Department of Water Affairs and Forestry

Directorate: National Water Resource Planning

INTERNAL STRATEGIC PERSPECTIVE:

CROCODILE WEST MARICO

WATER MANAGEMENT AREA

CROCODILE RIVER (WEST) CATCHMENT

Version 1: February 2004

Department of Water Affairs and Forestry
Directorate National Water Resource Planning

DEVELOPMENT OF INTERNAL STRATEGIC PERSPECTIVES FOR THE CROCODILE RIVER (WEST) CATCHMENT*

APPROVAL

Title	:	**Crocodile River (West) Catchment: Internal Strategic Perspective**
DWAF Report No	:	P WMA 03/000/00/0303
Consultants	:	Goba Moahloli Keeve Steyn (Pty) Ltd, Tlou & Matji (Pty) Ltd and Golder Associates (Pty) Ltd
Report Status	:	Version 1, February 2004
Version Controller	:	Mr R Botha
Date	:	February 2004

STUDY TEAM:

Approved for Goba Moahloli Keeve Steyn (Pty) Ltd

.....
CJ Chimpelo (Director)

Approved for Tlou & Matji (Pty) Ltd

.....
SJL Mallory (Study leader)

DEPARTMENT OF WATER AFFAIRS AND FORESTRY
Directorate National Water Resource Planning
Approved for Department of Water Affairs and Forestry

.....
CFB Havenga
Project Manager

.....
J A Van Rooyen
Manager: NWRP

REFERENCE

This report is to be referred to in bibliographies as:

Department of Water Affairs and Forestry, South Africa. 2004. Crocodile River (West) and Marico Water Management Area: Internal Strategic Perspective of the Crocodile River (West) catchment : Prepared by Goba Moahloli Keeve Steyn (Pty) Ltd, Tlou & Matji (Pty) Ltd and Golder Associates (Pty) Ltd, on behalf of the Directorate: National Water Resource Planning. **DWAF Report No. 03/000/00/0303.**

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This report will be updated on a regular basis until it is eventually superceded by the Catchment Management Strategy.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 Crocodile River (West) catchment 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)

- Crocodile River (West) Internal Strategic Perspective (*This Report*) (Report No: P WMA 03/000/00/0303
- The National Water Resource Strategy
- The Crocodile (West) and Marico WMA – Overview of Water Resources Availability and Utilisation (Report No: P WMA 03/000/00/0203
- The Crocodile (West) and Marico WMA – Water Resources Situation Assessment (Report No: P WMA 03/000/00/0301)

LATEST VERSION

This report is a living document and will be updated on a regular basis. If the version of this report is older than 12 months, please check whether a later version is not available.

This can be done on the DWAF website: http://www.dwaf.gov.za/documents/

or by contacting the Version Controller (see box overleaf)

VERSION CONTROL

CROCODILE (WEST) CATCHMENT INTERNAL STRATEGIC PERSPECTIVE

Version 1	February 2004
(List of Previous Versions)	(Dates)
Current Version Controller	Mr Rens Botha DWAF Gauteng Office Private Bage X995 PRETORIA 0001 +27 12 392 1308 BothaR@dwaf.gov.za

The most significant amendments included in the latest version will be indicated here.

EXECUTIVE SUMMARY

1. INTRODUCTION

The Department of Water Affairs and Forestry (DWAF), as the custodian of South Africa's water resources, wishes to make optimal use of these resources in promoting economic growth and wealth for all its citizens. On the other hand, armed with the National Water Act (NWA) and other legislation, it has the difficult responsibility of ensuring that such water utilisation is sustainable, and especially ensuring the sustainability of our natural environment.

The following document presents DWAF's strategic perspective on how it wishes to protect, allocate use, develop, conserve, manage and control the water resources within the Crocodile (West) River catchment until the regional responsible authority (to be known as the Catchment Management Agency or CMA) has been established and is in a position to take over most or all of these functions. The Crocodile River (West) Catchment, which spans portions of the Gauteng, North West and Limpopo Provinces forms part of the Crocodile West and Marico Water Management Area (WMA). The ISP for the rest of the WMA is described in a separate report (Report No. 03/000/00/0404.

The objective of the ISP is to provide a framework for DWAF's management of the water resources in each Water Management Area, thus ensuring consistency when responding to new water use licences, and informing existing water users (including authorities) on how the Department will manage the water resource within the area of concern. This document will be made available to stakeholders in the catchment through existing forums in order to promote discussion and to illicit comments. Comments received will be considered and used to improve the ISP, which will serve as input into the process of establishing a Catchment Management Strategy (CMS) after the CMA has become operational.

2. WATER LEGISLATION AND MANAGEMENT

This strategic planning initiative falls within the framework of the National Water Act (Act 36 of 1998) and the National Water Resources Strategy. The NWA of 1998 is the principal legal instrument relating to water resource management in South Africa. The Act is now being implemented incrementally. 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. 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.

- To achieve sustainable use of water.
- To achieve efficient and effective water use

DWAF are striving for an integrated planning and management approach, referred to as Integrated Water Resources Management (IWRM). The ultimate aim of this IWRM process is to arrive at:

- an allocation schedule that meets the requirements of the National Water Act (NWA) (Act 36 of 1998);
- water resources yield and other models that are representative of the flow regime of the river systems in the area;
- management class scenarios for the river (ie Reserve and Resource Quality Objectives set);
- a Catchment Management Strategy.

These deliverables can only be finalised once the CMA assumes responsibility for managing the water resources of their WMA. In the interim, DWAF's Regional Offices will continue to manage the water resources in their area of jurisdiction until such time as they can hand over these management functions to established and fully operational CMAs. In accordance with the NWA, DWAF (the Minister) will still remain ultimately responsible for the management of the water resources.

It must be borne in mind that this document forms the initial ISP for the Crocodile River (West) Catchment and was based largely on readily available information. As new information becomes available through actions initiated as a result of this ISP, the document will be updated so as to provide a relevant and up-to-date policy statement as to how the water resource of the Crocodile River (West) Catchment should be managed.

3. OVERVIEW OF THE CROCODILE RIVER (WEST) CATCHMENT

The Crocodile River is a major tributary of the Limpopo River (Drainage Region A) which discharges into the Indian Ocean in Mozambique (see **Figure 2.1**). The Pienaars, Apies, Moretele, Hennops, Jukskei, Magalies and Elands rivers are the major tributaries of the Crocodile River, which together make up the A20 tertiary hydrological catchment with its 39 quaternary catchments. The Crocodile River itself does not form any international boundaries but contributes to the flow of the Limpopo which is an international river basin shared with Botswana, Zimbabwe and Mozambique.

The upper portion of the catchment, south east of Hartbeespoort Dam, is located in the Gauteng Province. The north and north-east corners lie in the Limpopo Province whereas the central or western sections fall within the North West Province. The district and local municipal boundaries are shown in **Figures 2.1** and **2.2**. The total area of the Crocodile River Catchment is 29 400 km^2.

There are 9 major storage dams in the catchment with very limited scope for additional dams. Large quantities of water are transferred into the Crocodile River

(West) Catchment to augment the local water resources, constituting close to 46% of the total water use in the catchment. The most significant transfers of water are the supply of potable water via the Rand Water bulk distribution system from the Upper Vaal WMA to northern Johannesburg, Tshwane, Rustenburg and surrounds. A quantity of almost 520 million m^3 was transferred during the year 2000.

A small quantity of water is transferred from the Olifants WMA to the Cullinan Mine. Transfers out of the Crocodile River (West) Catchment are from the Pienaars River to the towns of Bela Bela and Modimolle in the Limpopo WMA and from the Vaalkop Dam into the Marico River Catchment to the Deelkraal cement factory. The total quantity transferred out of the Crocodile River (West) Catchment is approximately 3 million m^3/annum. Main transfers within the Crocodile River (West) Catchment are from the Roodekopjes Dam to Vaalkop Dam as well as via the Magalies bulk water distribution system. Water is also released from the Roodekopjes Dam for irrigation in the Lower Crocodile sub-area.

Groundwater forms an important feature with regard to water resources in the Crocodile River (West) Catchment. A large dolomitic aquifer stretches along the southern parts of the catchment. Significant volumes of water are drawn for irrigation and other purposes from this aquifer, including a significant portion of the water supply to the City of Tshwane. This aquifer extends across the boundaries of the various WMAs in this area. Sandy aquifers occur along the Lower Crocodile River, from which large quantities of water are abstracted for irrigation. These aquifers are recharged from rainfall as well as river flow. The remainder of the catchment is mostly underlain by fractured rock aquifers, which are well utilised for rural community water supplies.

The Crocodile River (West) Catchment was divided into four sub-areas to facilitate more detailed strategies. These sub-areas are the same as those used in the National Water Resources Strategy (NWRS) and are shown on **Figure 2.3.**

4. RECONCILIATION OF WATER REQUIREMENTS AND AVAILABLE WATER RESOURCES

The NWRS total water balance for the year 2000 figures are as follows:

Table 1: Reconciliation of Water Requirements and Available Water for the Year 2000 (million m^3/annum)

Component/Sub-area	Local Yield	Transfers In (2)	Local Requirements	Transfers Out (2)	Balance (1)
Upper Crocodile	336	279	556	17	42
Apies/Pienaars	186	182	280	87	1
Elands	86	71	113	24	20
Lower Crocodile	59	112	171	0	0
Total for Catchment	**667**	**519**	**1120**	**3**	**63**

Note (1): Surpluses are shown in the most upstream sub-area where they first become available.
(2): Transfers into and out of sub-areas include transfers between sub-areas as well as 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..

Taking future growth in water requirements and return flows into account, the reconciliation of water requirements and water availability for the year 2025 is shown **Table 2.**

Table 2: Reconciliation of Water Requirements and Available Water for the Year 2025 Base Scenario (million m³/annum)

Component/Sub-area	Local Yield (1)	Transfers In	Local Requirements (2)	Transfers Out	Balance (3)
Upper Crocodile	399	382	673	13	95
Apies/Pienaars	244	287	399	92	40
Elands	90	71	124	24	13
Lower Crocodile	59	113	173	0	(1)
Total for Catchment	**792**	**727**	**1369**	**3**	**147**

Source: NWRS

Note (1): Based on existing infrastructure and infrastructure under construction in the year 2000. Also includes return flows resulting from growth in requirements. Assumed that water will be transferred into the Apies/Pienaars and Upper Crocodile sub-areas from the Upper-Vaal WMA, to meet growth in these requirements.
(2): Based on growth in water requirements as a result of population growth and general economic development. Assumed no general increase in irrigation.
(3) Brackets around numbers indicate negative balance.

