNANCE
Management objective:	The objective of co-operative governance is to ensure that all regulating authorities which are involved in the management of the WMA are fully aware of the impact which their functions, decisions and planning have on the water resources of the WMA.
Background information:	The implementation of the NWA is rapidly bringing about the devolution of management of water resources to regional (or catchment) level. WUAs within each WMA operate at restricted local level as a co-operative association of individual users. WUAs may comprise of a 'transformed' Irrigation Board' or may be a new co-operative of users who undertake related water activities for mutual benefit. As a forerunner to the CMA, catchment forums have been established to involve the responsible authorities and stakeholders which have an interest in the particular river system. The forums function to assist the DWAF RO to manage the river system from both a quality and quantity perspective. Each of the three above mentioned institutions (CMA, WUAs and forums) involve input from various local authorities and government departments. Good co-operative governance is essential to ensure that the objectives of these institutions can be realised. Co-operative governance is in itself an over-arching strategy. In view of the many institutions which play a role in water resource management, this strategy is linked to most of the strategies in the ISP. Furthermore, land affairs issues, land use issues and marine issues are all related to water resources in one or more ways. The effective management of water resources in the WMA requires co-operation between DWAF, other government departments and local authorities. The RO has embarked on a number of co-operative governance initiatives to date. These include: • The development of the Western Cape Planning Model Committee for integrated systems planning of the WCWSS. Other participants are water service providers (local authorities including CCT) and Water User Associations. • Liaison with the Department of Environmental Affairs and Development Planning, the Department of Agriculture and local authorities, through SFRA LAAC (Streamflow Reduction Activities Licence Assessment Advisory Committee). • The establishment of the Irrigation Action Committee (IAC) involving DWAF, the Department of Agriculture, WCNCB and the Department of Land Affairs. The IAC addresses, amongst other issues, the provision of water to resource poor farmers. • The ongoing establishment of committees with other government departments to streamline processes of common interest. • A co-operative monitoring initiative aimed at the collection of all water management related data of common interest, and the mutual sharing of both raw data and derived information. *The following specific issues and concerns were identified in the Berg WMA*: **i. WMA** • The decommissioning of SAFCOL and resulting management of land use change, water availability, levels of assurance and water use. • The need to improve the sharing of water resource related information. • The management of WWTWs by one authority (local authorities, Department of Public Works) to meet the requirements set by another (DWAF). • The absence of litigation procedures between government departments to deal with water resource related issues and disputes. • The approval of land sub-divisions by the Department of Land Affairs without due consideration to the provision of water by DWAF. • Development planning by Local Authorities without due consideration to the provision of water by DWAF. • Mountain Catchment Area management for water provision.

5.2	CO-OPERATIVE GOVERNANCE (cntd)
Background information (cntd)	**ii. Klein Berg River** • The effluent quality, vandalism of wastewater infrastructure, and spills into the stormwater system in Tulbagh, requires addressing with the local authority. Pollution of rivers due to inadequate services in the informal settlement in Tulbagh also requires addressing with the local authority. **iii. Diep River** • Siltation of the Diep River due to sand mining activities involves co-operation between the RO, Departments of Agriculture and Mining, as well as local authorities. **iv. Kuils/Eerste/Lourens/Sir Lowry's Pass River** • Pollution of the Plankenbrug River due to inadequate services in the Khayamandi residential area requires addressing with the local authority. **v. The Cape Peninsula rivers** • The integrated nature of the WCWSS and the ownership of infrastructure by both DWAF and CCT.
Strategic approach	The importance of co-operation across Government Departments is now recognised more clearly than ever at all levels. Water is absolutely central to this, given the pivotal role it plays in all development. It is probable that DWAF is more aware of this than most other Departments. The historical approach of 'demand and we will deliver' has become one of 'if you require, or are going to require water, we will explore options with you once you have yourselves exhausted all other possibilities'. DWAF does not wish to exercise undue power through its control over the water resource. The approach is one of maximum information and understanding to all water users, and cooperation and negotiation to ensure wise management and an equitable sharing. This requires taking a very active role in all development and other co-operative governance, and in ensuring that water has a permanent position on the planning agenda of our co-departments. A major issue is the frequent lack of compliance by some local authorities, particularly in terms of discharges from WWTWs. Co-operative governance approaches are at present the only available tool, but DWAF has been required to investigate whether other methods can be invoked against non-compliant authorities. This is being addressed at national level, but it would be best to find regional solutions. Data and information should be seen as a joint asset and should not be held for gain. Data and information should as far as possible be shared amongst potential beneficiaries. The only proviso is that it should not be reasonably possible to misuse or misrepresent such data or information.

5.2	CO-OPERATIVE GOVERNANCE (cntd)
MANAGEMENT ACTIONS	
Required actions:	A strategy for co-operative governance at National level will require a set of guiding principles. The following general actions are required at Regional level: a. The RO, with Department of Environmental Affairs and Development Planning, the Department of Agriculture and local authorities to jointly address the future of the State owned land currently operated by SAFCOL. b. Compliance in the management of WWTW and discharge of effluent needs urgent attention. Policies must be developed to deal with disputes between local authorities, the Department of Public Works and the RO in relation to effluent quality and management of WWTWs. A process of litigation between government institutions is required at National level. c. Identify opportunities for sharing both monitoring and the capture of water management information, and for the sharing of information with other authorities, to avoid duplication of effort. d. Consultation between DWAF and relevant authorities regarding land sub-division and land use activities (e.g. sand mining) which impact on water quality. e. Identify the relevant local authorities and develop strategies with them relating to pollution of rivers, taking into account the recommendations of the dense settlement strategy (DWAF/DANIDA). f. Siltation in the Diep River to be investigated and addressed, involving the RO, the Department of Agriculture, Department of Minerals and Energy and local authorities.
Responsibility:	The implementation of the Strategy on **Co-operative Governance** is at National level (Directorate: Institutional Oversight) with input from the RO.
Priority:	Priority 2 – High. To be implemented on an ongoing basis.
Interfaces:	**a. Relevant documentation:** a1: NWRS: Chapter 3, Part 5 a2: Appendix 3: Wastewater Treatment Works **b. Linked ISPs / WMAs:** None**.** **c. Other role players and their functions:** Department Land Affairs, Department Agriculture, Department Minerals and Energy, Department Environmental Affairs and Planning, Department Public Works, Irrigation Action Committee, WCNCB, Local authorities, SAFCOL **d. Related strategies:** Due to the integrated nature of water resource management in the Berg WMA, all strategies have an element of co-operative governance needs. **e. Linked mapping:** None.

5.3	MANAGING THE ENVIRONMENT
Situation Assessment:	A key environmental issue in the ISP area relates to the Reserve and over-abstraction of water. This includes the regulation and use of the Berg River mainstem. The WMA includes the CCT, with all of the associated environmental risks and hazards, exacerbated by an extremely fast growing population. The settlement pattern tends to be first one of informal settlement – with attendant sewerage and wastewater problems polluting streams and groundwater. The CCT still has scope to better manage its wastewater effluent. Solid waste sites are reasonably under control. Much of the WMA once comprised lowland fynbos and this biotype has been almost completely transformed in favour of agriculture (primarily wheat). The mountains, on the other hand, hold mountain fynbos and a significant portion of the world's sixth floral kingdom. This has priceless ecological worth. The biggest immediate threat to both water resources and biodiversity, except for man, is that of invasive alien plants. Of no little concern is the longer-term threat of global warming which threatens the fynbos biome. Additional environmental issues include water pollution and especially diffuse pollution by fertilisers; the siting of new developments; and mountain catchment area management and the use of fire to reduce biomass and increase water provision. These and other issues are contained in specific ISPs – along with strategies to address priority concerns to DWAF. DWAF has developed a national strategy setting out its particular place and role in environmental management, notably the requirements of other environmental legislation (especially NEMA) by which DWAF must abide.
Strategic approach:	DWAF takes the conservation of the environment extremely seriously. It is important that the Department should view its own actions (such as the construction of weirs or diversions) through an environmental impact assessment. Broad decisions relating to allocation or other matters relating to water resource management should first be exposed to full consideration through Strategic Environmental Assessment.

SECTION 6: INSTITUTIONAL DEVELOPMENT AND SUPPORT STRATEGIES

The NWA provides for the transfer of water resources management responsibility to appropriate regional institutions. These include Water User Associations (WUAs), Water Service Providers, Water Services Authorities and Catchment Management Agencies (CMAs).

WUAs are co-operative associations of individual water users who wish to undertake water-related activities at a local level for their mutual benefit. They operate in terms of a formal constitution as set out in guidelines prepared by the Department. They are expected to support themselves financially through water use charges, set in terms of the pricing strategy, and payable by members. A WUA falls under the authority of the CMA in whose area it operates.

CMAs are statutory bodies, established by Government Notice, with jurisdiction in a defined WMA. Functions and responsibilities of CMAs include:

- Development of a Catchment Management Strategy (CMS). This may not be in conflict with the NWRS but is required to give effect to its provisions and requirements. The DWAF ISP for the particular WMA should provide a useful input to the CMS.
- Management of water resources, and co-ordination of the water-related activities of water users and other water management institutions within WMAs.

Additional functions may be delegated or assigned to a CMA by the Minister. The delegation and assignment of duties and responsibilities should progress to include the financial and administrative responsibilities for setting and collecting water use charges and the technical water resources management functions based on the CMS.

Three strategies have been identified as pertinent to the WMA. The first two are for the establishment of Water User Associations and for the establishment of a Catchment Management Agency. Both of these strategies are in fact national functions, and part of the fixed duties of the Department. National strategies with guidelines, plans of action and priority lists have been developed, and this ISP will not cover that ground again. The following brief specifics can however be mentioned:

Establishment of WUAs: The establishment of WUAs includes the transformation of irrigation boards as one of the first steps to be taken. This process is lagging behind the other three WMAs of the Western Cape. However there are groups of water users who are already combining resources to become more effective, whilst working towards the process of amalgamation into WUAs. The three irrigation boards in the Eerste River catchment have held a first public meeting towards forming one WUA. The downstream stakeholders in the Lower Berg River have also initiated joint discussions regarding water quality issues. Their intention is to be part of the Lower Berg WUA (in the process of transformation from irrigation board).

Priority should be given to the establishment of a WUA in the Klein Berg catchment, which is stressed. This may be best achieved through a leading role being played by the Klein Berg Irrigation Board.

Establishment of the CMA: The CMA establishment process in the Berg WMA will only commence in 2004. This is currently lagging behind that of the other three Western Cape WMAs, primarily due to the complex nature of the institutional arrangements, and lack of adequate funding. The Berg CMA proposal will only be drafted once there has been input from all stakeholders. A well structured public participation process must be put in place. A draft submission of the CMA proposal has been compiled by the RO for discussion purposes and to motivate for the funds required.

The third is the **Supply to Local Authorities** strategy which has been developed to address the current water supply options to local authorities. This emphasises the need for them to actively implement WC/DM and take all possible steps to manage their existing allocations carefully. The Department will ensure that the local authorities have access to the necessary information for decision-making. This strategy is presented in more detail in the following sections:

6.1	SUPPLY TO LOCAL AUTHORITIES
Management objective:	The objective of this strategy is to ensure that the WSDPs, IDPs and all other planning processes are aligned with this ISP and with the realities of available water supply to Local Authorities and District Municipalities. The current sources of supply to all towns and the potential options for future supply need to be identified.
Background information:	As part of the Integrated Development Plans (IDPs), local authorities have been requested to prepare Water Services Development Plans (WSDPs). These are intended to highlight the current sources of supply and future anticipated sources of supply to these authorities. Certain of the WSDPs have already been submitted. However, the detail and information provided varies and, in some cases, is incomplete. Until the WSDPs are completed to a suitable level of detail, the potential future sources of supply to local authorities are as suggested in this ISP (see Table 6.3.1).
	Certain local authorities and sub-areas of the CCT provide for their requirements through schemes operated by themselves, but augment these from the WCWSS as and when necessary. Typically Piketberg obtained water from local sources but since 1995 supply has been augmented from the Withoogte WTW, via Misverstand Weir. Franschhoek obtains water from streams in the Mount Rochelle Nature Reserve but has been supplied via a pipeline from Wemmershoek Dam since 2001. The towns of Pniel and Kylemore (G10C) also rely on local mountain streams but can be supplemented from Stellenbosch Municipality. Details of the potable water supply schemes in the Berg WMA are given in Appendix 2. These include Atlantis, Paarl, Simon's Town, Somerset West, Stellenbosch, Wellington and Strand.
	There are a number of towns in the Berg WMA that do not receive any water from the WCWSS. Tulbagh for instance obtains water from local sources only, but these are proving to be insufficient through the summer. The WSDP of the local authority has yet to be submitted and the extent of the problem cannot be well established. Two licence applications from the local authority are pending. One is for the raising of a small municipal dam, with the intention to divert water into it from a mountain stream. The second is for groundwater abstraction. Yzerfontein does not draw on the regional scheme but does get water through a 200mm diameter supply line from Darling. This is likely to become a limiting factor.
	These cases are also discussed under the Licensing Strategy (No 3.4). The expanding West Coast region and the Swartland were allocated 11 million m^3/a from Voëlvlei Dam in 1995. This allocation has subsequently doubled and the anticipated expansion of the West Coast region is likely to further increase their requirements.
	Table 6.3.1 provides the details of current supply and potential future supply options to the towns in the Berg WMA and indicates under which local authority the town resides.

6.1	SUPPLY TO LOCAL AUTHORITIES (cntd)
Strategic Approach	DWAF is not involved in providing water to those towns in the WMA which are not supplied through the WCWSS. Applications may however be made to DWAF for System water, or for the licensing of additional sources. With regard to the allocation of possible resources to be used in supply (either from the System, or a licence to use local resources), DWAF will first focus on ensuring that adequate steps are taken by local authorities to firstly implement the broad principles of Water Conservation and Demand Management (effluent re-use, savings, leakage reduction, invasive alien plant removal, etc) and other reconciliation interventions. Where consideration is given to the development of new schemes for local supply, DWAF will require first that the emphasis be placed on the development of local resources by that local authority. Groundwater will often be the preferred resource and DWAF will insist on proper groundwater investigations. Technical guidance will be made available from DWAF where possible and appropriate. More supportive technical assistance will be considered only where the towns do not have adequate resources themselves.
	From this it is clear that the responsibility for resolving local water supply problems lies with the local authority. DWAF is nevertheless responsible for the overall management of the resource and will, before authorising any new allocation, take steps to ensure that the local authorities have access to the necessary information for decision-making, and that they have taken all possible steps to manage the existing allocation carefully.
	IDPs and WSDPs should include a review of supply options (as per Table 6.3.1), indications of growth rates and plans for growth, and trends in the use of water (e.g. shifts from pit latrines to water borne sewerage). Water Supply and Sanitation Systems must be appropriate to available supply and the ability of the resource to handle discharges. DWAF will support the preparation of these documents through the provision of ideas, information, and technical expertise.