It is clear from **Table 1** and **Table 2** that current surplus in the Crocodile is expected to increase substantially over time. This is due to increased return flows and is based on the assumption that transfers will continue into the catchment to support continued economic growth. This is not necessarily the case and many of the strategies for this catchment relate to dealing with this situation of apparent surplus in the catchment.

5. MANAGEMENT STRATEGIES

5.1 *Upper Crocodile River Sub-catchment Area*

The southern portion of this sub-catchment is highly developed with the large industrial, urban and semi-urban sprawls of northern Johannesburg, Mid-Rand and southern Tshwane. The economic activity in this area generates a large portion of South Africa's Gross Domestic Product. Local water resources are insufficient to meet the water requirements in this area and therefore large volumes of water are transferred from the Vaal River System, via the Rand Water supply system, into this area. Large treated wastewater return flows are generated from these transfers which further supply other users downstream. The

rest of this area, mainly north of the Magaliesberg Mountain Range, includes significant irrigation (270 km ^{2}) and mining activities.

The main issue relating to this sub-area is the high projected growth in water requirements and the source of supply for these requirements. The first option, water demand management, will only have a limited impact, after which additional transfers into the area will need to be considered. However, the substantial return flows in the area will increase with increasing transfers resulting in a large surplus. It is important to develop a strategy that will optimise the use of this surplus, taking into account that the Vaal system is being supplied from other basins through Inter Basin Transfers. Very expensive projects will be required in future to increase the supply to the Vaal River system and the reuse of return flows in the Crocodile River (West) catchment must be considered as an option to delay costly additional transfer schemes. This reuse of return flows will result in an increase in the salinity of the Crocodile systems and the costs associated with this will need to be carefully considered. A cascading re-use is a feasible and preferable option, whereby the salts are always passed downstream and could conceivably be stored in slimes dams if mines are the end user in the system.

As an immediate strategy, all new use north of the Magaliesberg should be supplied from return flows, while a strategy needs to developed to supply users in the more upstream (southern) parts of the catchment as well. Some of the return flows could also be used for irrigation and establishing of emerging farmers should be considered.

5.2 Elands River Sub-catchment Area

This area forms the western drier portion of the Crocodile River Catchment. Rustenburg is the main urban centre in this sub-area and has grown rapidly in recent years due to the expansion of platinum mining activities here. There is potential for new mines to develop in this area.

Local water resources are under-utilised, while significant volumes of water are transferred to this area from the Vaal River System.

There is a significant amount of irrigation in this area (50 km^2), mostly situated along the northern foothills of the Magaliesberg.

The State/Tribal Authorities own a large portion of this area. Due to the vibrant economic activity in this area, people here (both urban and rural), and in the Upper Crocodile area, tend to be better off socio-economically than people in other parts of the country.

The rapid economic growth in this sub-area will certainly lead to increased water requirements. These increased requirements should be supplied from local sources, such as Bospoort Dam which is underutilised or increasing return flows in the Crocodile River.

5.3 Apies-Pienaars River Sub-catchment Area

A major part of this area is densely populated with the City of Tshwane (Pretoria) situated in the higher lying southern portion of the sub-catchment. The bulk of the water requirements of this area are supplied by Rand Water, sourced from the

Vaal River System, although significant quantities are also supplied from groundwater and from local sources. Water infrastructure in the existing urban areas of Mabopane, Hammanskraal and Temba, to the north of Pretoria is being upgraded which will have an impact on water usage in this area.

Irrigation in this sub-area is significant, with an estimated 67 km^2 of irrigated crops.

The same situation exists in the Apies/Pienaars sub-area as in the upper Crocodile, with increasing return flows resulting in projected surpluses in future. The difference here though is that the return flows become available in the Apies and Pienaars Rivers as opposed to the Crocodile which receives the return flows from the Upper Crocodile sub-area. Also, in the case of the Apies/Pienaars system, some of the surplus has already been allocated for improvement and expansion of the water supply to the areas north of Pretoria referred to above. The possibility of transferring the surpluses derived from return flows to the Western Highveld area in the Olifants WMA is also an option which is currently being investigated. It is important to ensure that increasing river flows due to return flows are not taken up by riparian irrigators, without first carefully considering alternative uses of this water.

5.4 Lower Crocodile River Sub-catchment Area

The area is characterised by large-scale irrigation activity along the mainstem of the Crocodile River (134 km^2) while in the rest of the sub-area the main activity is cattle and game farming. There are also a few mines in the area. Thabazimbi is the main town in this area. The water requirements of the Lower Crocodile sub-area can be met by return flows for the foreseeable future. It must be born in mind, however, that the NWRS reserves 45 million m^3/annum for the possible development of a new power station in the neighbouring Limpopo WMA. The allocation of surplus return flows in the Lower Crocodile must therefore be carefully considered.

6. WATER RESOURCES MANAGEMENT STRATEGIES

Twenty-two strategies have been grouped together under nine main strategic areas that are associated with the structures of the National Water Act and the National Water Resources Strategy. These are:

- Water Balance and Reconciliation
- Water Resources Protection
- Water Use Management
- Water Conservation and Water Demand Management
- Institutional Development and Support
- Integrated Environmental Management
- Waterworks Development and Management
- Monitoring and Information Management
- Implementation

Each sub-strategy under the above headings is focussed on recording the way in which the DWAF Regional Office, with the support of Head Office

Directorates, wishes to manage the water resources of the Crocodile (West) River Catchment in the interim, until such time as a Catchment Management Agency takes over various functions. These sub-strategies are presented in the following format:

- A situation assessment to provide the background
- A broad management objective
- An overall strategic approach that will be implemented
- Specific management actions that will be followed, along with the assigned responsibilities and priorities. These assignments will, outside of this ISP, be programmed and budgeted for by the Regional Office and other Directorates in DWAF.

INTERNAL STRATEGIC PERSPECTIVE:

CROCODILE WEST MARICO

WATER MANAGEMENT AREA

CROCODILE RIVER (WEST) CATCHMENT

TABLE OF CONTENTS

PART II

LIST OF FIGURES and PHOTOS

LIST OF TABLES

LIST OF ANNEXURES

LIST OF ABBREVIATIONS

CEIMP	Consolidated Environmental Implementation Management Plan
CMA	Catchment Management Agency
CMS	Catchment Management Strategy
DWAF	Department of Water Affairs and Forestry
IDP	Integrated Development Plan
ISP	Internal Strategic Perspective
IWRM	Integrated Water Resources Management
MAP	Mean Annual Precipitation
MAR	Mean Annual Runoff
MASL	Meters Above mean Sea Level
NEMA	National Environmental Management Act
NWA	National Water Act
NWRS	National Water Resource Strategy
RDM	Resource Directed Measures
RQO	Resource Quality Objectives
WMA	Water Management Area
WRSA	Water Resources Situation Assessment
WSDP	Water Services Development Plan
WSP	Water Sector Plan
WUA	Water User Association

GLOSSARY OF TERMS

Aquifer	A Stratum or Zone below the surface of the earth capable of producing water
Assessment (Water Resources Assessment)	An examination of the aspects of the supply and demand for water and of the factors affecting the management of water
Assurance of Supply	The reliability of 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 the 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.
Comprehensive water resources	Water Resources planning, development, and control that Management incorporates physical, social, economic and environmental interdependencies
Cost Recovery	Fee structures that cover the cost of providing the service or investment
Condensed Area	The equivalent area of alien vegetation with a maximum concentration / density that represents the more sparsely distributed alien vegetation that occurs over a large area.
Ecological Category	Ecological Category (A-D). A class indicating the ecological importance and sensitivity of an area, as it is likely to have been under natural (undeveloped) conditions and the risks of disturbance that should be tolerated. Values range from Category A (highly sensitive, no risks allowed) to category D (resilient systems, large risk allowed)
Water Demand	The use of price, quantitative restrictions, and other

Management	devices to limit the demand for water
Drainage Region	The drainage regions referred to in this document are either single large river basins, or groups of contiguous catchments or smaller catchments with similar hydrological characteristics. They follow the division of the country into drainage regions as used by the Department of Water Affairs and Forestry.
Ecosystem	A complex system formed by the interaction of a community of organisms with its environment
Ecosystem health	An ecosystem is considered healthy if it is active and maintains its organisations and autonomy over time, and is resilient to stress. Ecosystem health is closely related to the idea of sustainability.
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 the natural processes.
Edaphic	Pertaining to the influence of soil on organisms, or Resulting from or influenced by factors inherent in soil rather than by climatic factors.
Endemic	Occurring within a specified locality; not introduced.
Endoreic	Portion of a hydrological catchment that does not contribute towards river flow in its own catchment (local) or to a river flow in downstream catchments (global). In such catchments the water generally drains to pans where much of the water is lost through evaporation.
Ephemeral Rivers	Rivers where no flow occurs for long periods.
Historical Flow Sequence	A record of river flow over a defined period and under a defined condition of catchment development in the past, calculated from a record of observed flow corrected for inaccuracies, or from records of observed rainfall, or a combination of the two.
Hydrological Year	The Twelve-month period from the beginning of October in one year to the end of September in the following Year.
Irrigation Quota	The quantity of water, usually expressed as m3/ha per

	year, or mm per year, allocated to land scheduled under the scheme. This is the quantity to which the owner of the land is entitled at the point at which he or she takes delivery of the water and does not include conveyance losses to that point.
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.
Opportunity cost	The value of goods or services foregone, including environmental goods and services, when a scarce resource is used for one purpose instead of for its next best alternative use
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.
Present Ecological Status Class	A Class indicating the degree to which present conditions of an area have been modified from natural (undeveloped) conditions. Factors that are considered in the classification include the extent of flow modification, inundation, water quality, streambed condition, riparian condition and proportion of exotic biota. Values range from Class A (largely natural) to Class F (critically modified)
Quaternary Catchment	The basic unit of area resolution 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 alphanumerically in downstream order. A quaternary catchment number: for example D41A, may be interpreted as follows: the letter D denotes Primary Drainage Region D, the number 4 denotes secondary catchment 4 of Primary Drainage Region D, the number 1 shows that the secondary catchment has, in this case, been sub-divided into tertiary catchments, and the letter A shows that the quaternary catchment

	is the first in sequence downstream from the head of secondary catchment D41.
River basin	A geographical area determined by the watershed limits of a system of water, including surface and underground water, flowing into a common terminus
Reserve	The quantity and quality of water required (a) to satisfy basic human needs by securing a basic water supply, as prescribed under the Water Services Act, 1997 (Act No.108 of 1997) for people, who are now or who will, in the reasonably near future, be (iii) being supplied from, the relevant water resource; and (b) to protect aquatic ecosystems in order to secure ecologically sustainable development and use of the relevant water resource as indicated in the National Water Act (Act No.36 of 1998)
Resilience	The ability of an ecosystem to maintain structure and patterns of behaviour in the face of disturbance or the ability to recover following disturbance.
Resource Quality	The quality of all the aspects of a water resource including: 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 Objective	Quantitative and variable 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
Scheduled Land	Irrigable land to which a water quota has been allocated.
Sensitivity analysis	Assessment of the response of some factors as a result of changes in others
Sewage	Liquid refuse or waste matter carried off by sewers
Sewerage	The removal and disposal of sewerage and surface

	water by sewer systems
Subsistence Farming	Small-scale farming where almost all produce is consumed by the farmer's household or within the local community.
Suggested Ecological Management Class	A class of water resource indicating the suggested management objectives of an area which could possibly be attained within Five years. Values range from Class A (largely natural) to Class D (largely modified)
Stakeholder	Organization or individual that is concerned with or has an interest in water resources and that would be affected by decisions about water resources management
Strategy (Water resources Strategy)	A set of medium to long-term action programs to achievement of development goals and to implement water related policies.
Water Imports	Water imported to one drainage basin or secondary sub catchment from another.
Water Transfers	Water transferred from one drainage basin or secondary sub-catchment to another. Transfers in are synonymous with water imports.
Watercourse	A system of surface and underground waters that constitute, by virtue of their physical relationship, a unitary whole and that flow into a common terminus
Watershed	An area by a river or stream system; also referred to as a catchment area
Wetlands	Areas of marsh, fen, peat land, or water that include natural, artificial, permanent, and temporary areas with static or flowing water that is fresh,
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 CROCODILE RIVER (WEST) CATCHMENT INTERNAL STRATEGIC PERSPECTIVE

1.1 LOCATION OF THE CROCODILE (WEST) RIVER CATCHMENT WMA

The Crocodile (West) River catchment forms a major part of the Crocodile West and Marico WMA, the locality of which is shown in **Figure 1.1.**

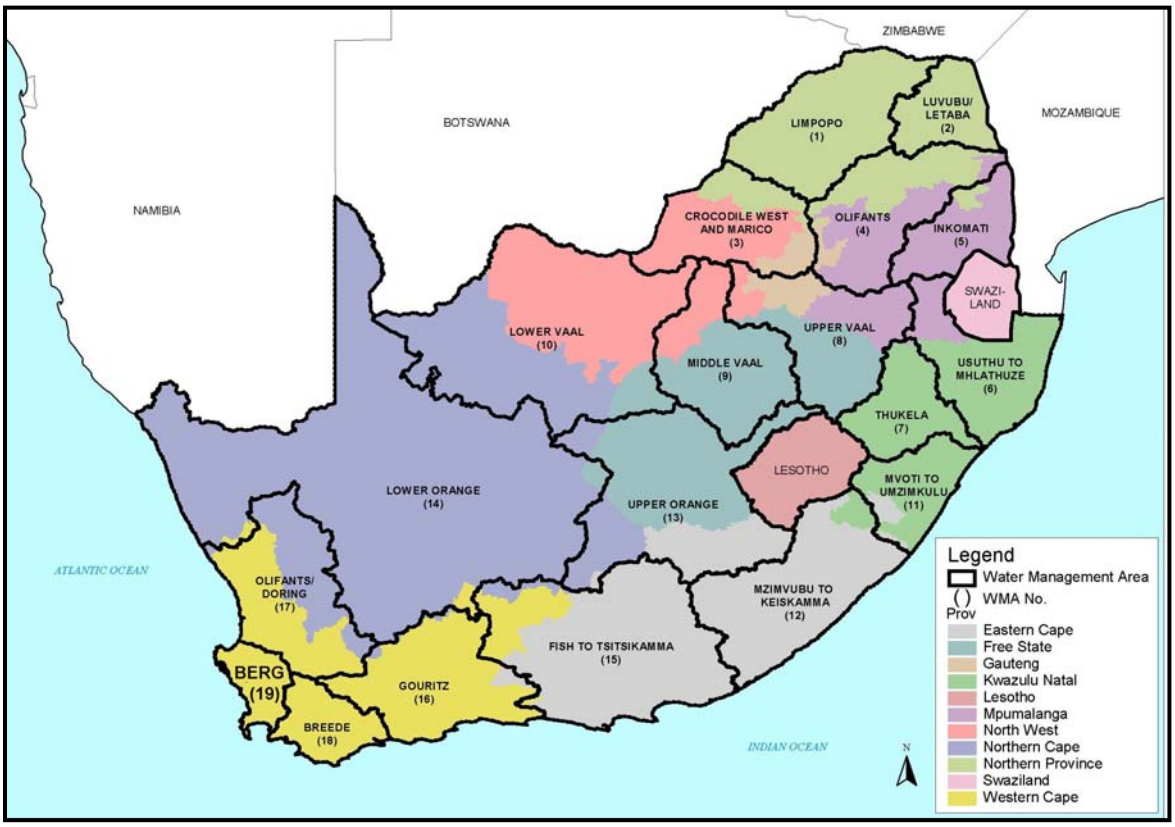


Figure 1.1: Location of the Crocodile River (West) Catchment

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 Crocodile River (West) 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 Crocodile River (West) catchment. This was achieved through interviews with individual members of DWAF's Regioanl Ofiices in Pretoria and Mafikeng 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 Crocodile River (West) 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 1.5).

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 Crocodile River (West) catchment. The current incumbent is Mr R Botha, 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.

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.

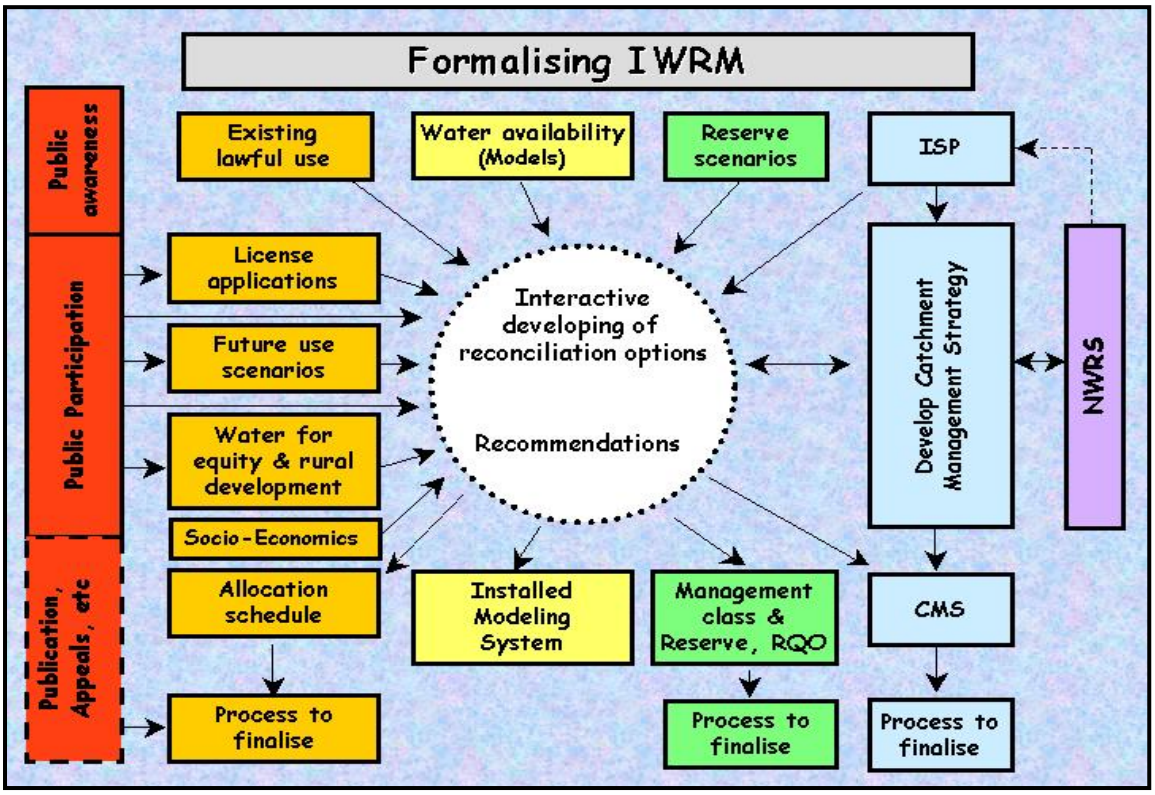


Figure 1.2: Diagram showing DWAF Integrated Water Resources Management approach

- 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 9.1) 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 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 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 7.3.

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 – GENERAL OVERVIEW OF THE CROCODILE RIVER (WEST) CATCHMENT

2.1 LOCALITY AND PHYSICAL CHARACTERISTICS

2.1.1 Locality or Geographic subdivision

The Crocodile River is a major tributary of the Limpopo River (Drainage Region A) which discharges into the Indian Ocean in Mozambique (see **Figure 2.1**). The Pienaars, Apies, Moretele, Hennops, Jukskei, Magalies and Elands rivers are the major tributaries of the Crocodile River, which together make up the A20 tertiary hydrological catchment with its 39 quaternary catchments. The Crocodile River itself does not form any international boundaries but contributes to the flow of the Limpopo River, which has an international river basin shared with Botswana, Zimbabwe and Mozambique.

The upper portion of the catchment, south east of Hartbeespoort Dam, is located in the Gauteng Province. The north and north east corners lie in the Limpopo Province whereas the central or western sections fall within the North West Province. The district and local municipal boundaries are shown on **Figures 2.1** and **2.2**. The total area of the Crocodile River Catchment is 29 400 km^2.

In keeping with the framework of the National Water Resource Strategy, discussions have in general been structured within four main sub-areas (Upper Crocodile, Apies-Pienaars, Elands, and the Lower Crocodile – see **Figure 2.3**). **Photos 2.1 to 2.4** depict the main traits of these sub-areas.

2.1.2 Topography

The Crocodile River and some of its main tributaries rise in the south of the catchment in the Witwatersrand topographical feature at an altitude close to 2000 masl. This feature in the southern part of the catchment may be described as gently rolling hills on the highveld plateau. The rivers wind their way through the Daspoort Ridge to the Magaliesburg mountain range at the Hartbeespoort Dam where the altitude is around 1200 masl. The Crocodile River then meanders through a reasonably flat weathered volcanic landscape, past the extinct Pilansberg volcano, and through the Thabazimbi mountains down to its confluence with the Groot Marico where it becomes the Limpopo River (altitude approximately 900 masl).

2.1.3 Geology and Soils

Annexure A presents a detailed overview of groundwater availability in the Crocodile River catchment.

The major feature geological feature of this catchment is the large area of volcanic intrusive rock (north of the Magaliesburg to Thabazimbi) referred to as the Bushveld Igneous Complex. Formations in this complex are extremely rich in minerals, which has led to large-scale exploitation of the platina group of metals in this area. Soil types in this area may be broadly classified as moderate to deep

clayey loams which are well utilised for agricultural crops and which also allow a relatively high percentage of runoff of water.