6.1	SUPPLY TO LOCAL AUTHORITIES (cntd)
MANAGEMENT ACTIONS	
Required actions:	Local authorities need to be assisted by DWAF in the planning of local schemes. The following actions are required in this regard: a. Study available IDPs and WSDPs and check for alignment with the ISP in terms of water conservation and demand management, future supply, as well as projections of future requirements. b. Liase with local authorities and District Municipalities where this is not the case to ensure that alignment is reached, either through adjustments to the IDP / WSDPs or to the ISP. c. Develop and provide local authorities with the principles against which DWAF will license water use. d. Indicate to the local authorities the degree to which support could be provided by the Department. e. Develop a specific strategy for the provision of water to Tulbagh.
Responsibility:	The implementation of the **Local Supply Strategy** is the responsibility of the RO, providing guidance to local authorities and in consultation with the Directorate: National Water Resource Planning.
Priority:	Priority 2 – High importance. Ongoing implementation over the long term.
Interfaces:	**a. Relevant documentation:** a1: NWRS: Chapter 2 a2: Berg Water Resource Situation Assessment Report: Chapter 4 a3: Appendix 2 : Potable Water Supply Schemes a4. Appendix 8 : Old and New Municipalities **b. Linked ISPs / WMAs:** None**.** **c. Other role players and their functions:** Local authorities : They are responsible for the implementation of local supply schemes. **d. Related Strategies:** 1.1: Reliability of the yield balance 1.3: Groundwater 3.5: Pollution control 4.1: Water conservation and demand management: Water Services **e. Linked mapping:** Figure 3.5.1 - Municipal boundaries and waste disposal sites

TABLE 6.3.1 CURRENT AND POTENTIAL SUPPLY OPTIONS TO TOWNS IN THE BERG WMA

District Municipality / METRO	Local Municipality	Towns	Current Source of Supply	Future Source of Supply
CITY OF CAPE TOWN	CCT	All towns within the CCT.	The WCWSS	The WCWSS
WEST COAST DISTRICT MUNICIPALITY	Berg River Municipality	Aurora	Groundwater abstraction from the Skurweberg Aquifer using 6 boreholes on Grootkloof Farm. Yield is approximately 8 *l*/s. Water quality is good. Because of the high iron content which is easily removed, treatment is required.	Additional utilisation of groundwater.
		Piketberg	Local spring provides good quality water at a yield of approximately 5 *l*/s. Since 1995, supply to the town has been augmented from the Withoogte WTW, supplied from Misverstand Weir.	First investigate groundwater utilisation. Alternatively Voëlvlei Dam, pending implementation of Voëlvlei Augmentation Scheme.
		Porterville	Local supply from a mountain spring.	Possible development of TMG groundwater resources in the vicinity.
		Hopefield	These towns are supplied by the West Coast District Municipality, which acquires water from the Berg River / Saldanha Regional Scheme. Water is abstracted from Misverstand Weir, treated at Withoogte Purification Works, pumped to Vergeleë Reservoir and distributed.	First option is the possible development of local resources in the intergranular aquifers/reservoirs. Voëlvlei Dam, pending implementation of Voëlvlei Augmentation Scheme.
		Langebaan		
		Paternoster		
		Laaiplek		
		Veldrift		
		Saldanha		
		Vredenburg		
	Swartland Municipality	Darling	These towns are supplied from the Berg River / Swartland Schemes, which receives bulk water from Voëlvlei Dam, treated at the Swartland Purification Works.	
		Koringberg		
		Riebeek-Wes		
		Riebeek-Kasteel		

TABLE 6.3.1 (Cntd) CURRENT AND POTENTIAL SUPPLY OPTIONS TO TOWNS IN THE BERG WMA

District Municipality	Local Municipality	Towns	Current Source of Supply	Future Source of Supply
WEST COAST DISTRICT MUNICIPALITY	Swartland Municipality	Hermon	Supplied from the Berg River / Swartland Scheme.	First option is the possible development of local groundwater resources. Voëlvlei Dam, pending implementation of Voëlvlei Augmentation Scheme.
		Gouda		
		Moorreesburg		
		Yzerfontein	From Voëlvlei Dam via the Swartland Purification Works as well as individual developments of the intergranular/reservoir.	
		Malmesbury	0,25 million m^3/a from local supply (Perdeberg Dam). Also from Voëlvlei Dam via the Swartland Purification Works.	
BOLAND	Witzenberg Municipality	Tulbagh	Local supply from Moordenaarskloof stream as well as from local springs. Shortages occur in summer.	Development of local groundwater resources in the vicinity. The alternative is an Inter Basin Transfer from the Breede WMA (Michell's Pass Diversion).
	Drakenstein Municipality	Paarl	From local supply out of two dams (Nantes and Bethel), which store abstracted winter water from the Berg River, as well as from the Wemmershoek Scheme.	Minor augmentation of supply to local dams from the Berg River. Also additional supply from the WCWSS.
		Saron	Abstracts water from the Leeu River from where it is piped over 8km to a reservoir in the town. The water is chlorinated before being distributed.	Investigate groundwater resources. Additional abstraction from the Leeu River.
		Wellington	80% of supply is from the Wemmershoek Scheme. A small component of local supply from Antoniesvlei in Bains Kloof.	Minor augmentation of existing local schemes. Also additional supply from the WCWSS.
	Stellenbosch Municipality	Franschhoek	Local supply from streams in the Mount Rochelle Nature Reserve can be supplemented via a new pipeline from Wemmershoek.	Additional supply from boreholes. Also from the CCT's pipeline off-take at the Berg River siphon (from the Riviersonderend Berg Tunnel) to Wemmershoek Dam or from the Berg River Dam.
		Pniel & Kylemore	Local supply from mountain streams via small reservoir. Supplemented by Stellenbosch Municipality	Supplement supply from the Banhoek Irrigation Scheme, which abstracts water from the Banhoek shaft of the Riviersonderend Berg Tunnel.
		Stellenbosch	Local abstractions from the Eerste River. Excess winter water stored in two off-channel dams (Idas Valley).	Additional abstraction from the Stellenboschberg tunnel outlet, to Paradyskloof Treatment Works.

SECTION 7: SOCIAL STRATEGY

The Department of Water Affairs and Forestry recognises that no decision regarding the use of water resources should be made without due consideration of the social, economic and ecological impacts of such a decision. Together with the technical and economical aspects this multi-faceted decision base has become more and more necessary as the resource becomes ever more scarce.

It is important that DWAF highlights the social aspects of its agenda. These are already very clear in the quest for equity, in the support for resource poor farmers, in the water supply and sanitation programme, and in the poverty alleviation drive, but it is nevertheless very important that any decision by DWAF remains transparent and that the Department never loses sight of its social responsibilities. Extensive public participation has been mandated through the NWA for many DWAF activities and those strategies appearing in this ISP with a strong social and public participation component are:

- Strategy for Supply to Local Authorities
- Groundwater Strategy
- Pollution Control Strategy
- Water Conservation and Demand Management Strategies
- Institutional development and support Strategies
- Changing land use – Clearing of Invasive Alien Plants Strategy
- ISP Implementation Strategy

DWAF is required to include the public in much of its management and decision–making process and the ISP Implementation Strategy (No 10.1) should be aimed at putting this into effect for the ISP process.

SECTION 8: WATERWORKS DEVELOPMENT AND MANAGEMENT STRATEGIES

Options for the future ownership of major water resource infrastructure currently owned and operated by DWAF, is being investigated at national level. In the interim, there is an ongoing need to manage the existing DWAF water resource infrastructure. New infrastructure must also be timeously planned - particularly National Infrastructure and local bulk supply schemes that will later become the responsibility of the CMA.

In the Berg WMA, ownership of major water resource infrastructure involves both DWAF and the CCT, while small schemes are operated by various water user associations, water service providers and authorities, as well as private users. This is of relevance when considering the operation, management and safety aspects of the individual infrastructure components. Of particular importance is the integrated operation, management and planning relating to the WCWSS as a whole, as well as the future implementation of new schemes.

Seven strategies have been identified for development, namely:

8.1 Strategy for System Management and Reconciliation
8.2 Theewaterskloof Tunnels
8.3 Implementing the Berg Water Project
8.4 Strategy for the Lower Berg
8.5 Operation during extreme drought
8.6 Recreation on dams and rivers
8.7 Public health and safety

8.1	STRATEGY FOR SYSTEM MANAGEMENT AND RECONCILIATION
Management objective:	To optimise the integrated operation of the Western Cape Water Supply System (WCWSS).
Background information:	The WCWSS is operated in an integrated, shared manner with the major components of infrastructure predominantly owned and operated by DWAF and the CCT. Some local authorities own and operate their own schemes, but most of them receive supplementary water from the WCWSS when required. The Broad Overview (Chapter 2, of Part 1) describes the various regional and local bulk water supply schemes and Appendix 2 summarises the existing potable water supply schemes. Appendix 6 lists the details pertaining to the existing irrigation boards. Major dams are listed in Appendix 11, which also provides information on the characteristics of each dam. The details of possible future bulk water supply schemes within the Berg WMA are given in Appendix 10. The WCWSS supplies water to the CCT, the West Coast District Municipality, to irrigators along the Upper Berg and Eerste Rivers, and to irrigators in the Swartland. The integrated nature of the system and ownership of the infrastructure within it, has necessitated an integrated management approach. Through the Western Cape Planning Model Committee (consisting of DWAF, the CCT and all major urban and agricultural stakeholders), operating rules have been developed for managing the system in the most efficient way. This approach is to be encouraged to ensure that yield is optimised and the risks of spillage from the system, reduced. DWAF has commissioned a pre-feasibility study to identify the potential sources of water supply to the area served by the West Coast District Municipality. This is currently in progress and includes interventions such as the implementation of WC/DM, effluent re-use, removal of riparian alien invasive plants, water trading and improved operation of Misverstand Dam (refer to the Water Quality Strategy, No 2.4). The potential development of new schemes to augment the yield out of Voëlvlei Dam is also addressed. The available yield is subject to the classification of the Lower Berg River and the resulting requirement of the Reserve. The Department's intention is to undertake a *WCWSS Reconciliation Strategies Study*, to commence in the 2004/05 financial year. The proposed approach is that the system should be updated on a regular, almost continuous basis, with smaller but more frequent research and information inputs regarding the review of requirements, availability, reconciliation interventions and an implementation strategy.
Strategic Approach:	The WCWSS is dependent on the supply of water from inter-basin transfers out of the Breede WMA. This interdependency must be taken into account during all planning of water resource development. Priorities need to be defined as to which users should receive preference such that the economic development of the Western Cape as a region is ensured. The Berg Water Project and any other future augmentation options, including options to augment the supply of water to the West Coast must be considered as part of any future development of the WCWSS, on which this region is also dependent.

8.1	STRATEGY FOR SYSTEM MANAGEMENT AND RECONCILIATION (cntd)
MANAGEMENT ACTIONS	
Required actions:	To optimise the efficiency of the operation and management of the WCWSS in an integrated manner and to develop reconciliation strategies to ensure adequate assurance of supply to all users of water from the system and equitable allocations during normal droughts.
Responsibility:	The implementation of the **System Management and Reconciliation Strategy** is the responsibility of the RO in conjunction with the Directorate: National Water Resource Planning and the Directorate: Planning Systems.
Priority:	Priority 1 – Very high. To be implemented on an ongoing basis.
Interfaces:	**a. Relevant documentation:** a1: Western Cape System Analysis a2: Berg Water Resource Situation Assessment Report: Chapter 4 a3: Appendix 2 : Potable Water Supply Schemes a4: Appendix 6 : Existing Irrigation Boards a5: Appendix 10 : Possible Future Bulk Water Schemes a6: Appendix 11 : Major Dams **b. Linked ISPs / WMAs:** None. **c. Other role players and their functions:** CCT : Owner of major water resource infrastructure components. **d. Related Strategies:** 3.8 Water pricing 5.2 Co-operative governance 8.2 The Theewaterskloof Tunnels 8.3 Implementing the Berg Water Project 8.4 Strategy for the Lower Berg 8.5 Operation during extreme drought 8.6 Recreation on dams and rivers 8.7 Public health and safety **e. Linked mapping:** None.

8.2	THE THEEWATERSKLOOF TUNNELS
Management objective:	To improve the operation and maintenance of the Theewaterskloof Tunnel system, which forms an integral part of the infrastructure of the WCWSS.
Background information:	The Riviersonderend-Berg River Government Water Scheme includes the tunnel system for the major inter-basin transfers between the Breede and Berg WMAs. The tunnel extends from the inlet/outlet works at Theewaterskloof Dam to the Kleinplaas balancing dam on the Jonkershoek River, via the Berg River Siphon. The Stellenboschberg Tunnel extends from Kleinplaas Dam, through the Stellenboschberg Mountains to the tunnel outlet. A short branch tunnel (Dasbos Tunnel) and the outlet into the Berg River are located near Franschhoek. The tunnel section between Theewaterskloof Dam and Kleinplaas Dam is equipped with two vertical inlet shafts for diverting the river flows at the Wolwekloof and Banhoek Weirs into the tunnel. By operating the control valves at Kleinplaas Dam, this section of the tunnel is capable of bi-directional flow. Water is transferred from Theewaterskloof Dam into the Berg WMA in summer. During winter, water from the Banhoek and Wolwekloof Weirs is transferred in the opposite direction for storage in Theewaterskloof Dam. The Charmaine Shaft serves to assist de-watering, which is primarily carried out via the tunnel outlet at the Berg River siphon. The operation and maintenance of the tunnel system is subject to a number of shortcomings. These include: • Cumbersome dewatering operations • Limited access for maintenance and repair work • Debris accumulation at the weirs feeding the vertical inlet shafts. • Access to the weirs is difficult during periods of high rainfall • Alkali aggregate reaction damage is evident at Kleinplaas Dam and at the Wolwekloof and Banhoek Weirs. • Limited ability to maintain supply to Cape Town during emergency closure.
Strategic Approach:	Whilst there are operating options available in terms of reducing spillage from the storage dams in the WCWSS, the critical infrastructure component remains the tunnel system between the Breede and Berg WMAs. There is no alternative means of transferring water between these two WMAs in the event of emergency tunnel closure, with potentially dire consequences for the CCT and irrigators. Emergency supply measures to the city must be identified for potential durations of tunnel closure. The Berg Water Project will offer some potential in this regard, through the construction of a water purification works and reticulation infrastructure to supply the city directly from the Berg River Dam, in isolation of the tunnel system. In light of the critical importance of these tunnels to the region, attention must be paid to remedial work required to improve the de-watering of the tunnels, the operation of the shafts and the Kleinplaas balancing dam.

8.2	THE THEEWATERSKLOOF TUNNELS (cntd)
MANAGEMENT ACTIONS	
Required actions:	Develop a detailed strategy for the operation, maintenance and disaster management for the Theewaterskloof tunnel system. The following actions are required: **OPERATION AND ROUTINE MAINTENANCE ACTIONS** a. The construction of a suitable access adit in the vicinity of the intersection of the Charmaine Shaft or the Berg River siphon should be considered during the implementation of the Berg Water Project design. b. The existing operation and ongoing maintenance procedures for the tunnel system should be documented by the RO, in conjunction with CCT. c. The extent of leakage in the shaft at Kleinplaas Dam to be established and repairs considered to ensure improved and safe access to the valves. Attention to be paid to the possible cavitation occurring at the Kleinplaas Dam control valves and the extent of leakage into the access shaft. Inspection and possible repair of alkali aggregate damage to Kleinplaas Dam and other components of the system (inlet weirs, shafts, etc). **DISASTER MANAGEMENT ACTIONS** a. Emergency supply arrangements to Cape Town in the event of tunnel closure need to be developed and documented for various durations of possible closure (days, weeks, months). b. The opportunity to develop an emergency supply system (treatment works, pump station, reticulation) should be considered as part of the Berg Water Project design.
Responsibility:	The implementation of the Strategy for the **Theewaterskloof Tunnels** is the responsibility of the RO in conjunction with the Directorate: National Water Resource Planning, the Directorate: Planning Systems and in consultation with the CCT.
Priority:	Priority 1 – Very high. To be implemented in parallel with the Berg Water Project.
Interfaces:	**a. Relevant documentation:** a1: Western Cape System Analysis a2: Berg Water Resource Situation Assessment Report: Chapter 4 **b. Linked ISPs / WMAs:** None. **c. Other role players and their functions:** CCT : Owner of major infrastructure components of the Western Cape Water Supply Scheme. **d. Related Strategies:** 3.8 Water pricing 5.2 Co-operative governance 8.1 Strategy for system management and reconciliation 8.3 Implementing the Berg Water Project **e. Linked mapping:** None.

8.3	IMPLEMENTING THE BERG WATER PROJECT
Management objective:	To optimise the implementation of the Berg Water Project within the existing WCWSS, allowing for improvements to the existing transfer system infrastructure, safety of downstream users and appropriate Reserve release operation.
Background information:	The Berg Water Project will consist of two sub-schemes, namely the Berg River Dam and the Berg River Supplement Scheme. The proposed overall scheme will consist primarily of: • The construction of the Berg River Dam on the Berg River at La Motte forestry plantation near Franschhoek. • The Dasbos pump station situated just downstream of the dam, with a pipeline to deliver water to the Dasbos Tunnel entrance of the existing Theewaterskloof Tunnel system. • Abstraction works on the Berg River downstream of the Dwars River confluence, with the Drakenstein pump station and delivery pipeline connecting to the Berg River Dam. Agreements have been entered into between DWAF and the Trans Caledon Tunnel Authority (TCTA), and between DWAF and the CCT for the Berg Water Project as follows: • In terms of the Agreement between DWAF and TCTA, TCTA will act as the implementing agent for the design and construction of the BWP and also for the funding of the capital cost thereof. DWAF will be responsible for the repayment of the capital plus finance charges to TCTA over a period of 25 years and for the operation of the BWP as an integral part of the WCWSS while complying with the requirements of the Reserve and the Dam Safety Office. • In terms of the agreement between DWAF and the CCT, the CCT will repay to DWAF the full capital cost of the project through the sale of water to the City less the capital cost component of any sales of water to other authorities. DWAF's operating costs of the BWP will be shared by all users of the WCWSS. The following operating issues and concerns were identified: • The proposed Reserve releases are significant (65 – 200 m^3/s) and the human factor in controlling such flood releases can impact on the safety and property of downstream inhabitants. • Certain rainfall and flow gauging stations in the upper reaches of the Berg River should be monitored as part of a flood warning system for the 200 m^3/s releases as well as the Wemmershoek Dam releases. • The timing of and level in the Berg River Dam from which the Reserve low flow and flood releases are to be made must still be planned, and operating rules for the releases formulated to ensure that water of acceptable temperature and quality is released into the river. • Rules for operating the Supplement Scheme and releasing the Reserve. • Possible water quality impacts from aquaculture activities.
Strategic Approach:	The Berg Water Project for which construction is due to be completed by 2007, will add an additional 81 million m^3/a to the yield of the WCWSS. This is intended primarily for the CCT. The design is such that Reserve releases simulating floods of up to 200 m^3/s will be possible. This capacity to release water up to such a significant rate, ensures that the project will ultimately be able to accommodate the Reserve requirements for the Berg River, once these have been finally determined. In so doing the opportunity to improve the ecological condition of the river will be possible.

8.3	IMPLEMENTING THE BERG WATER PROJECT (cntd)
MANAGEMENT ACTIONS	
Required actions:	The following actions are required: a. Adequate flood warning systems upstream of the dam and at Wemmershoek Dam to ensure appropriate timing and magnitude of Reserve releases. b. Installation of landline telephones to remote gauging stations is recommended, particularly where cellular reception is unreliable or unavailable. c. Planning of arrangements and development of operating rules for making the Reserve releases. d. Adequate training of personnel for operation of infrastructure is paramount to safe operation of releases.
Responsibility:	The implementation of the **Berg Water Project Strategy** is the responsibility of the RO (existing infrastructure), the Directorate: Options Analysis and the implementing agent (TCTA).
Priority:	Priority 1 – Very high. To be implemented from the design stage.
Interfaces:	**a. Relevant documentation:** a1: Skuifraam Dam Feasibility Study a2: CMC Integration of Raw Water Sources supplying the CMA a3: Appendix 10: Possible Future Bulk Water Schemes **b. Linked ISPs / WMAs:** None. **c. Other role players and their functions:** CCT (primary water user), TCTA (implementing agent) **d. Related Strategies:** 2.1 Reserve and resource quality objectives 3.8 Water pricing 8.2 The Theewaterskloof Tunnels 8.4 Strategy for the Lower Berg 8.6 Recreation on dams and rivers 8.7 Public health and safety 9.2 Monitoring networks and data capture **e. Linked mapping:** None.

8.4	STRATEGY FOR THE LOWER BERG
Management objective:	The improved management and operation of the Lower Berg System, which forms an integral part of the WCWSS and supply to the West Coast and Swartland.
Background information:	The Swartland and West Coast regions are among those users reliant on water from the Voëlvlei Government Water Scheme, of which Voëlvlei Dam (off-channel storage) forms an integral part. The natural catchment of the dam itself is only 31 km^2. Three diversion weirs, one on each of the Klein Berg, Leeu and Twenty Four Rivers feed a canal system which transfers water from these rivers into Voëlvlei Dam. Raw water from Voëlvlei Dam is released via a canal into the Lower Berg River. The Swartland Purification Works abstracts water directly from this canal. The Withoogte Purification Works abstracts water further downstream at Misverstand Dam, for supply to the Saldanha and West Coast regions. The Voëlvlei Purification Works is situated at Voëlvlei Dam and supplies water to the CCT via a pumping pipeline to Plattekloof Reservoir, from where it is distributed. The current operation and maintenance of the system has a number of shortcomings. These include: • Alkali aggregate damage to the feeder canals. • Leakage from the 24 Rivers siphon under the Klein Berg River. • Water quality problems in the Klein Berg River, which feeds Voëlvlei Dam, causing algal blooms in the reservoir. • Limited telemetry for monitoring abstractions from the river. • Absence of remote sensing to co-ordinate releases from Voëlvlei Dam. • Spills from Voëlvlei Dam outlet canal. • Inappropriate flow release mechanism at Misverstand Dam. • Operation of abstractions at Misverstand Dam could be improved. • Occasional high salinities of abstractions at Misverstand Dam when high salinity runoff from the local catchment occurs. *The following specific issues and concerns were identified in the Lower Berg*: **<u>OPERATION AND ROUTINE MAINTENANCE ISSUES</u>** • Voëlvlei Dam is stressed and is likely to be further stressed by the increasing demands in the expanding West Coast/Saldanha region. • The Leeu and Twenty Four Rivers weirs are alkali aggregate damaged and are silted. • The Klein Berg canal feeding Voëlvlei Dam leaks. Repairs will be costly and only selected slabs have been replaced to date. • The Klein Berg siphon leaks and requires maintenance. • Monitoring of abstractions from the Berg River downstream of Sonquasdrift (near Hermon) is not currently possible as no telemetry is in place. • There is no flow gauging in the Berg River downstream of Misverstand Dam. • Releases from Misverstand Dam are via a bottom gate outlet, unsuitable for controlled releases. • The water quality in the Klein Berg River is poor and the CCT has requested that DWAF bypass the first winter flows to reduce the impact on Voëlvlei Dam water quality. • Sanity in and downstream of Misverstand Dam may exceed 400mg/*l* for extended periods and affect certain West Coast industrial users and irrigators. (Refer to Water Quality Strategy, No 2.4)

8.4	STRATEGY FOR THE LOWER BERG (cntd)
Background information (cntd)	**OPERATION AND ROUTINE MAINTENANCE ISSUES (cntd)** • Voëlvlei Dam outlet canal is undersized and spills into an adjacent farm dam. • There is no remote sensing facility between Voëlvlei Dam and Misverstand Dam to control releases from the former and reduce spills from the latter. • Unless operated at full supply level, air is sometimes drawn in at the chamber feeding the Withoogte Pump Station from Misverstand Dam. Remedial measures have been implemented and the problem has improved. **DISASTER MANAGEMENT** • Repair work to the feeder canals and the Klein Berg Siphon will impact on the supply of water into Voëlvlei Dam. • Repairs to the Klein Berg siphon may not be possible in one dry season and will impact on the flow into the dam if repair work extends into the winter months.
Strategic Approach:	The focus of the management of the WCWSS, is on the prevention of spills. However, no automated systems are in place between Misverstand Dam and Voëlvlei Dam, with the result that water released from Voëlvlei is sometimes spilled from Misverstand. The installation of telemetry to automatically control releases and reduce spillage from the system, is seen as essential (and highly cost effective). The operation and maintenance of the diversions, canals and the Klein Berg siphon that feed Voëlvlei Dam are critical to ensuring that the yield of the dam is optimised. The current operation and maintenance procedures for this infrastructure must be documented and extended to include the way in which repairs to the feeder canals and siphon can be undertaken with least impact on the yield of the dam.

8.4	STRATEGY FOR THE LOWER BERG (cntd)
MANAGEMENT ACTIONS	
Required actions:	Develop a detailed strategy for the operation, maintenance and disaster management for the Lower Berg system. The following actions are required: **OPERATION AND ROUTINE MAINTENANCE ACTIONS** a. Reassess the timing for the implementation of the proposed Voëlvlei Augmentation Scheme in relation to the Berg Water Project. The introduction of the Voëlvlei Augmentation Scheme is possibly required ahead of the completion of the Berg Water Project. b. An assessment of the extent of repairs to the weirs, feeder canals and the 24 River siphon under the Klein Berg River that feed Voëlvlei Dam is required. c. The flushing in the Klein Berg River should be evaluated prior to the intended start of diversion, each year. Early rains that may occur in some years, might produce sufficient flushing, in which case the bypass may not be necessary every year. d. The proposed weir downstream of Misverstand Dam should be constructed and long term flow gauging implemented. e. Telemetry along the Berg River downstream of Sonquasdrift is to be considered for monitoring of abstractions. f. Overtopping of the canal from Voëlvlei Dam is not considered to be a major concern but upgrading of the canal is to be given consideration. g. To reduce spills from Misverstand Dam, a remote sensing facility to control Voëlvlei releases is recommended. h. The Voëlvlei Water Quality Forum is investigating the causes of water quality problems in Voëlvlei Dam. This includes the management of water quality in the catchment of the Klein Berg River and in Voëlvlei Dam. i. Raising of Misverstand Dam to be considered so as to reduce air intake at the Withoogte abstraction. j. Consideration to be given to replacing the existing bottom gate outlet at Misverstand Dam with sleeve valves. k. The existing operation and maintenance procedures for the Lower Berg System should be documented, reviewed and amended, if considered necessary. l. Means of managing abstractions from Misverstand Dam to provide water of acceptable salinity for the industrial development at Saldanha Bay should be investigated. **DISASTER MANAGEMENT ACTIONS** a. Emergency supply procedures need to be developed, in the event of repair work being required to the canals or the Klein Berg siphon. b. Integrate any disaster management plans with the Disaster Management Bill of January 2002. c. Possible sabotage of infrastructure to be addressed.
Responsibility:	The implementation of the **Lower Berg Strategy** is the responsibility of the RO (existing infrastructure), the Directorate: Options Analysis (feasibility analysis of new infrastructure) and the Directorate: National Water Resource Planning (all planning in the system context).
Priority:	Priority 1 – Very high. Decisions regarding the implementation of the augmentation schemes are required.

8.4	STRATEGY FOR THE LOWER BERG (cntd)
MANAGEMENT ACTIONS (cntd)	
Interfaces:	**a. Relevant documentation:** a1: Berg Water Resource Situation Assessment Report: Chapter 4 a2: CMC Integration of Raw Water Sources supplying the CMA a3: Voëlvlei Augmentation Scheme a4: Appendix 10 : Possible Future Bulk Water Schemes **b. Linked ISPs / WMAs:** None**.** **c. Other role players and their functions:** CCT : Receives approximately 70 million m^3/a from Voëlvlei Dam. West Coast District Municipality : Reliant on the Swartland and Saldanha Schemes **d. Related Strategies:** 1.1 Reliability of the yield balance 2.1 Reserve and resource quality objectives 2.4 Water quality 3.5 Pollution control 3.8 Water pricing 8.3 Implementing the Berg Water Project 8.6 Recreation on dams and rivers 8.7 Public health and safety 9.2 Monitoring networks and data capture **e. Linked mapping:** None

8.5	OPERATION DURING EXTREME DROUGHT
Management objective:	The development of an operational plan defining the provision of water to users during severe drought conditions, under which normal restrictions are no longer effective.
Background information:	Users of water from the WCWSS, and most critically Cape Town and environs, will increasingly experience the effects of drought as demands grow and exceed the yields of the sources of supply. Restrictions on use may quite often be required and these have significant economic consequences. The duration of a drought cannot be accurately predicted and when indications suggest the onset of a particularly dry period, water in storage dams must be used judiciously. When restrictions are put in place, the water allocated to meet basic human needs receives priority, followed by strategically important uses. Through the Western Cape Planning Model Committee (DWAF, the CCT and all other major urban and agricultural stakeholders) recommendations regarding water restrictions are presented to the Minister who finally decides on the imposition of restrictions or not. As such water shortages (common to the Western Cape) are effectively managed in this way. However a strategy defining how water will be provided to users during periods of extreme drought (water crisis situation) is not in place. A requirement of the NWRS is that the Department will co-operate with the National Department of Agriculture, which leads the drought working group established by the National Disaster Management Centre, in developing prevention and mitigation measures for drought conditions.
Strategic Approach:	Water resource management during drought is a function of both water supply and demand. The greater the demand and the smaller the supply the more susceptible the users become to drought. This requires keeping a close eye on the most likely user development scenario and ensuring that steps are taken to keep supply in tune with demand. WC/DM implementation is an ongoing priority. Over and above the standard restrictions, the operation of the system under increased severities of drought needs to be defined. There is no formal strategy in place defining how the WCWSS should be operated during severe drought, from whence emergency water supply will be provided and which users will be required to sacrifice water for the benefit of others. One mechanism to deal with extreme drought is short-term water trading across sectors. This would entail one sector sacrificing all or part of its allocation for use by another sector. In the Western Cape this is most likely to be via compensating agricultural losses for emergency water supply to urban users. The increased use of groundwater (under emergency conditions) is a further option. Other options include the increased use of treated effluent, the de-salination of seawater, the utilisation of dead storage in the Theewaterskloof and Misverstand Dam (40 and 5 million m^3 respectively) and the possibility of utilising storage in the Kogelberg / Rockview Dam, which would severely affect the operation of the Palmiet Pumped Storage Scheme. The effluent re-use option and the de-salination option would both require significant infrastructure development to be put in place (treatment plants and reticulation), before being able to function as emergency supply options. It would appear that the most feasible arrangement would be through short-term water trading and financial compensation to those users sacrificing their primary water needs for the benefit of others.

8.5	OPERATION DURING EXTREME DROUGHT (cntd)
MANAGEMENT ACTIONS	
Required actions:	The following actions are required: a. A review and documentation of procedures adopted during previous droughts highlighting shortcomings and successes. b. Identify the priority of sectoral water requirements under extreme drought conditions. c. Investigate the scale of balance between sacrifices made by the agricultural sector (taking financial compensation into account) in meeting the needs of the urban sector during extreme drought. d. Assess the possibility for emergency supply out of the TMG aquifer to the urban sectors in the Berg WMA, during periods of extreme drought. e. Evaluate the feasibility of establishing emergency de-salination facilities and increased effluent re-use for meeting essential needs during extreme drought events. f. Protocols need to be developed between the Breede and Berg WMAs with regard to the possible increase in supply of water from the Breede to the Berg as a drought alleviation option. g. Determine the measures and protocols that would be necessary to access the dead storage in the Theewaterskloof and Misverstand Dam and possibly also the storage in the Kogelberg / Rockview Dam.
Responsibility:	The implementation of the Strategy for **Operation During Extreme Drought** is the responsibility of the RO in conjunction with the Directorate: National Water Resource Planning.
Priority:	Priority 4 – Low.
Interfaces:	**a. Relevant documentation:** a1: NWA: Chapter 14, Part 3 a2: NWRS: Chapter 3, Part 7 **b. Linked ISPs / WMAs:** None**.** **c. Other role players and their functions:** CCT : Owns water resource infrastructure Department of Agriculture : Responsible for managing the impacts of drought **d. Related Strategies:** 4.1 Water conservation and demand management: Water Services 4.2 Agricultural water conservation and demand management 8.1 Strategy for system management and reconciliation 8.6 Recreation on dams and rivers 8.7 Public health and safety **e. Linked mapping:** None

8.6	RECREATION ON DAMS AND RIVERS
Management objective:	To identify and implement the zoning policy on existing and new dams and to manage recreational activities on the inland water bodies of the WMA.
Background information:	The NWA defines recreation on rivers and dams as a water use. General Authorisations have been developed to establish the limits within which water resources may be used for recreational purposes. There is an existing policy in place for zoning of dams, concessions, and stakeholder involvement as far as recreational use is concerned. The Berg River WMA holds one of the biggest metropolitan areas in the country. Many of the population are 'immigrants' from very poor parts of the country seeking jobs and new lives. Although outdoor recreational opportunities abound in both the Berg and Breede WMA with expanses of both mountain and coastline, the growing population, pressure of urban living, and squalor of squatter settlements places a particular responsibility on DWAF to ensure that dams and rivers under its control are open to recreational use - and particularly use by the disadvantaged, although these may not be the traditional users of such facilities. The Berg River in particular, is of significant recreational importance in the WMA, one notable event being the Berg River Canoe Marathon between Paarl and Velddrif. The dams in the Berg WMA also offer recreational opportunities. In particular, Voëlvlei Dam is used extensively for fishing and non-motorised water sports. The Berg River Dam will offer further opportunities for recreation.
Strategic Approach:	In the Berg WMA, DWAF sees its role as being to maximize recreational benefit from the use of state assets. At the same time this should not be at unreasonable cost to other water users. The RO needs first to list and categorise all those dams and rivers that serve as 'recreational assets' in this WMA. The status of management of these assets, and the likely negative impacts which current use might have, need to be evaluated. At the same time the very real social benefits of the recreational opportunities provided by dams and rivers need to be taken into account. No asset should be further restricted or closed to use without very close consideration of the social cost that this might carry, and such a decision should not be taken lightly.

8.6	RECREATION ON DAMS AND RIVERS (cntd)
MANAGEMENT ACTIONS	
Required actions:	The following actions are required: a. Review and implement the existing recreational use policy in the Berg WMA. b. Operational procedures should be developed for all those dams which have an impact on recreational use of the Berg River and other rivers in the WMA. c. Identify conditions and operating rules under which releases for recreational use may or may not take place (e.g. during drought years). Releases for recreational purposes should be linked wherever possible to releases also required by the Reserve. d. Focus on the dams which impact on flow in the Berg River, namely: - Berg River Dam - Wemmershoek Dam - Voëlvlei Dam - Misverstand Dam
Responsibility:	The implementation of the strategy for **Recreation on Dams and Rivers** is the responsibility of the RO.
Priority:	In view of the importance of the Berg River for recreational purposes, this strategy is of Rank 3 importance.
Interfaces:	**a. Relevant documentation:** a1: NWA: Chapter 12 a2: NWRS: Chapter 4, Part 1 **b. Linked ISPs / WMAs:** None. **c. Other role players and their functions:** CCT : Owner of certain water resource infrastructure **d. Related Strategies:** 5.2 Co-operative governance 8.3 Berg Water Project 8.4 Strategy for the Lower Berg 8.5 Operation During Extreme Drought **e. Linked mapping:** None

8.7	PUBLIC HEALTH AND SAFETY
Management objective:	The objective of this strategy is in the first instance to prevent water related disasters, and in the second to mitigate the effects of disasters which may occur. This should be done by implementing the strategies and policies which have already been developed through the National Disaster Management Act, as well as those developed by DWAF.
Background information:	Disaster management planning, floods, dam safety, emergency pollution and droughts are all aspects of water resource management, which impact on public safety. The National Disaster Management Centre, established under the National Disaster Management Act, will be responsible for the development of the National Disaster Management Framework. The aspects requiring strategies are dealt with below only at National Level. Strategies outlining issues specific to the WMA, and approaches to these issues, must still be developed. **A: DISASTER MANAGEMENT PLANNING** DWAF is investigating the establishment of a dedicated public safety unit to deal with its water resources management, relating to disasters and emergencies. These include: • Droughts (discussed under Strategy No 8.5) • Naturally occurring floods or dam failures • Dam safety • Pollution of water resources from spills of hazardous or toxic materials A typical disaster would be the collapse of the Theewaterskloof Tunnel. This is discussed under Strategy No 8.2. The following issues and concerns have been raised: • There is a need for each District Municipality to have a disaster management forum. • Emergency Preparedness Plans (EPPs) should be in place for DWAF's dams in the WMA, as should EPPs for private dams (for Category 2 and 3) **B: FLOODS** The National Disaster Management Centre has established working groups to provide input to the National Disaster Management Framework. DWAF will lead the working group which has been tasked with developing a National Flood Management policy. The policy will include proposals for guidelines and standards, and institutional responsibilities, relating to: • The safe operation of large storage dams and protection of downstream areas • The safe and sustainable use of the floodplains of rivers • The appropriate design of services infrastructure situated on or adjacent to rivers • Effective flood warning systems for all flood-prone areas