Photo 2.1: Upper Crocodile Sub-area – photograph showing downtown Johannesburg

Photo 2.2: Apies-Pienaars Sub-area – typical smallholder setting in this area showing large plot sizes

Photo 2.3: Elands Sub-area – Tribal lands near Sun City. Villages such as these rely on groundwater for their supplies

Photo 2.4: Lower Crocodile River Sub-area – aerial photograph showing the main stem of the river with conventionally irrigated lands as well as centre pivots

Dolomitic rock is found in a band running east-west between Rietvlei Dam and Mogale City (formerly Krugersdorp). These dolomitic compartments tend to be chert-rich, with consequent high water storage capacity. Dewatering of these compartments has led to sinkholes in the past.

Some of the gold-bearing seams of the Witwatersrand Ridge in the south fall within the upper catchment but only a few goldmines still operate here. Soils in this higher and undulating southern part of the catchment are broadly classified as sandy loam, which are easily susceptible to erosion.

The balance of catchment consists of sedimentary rock, with the quartsitic Magaliesberg Mountain Range being the prominent feature (see **Photo 2.5)**.

Soils in the northern part of the catchment are classified as sandy loams.

Photo 2.5: Magaliesberg Mountain Range at the Hartbeespoort Dam

2.1.4 Climate

The upper higher lying areas of the catchment experience cold winters (daily average minima and maxima of 1^0C and 15^0C respectively) and reasonably hot summers (10^0 and 30^0 C). Frost is prevalent in winter. North of the Magaliesberg Mountain Range very little frost occurs and winters are more moderate. Summer midday temperatures can reach maxima of 35^0 C to 40^0C in the shade.

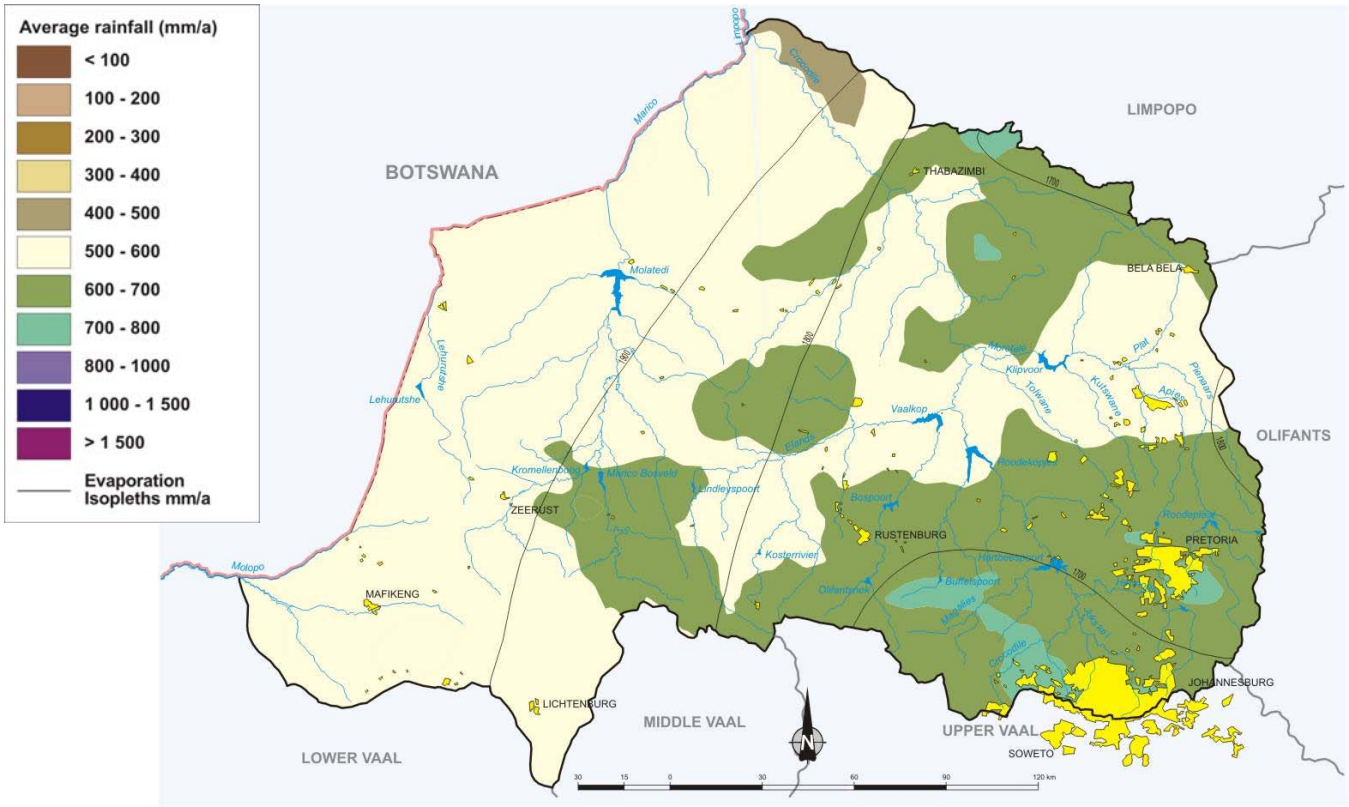
Summer (October to April) rainfall patterns predominate with the traditional heavy deluges in the afternoon (cumulonimbus induced thundershowers being the norm). December and January are the peak rainfall months with hail being prevalent. Frontal climatic systems bring soft soaking rains on occasion.

Mean Annual Precipitation (MAP) is generally higher in the southern and eastern parts of the catchment where this value averages out at around 800mm per annum (See **Figure 2.4**). The northern and western lower lying areas tend to have a MAP of between 500-600mm. MAPs fluctuate in dry/wet cycles of between 7 and 10 years (variations from 300mm in dry years to 1000mm in good rainfall years). During certain years large-scale flooding occurs in this catchment which wreak tremendous damage on irrigation farming operations (mainly north of Magaliesberg). This irrigation farming tends to be located on the broad floodplains associated with the middle and lower Crocodile River System.

The generalised Mean Annual Evaporation (MAE - Gross Symon's Pan) varies from about 1600mm in the south to around 2000mm at the Crocodile River's confluence with the Limpopo River in the north. The coefficient of variation ranges from 25% to 35% on these values.

The mean annual gross irrigation requirement (based on rainfall and evaporation) ranges from 1400mm in the south east to around 2000mm in the drier north western parts. The minimum mean monthly requirement usually occurs in June (±100mm) and the maximum mean monthly requirement occurs in September (140 - 240 mm for perennial crops). This phenomenon needs to be factored into the managerial approach adopted by water resource managers.

Figure 2.4: Rainfall in the Crocodile West and Marico WMA (Source: NWRS)



2.1.5 Vegetation

There are two main types of natural vegetation in the Crocodile River catchment (Acocks classification system):

- False grassland, in the portion of the catchment south of the Magaliesberg. Vegetation associated with this veld type is sour, wiry grassveld, proteas and acacias
- Tropical bushveld and savannah, north of the Magaliesberg (see **Photo 2.6**).

The upper false grassland areas in the south of the catchment have been significantly modified by urban development and smallholder agricultural activities. Exotic vegetation predominated the banks of the various tributaries until recently. Very active intervention of the national Working for Water Programme and local resident organisations (including the Jukskei River Water Forum) have however begun to eradicate this invasive alien vegetation with the view of rehabilitating greenbelts along these tributaries.

Aquatic weeds such as water hyacinth *Eichhornia crassipes* and toxic blue green algae *Microcystis aeruginosa* have in the past, and still do, cause serious problems in the Hartbeespoort Dam.

Photo 2.6: Tropical bushveld (looking from the Pilansberg northwards to the Magaliesberg)

Vegetation north of the Magaliesberg Mountains but south of the Vaalkop/Roodekopjes dam areas has been reasonably modified by agricultural (perennial crops and citrus trees) and mining activities. Exotic trees dominate the riparian vegetation along the Crocodile River and its main tributaries in this area.

North of the latitude of the Vaalkop Dam, vegetation remains reasonably unspoiled. Flora around dense rural settlements has suffered somewhat due to the demand for firewood and livestock overgrazing.

2.1.6 Indigenous Fauna

The environment in the more densely settled rural areas in the southern portion of the Crocodile River Catchment still contains populations of small game and their predators, reptiles and a wealth of bird species. The Magaliesberg Mountain Range and the more rural areas further to the north still have medium and large sized game. Game farms to the north form some sort of sanctuary to these animal populations. The aquatic riverine environment has been significantly modified by developmental pressure on the river system. Only a few indigenous fish species still remain, with exotic fish species dominating these watercourses. More needs to be learned regarding the status of these indigenous fish species in this catchment.

2.1.7 Environmentally Sensitive Areas

As mentioned above, attention is being paid to greenbelts along the river courses in the upper and eastern more densely populated parts of the catchment. Conservation of the aquatic riparian habitats of this river system will also receive due consideration in future. More knowledge regarding the status of all the natural habitats in the Crocodile River Catchment is required (see **Strategy 6 and Strategy 2.2** contained in the Part II of this ISP). The following environmentally sensitive areas and, in some cases, specific issues, have been identified:

- In the Tarlton area in the upper Crocodile River Catchment just south of Johannesburg, peat wetlands are found that have been drained to a large extent, that have regularly been burnt and that are generally not in a good condition. Other wetlands are found upstream of Rietvlei Dam, in the Pienaars River sub-catchment, and along the Crocodile River. More in-depth knowledge of the status of these wetlands needs to be collated and strategies developed to reinstate them where required. These issues and strategies to address them are referred to in more detail to **Strategy 6.1** in Part II of this ISP report.
- The upper more urbanised portion of the Crocodile River catchment (especially the Jukskei and Hennops rivers) has been under severe threat of pollution in the past few decades for example from: poor sanitation systems in Alexandra and Thembisa townships; spillage's from overloaded sewerage systems in Sandton and other urban areas; plastic bags and other solid wastes polluting the sediments in the rivers; agricultural chemicals; organic nutrients from compost-making operations and chicken/pig farming practices; *et cetera*). A more detailed situation assessment and potential strategies to address these issues are in **Strategy 2.2** in Part II of this ISP report.
- The Kromdraai Conservancy, which includes the Sterkfontein Caves (world heritage site), is situated on the dolomites near Mogale City (formerly Krugersdorp). This area also hosts the Crocodile River Ramble where artists and other tourism facilities host a significant trading environment. The groundwater levels and quality of surface water are important to these tourism activities.
- The Hartebeespoort Dam has suffered severe water quality problems (eutrophication, algal blooms that cause toxicity problems) that emanate from the upper catchment. Recreation and tourism, and even real estate

prices, have been affected by these undesirable aquatic conditions. The environmental report published by RD Walmsley Mzuri Consultants[10] and more recent interventions by the Kwena Water Forum address these issues in more detail. Please refer to **Strategy 2.2** in Part II of this report.