8.7	PUBLIC HEALTH AND SAFETY (cntd)
Background information (continued) :	**C: DAM SAFETY** DWAF's Dam Safety Office administers the Act's provisions relating to the safety of all new and existing dams. These provisions ensure that dams are designed, constructed, operated and maintained according to the requirements of approved professional persons to minimise the risk of loss of life or damage to property caused by dam failure or operational shortcomings. All dams with a safety risk must be registered with the Department. All dam owners are required to have their dams regularly inspected by an approved professional person and to make any necessary repairs or alterations to ensure the safety of the dam. For Category 2 and 3 dams, dam owners are required to prepare an EPP detailing the actions to be taken in the event of an actual or imminent dam failure, or any other emergency situation relating to the dam. DWAF is currently preparing new regulations relating to the safety of dams. The drafting process is expected to be complete in 2003. Thereafter the proposed regulations will be the subject of a public consultation process. **D: HAZARDOUS SPILLS** DWAF's approach to water quality management is, as far as possible, to promote the reduction of discharges of waste or water containing waste into water resources. In emergency situations, where harmful substances are accidentally or negligently discharged into water resources, the NWA makes those who have caused the pollution responsible for remediating the impacts. At present all pollution incidents must be reported to DWAF, so that appropriate Departmental responses can be co-ordinated with the relevant emergency services and disaster management centres. **E: DROUGHTS** As discussed under Strategy No 8.5 (Operation during Extreme Drought Strategy).
Strategic Approach:	'Public Heath and Safety' has been taken, for the purposes of this ISP to deal strictly with direct water related issues / disaster – notably floods, dam safety, hazardous spills and droughts. Droughts are covered under Strategy No 8.5 (Operation during Extreme Drought). Only the national approach is presented in the Background Information above. Several national policy frameworks are either in place or in development. Specific strategies appropriate to specific regional concerns must still be developed. The situation with regard to the Berg WMA needs to be unpacked in more detail and this calls for a local strategy that can refer to the national frameworks provided. Specifically this strategy needs to highlight areas of risk (for example by pin-pointing the sites and chances of hazardous spills, or those areas particularly vulnerable to flood damage, such as dense settlements on floodplains). Contingency plans must be developed and this information widely disseminated amongst both water managers and potentially affected stakeholders. A number of other specific actions that should be included in this strategy are listed below under 'Management Actions'. This ISP has not achieved this, but the development of a thorough Public Health and Safety Strategy must be seen as a Departmental responsibility, and one that should be taken on with concern and immediacy.

8.7	PUBLIC HEALTH AND SAFETY (cntd)
MANAGEMENT ACTIONS	
Required actions:	The following actions are required: Develop a Public Health and Safety Strategic Plan for the Berg WMA which focuses on specific concerns in the WMA, but brings the national context strongly to bear. **A: DISASTER MANAGEMENT PLANNING:** The actions required for appropriate disaster management planning are: a. Development of procedures to supply water during periods of partial supply or non-supply due to drought or infrastructure failure. b. Integration of any disaster management plans with the National Disaster Management Framework. c. The establishment of disaster management forums at District Municipality level (DWAF to encourage this). d. Ensure EPPs are in place for all dams (including those owned by other authorities or private owners) of Category 2 and 3. **B: FLOODS** a. Ensure that suitable flood warning systems are in place. b. Evaluate the need for, and implement, flood-warning systems at those dams where downstream inhabitants or property are at risk. **C: DAM SAFETY** The actions required regarding dam safety are: a. Implement the requirements of the NWA. b. Take action against owners of unsafe dams. c. Ensure dam safety inspections are conducted as required by the Dam Safety Office. **D: HAZARDOUS SPILLS** The actions required are: a. Maintain a register of relevant emergency services and disaster management centres. b. Develop a register of risk sources and areas and prepare emergency plans. c. In the event of a spill, contact the relevant emergency services and disaster management centres. d. Ensure that the polluter remedies the effect of the spill. **E: DROUGHTS** Refer to Strategy No 8.5 (Operation During Extreme Drought).
Responsibility:	The implementation of the strategy on **Public Health and Safety** is the responsibility of the RO in conjunction with the Directorate: Policy and Strategy Coordination.
Priority:	In view of the current development of surface water resources in the Berg WMA, this strategy is of priority 2 – High. Implementation is ongoing.

8.7	PUBLIC HEALTH AND SAFETY (cntd)
MANAGEMENT ACTIONS (cntd)	
Interfaces:	**a. Relevant documentation:** a1: NWRS: Chapter 3, Part 7 **b. Linked ISPs / WMAs:** None**.** **c. Other role players and their functions:** CCT Local authorities **d. Related Strategies:** 5.2 Co-operative governance 8.1 Strategy for system management and reconciliation 8.3 Implementing the Berg Water Project 8.4 Strategy for the Lower Berg 8.5 Operation during extreme drought **e. Linked mapping:** None

SECTION 9: MONITORING AND INFORMATION MANAGEMENT STRATEGIES

To meet the requirement for integrated information the Department is reviewing, and revising where necessary, all data-acquisition, monitoring and information systems. National systems will be designed so that CMAs, when they are established, can take responsibility for information management in their WMAs, as well as have access to information from any other WMAs. The national information system for water services, required by the Water Services Act, will be linked to information systems for water resources.

The Act requires any person, on the request of the Minister, to provide data and information to facilitate the management and protection of water resources. Regulations may be written in this respect.

The Act requires the Minister to establish national monitoring systems for water resources to collect appropriate data and information. This puts a strong responsibility on the Department. The Department operates several monitoring systems that collect some of the required data and information. The Department is addressing the shortcomings of the current arrangements by amalgamating all existing and planned monitoring and assessment systems into a structured and coherent monitoring, assessment and information system.

An important component of the monitoring and assessment strategy will be to develop co-operative, collaborative relationships between the Department and other organisations that also operate water-related monitoring, assessment and information systems. The achievement of this high level of co-operation and information sharing is being piloted in the Berg WMA.

Three strategies have been identified for development, namely:

9.1 Abstraction control strategy
9.2 Monitoring networks and data capture strategy
9.3 Information management strategy

9.1	ABSTRACTION CONTROL
Management objective:	To facilitate improved control and management of water abstractions, compliance with authorisations and reliable information on actual water use.
Background information:	The control of over abstraction for use is applicable to both surface and ground water resources. So too are tariff calculations by municipalities, Irrigation Boards, WUAs, and private users. Abstraction control is generally managed through the installation of bulk meters at abstraction points from bulk infrastructure. Abstraction control by service providers and large private users from their own infrastructure is their responsibility but will ultimately become the responsibility of the WUAs. The monitoring of abstractions is necessary to ensure that: • Records of actual water use are kept • Tariff calculations can be made and applied where necessary • Sectoral water use can be determined • Authorisations are complied with The following issues and concerns were identified: • Abstraction of groundwater is poorly monitored • There is a need to ensure adequate technical capacity within local authorities to conduct monitoring of surface and groundwater • There is limited monitoring along the Berg River downstream of Sonquasdrift to monitor (and thus control) abstraction.
Strategic Approach:	Control of over abstraction is going to become ever more critical as water becomes scarcer and competition for the resource intensifies. This is a particular concern in the case of relatively uncontrolled shared water, such as open aquifers accessed by many different users, and where dam releases are made for selective uptake by farmers further downstream. These are systems open to abuse. However first indications show verification of actual water use to reasonably accurately reflect the use registered by farmers, which suggests a lesser level of concern in this WMA than may be the case in others. Abstraction control must, as far as possible be left in the hands of WUAs, with users expected to care for their collective interests through self-policing. Additional monitoring is always going to be required – particularly on behalf of the Reserve, which is in no position to fight for itself. A strategy for the WMA is required which identifies hot spots and potential trouble spots and then seeks to get the resources in place to implement this first commandment of water management. This must be prepared by the RO as a matter of urgency.

9.1	ABSTRACTION CONTROL (cntd)
MANAGEMENT ACTIONS	
Required actions:	The following actions are required: a. Review the current efficiency and acceptability of abstraction control by DWAF, other service providers and large private users. b. Ensure that the scope of appointment of the WUAs addresses their responsibility in terms of monitoring of abstractions. c. Develop an Abstraction Control Strategy Plan for the Berg WMA.
Responsibility:	The implementation of the Strategy **Abstraction Control** is the responsibility of the RO, in consultation in with the Directorate: Water Abstraction and Instream Use.
Priority:	Priority 1 – Very high. To be implemented over the long term.
Interfaces:	**a. Relevant documentation:** a1: NWA: Chapter 14 a2: NWRS: Chapter 3, Part 6 **b. Linked ISPs / WMAs:** None**.** **c. Other role players :** CCT of Cape Town WUAs Large private abstractors The above role-players are each responsible for monitoring of abstraction to some degree. **d. Related Strategies:** 2.1 Reserve and resource quality objectives 3.2 General Authorisations 3.4 Licensing 9.2 Monitoring networks and data capture **e. Linked mapping:** Figure 3.2.1 : General Authorisations (Groundwater Abstraction)

9.2	MONITORING NETWORKS & DATA CAPTURE
Management objective:	The design and implementation of effective monitoring networks and repository databases to ensure adequate quantification of the balance between sustainable water use and protection for surface freshwater bodies and groundwater.
Background information:	Resources currently available for monitoring are generally inadequate throughout all existing systems across South Africa. A National Monitoring Strategy is currently being developed by the Department. Some notable issues in the Berg WMA relate to inadequate groundwater monitoring, groundwater / surface water interaction and a need to implement estuarine flow gauging. *The following specific issues and concerns were identified for the Berg WMA*: **A. SURFACE WATER MONITORING** **i. WMA** • A base-line monitoring programme of the Berg River is currently in progress to establish the existing biota in the river. This will be used to evaluate the extent of potential impacts of Reserve releases from the Berg River Dam and other potential schemes. • Monitoring of wetlands and estuaries is insufficient. • Monitoring of the interaction between surface and groundwater is insufficient. • There is a need for monitoring of Reserve releases to ensure compliance with the applicable authorisation requirements. • There are a number of major players in the gathering of hydrological information, notably DWAF, CCT, Department of Agriculture, and CSIR. A coordinating committee has already been established. • Global warming is predicted to have a very serious impact on the Western Cape, with a possible 30% reduction in MAR. This must be monitored, predicted, and steps taken to mitigate reduced flows. A specific strategy may necessary in future ISPs. • A number of rainstations with long-term records operated by the Weather Bureau have been closed, adversely affecting the ability to calibrate rainfall runoff models. This is a National issue. **ii. Berg River upstream of Hermon** • During the Berg River Dam Feasibility study, it was identified that the spatial distribution of rain stations in the upper catchments of the Berg River is inadequate to support accurate modelling. • The impact of snow and snowmelt on the hydrograph affects our interpretation of catchment hydrology (rainfall: runoff response). **iii. Berg River downstream of Hermon** • The Berg River estuary has a high ecological importance associated with it, yet there is no monitoring of inflow to the estuary. Consequently the estuarine Reserve requirement is not established and cannot be reliably allowed for in the evaluation of the system yield. **iv. Cape Peninsula Rivers** • The interaction between surface and groundwater and the possibility of attenuating flooding by drawing down the Cape Flats aquifer, prior to winter is not established. **v. Steenbras River** • There is no water quality monitoring of the Steenbras River, other than in the dam itself. The effect of dilution in the Upper Steenbras Dam, of the Palmiet River IBT (23 million m^3/a) is not well established.

9.2	MONITORING NETWORKS & DATA CAPTURE (cntd)
Background information:	**B. GROUNDWATER MONITORING** **i. WMA** • The location and status of monitoring boreholes in this WMA is not well documented. • The quality component of the groundwater Reserve assumes a baseline condition of "no deterioration" and does not take resource specific water quality aspects into consideration. • A Reserve determination procedure for groundwater is available, but there is generally insufficient monitoring data available to support the determination. In the absence of a groundwater Reserve determination, authorisations for groundwater abstractions have been put on hold. • Aquifer recharge dynamics are not well understood. • Resource capacity for monitoring is inadequate. • Very little groundwater monitoring is done by the RO and the impacts of pollution from industry, land contamination, cemeteries, sub-surface fuel tanks and sand-mining operations cannot be observed. **ii. Berg River downstream of Hermon** • The natural recharge (rainwater) of the Langebaan Road upper aquifer has been confirmed. Recharge of the lower aquifer is uncertain as this is not monitored **iii. Cape Peninsula Rivers** • Monitoring boreholes are in place in the Cape Flats but many are not in operation - only three boreholes are monitored.

9.2	MONITORING NETWORKS & DATA CAPTURE (cntd)
MANAGEMENT ACTIONS	
Strategic approach	As water resources get scarcer ever better information is required for its careful management. This especially when funds must be raised through the sale of water. Some data is national in nature and concern. It is critical that national networks are well funded and maintained – both as input into regional management and *vice versa*. In the Western Cape a start has already been made by getting all the co-operative governance partners involved in monitoring, to coordinate a strategy, based on mutual needs and on achieving efficiencies by combining efforts in terms of both data collection and information management. DWAF has proved to be an obvious driver in this process and has been requested to maintain this role. More attention and resources are required if this is to keep its momentum. This is of particular relevance to the Berg WMA as the Berg River catchment was selected as the first system in which to pilot co-operative monitoring and information management. One of the core strategic approaches already adopted by this group is that no data should have exclusive ownership and that the sharing of data should be maximized to the benefit of all. There are concerns regarding the possible mis-interpretation of organisation-specific data by others, and there will inevitably be the need for some cost recovery in certain instances – however these broad principles are endorsed and need to be carried forward through this strategy.
Required actions:	Develop a detailed regional strategy for the monitoring needs of the WMA, taking the following into account: • The importance of national networks – these must be well supported and funded. • Catalogue of all aspects that need to be monitored - grouping all monitoring requirements into goal-oriented logical systems and sub-systems. • The information requirement / monitoring needs for the various systems. • Identification and motivation of required or additional monitoring points or functions required for the WMA. • Amalgamation of the identified existing and planned monitoring and assessment systems needs, into a coherent and structured monitoring, assessment and information system. • Review resources required for adequate monitoring of surface and groundwater. • Regularly review and update the regional monitoring strategy. • Develop co-operative relationship between the RO and other organisations or individuals that have relevant data or operate water-related monitoring. **A. SURFACE WATER MONITORING** a. Implement monitoring of all wetlands and estuaries. b. The monitoring requirements related to the implementation and control of Reserve requirements need to be defined. c. Establish flow-gauging facilities on the Berg River downstream of Misverstand Dam and implement long term monitoring for the in-stream and estuarine flow requirements.

9.2	MONITORING NETWORKS & DATA CAPTURE (cntd)
MANAGEMENT ACTIONS	
Required Actions (cntd):	**B. GROUNDWATER MONITORING** **i. WMA** a. A site-specific approach to be investigated in which acceptable levels of deterioration are identified for certain groundwater resources. b. Monitoring should form a requirement of future groundwater authorisations so as to improve the availability of data. c. Initiate a co-operative approach to establish monitoring requirements between the CCT, the RO and the Water Research Commission. The CCT is busy with a study to establish the status of borehole monitoring. d. A Western Cape Monitoring Study should identify the optimum monitoring options, monitoring networks and monitoring programme to be implemented (what is currently monitored and what is required). e. Identify research done to date on the impact of global warming on aquifer recharge. f. Re-establish old monitoring boreholes. g. Consolidate available data from private monitoring operations, consultants and drilling contractors. **ii. Berg River downstream of Hermon** a. Boreholes need to be established to monitor ground, surface and seawater interaction. **iii. West Coast Rivers** a. Completion of a groundwater Reserve determination is required in order to process the applications for authorisation to abstract groundwater in this area. b. Boreholes need to be established to monitor ground, surface and seawater interaction. **iv. Cape Peninsula Rivers** a. Investigate the possibility of flood control in the Cape Flats by intentionally lowering groundwater levels in the Cape Flats Aquifer prior to winter (could form part of the Berg River Baseline Monitoring Study).
Responsibility:	The implementation of the strategy on **Monitoring Networks and Data Capture** is the responsibility of the RO, in conjunction with the Directorate: Hydrological Information, the Directorate: Information Programmes and the Directorate: Waste Discharge and Disposal.
Priority:	Priority 1 – Very high. To be implemented over the long term.

9.2	MONITORING NETWORKS & DATA CAPTURE (cntd)
MANAGEMENT ACTIONS (cntd)	
Interfaces:	**a. Relevant documentation:** a1: NWA: Chapter 14 a2: NWRS: Chapter 3, Part 6 a3: Western Cape System Analysis a4: Skuifraam Dam Feasibility Study – Hydrology **b. Linked ISPs / WMAs:** None. **c. Other role players and their functions:** CCT : Monitors certain rivers and groundwater resources in the WMA. Water Research Commission : Needs to be co-operatively involved in establishing monitoring requirements. **d. Related Strategies:** 2.1 Reserve and resource quality objectives 2.3 Solid waste management 3.2 General Authorisations 3.4 Licensing 3.5 Pollution control 8.3 Implementing the Berg Water Project 8.4 Strategy for the Lower Berg 9.1 Abstraction control

9.3	INFORMATION MANAGEMENT
Management objective:	To facilitate improved access to shared information within the WMA.
Background information:	There is a need to facilitate sharing of information and integrity of information between the various role players in the WMA. Both the CCT and DWAF have extensive databases of information which are relevant to the water resource management in the Berg WMA. As such, information held by those and other institutions (Government and private) should be appropriately shared. The RO is currently investigating the implementation of the HYDSYS data management system. This system will allow for data to be stored, verified and processed locally. This information will then be copied to the National database and, as such, the local database serves as a backup. The following shortcomings were identified: • Capturing of registration data is still in progress and verification of that data is required. • The mapping of invasive alien plants from 2001 aerial photography is not yet complete. • There is a need to improve the sharing of information between DWAF and local authorities.
Strategic Approach:	As for Strategy No 9.2 (Monitoring Networks and Data Capture) the Western Cape Region has agreed to co-ordinate and share both data collection and information management to the best of its ability. This strategy will seek to enhance this process, whilst respecting organisational needs for data security and the maintenance of data integrity. DWAF will endeavour to ensure that the data it gathers and the information it has at its disposal is made available as widely as is possible, practical, and useful to the common benefit of the water resource and its users.

9.3	INFORMATION MANAGEMENT (cntd)
MANAGEMENT ACTIONS	
Required actions:	The following actions are required: a. Support the coordinating committee for monitoring and information. b. The WUAs should be equipped in such a way that they are able to access the relevant information on the HYDSYS system (or any other preferred system) for its own purposes.
Responsibility:	The implementation of the strategy for **Information Management** is the responsibility of the RO, in consultation with the Directorate: Information Programmes and the CCT.
Priority:	Priority 4 – Low.
Interfaces:	**a. Relevant documentation:** a1: NWA: Chapter 14 a2: NWRS: Chapter 3, Part 6 **b. Linked ISPs / WMAs:** None. **c. Other role players and their functions:** CCT : RO and CCT to facilitate sharing of and access to information. WUAs : Will eventually need to access the information management system for their own monitoring purposes. **d. Related Strategies:** 5.2 Co-operative governance 8.1 Strategy for system management and reconciliation 9.2 Monitoring networks and data capture **e. Linked mapping:** None.

SECTION 10: IMPLEMENTATION STRATEGIES

This ISP will be made available to a wider audience at the same time as water resource planning and management is being implemented in terms of the strategies contained therein. Some strategies still need to be developed and the ISP is open to continuous improvement. Input from stakeholders is both expected and desired to ensure acceptability of the strategies presented and to assist in their improvement.

One strategy has been identified for development, namely:

10.1 ISP implementation strategy

10.1	ISP IMPLEMENTATION
Management objective:	To ensure that the approaches put forward by the Department through this ISP are adopted and implemented in the Berg WMA. This will require commitment, funding and capacity.
Background information:	The ISP is an internal document developed by the Department pf Water Affairs and Forestry. The ISP sets out the approaches which the Department is taking towards water management in the Berg WMA – and lists suggested actions towards achieving good management of its water resources. The wider public has not been given opportunity to input into this ISP – yet it is recognised that the approaches adopted have a significant impact on the populace of the Berg WMA. Whilst the approach to date in developing this ISP has been non-participatory, it must be remembered that this is not a Catchment Management Strategy – but DWAF setting out how it sees the situation, and the steps which it views as most appropriate in dealing with the situation. However the ISP is not a closed document and it will to be made available to the wider public for comment and input. This makes the ISP an inherently transparent document – opening out the thinking and planning of the Department. Although DWAF makes no commitment to adopt every comment made, these will be taken seriously and the ISP will be updated and improved as newer and better perspectives are formed. Once the CMA has been established it will be required to develop a CMS, and this will require full public participation. It is to be hoped that the ISP will be taken as useful baseline information and, indeed, that the approaches adopted here are found to be acceptable to, and adaptable by, the new dispensation.
Strategic approach:	The ISP is guided by the approach set out in the NWRS – and details this approach for the Berg WMA. The ISP carries significant weight in expressing how water resource planning and management will be carried out in the WMA. It is not, however, an inflexible document. As such the ISP may be adjusted and adapted when new and better ideas are presented. Despite this the approaches and requirements of this ISP may not be ignored. The implementation of the ISP is an enormous task and will have to be tackled in a stepwise fashion. Much of what is in this document describes the day-to-day functions of the Department – but there are many new tasks, functions, and actions set out in response to DWAF's visions for the future. It is recognised that it is quite impossible to immediately launch into, and achieve, all that is required by this ISP. Funds and capacity are blocks that must be climbed over. The approach is to take the ISP and to use it as instruction, guidance, and motivation in the development of yet clearer management and action plans. These must be built into Departmental Business Plans, and budgeted for as part of Departmental operating costs. This will necessarily be in a phased manner as dictated by available resources, but it is important that the ISP be used to leverage maximum funds, maximum capacity, and to bring optimum management to the WMA. The position with regard to the 'Authority of Information Contained in the ISP' is set out in Para. 1.3.4 of Chapter 1 of this ISP document.

10.1	ISP IMPLEMENTATION STRATEGY (cntd)
MANAGEMENT ACTIONS	
Required actions:	The following actions are required: a. Publish the ISP to be accessible for public input and comment (consider hard-copy and web-based options). Copies will be presented to key stakeholders on request. It is not the intention to have a major drive for public input, but merely to create opportunity for input. b. There are many actions in the ISP which do require public involvement – and it is important that the thinking with regard to, for example, the use of groundwater, and the importance of WC/DM, is delivered forcefully both to local authorities, other direct water users such as agriculture, and the wider public. c. Collate and consider all comment in revising and improving the ISP. d. The ISP should be open to continuous improvement, with possible updating on a bi-annual basis. e. All Regional Office water resource management staff, Working for Water, CCT and other major stakeholders should have access to, or copies of, the ISP f. Approaches set out in the ISP need to be accepted and adopted by both national and regional staff. Where there is resistance to ideas then this needs to be resolved in an open climate of debate and understanding. Modification of the ISP is not ruled out. g. The practicalities of implementation demands must always be considered. h. Most actions in this ISP have been assigned to the Region. It is critically important that the tasks outlined are prioritised, budgeted for, and built into regional and national business plans and budgets.
Responsibility:	The RO is responsible for implementing this strategy..
Priority:	Priority 1 – Very high. The implementation is to be ongoing until the Berg CMA is established and the ISP is superceded by a CMS.
Interfaces:	**a. Relevant documentation:** a1: NWA a2: NWRS **b. Linked ISPs / WMAs:** Breede WMA. **c. Other role players and their functions:** None **d. Related Strategies:** All ISP strategies. **e. Linked mapping:** None

SECTION 11: ADDITIONAL STRATEGIES TO BE DEVELOPED

The following strategies have been identified for development during the next revision of this ISP document. A brief motivation for their need is provided.

YIELD BALANCE AND RECONCILIATION STRATEGIES

Imports from other Water Management Areas

A strategy is required to address the importation of additional water from the Breede WMA as well as the possibility of importing water from the Olifants / Doring WMA.

Water Supply to the Saldanha area

A strategy is required to address the anticipated industrial expansion in this area and the provision of water to meet the anticipated increase in requirements. Water conservation and demand management, securing water from Voëlvlei Dam, trading of existing authorisations, groundwater development, artificial aquifer recharge and other interventions need to be assessed and compared.

Use of the Cape Flats Aquifer

A strategy is required to address how the available yield from the Cape Flats aquifer could be best utilised. Options include augmenting the WCWSS, and serving the local requirements of commercial irrigation (vegetable farmers) and greening of the Cape Flats.

Water Supply to Tulbagh

A strategy must be developed to address the water shortages at Tulbagh.

WATER RESOURCE PROTECTION STRATEGIES

Impacts of Agricultural Practices

A strategy is required to address the impacts of farming practices on the water quality of the surface and groundwater resource.

WATER USE MANAGEMENT STRATEGIES

Compulsory Licensing

A strategy is required to address the priority for Compulsory Licensing in the Berg WMA.

APPENDICES

Supporting Information Tables

Appendix 1	ISP Sub-Areas
Appendix 2	Potable Water Supply Schemes
Appendix 3	Wastewater Treatment Works
Appendix 4	Solid Waste Disposal Sites
Appendix 5	General Authorisations - Abstraction
Appendix 6	Existing Irrigation Boards
Appendix 7	Forums
Appendix 8	Old and New Municipalities
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Appendix 10	Possible Future Bulk Water Supply Schemes
Appendix 11	Major Dams
Appendix 12	Flow Gauging Stations
Appendix 13	Selected Post 1993 Reports

Appendix 1 – SUB-AREAS IN THE BERG WMA

Quaternaries	Rivers/River Reaches	Towns/Suburbs
BERG UPSTREAM OF HERMON (Quats G10A-G10D)		
G10 A	Assegaaibos/Franschhoek Wemmershoek Confluence	
G10 B	Wemmershoek/Zakariahshoek	
G10 C	Dwars/Wemmershoek Confluence/Dal Josaphat	Pniel/Klein Drakenstein/Paarl
G10 D	Dal Josaphat/Hermon	Wellington
KLEIN BERG (Quats G10E)		
G10 E	Kleinberg	Tulbagh
BERG DOWNSTREAM OF HERMON (Quats G10F-G10M)		
G10 F	Hermon to Klein Berg Confluence	Hermon/Saron/Riebeek Wes/Riebeek Kasteel
G10 G	24 & Leeu Rivers to Canal	
G10 H	Krom/Assegaaibos tributaries	Porterville/Piketberg
G10 J	Klein Berg Confluence/Misverstand	Moorreesburg
G10 K	Misverstand/Sout Confluence	
G10 L	Sout	Darling/Hopefield
G10 M	Sout Confluence/Mouth	Vredenburg/Saldanha/Velddrif
COMBINED WEST COAST RIVERS (Quats G21A-G21B)		
G21A	Dwars/Modder	Yzerfontein
G21B	Sout	Atlantis/Mamre/Melksbostrand

Appendix 1 – SUB-AREAS IN THE BERG WMA (cntd.)

Quaternaries	Rivers/River Reaches	Towns/Suburbs
DIEP RIVER (Quats G21C-G21F)		
G21 C	Kasteelburg/above Malmesbury	
G21 D	Above Malmesbury/ Mosselbank Confluence	Malmesbury
G21 E	Mosselbank	Kraaifontein/Upper Durbanville
G21 F	Mosselbank Confluence/Mouth	Tableview/Milnerton/Bloubergstrand
COMBINED KUILS/EERSTE, LOURENS AND SIR LOWRY'S RIVERS (Quats G22E-G22K)		
G22 E	Kuils	Durbanville/Bellville/Brackenfell/ Kleinvlei/Khayelitsha
G22 F	Eerste: Jonkershoek	
G22 G	Eerste: Jonkershoek to Plakenbrug	Stellenbosch/Cloetsville/Khayamandi
G22 H	Eerste: Plankenbrug/Moddergatspruit/Mouth	Firgrove/Macassar
G22 J	Lourens	Somerset West / Strand
G22 K	Sir Lowry's Pass	Sir Lowry's Pass/Strand/ Gordon's Bay
COMBINED CAPE PENINSULA RIVERS (Quats G22A-G22D)		
G22 A	Silvermine/Wildevoelvlei/Elsieskraal	St James/Fish Hoek/Simonstown/Noordhoek/Ocean View/ Kommetjie/Scarborough/Cape Point
G22 B	Disa/Hout Bay/12 Apostles	Hout Bay/Camps Bay/Clifton/ Sea Point/Green Point/City Bowl/ Woodstock
G22 C	Elsieskraal,Liesbeek,Vygekraal,Black,Salt	Parow/Goodwood/Pinelands/Claremont/Rondebosch/Rosebank/ Observatory/Bonteheuwel/ Heideveld/Langa/Athlone/Paarden Eiland
G22D	Diep River/Kaisers/Sand/Lotus/Zeekoevlei	Wynberg/Constantia/Plumstead/ Muizenberg/Grassy Park/Mitchell's Plain
STEENBRAS RIVER (Quat G40A)		
G40 A	Steenbras	

Appendix 2 – POTABLE WATER SUPPLY SCHEMES IN THE BERG WMA

Scheme Name	Raw Water Source	Area Supplied	Scheme Capacity	
			10^6 m^3/a	Limiting factor
1. WESTERN CAPE WATER SUPPLY SYSTEM				
Table Mountain and Southern Peninsula Water Supply Schemes	Hely Hutchinson Dam De Villiers Dam Victoria Dam Alexandra Dam Woodhead Dam Albion Spring	Cape Metropolitan Area	5	Raw water yield
	Kleinplaas Dam Lewis Gay Dam	Simon's Town Simon's Town	1,8	Raw water yield
Steenbras Water Supply Schemes	Steenbras Upper Dam Steenbras Lower Dam	Strand, Newlands, Wynberg	40	Raw water yield
Wemmershoek Water Supply Schemes	Wemmershoek Dam	Cape Town Met. Area Paarl Wellington	54	Raw water yield
Voëlvlei Government Water Supply Scheme	Voëlvlei Dam, receiving water from Klein Berg River, Leeu River, Twenty Four Rivers, own small catchment area	Cape Town Met. Area Armscor Factory at Krantzkop Swartland to Saldanha Regional Schemes	89	Raw water yield
RSE/Berg Government Water Supply Scheme	Theewaterskloof Dam	Stellenbosch Cape Metropolitan Area	124	Raw water yield
Atlantis	36 boreholes	Atlantis Mamre	6,0	Raw water yield
Paarl	Nantes Dam Bethel Dam Berg River Pump station	Paarl	2,8	Raw water yield
Somerset West	Land-en-Zeezicht Dam 4 boreholes	Somerset West	2,0	Raw water yield
Strand	Lourens River	Strand	0,8	Raw water yield
Stellenbosch	Eerste River at Jonkershoek	Stellenbosch	5,5	Raw water yield
Wellington	Antoniesvlei (supplementing supply from Wemmershoek)	Wellington	0,5	Raw water yield

Appendix 2 – POTABLE WATER SUPPLY SCHEMES IN THE BERG WMA (cntd.)

Scheme Name	Raw Water Source	Area Supplied	Scheme Capacity	
			10^6 m^3/a	Limiting factor
2. OTHER SCHEMES				
Piketberg	Misverstand Dam and local sources	7 750 people	1,0	Treatment capacity
Saron	Twenty-four Rivers Canal	Saron	0,34	Pipeline capacity
Porterville	Local sources	4 350 people	0,6	Raw water yield
Tulbagh	Local sources	4 700 people	0,6	Not known
Franschhoek	Local sources	4 500 people	0,6	Raw water yield
Pniel	Local sources	2 150 people	0,04	Storage

Appendix 3 – WASTEWATER TREATMENT WORKS IN THE BERG WMA

Water Management Area	Quaternary Catchment	Controlling Municipality	Name	(Ml/d)	Flow Description	Point of Discharge
Berg upstream of Hermon	G10A	Stellenbosch Municipality	Franschhoek	0.2	Avg Daily Flow	*To be determined*
	G10A	Department Public Works	La Motte State Forest	?	Not determined	*To be determined*
	G10B	Department Public Works	Drakenstein Prison	2.9	Avg Daily Flow	*Berg River*
	G10C	Drakenstein Municipality	Paarl	16.3	Avg Daily Flow	*To be determined*
	G10D	Drakenstein Municipality	Wellington	0.6	Avg Daily Flow	*To be determined*
Klein Berg	G10E	Witzenberg Municipality	Tulbagh	0.2	Avg Daily Flow	*To be determined*
Berg downstream of Hermon	G10F	Drakenstein Municipality	Gouda	<0.1	Avg Daily Flow	*To be determined*
	G10F		Riebeek-Wes	0.1	Avg Daily Flow	*To be determined*
	G10H	Berg River Municipality	Porterville	0.2	Avg Daily Flow	*To be determined*
	G10H	Berg River Municipality	Piketberg	0.5	Avg Daily Flow	*To be determined*
	G10J	Swartland Municipality	Moorreesburg	0.5	Avg Daily Flow	*To be determined*
	G10L	Swartland Municipality	Darling	0.1	Avg Daily Flow	*To be determined*
	G10L	Saldanha Bay Municipality	Hopefield	0.1	Avg Daily Flow	*To be determined*
	G10M	Saldanha Bay Municipality	Saldanha	1.0	Avg Daily Flow	*To be determined*
	G10M	Saldanha Bay Municipality	Vredenberg	1.1	Avg Daily Flow	*To be determined*
	G10M	Saldanha Bay Municipality	Laingville (St Helena Bay)	0.1	Avg Daily Flow	*To be determined*
	G10M	Saldanha Bay Municipality	Paternoster	?	Not determined	*To be determined*
	G10M	Saldanha Bay Municipality	Langebaan	0.6	Avg Daily Flow	*To be determined*
	G10M	Saldanha Bay Municipality	Shelly Point	?	Not determined	*To be determined*
	G10M	Berg River Municipality	Velddrif	0.2	Avg Daily Flow	*To be determined*
		Department Public Works	Riebeek Prison	<0.1	Avg Daily Flow	*To be determined*
West Coast Rivers	G21B	CCT	Wesfleur (Atlantis)	12	Capacity	Groundwater recharge of Atlantis aquifer
	G21B	CCT	Melkbosstrand	2,5	Capacity	To Atlantic via Soute River
Diep	G21D	Swartland Municipality	Malmesbury	1.1	Avg Daily Flow	*To be determined*
	G21D	Swartland Municipality	Malmesbury - Kalbaskraal	?	Not determined	*To be determined*
	G21F	CCT	Potsdam (Milnerton)	35	Capacity	Diep River, Rietvlei, Milnerton Lagoon. Irrigation of sports fields, Century City Water Feature, Table Bay