- The Magaliesberg Mountain Range is a declared nature conservation area. Private individuals, companies and local authorities own the farms in the area.
- Groundwater in the dolomites in the southern portion of the catchment are very susceptible to pollution from sewerage and industrial spills. The links between mine leachates and the underground dolomitic compartments that are shared with the Middle and Upper-Vaal WMAs are not understood. See **Strategy 2.2.**
- The Pilansberg and Borakalalo game reserves, six other nature reserves, and numerous game farms are located in the Crocodile River (West) Catchment.
- Livestock overgrazing, soil erosion and high sediment loads are prevalent in the lower Elands River catchment south of the Pilansberg. This could become a problem in the long-term as it will reduce the yield of the Vaalkop Dam. See **Strategy 5.1.3.**
- Signs of salinity problems along the banks of the Lower Crocodile River have been noticed. This needs to be investigated and a strategy developed to address this if it should be found to be a problem.
- A parallel strip of land on the northern side of the Magaliesberg Mountain Range (between Tshwane and Sun City) is extensively mined (open cast and underground) for the Platina group of metals (see **Photo 2.7)**. Apart from the destruction of habitat and aesthetics of the area, these mines are dewatering the area around their operations at a significant rate that could effect natural vegetation and farming practices between the mountains and this mining corridor. Under current legislation, the mines will have to prove that they are not effecting the livelihoods of farming communities and the natural environment (see **Environmental Strategy 6.1.5** for more details).

Photo 2.7: Mines between Brits and Rustenburg

2.1.8 Classification of Rivers in Catchment

Paragraph 2.6 of the WRSA Report[8] provides a description of the present ecological state of the main stem and tributaries in the Crocodile River Catchment as they now stand. Estimates of the ecological flow requirements (or Ecological Reserve) have been determined in most of the catchment at a Desktop Level (according to definitions in the **Resource Directed Measures protocol[11]** published in 1999 and its subsequent amendments). Only in the Apies-Pienaars River Sub-catchment has the Reserve been determined at an intermediate level of detail (**IWRM Project[9]**).

The WRSA Report warns that the Desktop Reserve estimates need to be used with circumspection, as they may not be truly representative of the actual riverine ecological water requirements. Furthermore, as a result of increasing treated wastewater return flows to the Crocodile River System (i.e. currently almost doubles the natural Mean Annual Runoff), the problem is actually that there may be too much water in the system at certain times of the years, which could have a negative effect on the integrity of the local ecology. Actual implementation of the entire desktop Reserve flow regime is also not possible due to the release capabilities of dams here.

Photo 2.8: Rural settlements and groundwater pollution

It can therefore be seen that more detailed studies are required in this regard before the impact of the implementation of an Ecological Reserve in this river system can be assessed properly. Very preliminary indications show that irrigation in the lower river reaches may be impacted the most, if the ecological flow requirements in the lower reaches right down to the Limpopo River are to be met. The Reserve may have to be gradually introduced over a period of years and possibly in parallel with a compulsory licencing process so as to lessen the overall impact on the socio-economy of the region. Please refer to **Strategy 2.1** in Part II of this ISP for more discussion and statements of DWAF strategies to deal with this issue.

2.2 DEMOGRAPHY, LAND USE AND DEVELOPMENT

2.2.1 Population and Domestic Water Requirements

The Crocodile West and Marico WMA is the second most populous WMA in the country, which closely relates to the large proportionate contribution to the national economy (this area generates almost a third of the country's Gross Domestic Product). The total population of this catchment has been estimated to be about 4.9 million people (1995 data). Most of these people reside in the urban metropolitan area of Johannesburg and Tshwane. The Upper Crocodile Sub-area hosts a population of around 2.2 million. Another 2.2 million people stay in the Apies-Pienaars Sub-area with around 370 000 people residing in the Elands River Sub-area and only about 150 000 people in the Lower Crocodile portion of the catchment. These population statistics will need to be correlated with District and Local Municipalities to arrive at uniform planning data (see **Water Use Management Strategy 3**).

A large portion of this population is under 20 years of age, with an unemployment rate somewhere in the 30 to 40% bracket. Many of these unemployed people have migrated from the rural areas (where they still have homes) and from neighbouring countries (large illegal Mozambican and Zimbabwean settlements) to the squatter camps that are more and more prevalent around Johannesburg, Tshwane and Rustenburg. Government policies regarding free basic water now have to be practically implemented by the district and local municipalities. The consequent demand for new water services have started placing a significant load on the water resources of the area.

Since mostly men migrate closer to the bigger centres in search of work, women and young people tend to be left in the rural villages which are reasonably closely scattered in the areas north of the Magaliesberg Mountain Range, north west up to the Pilansberg, and in a broad band across to the N1 Polokwane highway in the east, and Bela-Bela (formerly Warmbaths) in the north. Magalies Water has had a very active community water services programme which has provided basic levels of water service to most of these rural villages over the last decade or so. In general, these villages depend on groundwater as their main source of water supply. Lack of adequate sanitation facilities in informal and rural settlements has begun to cause both ground and surface water pollution problems that need to be addressed (see **Strategy 2**).

District and Local Municipalities, and Rand Water have concentrated their water service provision efforts on the more densely settled areas. For example, the City of Tshwane Metropolitan Council (Greater Pretoria area) are intending to spend close on 500 million Rand over the next few years to establish new water systems in the area to the north of Pretoria.

2.2.2 Broad Overview of Land Use and Spatial Patterns

The urban areas of northern Johannesburg, Midrand and the areas under the City of Tshwane Metropolitan Council dominate landuse in the south-eastern portion of the catchment (A21 and A23). See landuse map (**Figure 2.2**). Urban areas cover an area of 665 km^2. Activities in these areas make up a significant portion of the economic activity (i.e. service and government sectors, manufacturing

and industry). Together with mining activities they constitute close on a quarter of the countries Gross Domestic Product, which makes water supply to this catchment very important.

Smallholding and commercial agricultural activities (limited formal irrigation) take place in the area to the north west of Johannesburg, but south of the Magaliesberg northern range.

The area between Rustenburg and Brits on the northern side of the Magaliesberg range is known for its citrus farming activities, whereas irrigated cash crop farming takes place below the Hartebeespoort Dam and Brits (see **Photo 2.9**). Irrigation also occurs down the mainstream of the Crocodile River, the most significant areas being just south and north of the town of Thabazimbi. About 650 km^2 of irrigation has been recorded (Source: WRSA Report[8]).

Numerous mines occur mainly in a circular belt around the perimeter of the bushveld igneous complex. These mines are mainly focussed on the Platina group of metals which are in great demand on the world market at the moment. Consequently numerous new mines have been opened in the Rustenburg area and many others are in advanced stages of planning. These mines draw most of their water from the Vaal River System or from the Vaalkop Dam. **Strategy 1** in Part II refer to how water resources and supplies in this area will be managed in future.

The rest of the area is used for dryland farming (limited), cattle grazing and game ranching.

Photo 2.9: Farming activities just north of Hartbeespoort

2.2.3 International Obligations

The Limpopo River Basin, of which the Crocodile River is a tributary, is shared by a number of countries, namely, South Africa, Botswana, Zimbabwe and Mozambique. There are no water-related agreements on the Limpopo as a whole, although there is an agreement between South Africa and Mozambique (formerly Portugal) relating to the Massinger Dam situated on the Olifants River which is a tributary of the Limpopo River.

The Limpopo Basin Permanent Technical committee serves as the forum for all the Limpopo basin countries (South Africa, Botswana, Zimbabwe and Mozambique). The Limpopo River Basin Commission was formed on 27 November 2003 and will be responsible for developing a water use agreement for the Limpopo Basin. This is a National DWAF responsibility and until an agreement is in place, further development of the water resources falls under the authority of the Minister of DWAF and cannot be delegated to the CMA (see **Strategy 1.5**).

Compared to the natural mean annual runoff of 646 million m^3/annum which originates from the Crocodile River Catchment, an estimated average of 549 million m^3/annum still flows out of the catchment into the Limpopo River.

2.2.4 Power Generation

There are three relatively small thermal power stations in this catchment. These include:

- Kelvin Power Station situated in Kempton Park. This station is supplied with approximately 12.8 million m^3/annum treated effluent for cooling from the Johannesburg Northern Sewerage Works;
- The Tshwane Power Station situated in Tshwane West next to Iscor Iron and Steelworks. It receives 6 million m^3/annum of treated effluent from the Daspoort Sewerage Works; and
- Rooiwal Power Station north of Tshwane, which receives its supply of 7.7 million m^3/annum from the sewerage works of the same name adjacent to the power station.

2.2.5 Mining

Mining remains an important and stable sector of the regional economy, with strong employment opportunities. The primary minerals mined in the Crocodile River Catchment include: platinum and its associated platina group of minerals such as palladium; gold; chrome; manganese; iron ore; diamonds; granites; mineral sands; vanadium; limestone and andalusite.

Most of the gold mines in the Upper Crocodile River Sub-area are mined out and have been closed. Problems such as leachates from the old mine dumps (especially cyanide) and acid water decants from the dumps have been posing a threat to water quality in the river (see **Strategy 2.2**). Some of the old mine dumps are now being reworked. The impacts of these reworking operations are not known. Dolomitic groundwater flows between the Upper-Vaal WMA (where there are more old mines) may be linked to the Crocodile River dolomitic compartments, but no information was obtained at time of writing this version of the ISP.

New mines are springing up on the axis between Tshwane, Rustenburg and Sun City. Although mainly platinum mines (due to the high world demand for this metal), other mines have also been opened or are being seriously considered due to the sunset clause in the new Mining Bill which indicates that mining rights holders would either have to use or lose these rights.

This rapid expansion, along with the consequent growth in secondary industries and trade support professions, has stimulated significant economic growth in the Rustenburg area. This in turn has led to a demand for bulk and treated water. Mines have been approaching Rand Water for the supply of water from the Vaal River System.

Dewatering of these mines, especially between Brits and Rustenburg is causing much concern with local citrus farmers and environmentalists (natural vegetation), which believe that their groundwater, their main source of supply, is being depleted by the mines' dewatering activities (see **Photo 2.10**). These issues, and DWAF strategies, are discussed in **Strategy 1** and **Strategy 6.1** in Part II of this ISP report.

2.2.6 Industry

Most industries are situated in the peripheral industrial zones in and around Johannesburg and Tshwane, and purchase water from local authorities. Recent developments such as the Platinum Spatial Development Initiative (Rustenburg area mentioned above) and the Mabopane-Centurion Development Corridor have started gaining momentum in the last few years. The opening of the Platinum Highway between Tshwane and Mafikeng should lead to a further enabling environment for industrial development, especially light industry in the vicinity of the Wonderboom Airport.

Photo 2.10: Mine Dewatering near Rustenburg

2.2.7 Irrigation

Although the use of scarce water by the irrigation sector is often frowned upon because of the perceived inefficient use of this resource (ie conveyance losses and the relatively low income per cubic metre of water used when compared with the mining and manufacturing sectors), the supply of food and employment in South Africa still remains a priority. A sound balance needs to be achieved in this regard. It will be necessary to re-evaluate and prioritise the various agricultural uses of water in the Crocodile River and over time to slowly phase out unnecessary and inefficient irrigation practices.

The total area irrigated in the Crocodile River Catchment in 1995 was estimated to be in the region of 650 km^2. The bulk of this is situated below the Hartbeespoort Dam (mainly citrus and high value market garden crops) and in the Amandelbult area further downstream near Thabazimbi (lower value irrigated crops such as maize, wheat, fodder).

A recently completed water use registration process has shown significantly less irrigation than was thought to be in existence previously. More groundwater use has also been recorded. Verification of existing lawful water use is therefore a critical activity that should start as soon as possible. See **Strategy 1.2.1.**

Water losses in the canal conveyance systems in the Hartbeespoort Government Water (Irrigation) Scheme have been quoted (by scheme manager) as being between 40 and 60% of the water released from the dam. These losses need to be addressed as this water could be used for other higher value uses instead of importing more expensive water from the Vaal River System. Please refer to **Strategies 1.2** and **4.1** in Part II for discussion of strategies in this regard.

According to the Hartebeespoort Water Scheme Manager, emerging farmers are being settled on farms in this area that have been purchased by the Department of Agriculture and Land Affairs. No information regarding further major agricultural (emerging farmer) schemes could be gleaned at time of writing this version of the ISP, but every effort will be made to update this knowledge base with a view to DWAF supporting other government departments in this policy objective.

2.3 EXISTING WATER RELATED INFRASTRUCTURE

The current level of development including the new mining and other booming economic activities in the Crocodile River Catchment has been founded on previous public spending on infrastructure. This most definitely includes the water resources and water supply infrastructure which is of a high standard. **Chapter 4 of the WRSA Report** provides a detailed description of this infrastructure.

2.4 NATIONAL AND REGIONAL WATER PLANS AND OTHER LEGISLATION

The National Water Act (Act 36 of 1998), the National Water Resources Strategy, and the Catchment Management Strategy will guide further water policy and

plans in managing the water resources of the catchment. This legislation is inextricably linked to national policy (e.g. poverty eradication and socio-economic development), other legislation (e.g. environmental laws and regulations), as well as regional integrated development planning.

Water Service Development Plans (WSDPs) have recently been prepared by all local and district authorities. It has been noticed that water resource planning has not been sufficiently included into these WSDPs and closer co-operation between the Directorates: Water Services Planning and Information and National Water Resource Planning is required in order to ensure that water resources aspects and taken into account in the WSDPs where appropriate. This ISP report could form a first-order source of information in this regard.

The National Water Resources Strategy has been published for public comment and will be published in its final form early in 2004, after public comment has been reviewed. The Catchment Management Strategy will be developed once the Catchment Management Agency (CMA) has been established and is operational to assume this and other functions. The proposal to establish the CMA for the Crocodile West/Marico Water Management Area has recently been submitted to the Minister of Water Affairs and Forestry for approval.

In the interim, this ISP will serve as DWAF's strategy to provide direction towards the management of the water resources of the Crocodile River (West) Catchment. This ISP is also intended to provide a portion of DWAF's input to the development of the Catchment Management Strategy.

Co-operative governance (co-ordinated planning and operation with other national, provincial, district and local authorities) and other legal requirements are undertaken by the various departments, but more could be done to improve these communication channels. Such communication is much needed to streamline public service inputs into the provision of an enabling environment that can encourage equitable and sustainable social and economic development in this region (refer to **Strategy 1.6** and **6.1** in Part II).

DWAF have recently published a **Consolidated Environmental Implementation and Management Plan (CEIMP)**[10] which spells out how the Department will incorporate all relevant environmental and other legislation into its water resources management and other responsibilities. This CEIMP forms the backbone of the **Environmental Strategy 6.1** presented in this ISP.

CHAPTER 3 – BROAD PERSPECTIVE REGARDING THE WATER SITUATION IN THE WMA

This chapter presents an overview of the water requirements attributed to the water user sectors described in Chapter 3; a perspective of the water availability in the catchment; and an overview of the water balance and reconciliation options.

3.1 WATER REQUIREMENTS AND UTILISATION (CURRENT & FUTURE)

Approximately 60% of the total water requirements in the Water Management Area (WMA) are attributable to the urban, industrial and mining sectors; roughly 37% to irrigation, and the remainder for rural water supplies and power generation.

Just over three quarters of this demand falls within the Upper Crocodile and Apies/Pienaars sub-areas, which again reflects the dominance of the urban and industrial development in this part of the catchment.

A summary of the sectoral water requirements in each of the sub-areas is given in **Table 3a.** These values are sourced from the NWRS[5] and the Overview of Water Resources Availability and Utilisation report[13]. This ISP has quoted the water use and water availability data in these two documents as the most up to date values.

Values shown in Table 3a have been standardised at a 1:50 year or 98% level of assurance of supply.

Table 3a: Year 2000 Water Requirements (million m³/annum)

Sector/Sub-area	Irrigation	Urban (1)	Rural (1)	Mining & Bulk Industrial (2)	Power Generation (3)	Total Local Require-ments	Transfers Out	Grand Total
Upper Crocodile	208	292	5	38	13	**556**	**17**	**573**
Apies/Pienaars	41	211	7	6	15	**280**	**87**	**367**
Elands	32	23	10	48	0	**113**	**24**	**137**
Lower Crocodile	137	3	3	28	0	**171**	**0**	**171**
Total for Catchment	**418**	**529**	**25**	**120**	**28**	**1120**	**3**	**1123**

Note (1): Includes component of Reserve for basic human needs.
(2): Mining and bulk industrial water use that are not part of urban systems.
(3): Includes water for thermal generation only.

These water requirements have been accepted by DWAF as the best data available. Even so it is realised that more accurate values may be generated

from the effort being made by the Regional Offices to register water use and to have legal use verified (see **Strategy 1**). The registration process is indicating that there is less irrigation than has been assumed in the past. Groundwater apparently also plays a much bigger role in supplying these irrigation water requirements. There is also some uncertainty surrounding current urban water use and return flows.

With regard to future water requirement scenarios, it is expected that strong population growth (due to migration to these urban areas) will occur, accompanied by a concentration of economic development in the Tshwane-Johannesburg area. A significant growth in water requirements in the Upper Crocodile and Apies/Pienaars sub-areas may therefore be expected. Additional water requirements will also be expected in the Elands Sub-area as a result of the rapid expansion in mining related activities. No meaningful changes in the requirements for water are foreseen in the Lower Crocodile Sub-area.

Various development and water requirement scenarios dating to the year 2025 have been analysed (please refer to the **WMA report[13]** for motivations and values).

3.2 WATER RESOURCES AVAILABILITY (SURFACE AND GROUNDWATER)

The natural surface Mean Annual Runoff (MAR) is approximately 646 million m^3/annum.

Streamflow reduction due to invasive alien vegetation has not been considered to have a large impact on water availability in this catchment. More survey work in co-operation with Working for Water would need to be conducted to confirm this assumption.

The theoretical recharge of the Crocodile River Catchment was estimated at 260 million m^3/annum (see **Annexure A**) with only about half of this currently being utilised. In the drier areas (in the bottom half of the catchment below Hartbeespoort Dam), there is definite scope for small abstractions to meet the needs of rural water users (domestic and small-scale irrigation). Boreholes in these areas yield between 0,5 and 1,5 l/s on average. Large-scale abstractions from dolomitic compartments in the upper catchment could possibly have a negative impact on the Ecological Reserve and would therefore need to be monitored (see **Strategy 2.2.).** This will require detailed groundwater studies to resolve.

A summary of the natural MAR, together with the desktop estimates of the ecological water requirements (Ecological Reserve) is given in **Table 3b**. More detail on the estimation of the Reserve is discussed **in Paragraph 5.2 of the WRSA Report[8]** and **Addendum 3 of the WMA Report[13]**.

The Crocodile River system is regulated by 9 major dams, which are:

- Rietvlei, Hartbeespoort and Roodekopjes dams in the Upper Crocodile Sub-area;
- Roodeplaat and Klipvoor dams in the Apies/Pienaars Sub-area;
- Olifantsnek, Bospoort, Lindleyspoort and Vaalkop dams in the Elands Sub-area.

Table 3b: Natural Mean Annual Runoff and Ecological Reserve (million m³/annum)

Component / Sub-area	Natural MAR	Ecological Reserve
Upper Crocodile	253	57
Apies/Pienaars	142	34
Elands	113	15
Lower Crocodile	138	25
Total for Catchment	**646**	**131**

No large dams occur in the Lower Crocodile Sub-area. The development of surface water resources in the catchment has reached its potential since no more economical dam sites are available. Local catchment storage provides a yield of about 186 million m³/annum, or 14% of the water required. Groundwater makes up around 125 million m³/annum, or 10%, with large quantities of water having to be transferred into the catchment to augment local resources (i.e 648 million m³/annum transferred from the Vaal River System, which makes up 49% of the total water available). The transfers into and out of the Crocodile River (West) Catchment are shown on **Figure 3.1.** Treated wastewater return flows play an important role downstream where this water is once again used (makes up 27% of the water available or 356 million m³/annum). Increasing quantities of these return flow from the urban and industrial areas are being experienced that could serve as a potential source of water for future development as well. The cascade effect of water use down the catchment is envisaged but water quality considerations will have to be monitored.