Appendix 3 – WASTEWATER TREATMENT WORKS IN THE BERG WMA (cntd)

Water Management Area	Quaternary Catchment	Controlling Municipality	Name	(Ml/d)	Flow Description	Point of Discharge
Kuils / Eerste	G22E	CCT	Mitchell's Plain	38	Capacity	To False Bay
	G22E	CCT	Kuilsriver (closed)	n/a	Capacity	Not applicable
	G22E	CCT	Kraaifontein	7	Capacity	To Maasdrift River, tributary of Diep River thence to Rietvlei
	G22E	CCT	Scottsdene	7,5	Capacity	To Kuilsriver then to False Bay
	G21F	Boland District Municipality	Philadelphia	<0.1	Avg Daily Flow	*To be determined*
	G22E	CCT	Bellville	56	Capacity	To Kuilsriver then to False Bay
	G22G	Stellenbosch Municipality	Stellenbosch	8.4	Avg Daily Flow	*To be determined*
	G22G	Stellenbosch Municipality	Stellenbosch - Klapmuts	?	Not determined	*To be determined*
	G22G	Spier Properties (PTY) LTD.	Spier Properties	?	Not determined	*To be determined*
	G22G	Spier Properties (PTY) LTD.	Spier - Chef Training School	?	Not determined	*To be determined*
	G22H	CCT	Zandvliet	55	Capacity	To Eerste River then to False Bay
	G22H	CCT	Macassar	35	Capacity	To Eerste River then to False Bay
	G22K	CCT	Gordon's Bay	3	Capacity	To Sir Lowry's diversion canal and False Bay
Peninsula	G22A	CCT	Simon's Town	3,8	Capacity	To False Bay
	G22A	CCT	Wildevoëlvlei	14	Capacity	Into Wildevoëlvlei and then to Atlantic
	G22A	CCT	Millers Point (small bioreactor)	?	Not determined	To False Bay
	G22B	CCT	Green Point Sea Outfall	40	Capacity	To sea (Atlantic)
	G22B	CCT	Camps Bay Sea Outfall	5,5	Capacity	To sea (Atlantic)
	G22B	CCT	Llandudno	0,3	Capacity	To sea (Atlantic)
	G22B	CCT	Hout Bay (sea outfall)	17,5	Capacity	To sea (Hout Bay)
	G22B	CCT	Oudekraal (small bioreactor)	?	Not determined	Pumped to Camps Bay outfall (Atlantic)
	G22C	CCT	Athlone	120	Capacity	To Black River then to Table Bay
	G22C	CCT	Parow North	1,2	Capacity	To irrigation of golf course
	G22D	CCT	Cape Flats	200	Capacity	To False Bay
	G22D	CCT	Borcherd's Quarry	30	Capacity	To Table Bay via Black River and to golf course irrigation
To be determined		Department Public Works	Paardeberg Prison	?	Not determined	*To be determined*
		Public Works	Voorberg Prison			*To be determined*
		Boland District Municipality	Raithby	?	Not determined	*To be determined*
		Boland District Municipality	Klipheuwel	?	Not determined	*To be determined*

Appendix 4 – SOLID WASTE DISPOSAL SITES IN THE BERG WMA

Water Management Area	Quaternary Catchment	Area	Local Authority	District Municipality	Type of Site
Berg Upstream of Hermon	G10A	Franschhoek	Stellenbosch Municipality	Boland District Municipality	Compost Site
	G10A	Franschhoek	Stellenbosch Municipality	Boland District Municipality	Domestic Dumping Site
	G10D	Wellington	Drakenstein Municipality	Boland District Municipality	Domestic Dumping Site
Klein Berg	G10E	Tulbagh	Witzenberg Municipality	Boland District Municipality	General Waste Disposal Site
Berg Downstream of Hermon	G10F / G10J border	Saron	Drakenstein Municipality	Boland District Municipality	Domestic Dumping Site
	G10H	Piketberg	Berg River Municipality	West Coast District Municipality	Dumping Site
	G10H	Porterville	Berg River Municipality	West Coast District Municipality	Dumping Site
	G10H	Porterville	Berg River Municipality	West Coast District Municipality	Incinerator
	G10J	Moorreesburg	Swartland Municipality	West Coast District Municipality	Dumping Site
	G10J	Moorreesburg	Swartland Municipality	West Coast District Municipality	Compost Site
	G10L	Darling	Swartland Municipality	West Coast District Municipality	Dumping Site
	G10M	Saldanha Steel	Industry Saldanha Area	West Coast District Municipality	Dumping Site
	G10M	Saldanha	Saldanha Bay Municipality	West Coast District Municipality	Dumping Site
	G10M	Velddrif	Berg River Municipality	West Coast District Municipality	Dumping Site
	G10M	Langebaan	Saldanha Bay Municipality	West Coast District Municipality	Dumping Site
	G10M	Langebaan	Saldanha Bay Municipality	West Coast District Municipality	Garden Dumping Site
	G21D	Malmesbury	Swartland Municipality	West Coast District Municipality	Dumping Site/Recycling
	G21D	Malmesbury	Swartland Municipality	West Coast District Municipality	Incinerator
	G30A	Aurora	Berg River Municipality	West Coast District Municipality	Dumping Site
Diep	G21F	Vissershok (Brunig)	CCT (Tygerberg)	CCT	Composting Plant
	G21F	Fuel Firing Service	CCT	CCT	Oil Refinery
	G21F	Vissershok Landfill Pty Ltd	CCT	CCT	Landfill

Appendix 4 – SOLID WASTE DISPOSAL SITES IN THE BERG WMA (cntd)

Water Management Area	Quaternary Catchment	Area	Local Authority	District Municipality	Type of Site
Kuils / Eerste	G22G	Stellenbosch	Stellenbosch Municipality	Boland District Municipality	Domestic/Building/Garden Dumping Site
	G22G	Klapmuts T/S	Winelands District Council	Boland District Municipality	Transfer Station
	G22G	Klapmuts	Winelands District Council	Boland District Municipality	Closed
	G22G	Klapmuts	Winelands District Council	Boland District Municipality	Compost Site
	G22E	Durbanville (Tygerberg)	CCT	CCT	Transfer Station - Garden Refuse
	G22H	Faure	CCT	CCT	Domestic Dumping Site
	G22K	Gordon's Bay	CCT	CCT	Domestic Dumping Site
	G22E	Bellville	CCT	CCT	General Waste Disposal Site
	G22K	Somerset-West (Waterkloof)	CCT	CCT	Waste Transfer Station
	G22E	Bellville (Wastetech)	CCT	CCT	Closed Waste Disposal Site
	G22H	Macassar	CCT	CCT	Domestic Dumping Site
	G22E	Swartklip / Mitchell's Plain	CCT	CCT	Domestic Dumping Site
	G22E	Bellville South / Sacks Circle	CCT	CCT	Domestic Dumping Site
	G22E	Brakenfell	CCT	CCT	Domestic Dumping Site
Peninsula	G22D	CCT	CCT	CCT	Landfill
	To be determined	Sonumed	CCT	CCT	Medical Waste Site
	G22D	Coastal Park	CCT	CCT	Domestic Dumping Site
	G22C	Athlone	CCT	CCT	Domestic Dumping Site
	G22C	Milnerton Mediclinic	CCT	CCT	Incinerator
		Radnor CP	CCT	CCT	Domestic Dumping Site
		Everite Factory	CCT	CCT	Domestic Dumping Site
			Drakenstein Municipality	Boland District Municipality	Closed Dumping Site
		BCL Envirocare	CCT	CCT	Incinerator
Potential Sites	G21B	*To be determined*	CCT	CCT	*To be determined*

Appendix 5 – GENERAL AUTHORISATIONS IN THE BERG WMA – ABSTRACTIONS

Area	Abstraction (m^3 / hectare / annum)
BERG UPSTREAM OF HERMON	
Quats G10A & G10B	750
Quats G10C & G10D	300
KLEIN BERG	
Quat G10E	750
BERG DOWNSTREAM OF HERMON	
Quats G10F, G10H - G10M	300
Quats G10G	750
COMBINED WEST COAST RIVERS	
Quat G21A	300
Quat G21B	750
DIEP RIVER	
Quats G21C - G21F	300
COMBINED KUILS/EERSTE, LOURENS AND SIR LOWRY'S RIVERS	
Quat G22F	750
Quats G22E, G22G - G22K	300
COMBINED CAPE PENINSULA RIVERS	
Quats G22A - G22D	750
STEENBRAS RIVER	
Quat G40A	750

Note : There are no GAs for Surface Water Abstractions in the Berg WMA

Appendix 6 – EXISTING IRRIGATION BOARDS IN THE BERG WMA

Water Management Area	Quaternary Catchment	Name	Scheduled Area (ha)	Quota (m^3/ha/a)	Water Source
Berg Upstream of Hermon	G10A	Banhoek	450	4000	Theewaterskloof via Bankoek Diversion Intake
	G10C	Daljosaphat	215	Unknown	Dal River
	G10C	Palmiet	313	3300	Hugo's River
	G10C	Berg River	11242	4000-6000	Natural Berg River runoff and Theewaterskloof dam
	G10C	Simonsberg	125	4000	Summer abstraction from Berg River
	G10C	Noord-Agter Paarl	1079	5000	Natural Berg River winter runoff and Theewaterskloof dam
	G10C	Suid-Agter Paarl	876	4000	Natural Berg River winter runoff and Theewaterskloof dam
	G10C	Dwars River	1458	Unknown	
	G10C	La Motte	230	Unknown	Berg River
	G10D	Perdeberg	1487	6000	Natural Berg River winter runoff and Theewaterskloof dam
	G10D	Kromme River	646	Unknown	
Klein Berg	G10E	Klein Berg	1465	Unknown	
Berg Downstream of Hermon	G10F	Riebeek Wes	697	--	Natural winter flow in Berg River
	G10F	Riebeek Kasteel	150 (winter) 177 (summer)	5000	Natural Berg River winter runoff and Theewaterskloof dam
	G10F, G10J, G10K	Lower Berg River	1051 (winter) 3644 (summer)	7000	Voelvlei, Theewaterskloof and Berg River flow. Farm dam storage.
Kuils / Eerste	G22F	Stellenbosch	1703	4000	Theewaterskloof Dam via Stellenboschberg Tunnel outlet
	G22H	Helderberg	1192	340	Theewaterskloof dam via pipeline to Faure Water Treatment Works
	G22H	Lower Eerste River	514	--	Theewaterskloof Dam via Stellenboschberg Tunnel outlet
Ref : Berg WMA - Situation Assessment Report (Ninham Shand, 2002)					

Appendix 7 - FORUMS IN THE BERG WMA

Water Management Area	Existing and Proposed Forums	Comment
Klein Berg	Klein Berg Forum	*Status to be determined from DWAF*
Upper and Lower Berg	Lower Berg River Catchment Forum	*Status to be determined from DWAF*
	Voëlvlei Water Quality Forum	*Status to be determined from DWAF*
	Saldahna Bay Water Quality Forum	Established and functioning
	St. Helena Bay Forum	
	WEMCO Provincial Environmental Monitoring Committee	*Status to be determined from DWAF*
	Saldanha Groundwater Monitoring Forum	*Status to be determined from DWAF*
	St Helena Bay Water Quality Trust	*Status to be determined from DWAF*
	Langebaan Road/Elandsfontein Ground water Management Trust	*Status to be determined from DWAF*
	Saldanha Steel Environmental Monitoring Committee	Established and functioning
	Berg River Environmental Forum	*Status to be determined from DWAF*
West Coast Rivers	Sout / Donkergat River Catchment Forum	Not yet established by DWAF / CCT
Diep	Diep River Catchment Forum	Not yet established, DWAF to be the lead agent for this forum.
Kuils / Eerste	Kuils River Forum	Established but has not met for past 6 months
	Eerste River Catchment Management Forum	Not yet established by DWAF
Peninsula	Noordhoek Catchment Forum	Established and functioning
	Hout Bay Catchment Forum	Established and functioning
	Sand River Catchment Forum	Established and functioning
	Salt River Catchment Forum	Established and functioning
	Lotus River - Zeekoevlei Catchment Forum	Established and functioning
	South Peninsula Forum	Established and functioning
Other	Cape Metropolitan Coastal Water Quality Committee	Established and functioning
	False Bay Water Quality Advisory Committee	Established but future remains uncertain
	Die Benede-Bergrivier Substreekstruktuurplan	*Status to be determined from DWAF*

Appendix 8 - OLD AND NEW MUNICIPALITIES IN THE BERG WMA

OLD MUNICIPAL NAMES	NEW LOCAL MUNICIPALITY NAME	NEW DISTRICT MUNICIPALITY NAME
Cape Metro	CCT	CCT
CCT		
Oostenberg Municipality		
Helderberg		
Blaauwberg Municipality		
South Peninsula Municipality		
Tygerberg		
Bitterfontein / Nuwerus	Falls Directly Under West Coast District Municipality	WEST COAST DISTRICT MUNICIPALITY (WCDM)
Rietpoort		
West Coast		
Aurora	Berg River Municipality	
Piketberg		
Porterville		
Hopefield	Saldanha Bay Municipality	
Langebaan		
West Coast Peninsula		
Darling	Swartland Municipality	
Koringberg		
Malmesbury		
Moorreesburg		
Yzerfontein		
Tulbagh	Witzenberg Municipality	BOLAND DISTRICT MUNICIPALITY
Breede River	Falls Directly Under Boland District Municipality	
Winelands		
Paarl	Drakenstein Municipality	
Saron		
Wellington		
Franschhoek	Stellenbosch Municipality	
Pniel		
Stellenbosch		

Appendix 9 – RESOURCE POOR FARMERS AND COMMUNITIES IN THE BERG WMA

Water Management Area	Quaternary Catchment	Area	Implementing Authority
Berg downstream of Hermon	G10F / G10J border	Saron	DWAF and Department of Agriculture
To be determined		Safic	Department of Land Affairs
Klein Berg	G10E	Tulbagh (Kluitjieskraal)	Department of Land Affairs
Kuils / Eerste	G22G	Khayamandi	Department of Land Affairs
Peninsula	G22D	Philippi	Department of Land Affairs
Berg downstream of Hermon	G10H	Goedverwacht (Piketberg)	Department of Agriculture
	G10H	Wittewater (Piketberg)	Department of Agriculture
Diep	G21D	Riverlands	DWAF and Department of Agriculture
West Coast Rivers	G21A	Mamre	Department of Land Affairs

Appendix 10 – POSSIBLE FUTURE BULK WATER SUPPLY SCHEMES IN THE BERG WMA

Water Management Area	Quaternary Catchment	Scheme	Estimated Yield (10^6 m^3/a)	Estimated Cost (R million)
Klein Berg	G10E	Pumped storage from Voëlvlei	To be determined	To be determined
	G10E	Transfers from the Wit River and Michell's Pass (Breede WMA)	To be determined	To be determined
Berg downstream of Hermon	G10M	Recharge of Langebaan Rd aquifer by injection of pre-treated Berg River winter (excess) water.	To be determined	To be determined
	n/a	Buying out existing water rights from farmers.	To be determined	To be determined
	G10H	Misverstand Dam Raising	To be determined	To be determined
	G10F	Voëlvlei Augmentation	30	200
	G10F	Raise Voëlvlei Dam	To be determined	To be determined
West Coast Rivers	G21A, G21B	Development of local supply schemes, integrating surface and ground water use.	To be determined	To be determined
Kuils / Eerste	G22E	Possible recharge site for Cape Flats Aquifer at Macassar	To be determined	To be determined
	G22H	Eerste River diversion	8	77
	G22J	Lourens River diversion	19	35
Peninsula	G22D	Cape Flats wellfield could provide an estimated 18 million m^3/a.	18	161
Steenbras	G40A	Raising the Steenbras dams for additional transfers from Palmiet (Breede WMA)	To be determined	To be determined
Other	n/a	Table Mountain Group Aquifer	To be determined	To be determined
	n/a	De-salination of sea water	Unlimited	To be determined
	n/a	Molenaars pipeline from Breede WMA	18	To be determined
	n/a	The re-use of treated effluent	160	To be determined

(1) Costs are based on Year 2000 price levels.