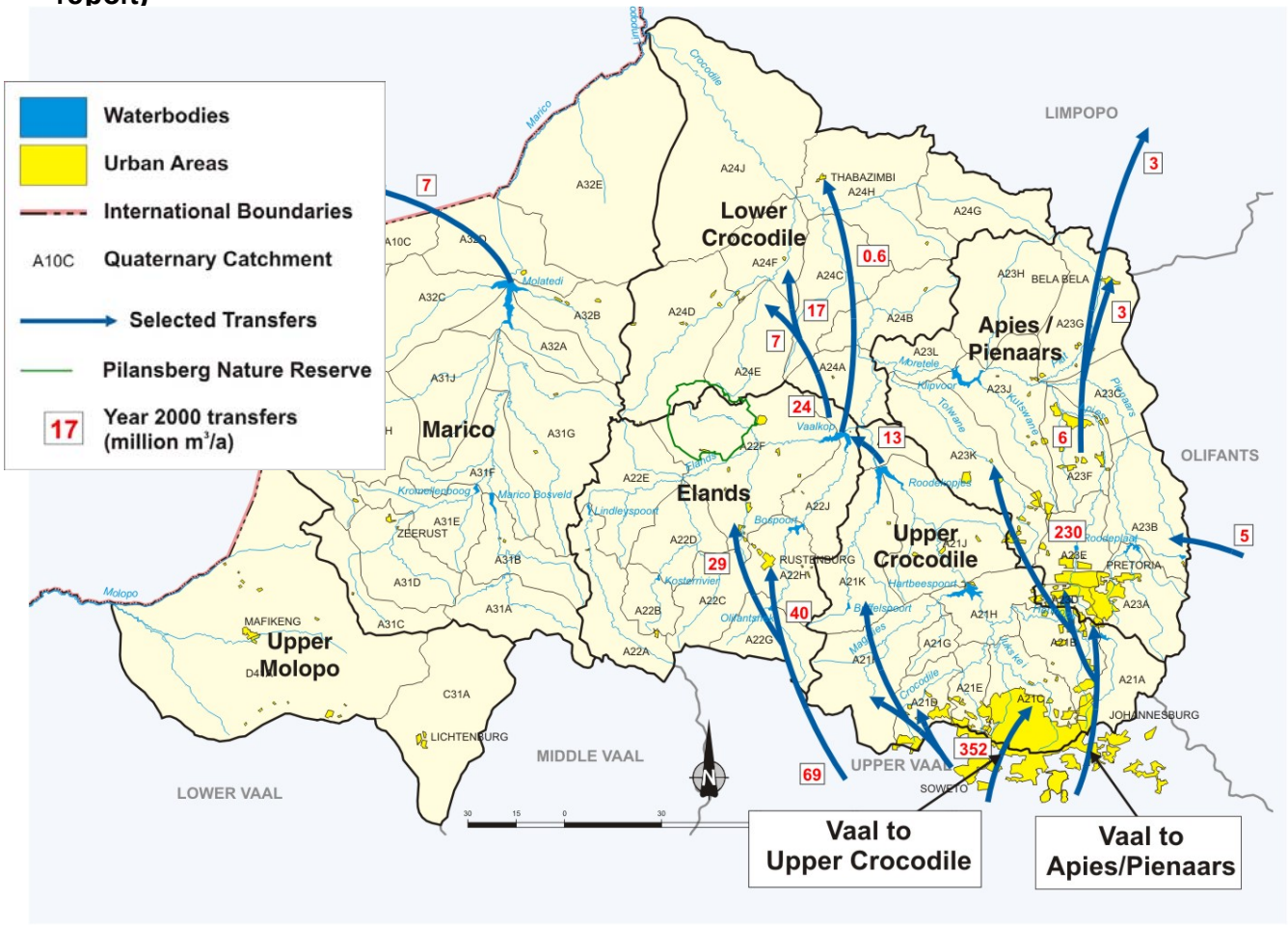
To summarise, the total available water or yield in the catchment has been estimated as set out in **Table 3c** below. Hydrological and system yield analyses have been conducted in a fair amount of detail over the past two decades, which allows a reasonably high level of confidence to be placed on these values given the current data input.

Table 3c: Available Yield in the Year 2000 (million m³/annum)

Component / Sub-area	Natural Resource		Usable Return Flow			Total Local Yield
	Surface Water (1)	Groundwater	Irrigation	Urban	Mining & Bulk	
Upper Crocodile	111	31	21	158	15	336
Apies/Pienaars	38	36	4	106	2	186
Elands	30	29	3	10	14	86
Lower Crocodile	7	29	14	1	8	59
Total for Catchment	**186**	**125**	**42**	**275**	**39**	**667**

Note (1): After allowance for the impacts on yield of: ecological component of the Reserve, river losses, alien vegetation, dryland agriculture and urban runoff.

Figure 3.1: Transfers in and out of the Crocodile River (West) catchment (Source: WMA report)



3.3 MANAGEMENT OBJECTIVES AND STRATEGIES TO BALANCE SUPPLY AND DEMAND (RECONCILIATION)

3.3.1 Introduction

The yield balances given in the NRWS[5] and the WMA report[13] have been used in this ISP as the best available figures.

Complex system models already exist for the Crocodile River (West) Catchment and it is recommended that the yield balances be revised once the return flow study and the verification of existing lawful use is completed (see **Strategy 1**). The water resource planners must ensure that the correct spatial distribution of sources and abstraction points are modelled.

3.3.2 Reconciliation of the water requirements and available resource

Current

The water balance presented in the NWRS[5] and the WMA[13] report and repeated here in **Table 3d** is the difference between the available yield and the sum of all the water requirements and losses.

Table 3d: Reconciliation of Water Requirements and Available Water for the Year 2000 (million m³/annum)

Component/Sub-area	Local Yield	Transfers In (2)	Local Requirements	Transfers Out (2)	Balance (1)
Upper Crocodile	336	279	556	17	42
Apies/Pienaars	186	182	280	87	1
Elands	86	71	113	24	20
Lower Crocodile	59	112	171	0	0
Total for Catchment	**667**	**519**	**1120**	**3**	**63**

Note (1): Surpluses are shown in the most upstream sub-area where they first become available.
(2): Transfers into and out of sub-areas include transfers between sub-areas as well as 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. So also for tables 3e and 3f.***

The balances in the Apies/Pienaars and Upper Crocodile sub-areas are due to urban return flows in excess of what is currently used in these sub-catchments. Only the Rietvlei Dam catchment (A21A) and the Sterkstroom River (A21K) in the Upper Crocodile Sub-area experience significant negative water balances (see **Strategy 1** for more discussions and management strategies). It must be remembered that an application for a new use in a quaternary which has surplus water available does not always mean that this water use will be licenced. This "surplus" water may already be used downstream.

Future

A perspective of the future situation is given in **Table 3e** for the most probable scenario in 2025, and **Table 3f** which is representative of a possible high water use. In both cases it was assumed that growth in water requirements for urban and industrial use in the Tshwane-Johannesburg area will be supplied through additional transfers from the Upper-Vaal WMA. In these scenarios, growth in urban return flows from this area have been assumed which will result in larger yield surpluses being experienced.

Table 3e: Reconciliation of Water Requirements and Available Water for the Year 2025 Base Scenario (million m³/annum)

Component/Sub-area	Local Yield (1)	Transfers In	Local Requirements (2)	Transfers Out	Balance
Upper Crocodile	399	382	673	13	95
Apies/Pienaars	244	287	399	92	40
Elands	90	71	124	24	13
Lower Crocodile	59	113	173	0	(1)
Total for Catchment	**792**	**727**	**1369**	**3**	**147**

Note (1): Based on existing infrastructure and infrastructure under construction in the year 2000. Also includes return flows resulting from growth in requirements. Assumed that water will be transferred into the Apies/Pienaars and Upper Crocodile sub-areas from the Upper-Vaal WMA, to meet growth in these requirements.

(2): Based on growth in water requirements as a result of population growth and general economic development. Assumed no general increase in irrigation.

Table 3f: Reconciliation of Water Requirements and Available Water for the Year 2025 High Scenario (million m³/annum)

Component/Sub-area	Local Yield (1)	Transfers In	Local Requirements (2)	Transfers Out	Balance
Upper Crocodile	511	584	880	13	202
Apies/Pienaars	360	517	630	95	152
Elands	97	71	141	24	3
Lower Crocodile	62	116	179	0	(1)
Total for Catchment	**1030**	**1159**	**1830**	**3**	**356**

Note (1): Based on existing infrastructure and infrastructure under construction in the year 2000. Also includes return flows resulting from growth in requirements. Assumed that water will be transferred into the Apies/Pienaars and Upper Crocodile sub-areas from the Upper-Vaal WMA, to meet growth in these requirements.

(2): Based on growth in water requirements as a result of population growth and general economic development. Assumed no general increase in irrigation.

(3): Brackets around numbers indicate negative balance.

3.3.3 Management Approach

Upper Crocodile sub-area

The future scenarios shown in **Table 3e** and **Table 3f** show that surpluses will increase in future due to increasing return flows from the Johannesburg/Tshwane area. This is based on the assumption that the increasing water requirements of the Johannesburg/Tshwane area will continue to be met from the Vaal system. It is important to develop a strategy that will optimise the use of this surplus, taking into account that the Vaal system is being supplied from other basins through Inter Basin Transfers. Very expensive projects will be required in future to increase the supply to the Vaal River system and the reuse of return flows in the Crocodile River (West) catchment must be considered as an option to delay costly additional transfer schemes. This reuse of return flows will result in an increase in the salinity of the Crocodile system and the costs associated with this will need to be carefully considered. A cascading re-use is a feasible and preferable option, whereby the salts are always passed downstream and could conceivably be stored in slimes dams if mines are the end user in the system.

As an immediate strategy, all new use north of the Magaliesberg should be supplied from the use of return flows, while a strategy needs to developed to supply users in the more upstream (southern) parts of the catchment as well. Some of the return flows could also be used for irrigation and establishing of emerging farmers should be considered.

Other water balance issues and strategies are listed and discussed in **Strategy 1** in Part II of this report.

On-going liaison with the various District and Local Municipalities and other water users (e.g. mines, industry, irrigation water user associations and the nine Water Forums in the catchment) needs to continue in order to ensure that optimal use is made of the available water resources. Water conservation, water demand management and optimisation of the usage of local water resources will feature high on the agenda in these discussions.

Apies/Pienaars sub-area

The same situation exists in the Apies/Pienaars sub-area as in the upper Crocodile, with increasing return flows resulting in projected surpluses in future. The difference here though is that the return flows become available in the Apies and Pienaars Rivers as opposed to the Crocodile which receives the return flows from the Upper Crocodile sub-area. Also, in the case of the Apies/Pienaars system, some of the surplus has already been allocated for improvement and expansion of the water supply to the rapidly expanding urban areas north of Pretoria. The possibility of transferring the surpluses derived from return flows to the Western Highveld area in the Olifants WMA is also an option which is currently being investigated. It is important to ensure that increasing rive flows due to return flows are not taken up by riparian irrigators, without first carefully considering alternative uses of this water.

Elands sub-area

There is rapid economic growth in this sub-area due to mining activities and this will certainly lead to increased water requirements. These increased requirements should be supplied from local sources, such as Bospoort Dam which is underutilised or increasing return flows in the Crocodile River.