Appendix 11 – MAJOR DAMS IN THE BERG WMA

Water Management Area	Quaternary Catchment	Dam Name	Live Storage (10^6 m^3)	Yield (10^6 m^3/a)					Owner
				Domestic	Irrigation	Other	Total	Assurance	
Berg Upstream of Hermon	G10B	Wemmershoek	58,8	54,0	0	0	54,0	1:50 Yr	CCT
	G10C	Nantes	0,77	0,5	0	0	0,5	1:20 Yr	Paarl
	G10C	Bethel	0,54						
Berg downstream of Hermon	G10H	Voëlvlei	164,1	89	32	0	121	1:50 Yr	DWAF
	G10J	Misverstand	6,1	5	0	0	5	Abstraction site	DWAF
Cape Peninsula	G22A	Lewis Gay	0,18	1,8	0	0	1,8	1:20 Yr	CCT
	G22A	Kleinplaas (Simonstown)	1,37						
	G22B	Alexandra	0,13	5	0	0	5	1:100 Yr (incl Albion Spring)	CCT
	G22B	Woodhead	0,95						
	G22B	De Villiers	0,24						
	G22B	Victoria	0,13						
	G22B	Hely Hutchinson	0,92						
	G22D	Silvermine	0,08	?	?	?	?	Not known	CCT
Kuils / Eerste	G22F	Kleinplaas (Jonkershoek)	0,36	18,5	1,5	0	20	Own yield is 20 million m^3/a	DWAF
	G22G	Idas Valley 2	1,54	?	?	?	?	Balancing dams for water in Eerste River	Stellenbosch
	G22G	Idas Valley 1	0,50						
	G22J	Land-en-Zeezicht	0,45	?	0	0	?	Off channel storage	Somerset West
Steenbras	G40A	Steenbras Upper	31,8	62,5	0	0	62,5	1:50 Yr (includes 22,5 million m^3/a from Palmiet transfer)	CCT
	G40A	Steenbras Lower	33,7						
(Ref : Water Resources Situation Assessment Report P19000/00/031)									

Appendix 12 – FLOW GAUGING STATIONS IN THE BERG WMA

Water Management Area	Station No	Place or Description	River / Pipeline	Latitude	Longitude	Catchment Area	Record Period of Primary Data	
						(km^2)	From	To
Berg Upstream of Hermon	G1H001A01	Wintershoek	Wemmersriver	33 49'05"	19 05'19"	85	Jan-1955	Dec-1956
	G1H003A01	La Provence	Franschhoek	33 53'26"	19 04'44"	46	Mar-1949	May-2002
	G1H004A01	Driefontein	Berg	33 55'36"	19 03'41"	70	Apr-1949	May-2002
	G1H005A01	Zanddrift	Berg	33 37'47"	18 59'06"	717	Apr-1950	Feb-1951
	G1H007A01	Wellington	Berg	33 38'21"	18 59'06"	713	Apr-1951	May-1977
	G1H014A01	Zachariashoek	Zachariashoek	33 49'39"	19 02'08"	3	Jun-1964	Nov-1992
	G1H015A01	Zachariashoek	Kasteelkloofspruit	33 48'55"	19 03'43"	2	Jun-1964	Jul-1988
	G1H016A01	Zachariashoek	Kasteelkloofspruit	33 49'19"	19 03'35"	3	Jun-1964	Nov-1992
	G1H017A01	Zachariashoek	Kasteelkloofspruit	33 49'35"	19 01'43"	2	Jun-1964	Jul-1988
	G1H018A01	Zachariashoek	Bakkerskloofspruit	33 49'21"	19 02'50"	3	Jun-1964	Nov-1992
	G1H019A01	The Sanctuary	Banghoek	33 54'44"	18 56'36"	25	Apr-1968	May-2002
	G1H020A01	Noorder Paarl	Berg	33 42'29"	18 59'29"	609	Mar-1966	May-2002
	G1H032A01	Bosmanshoek	Banghoek	33 57'11"	18 58'44"	7.6	Mar-1975	Jul-1978
	G1H037A01	Wellington	Krom	33 37'39"	18 59'29"	69	May-1978	May-1992
	G1H038A01	Wolwekloof	Wolwekloof : Ogee	33 56'37"	19 01'39"	17	Sep-1978	May-2002
	G1H041A01	De Eikeboomen	Kompanjies	33 28'45"	18 58'41"	121	Aug-1979	Apr-2002
	G1H042A01	Ogee : Banghoek	Banghoek	33 57'10"	18 58'45"	7.6	Jun-1982	Dec-1989
	G1H044M01	Franschhoek Forestry Reserve	Jonkershoek Tunnel Berg River Outlet	33 57'15"	19 04'25"	n/a	Feb-1984	Mar-2002
	G1H045A01	Paarl WWTW	Effluent discharge	33 40'53"	18 58'45"	n/a	Dec-1983	Mar-1987
	G1H046A01	Wellington WWTW	Effluent discharge	33 39'31"	18 58'11"	n/a	Jan-1984	Dec-1989
	G1H052M01	Waterval	Jonkershoek Tunnel Dasbos Outlet	33 54'10"	19 01'54"	n/a	Jan-1982	Mar-2002
	G1H053M01	Franschhoek Forestry Reserve - East Portal	Theewaterskloof Tunnel - bi directional meter	33 57'10"	19 04'29"	n/a	Feb-1987	Mar-2002
	G1H054M01	Franschhoek Forestry Reserve - East Portal	Wemmershoek Outlet (minor)	33 57'18"	19 04'33"	n/a	Feb-1986	Jan-2002
	G1H055M01	Franschhoek Forestry Reserve - East Portal	Wemmershoek Outlet (main)	33 57'18"	19 04'33"	n/a	Feb-1984	Mar-2002
	G1H060A01	River Compensation	Wolwekloof	33 56'39"	19 01'39"	17	Aug-1978	May-2002

Appendix 12 – FLOW GAUGING STATIONS IN THE BERG WMA (cntd)

Water Management Area	Station No	Place or Description	River / Pipeline	Latitude	Longitude	Catchment Area	Record Period of Primary Data	
						(km^2)	From	To
Berg Upstream of Hermon	G1H061A01	Inlet to Shaft	Wolwekloof	33 56'39"	19 01'39"	n/a	May-1982	Feb-2002
	G1H062A01	Banghoek	Compensation releases	33 57'10"	18 58'45"	n/a	Dec-1989	Feb-2002
	G1H063A01	Shaft Inlet : Banghoek	Banghoek	33 57'10"	18 58'45"	7.6	Oct-1982	Feb-2002
	G1H064A01	River Compensation	Banghoek	33 57'10"	18 58'45"	7.6	Jun-1982	Feb-2002
	G1H071M01	Winterhoek	Wemmershoek outlet pipeline	33 49'56"	19 05'00"	n/a	Oct-1973	Aug-1992
	G1H072M01	Winterhoek, Wemmershoek Dam	Wemmershoek compensation pipeline	33 49'56"	19 05'00"	n/a	Oct-1973	Sep-1991
Klein Berg	G1H008A01	Nieuwekloof	Klein Berg	33 18'41"	19 04'31"	395	Nov-1976	Jul-1985
	G1H011A01	Watervalsberge	Watervals	33 22'44"	19 06'00"	27	Apr-1964	Mar-2002
	G1H012A01	Watervalsberge	Watervals	33 21'08"	19 06'04"	36	Apr-1964	Jun-1996
	G1H021A01	Mountain View	Klein Berg	33 11'05"	19 09'19"	19	Mar-1968	May-2002
	G1H057A01	Watervalsberge	Canal from Watervals River	33 21'08"	19 06'04"	n/a	Apr-1964	Jun-1996
Berg downstream of Hermon	G1H002A01	Driebosch	Twenty Four	33 08'02"	19 03'39"	187	Dec-1920	Oct-1970
	G1H006A01	Hopefield	Sout	33 03'42"	18 20'46"	1690	May-1950	Oct-1954
	G1H013A01	Drieheuwels	Berg	33 07'57"	18 51'45"	2934	May-1964	May-2002
	G1H023A01	Jantjiesfontein	Berg	32 55'30"	18 19'45"	8238	Oct-1980	Apr-2002
	G1H024A01	Kliphoek	Berg	32 49'00"	18 11'39"	n/a	Oct-1980	Apr-2002
	G1H028A01	Driebosch	Vier en Twintig	33 08'02"	19 03'39"	183	May-1972	May-2002
	G1H029A01	De Hoek Estates	Leeu	33 09'24"	19 03'08"	36	Nov-1972	May-2002
	G1H031A01	Misverstand	Berg	33 59'49"	18 46'44"	4012	May-1974	May-2002
	G1H034A01	Hollerivier	Moorreesburgspruit	33 03'58"	18 45'35"	134	Jul-1976	May-2002
	G1H035A01	Matjiesfontein	Matjies	33 02'52"	18 49'58"	676	Jul-1975	May-2002
	G1H036A01	Vleesbank	Berg	33 26'06"	18 57'25"	1312	Mar-1978	May-2002
	G1H040A01	La Fontaine	Vis	33 22'21"	18 55'30"	39	Aug-1979	May-2002
	G1H043A01	Vrisgewaagd	Sandspruit	33 09'41"	18 53'35"	152	May-1980	May-2002
	G1H048M01	Misverstand Dam	Pipeline to Withoogte	33 01'39"	18 47'25"	n/a	Mar-1986	Apr-2002
	G1H058A01	Driebosch	Canal from Twenty-Four Rivers	33 08'02"	19 03'39"	183	May-1972	May-2002
	G1H059A01	De Hoek Estates	Canal	33 09'24"	19 03'08"	n/a	Mar-1973	May-2002
	G1H065A01	Voelvlei	Canal from Voëlvlei	33 21'05"	19 01'12"	n/a	Oct-1951	Feb-2002
	G1H066A01	Voelvlei	Klein Berg canal into Voelvlei	33 21'05"	19 01'12"	n/a	Jun-1951	Feb-2002
	G1H067A01	Voelvlei	Twenty Four rivers canal into Voelvlei	33 21'05"	19 01'12"	n/a	May-1972	Feb-2002

Appendix 12 – FLOW GAUGING STATIONS IN THE BERG WMA (cntd)

Water Management Area	Station No	Place or Description	River / Pipeline	Latitude	Longitude	Catchment Area	Record Period of Primary Data	
						(km^2)	From	To
Berg downstream of Hermon	G1H068M01	Voelvlei	Swartland pipeline	33 21'05"	19 01'12"	n/a	Oct-1968	Feb-2002
	G1H069M01	Voelvlei	ICS pipeline	33 21'05"	19 01'12"	n/a	Feb-1958	Jun-1982
	G1H070M01	Voelvlei	Cape Town pipeline	33 21'05"	19 01'12"	40	Feb-1971	Feb-2002
	G1R001A01	Voelvlei Dam	Voelvlei Dam	33 21'05"	19 01'12"	40	Jun-1951	Feb-2002
	G1R003A01	Misverstand Dam	Misverstand Dam	33 01'39"	18 47'25"	3967	Jul-1977	Feb-2002
Diep	G2H012A01	Malmesbury	Diep	33 27'52"	18 44'26"	244	Mar-1965	Feb-2002
	G2H013A01	Klipheuwel	Mosselbank	33 42'18"	18 42'02"	473	Apr-1966	May-1986
	G2H014A01	Vissershok	Diep	33 47'23"	18 32'58"	1360	Apr-1967	Nov-1982
	G2H042A01	Adderley	Diep	33 43'36"	18 36'56"	Unknown	Oct-1998	Apr-2002
Kuils / Eerste	G2H001A01	Carnoustie	Plankenbrug	33 54'13"	18 51'12"	70	Jun-1934	Jan-1938
	G2H002A01	Jonkershoek	Bosboukloof	33 57'44"	18 55'52"	2	Oct-1937	Mar-1961
	G2H006A01	Jonkershoek	Abdolskloof	33 57'50"	18 56'10"	<1	May-1940	Mar-1961
	G2H008A01	Jonkershoek	Jonkershoek	33 59'11"	18 57'23"	20	Jun-1947	Apr-1995
	G2H011A01	Macassar	Eerste	34 04'16"	18 46'15"	395	Dec-1950	Apr-1952
	G2H015A01	Faure	Eerste	34 01'49"	18 44'54"	338	Apr-1968	May-1980
	G2H016A01	Somerset West	Lourens	34 05'13"	18 51'31"	92	Apr-1970	Apr-1991
	G2H019A01	Stellenbosch	Eerste	33 56'37"	18 50'39"	176	May-1976	May-1984
	G2H020A01	Stellenbosch	Eerste	33 56'58"	18 50'19"	183	May-1978	Feb-2002
	G2H021A01	Kuilsrivier	Kuils	33 56'32"	18 40'27"	133	May-1978	Oct-1987
	G2H026A01	Spier	Spier Canal	33 58'05"	18 47'28"	n/a	Oct-1980	Jun-1992
	G2H027M01	Nietgegund, Kleinplaas Dam	KWV pipeline	33 57'43"	18 52'11"	n/a	Nov-1984	Jan-1992
	G2H029A01	Strand	Lourens	34 06'00"	18 49'22"	107	Dec-1986	Feb-2002
	G2H030A01	Stellenbosch	Right bank canal	33 56'37"	18 50'39"	-	May-1976	Feb-2002
	G2H031M01	Jonkershoek, Kleinplaas Dam	Jonkershoek tunnel outlet - Valve 1	33 58'21"	18 56'56"	n/a	Mar-1984	May-1999
	G2H032M01	Jonkershoek, Kleinplaas Dam	Jonkershoek tunnel outlet - Valve 2	33 58'21"	18 56'56"	n/a	Mar-1984	Mar-2001
	G2H033M01	Jonkershoek, Kleinplaas Dam	Jonkershoek tunnel outlet - Valve 3	33 58'21"	18 56'56"	n/a	Mar-1984	Jun-2001
	G2H034M01	Kleinplaas Dam	Pipeline to Cape Town from tunnel	33 58'28"	18 56'37"	n/a	May-1982	Mar-2002
	G2H035M01	Kleinplaas Dam	Pipeline to S'Bosch/KWV from tunnel	33 58'50"	18 53'01"	n/a	May-1984	Jul-1993

Appendix 12 – FLOW GAUGING STATIONS IN THE BERG WMA (cntd)

Water Management Area	Station No	Place or Description	River / Pipeline	Latitude	Longitude	Catchment Area	Record Period of Primary Data	
						(km^2)	From	To
Kuils / Eerste	G2H036M01	Kleinplaas Dam	Paradyskloof pipeline	33 57'45"	18 52'25"	n/a	Nov-1983	Jan-1992
	G2H037A01	Kleinplaas Dam	Jonkershoek	33 59'02"	18 57'11"	21	Jun-1989	Apr-2002
	G2H037A01	Klein Welmoed	Eerste River	34 00'17"	18 45'50"	n/a	Nov-1998	Apr-2002
	G2R001A01	Kleinplaas Dam	Jonkershoek	33 58'45"	18 57'00"	31	Jan-1983	May-2002
	G2H005A01	Kleinplaas Dam	Jonkershoek	33 58'21"	18 56'56"	31	Oct-1947	Feb-2002
Steenbras	G4H001A01	Kogelbaai	Steenbras	34 11'19"	18 51'18"	67	1916	1921
	G4R001A01	Lower Steenbras Dam	Steenbras - Lower Dam	34 11'13"	18 51'10"	66.8	1921	
	G4R007A01	Upper Steenbras Dam	Steenbras - Upper Dam	34 10'06"	18 54'00"	26.6	1988	

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Water Management Area	Report Title	Author	Ninham Shand Reference	Report Date
Upper and Lower Berg River	Voelvlei Augmentation Scheme: Feasibility Study. Main Report	Gibb Africa (Pty) Ltd	GIBAFR/004	2001
	Voelvlei Augmentation Scheme: Feasibility Study. Summary Report	Gibb Africa (Pty) Ltd	GIBAFR/005	2001
	Voelvlei Augmentation Scheme: Feasibility Study. New Infrastructure Design and Costs	Gibb Africa (Pty) Ltd	GIBAFR/006A	2001
	Voelvlei Augmentation Scheme: Feasibility Study. Draft Environmental Impact Report	Gibb Africa (Pty) Ltd	GIBAFR/008	2001
	Review of the Long-term Urban Demand for Water in the Cape Town - Saldanha Supply Area	Institute for Futures Research; Ninham Shand; Palmer Development Group	IRF/NS/PDG/001	2000
	Workshop to Consider the Effects of Water Conservation and Demand Management on the Future Demands of Irrigation Water Supplied from Theewaterskloof and Voëlvlei Dams: Proceedings	Ninham Shand	3069	2000
	Voelvlei Augmentation Scheme: Feasibility Study. Volume 2: Hydrology Report	Gibb Africa (Pty) Ltd	GIBAFR/002	2000
	Voelvlei Augmentation Scheme: Feasibility Study. New Infrastructure Design and Costs	Gibb Africa (Pty) Ltd	GIBAFR/006A	2000
	Profile on Water Management in the Berg, Breede, Gouritz & Olifants / Doring WMA : The Utilisation and Availability of water	Ninham Shand	3152	2000
	Berg River : Proposed Management Arrangements for Resource Monitoring and Reserve Determination	Ninham Shand	3047	2000
	Feasibility Study of the Skuifraam Supplement Scheme: System Yield Analysis	Ninham Shand	2812	1999
	Skuifraam Dam Feasibility Study: System Analysis	Ninham Shand	2677	1999
	Skuifraam Feasibility Study: Main Report	Ninham Shand	2780	1999
	Skuifraam Feasibility Study: Outlet Works Flood Release Workshop Proceedings	Ninham Shand	2869	1999
	Voelvlei Augmentation Scheme: Feasibility Study. Volume 1: Hydrology Report	Gibb Africa (Pty) Ltd	GIBAFR/001	1999
	Voelvlei Augmentation Scheme: Feasibility Study. Volume 3: Hydrology Report	Gibb Africa (Pty) Ltd	GIBAFR/003	1999
	Voelvlei Augmentation Scheme: Feasibility Study. Environmental Scoping Report	Gibb Africa (Pty) Ltd	GIBAFR/007	1999
	Berg Dam : Environmental Motivational Report for Exemption	Ninham Shand	2927	1999
	Skuifraam Feasibility Study: Guidelines for Implementation	Ninham Shand	2805	1998
	Feasibility Study of the Skuifraam Supplement Scheme: Engineering Aspects	Ninham Shand	2680	1998
	Skuifraam Dam Feasibility Study. Flood Frequency Analysis: Flood Magnitudes for Required Exceedance Probabilities. Filed: Box 2	Ninham Shand	2810	1997
	Feasibility Study Skuifraam Supplement Scheme: Environmental Impact Assessment	Ninham Shand	2688	1997
	Skuifraam Feasibility Study: Inception Report	Ninham Shand	2662	1997

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Water Management Area	Report Title	Author	Ninham Shand Reference	Report Date
	Skuifraam Feasibility Study: Hydrology	Ninham Shand	2596	1997
	Skuifraam Feasibility Study: Main Report	Ninham Shand	2542	1997
	Skuifraam Feasibility Study: Flow Gauging Stations	Ninham Shand	2622	1997
	Skuifraam Feasibility Study: The Riversonderend. Situation Assessment, with Specific Reference to the Effects of Theewaterskloof Dam on the Riverine Ecosystem	Southern Water's Ecological Research and Consulting CC & UCT Freshwater Research Unit	2811	1996
	Skuifraam Feasibility Study. Ancillary Schemes: Engineering Aspects	Ninham Shand	2813	1996
	Skuifraam Feasibility Study. Skuifraam Dam: Engineering Aspects	Ninham Shand	2814	1996
	Skuifraam Feasibility Study: Environmental Impact Assessment. Volume 2: Annexure Report	Ninham Shand	2518A	1996
	Skuifraam Feasibility Study: Environmental Impact Assessment. Volume 1	Ninham Shand	2518	1996
	Skuifraam Feasibility Study: Environmental Impact Assessment. Summary Report	Ninham Shand	3019	1996
	Skuifraam Feasibility Study: Situation Assessment	Ninham Shand	2491	1996
	Skuifraam Feasibility Study: Berg River IFR Refinement Workshop Proceedings	Southern Waters	2606	1996
	Skuifraam Dam Feasibility Study: Berg River IFR Refinement Workshop Proceedings (31 January, 1 & 2 February 1996, Riebeek Wes)	Southern Waters	2606	1996
	Skuifraam Dam Feasibility Study: Molenaars River, South-Western Cape, Bulk Water Estimate for Environmental Maintenance	Southern Water Ecological Research and Consulting CC	3017	1995
	Effects of Water Conservation and Demand Management on the Growth of Urban and Agricultural Water Demands on the Timing of the Implementation of the Skuifraam Scheme	Ninham Shand	3151	1995
	Skuifraam Feasibility Study: Berg River Scheme. Robertsvlei Saddle Dam: Engineering Geological Report for Design; Foundation Conditions and Construction Materials	Forbes Dick & Associates	FDA/003	1995
	Skuifraam Feasibility Study:Skuifraam Dam. Berg River , Franschhoek District. Preliminary Geological Report: Availability and Properties of Concrete Aggregates and Embankment Fill Materials	Forbes Dick & Associates	FDA/001	1995
	Skuifraam Feasibility Study: Berg River Scheme. Skuifraam Dam Site: Engineering Geological Report for the Design; Foundation Conditions for the Main Dam. Volume 1: Text and Drawings	Forbes Dick & Associates	FDA/002	1995
	Skuifraam Feasibility Study: Berg River Scheme. Skuifraam Dam Site: Engineering Geological Report for Design; Foundation Conditions for the Main Dam. Volume 2: Borehole Logs and Core Photographs	Forbes Dick & Associates	FDA/002A	1995
	Western Cape System Analysis. In-Stream Flow Requirements: Volume 1: Proceedings of Skuifraam Dam Worksessions	Ninham Shand & BKS Inc	2066A	1995
	Upper Berg River Valley Water Supply. Environmental Impact Assessment : Addendums. Volume 2	Ninham Shand	2243	1995

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Water Management Area	Report Title	Author	Ninham Shand Reference	Report Date
	Upper Berg River Valley Water Supply. Environmental Impact Assessment : Summary Report	Ninham Shand	2243	1995
	Upper Berg River Valley Water Supply. Environmental Impact Assessment: Main Report. Volume 1	Ninham Shand	2243	1995
	Skuifraam Dam Feasibility Study: Berg River Scheme. Robertsvlei Saddle Dam: Engineering Geological Report for Design; Foundation Conditions and Construction Materials	Forbes Dick & Associates	FDA/003	1995
	Skuifraam Dam Feasibility Study: Skuifraam Dam. Berg River, Franschhoek District. Preliminary Geological Report: Availability and Properties of Concrete Aggregates and Embankment Fill Materials	Forbes Dick & Associates	FDA/001	1995
	Skuifraam Dam Feasibility Study: Berg River Scheme. Skuifraam Dam Site: Engineering Geological Report for the Design. Foundation Conditions for the Main Dam. Volume 1: Text and Drawings	Forbes Dick & Associates	FDA/002	1995
	Skuifraam Dam Feasibility Study: Berg River Scheme. Skuifraam Dam Site: Engineering Geological Report for Design, Foundation Conditions for the Main Dam. Volume 2: Borehole Logs and Core Photographs	Forbes Dick & Associates	FDA/002A	1995
	Western Cape System Analysis. Development of the Upper Berg River (Skuifraam Scheme)	Ninham Shand & BKS Inc	2105	1994
	Upper Berg River Valley Water Supply. Environmental Impact Assessment: Addendums. Volume 2	Ninham Shand	2243	1994
	Upper Berg River Valley Water Supply. Draft Environmental Impact Assessment	Ninham Shand	2243	1994
	Western Cape System Analysis. The Riversonderend-Berg Sub-system Analysis : Final	Ninham Shand & BKS	2048	1994
	Western Cape System Analysis. Development of the Upper Berg River (Skuifraam Scheme)	Ninham Shand & BKS	2105	1994
	Western Cape System Analysis. Water Requirements for the Maintenance of the Berg River Estuary. Volume 2: Compilation of Papers by Consultants. Final	Ninham Shand & BKS	2116	1994
	Western Cape System Analysis. Water Requirements for the Maintenance of the Berg River Estuary. Volume 1: Report on Worksession	Ninham Shand & BKS	2095	1994
	Western Cape System Analysis. Berg River Sub-system Analysis	Ninham Shand & BKS	2030	1994
	Report on the Safety Inspection of Wemmershoek Dam. Volume 2: Drawings	Ninham Shand	2141A	1993
	Report on the Safety Inspection of Wemmershoek Dam. Volume 1	Ninham Shand	2141	1993
	Western Cape System Analysis. Collection, Storage and Manipulation of Data: Volume 4: The Berg River Basin	Ninham Shand & BKS	1994	1993
	Western Cape System Analysis. Report on the Preliminary Berg River Environmental Assessment Worksession	Ninham Shand & BKS	1868	1993
	Western Cape System Analysis. Hydro-Salinity Modelling of the Berg River Basin	Ninham Shand & BKS	1907	1993
	Western Cape System Analysis. Hydrology of the Berg River Basin	Ninham Shand	2010	1993
	Western Cape System Analysis. Water Quality. Volume 2: Data for Berg River Basin: Final	Ninham Shand	1908	1993

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Water Management Area	Report Title	Author	Ninham Shand Reference	Report Date
Diep River	Diep River Corridor between Blaauwberg Road Bridge and the N7 Freeway: Management Plan	Ninham Shand	3005	1999
	Western Cape System Analysis. Hydrology of the Diep River Basin	Ninham Shand & BKS Inc	2019	1994
	Western Cape System Analysis. Water Quality. Volume 3: Data for Eerste, Lourens, Steenbras, Palmiet, Riviersonderend and Diep River Basins: Final	Ninham Shand	1908B	1993
Cape Peninsula Rivers	Third Safety Inspection of Hely Hutchinson Dam.	Ninham Shand	1577	2002
	Report on the Second Safety Inspection of Woodhead Dam	Ninham Shand	1865	2002
	Woodhead & Hely-Hutchinson Dams: Strengthening with Post Tensioned Cables. Final Design Report	Ninham Shand	2992	2001
	Woodhead & Hely-Hutchinson Dams: Strengthening with Post-Tensioned Cables. Construction Completion Report. Volume 1	Ninham Shand	2992	2001
	Woodhead & Hely-Hutchinson Dams: Strengthening with Post-Tensioned Cables. Report on Geotechnical Investigation	Ninham Shand	2992	2001
	Woodhead & Hely-Hutchinson Dams: Strengthening with Post-Tensioned Cables. Construction Completion Report. Volume 2	Ninham Shand	2992	2001
	Rehabilitation of Table Mountain Dams. Access Road (Contract Number WS 3/2001): Tender Report	Ninham Shand	3160	2001
	Tygerberg Hospital Detention Dam: An Investigation into the Necessity for Detention Facilities on the Elsieskraal River Upstream of Parow Station	Ninham Shand	3098	2000
	Woodhead and Hely-Hutchinson Dams: Strengthening with Post-Tensioned Cables. Tender Report	Ninham Shand	3003	1999
	Woodhead and Hely-Hutchinson Dams: Strengthening with Post-Tensioned Cables: Design Report	Ninham Shand	2992	1999
	Investigation into Cleaning of the Black / Vygekraal Rivers	Ninham Shand	2946	1999
Cape Peninsula Rivers	Woodhead and Hely Hutchinson Dams: Improvements to Stability. Technical Report.	Ninham Shand	2823	1998
	Environmental Impacts of the Options to Improve the Stability of the Hely-Hutchinson / Woodhead Dams on Table Mountain: Scoping Report	Ninham Shand	2825	1998
	Elsieskraal River Proposed Channel Modifications	Ninham Shand	2849	1998
	First follow-on Safety Inspection Report on the Hely-Hutchinson Dam	Ninham Shand	1577	1996
	Conversion and Updating of the Elsieskraal River Catchment Model	Ninham Shand	2919	1995
	Constantia Valley Riverine Open Space Study: Phase 1 Westlake and Diep Rivers	Ninham Shand	2035	1993
	Review of the April/May 1993 Storms over the Elsieskraal River Catchment	Ninham Shand	2060	1993
	Report on the Safety Inspection of Woodhead Dam	Ninham Shand	1865	1992
	Report on the Hydrological Monitoring of the Elsieskraal River Catchment and the Re-evaluation of the Recording Instruments	Ninham Shand	1901	1992

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Water Management Area	Report Title	Author	Ninham Shand Reference	Report Date
Kuils/Eerste, Lourens, Sir Lowry's Pass Rivers	Integrated Water Resource Planning Study: Treatment of Water from the Proposed Eerste and Lourens River Diversions and Cape Flats Aquifer (Supporting document)	Morrison, I R	3216M	2001
	Integrated Water Resource Planning Study: Eerste River Diversion Report No. 2	Ninham Shand	3216A	2001
	Effects of Water Abstraction on the Estuaries of the Eerste and Lourens Rivers. (Integrated Water Resource Planning Study)	Huizinga, P; Taljaard, S; Van Niekerk, L	3216Q	2001
	Kuils River Channel Upgrade between the R300 and Van Riebeek Road: Scoping Report	Ninham Shand	2952	1999
	Kuils/Eerste River System Evaluation of Nutrient Flux Downstream of Bellville WWTW	Ninham Shand	3028	1999
	Report on Access for Maintenance of the Kuils River between the N1 and Bottelary Road	Ninham Shand	2914	1999
	Kuils River Moss Study: Disaster Management. 1 in 50 Year and 1 in 2 Year Floodline Drawings	Ninham Shand	3010	1999
	Kuils River Metropolitan Open Space System (Moss). Volume 2: Annexures	Ninham Shand & Chittenden Nicks	2913A	1999
	Kuils River Metropolitan Open Space System (Moss). Volume 1	Ninham Shand & Chittenden Nicks	2913	1999
	Kuils River Metropolitan Open Space System (Moss): Book of Drawings	Ninham Shand & Chittenden Nicks	2913B	1999
	Kuils River between the N1 and Bottelary Road: Access for Maintenance and Recreation (Plus related River Upgrade Projects). Action Plan	Ninham Shand	3031	1999
Kuils/Eerste, Lourens, Sir Lowry's Pass Rivers	Kuils Eerste River System Evaluation of Nutrient Flux Downstream of Bellville WWTW	Ninham Shand	3028	1999
	Preliminary Environmental Comment on Canalisation Proposals for the Upper Kuils River	Ninham Shand	2239	1994
	Kuils River Environmental Management Study	Ninham Shand	2194	1994
	Kuils River Flood Control. Report on the Potential Effect on Flood Risk of Filling on the Floodplain	Ninham Shand	2210	1994
	Kuils River Environmental Management Study	Ninham Shand	2079	1993
	Canalisation of the Kuils and Bottelary Rivers: Draft Report on Environmental Aspects of the Preliminary Design	Ninham Shand	2038	1993
	Western Cape System Analysis. Hydrology of the Eerste, Lourens and Sir Lowry's Pass River Basins	Ninham Shand	1963	1993
	Integrated Water Resource Planning Study: Eerste and Lourens Rivers Rapid Reserve Assessment (Summary document)	Southern Waters	1908B	1993
Steenbras River	Report on the Third Safety Inspection of Steenbras Upper Dam	Ninham Shand	1527B	2002
	Report on the Third Safety Inspection of Steenbras Lower Dam	Ninham Shand	1528B	2002
	Operation and Maintenance Manual for the Steenbras Hydro-Electric Lower Dam. Volume 1-3	Ninham Shand	2203B	2001

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Water Management Area	Report Title	Author	Ninham Shand Reference	Report Date
	Report on the Second Safety Inspection of the Steenbras Hydro-Electric Lower Dam	Ninham Shand	2203A	2000
	Implementation of the Recommendations in the Second Dam Safety Report for Steenbras Lower Dam	Ninham Shand	2846	1999
	Western Cape System Analysis: Palmiet/Steenbras Sub-system Analysis	Ninham Shand	2085	1999
	Steenbras Power Station: Report on the Minimum Drawdown Level of the Upper Reservoir	Ninham Shand	2840	1998
	Steenbras Pumped Storage Scheme: Inspection of the Waterways and Lower Forebay in December 1996 and January, February 1997	Ninham Shand	2597	1997
	Report on the First Follow-on Dam Safety Inspection of the Steenbras Upper Dam	Ninham Shand	1527	1996
	Report on the First Follow-on Dam Safety Inspection of the Steenbras Lower Dam	Ninham Shand	1528A	1996
	Steenbras Pumped Storage Scheme: Inspection of the Waterways and Lower Forebay in February 1995	Ninham Shand	2292	1995
	Report on the Safety Inspection of Steenbras Hydro-Electric Lower Dam. Volume 1 and Volume 2: Book of Drawings	Ninham Shand	2203	1994
	Western Cape System Analysis. Development of Irrigation in the Riversonderend and Palmiet/Steenbras Basins	Ninham Shand & BKS Inc	2170	1994
Steenbras River	Western Cape System Analysis. Hydrology of Palmiet/Steenbras River Basin	Ninham Shand & BKS Inc	1854A	1993
	Western Cape System Analysis. Collection, Storage and Manipulation of Data: Volume 3: The Palmiet/Steenbras River Basin	Ninham Shand & BKS Inc	1994C	1993
	Western Cape System Analysis. Water Quality. Volume 3: Data for Eerste, Lourens, Steenbras, Palmiet, Riversonderend and Diep River Basins: Final	Ninham Shand	1908B	1993
General	Integration of Raw Water Sources Supplying the CMA	Ninham Shand	3243	2002
	Integrated Water Resource Planning Study: Potential Savings Through Pressure Management. Report No.5	Ninham Shand	3216D	2001
	Integrated Water Resource Planning Study: Potential Savings Through Leakage Repair of Piping. Report No.6	Ninham Shand	3216E	2001
	Integrated Water Resource Planning Study: Potential for the use of Treated Waste Water within the CMA. Report No.8	Ninham Shand	3216G	2001
	Integrated Water Resource Planning Study: Administration Report. Volume 1. Report No.10	Ninham Shand	3216I	2001
	Integrated Water Resource Planning Study: Administration Report. Volume 2. Report No.10	Ninham Shand	3216J	2001
	Integrated Water Resource Planning Study: Cape Flats Aquifer	Ninham Shand, Umvoto Africa	3216C	2001
	Integrated Water Resource Planning Study: Main Report	Ninham Shand	3216	2001

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Water Management Area	Report Title	Author	Ninham Shand Reference	Report Date
	Watermeesterbepaling	Ninham Shand	3049	2000
	Strategic Evaluation of Bulk Wastewater: Kuils River WWTW (WWT/20). Status Quo Report. Report 7	Cape Wastewater Consultants, Ninham Shand, Africon Engineering International	CWC/007	1999
	Western Cape System Analysis. Desalination/Reclamation (in 4 Volumes) Volume 1: Seawater Desalination; Single Stage Reverse Osmosis; Volume 2: Seawater Desalination; Two Stage Reverse Osmosis; Volume 3: Desalination of Diep River Water; Volume 4: Reclamation	Ninham Shand, BKS Inc & Stewart Scott	1908B	1993