Lower Crocodile

The water requirements of the Lower Crocodile sub-area can be met by return flows for the foreseeable future. It must be born in mind, however, that the NWRS reserves 45 million m^3/annum for the possible development of a new power station in the neighbouring Limpopo WMA. The allocation of surplus return flows in the Lower Crocodile must therefore be carefully considered.

CHAPTER 4 - NATIONAL ISSUES & STRATEGIES

A number of other issues have been mentioned during the course of the ISP development process, which have been common to most water management areas in the country. Some issues even refer to the need for new or additional policy in the water field. A document outlining these issues as well as strategies are to be published by the Directorate: National Water Resources Planning in 2004.

CHAPTER 5 – PROTECTION OF THE WATER RESOURCES

5.1 INTRODUCTION

All water users in the Crocodile River (West) Catchment require an adequate supply of water that is fit for their particular use, and to their benefit.

The challenge is to marry continued development with the supply of water that is fit for use by all users, including the aquatic ecosystem. This is the principle of sustainability or equilibrium, which forms the basis of our water and environmental legislation and the international Agenda 21.

This chapter focuses on ways in which DWAF is implementing the various provisions of the National Water Act with a view to achieving this balance in the Crocodile River (West) Catchment.

5.2 RESOURCE DIRECTED MEASURES

The NWA calls for the:

5.2.1 Classification of Water Resources

All rivers are to be classified in due course. A classification system is currently being developed and should be published in 2004. This classification is expected to refer to whether the river should be left alone in its natural state (Class 1), whether it can be used but protection mechanisms put in place to maintain ecological integrity (Classes 2 and 3). It is important to note, however, that even a Class 3 river must be sustainable from an ecological point of view.

For the purposes of preparing the NWRS and this report, the desktop estimates of the impact of the ecological Reserve have been used assuming the present ecological state of the rivers in the catchment. These estimates will have to be revisited in due course, probably as part of a compulsory licensing exercise.

5.2.2 Basic Human Needs Reserve

The Basic Human Needs Reserve has been factored into the urban and rural water requirement component referred to in Chapter 3 of this ISP. It refers to the essential needs of the individuals who live in the catchment, which includes water for drinking, for food preparation and for personal hygiene.

People who live in the urban areas, with the exception of some informal settlements, also have access to a higher level of water supply and sanitation than the basic levels referred to here.

People in the rural areas in the Elands River Sub-area by large have at least basic levels of service (now free basic water) thanks to the diligent efforts of Magalies Water, DWAF and other organisations over the past decade and more. There is a reasonably high level of cost recovery from these communities as a result of a

high level of community participation. Requests for higher levels of service are becoming more abundant mainly due to the fact that household incomes, and expectations, are steadily increasing in these areas.

Water supply problems in the Elands Sub-area are often due to power outages because of a poor electrical reticulation in this part of the catchment. These problems have also been attributed to boreholes that dry-up, collapse and/or which have been gradually polluted after 8 to 10 years by poor sanitation practices. Sustainability strategies need to be developed, especially with regard to the new sanitation provision initiative recently launched by DWAF (see **Water Resources Protection Strategy [#2]**).

The semi-urban areas in the triangle between Brits, Tshwane and Temba (on the way to Bela-Bela) have been serviced with basic levels of water supply in the past. Poor cost recovery and a scourge of illegal connections have led to the collapse of these systems (poor maintenance, poor pressure differentials and hence interrupted supply). Efforts by Rand Water and local municipalities are now being conducted to reverse this trend and to once again provide the basic free water component of the Reserve.

5.2.3 The Ecological Reserve

The Ecological Reserve relates to the water required to protect the aquatic ecosystems of the water resource. The Minister is required to determine the Reserve for all or part of any significant water resource. As has been noted, only a low confidence desktop Reserve Determination has been carried out for the Crocodile River Catchment, with the exception of the Apies/Pienaars River System where a more detailed Intermediate Reserve has been determined. It is felt that the necessity to conduct a Comprehensive Reserve Determination in the Crocodile River Catchment (quality issues aside) is not that high a priority when compared with other WMAs (and more ecologically sensitive ecosystems) in the country. It must be remembered that flows in the main rivers could be near to or even higher than the natural flows due to the urban return flows that originate from water from other WMAs. Reserve determinations may well be necessary in some of the minor tributaries (e.g. some small streams in the Magaliesberg Conservation Area).

5.2.4 Determining Resource Quality Objectives (sections 13 to 15 of the NWA)

In line with the river classification system, the purpose of Resource Quality Objectives (RQOs) is to establish clear goals relating to the quality of the relevant water resources. Although much diverse work has been done on many water quality aspects of the Crocodile River Catchment, there is now a need to consolidate this information and, with public participation, set RQOs that create the optimum balance between the need to protect and sustain the water resources and the need to develop and use them.

The RQOs will relate to the:

- Reserve;
- instream flow;

- water level;
- presence and concentration of particular substances in the water;
- characteristics and quality of the water resource and the instream and riparian habitat;
- characteristics and distribution of aquatic biota;
- regulation and prohibition of instream or land-based activities which may affect the quantity of water in or the quality of water of the resource; and
- any other characteristic that stakeholders may wish to abide by.

The Department's Directorate of Waste Discharge and Management has spent much time in developing processes, guidelines, policies, and strategies to arrive at sustainable RQO's via the public consultative process. This is with the view of fulfilling the NWAs requirements to authorise activities that, if not controlled, would have a high potential for unacceptable impact, such as discharging waste into a watercourse.

5.3 SOURCE DIRECTED MEASURES

Although inextricably linked to the Reserve, provisions in the NWA equip DWAF Water Resource Managers' with the tools to enforce water quality regulations in order to ensure fitness for use for all users.

5.3.1 Background

Water quality management has a firm legal foundation. The South African Constitution guarantees everyone's right to an environment that is not harmful to their health or well-being. The NWA embodies these principles and policies and requires that water quality be managed in an integrated manner at national level in terms of the NWRS, and at regional or catchment level in terms of the Catchment Management Strategies.

5.3.2 Water authorisation categories

Allowance is made for the following mechanisms in addressing water quality issues.

- **General Authorisations:** Where the local environment can absorb the water quality impact, it is possible to promulgate a general authorisation. No licence need be applied for such uses, unless compulsory licencing calls for it. A list of General Authorisations for the Crocodile River (West) Catchment is available. DWAF Officials have requested that further general authorisations be investigated and adopted (eg for septic tanks), since it would reduce the large amount of administration involved in evaluating and issuing full licenses.

- **Licencing:** With the exception of General Authorisations, all water uses need to be licenced. Licences are subject to stringent conditions, including conditions that specify the quality of water containing waste being discharged or disposed of. Such water use licence applications will be evaluated against the Water Quality Guidelines that have been drawn up by the DWAF (related to Resource Quality Objectives). A strategy has

been suggested to make these guidelines specific to all relevant parts of the Crocodile River Catchment (eg RQOs for a specific reach of the river)(see **Water Quality Strategy 2.2**). This is a great need for clearly documenting these requirements in the Crocodile River Catchment. This will facilitate communication between DWAF officials and private sector development planners in that there will be a consistent way of evaluating licences in specific areas of the catchment.

5.3.3 Licence evaluation

Licence applications will continue to be evaluated against DWAF water quality guidelines. Decisions are then made in terms of a hierarchy of principles outlined below:

I Prevention of pollution

Prevention is better than cure. This is usually the most expensive option but may be required in certain cases. Specific areas in the Crocodile River Catchment where the environment cannot absorb controlled discharges of waste will need to be identified (see **Water Quality Strategy 2.2**).

II Minimisation of pollution at source

The next level of condition would be for a water user (eg an industrial plant) to minimise unavoidable waste production on site. This could include recycling/re-use of waste or water containing waste; detoxifying waste; neutralisation of waste; treatment of waste streams; introduction of cleaner technologies and best management practices.

III Disposal of waste and/or discharge of water containing waste according to the precautionary principal

If there are no alternatives to the disposal of waste and/or the discharge of water containing waste, then the precautionary principle could be applied. In the case of the disposal of waste, the minimum standards listed in the DWAF guidelines will be adopted. In the instance of the discharge of water containing waste, the Waste Discharge Standards (currently the General and Special Standards for Phosphate), apply as the minimum requirement. Such disposal will only be allowed if the receiving environment has the capacity to assimilate the additional waste load.

IV Disposal of waste and/or discharge of water containing waste according to the differentiated approach

If it is believed that the minimum requirements will not ensure fitness for use of the receiving environment, stricter standards will be enforced in accordance with the differentiated approach. This approach takes account of catchment-specific conditions and includes the determination of RQOs and setting standards that must ensure compliance with RQOs. The levels at which the objectives will be set will be determined through the application of the management classification system for the resource that was mentioned above. Again, clearly defined and spatially pegged RQOs and other requirements for specific reaches of river in the Crocodile Catchment would be the ideal that water resource managers need to strive for in fulfilling their responsibilities.

5.3.4 Enforcement

The basic principle of the "polluter pays" will be adopted in the Crocodile River Catchment. The person who owns, controls, occupies and/or uses the land or mode of transport where the pollution can originate, is responsible for taking measures to prevent pollution of the water resource. If these measures are not taken or if pollution actually occurs, DWAF (or the CMA in future) may itself do whatever is necessary to prevent pollution or to remedy its effects, and to recover all reasonable costs from the person(s) responsible for the pollution.

Other strategies to govern and regulate these water quality initiatives will be discussed in the pricing chapter and strategy in Part II below.

Management approaches with regard to assessing performance and compliance with the above standards will need to be incorporated in a monitoring and information strategy.

5.3.5 Catchment specific water quality issues

Issues relating to the potential water resource pollution threats in the catchment are listed and discussed in the **Water Quality Strategy 2.1** in **Part II**.

Strategies need to be developed to systematically deal with these problems with the long-term view of improving the water quality and riverine environments (eg by encouraging district and local authorities to further develop and enforce bylaws, drafting regulations, *et cetera*).

CHAPTER 6 - USE OF WATER AND REGULATION

6.1 INTRODUCTION

The ISP has so far focussed on providing a background overview of the catchment, the current water balance, and the main water resource protection mechanisms employed by DWAF. This chapter deals with water use allocations and the way in which DWAF intends managing the licencing process in the Crocodile River (West) Catchment. All the matters discussed below should be read with Chapter 4 of the NWA in view (ie Sections 21 to 55) as well as Schedule 1 appended to the NWA.

6.2 WATER USES

In general, water use must be licenced unless it is listed in Schedule 1, is permissible under a general authorisation, or if a responsible authority waives the need for such a licence. Once existing lawful use is verified in this catchment it will be licenced under certain conditions, for a limited period of time and reviewed every 5 years. Licencing of new users follows a procedure whereby the application is processed according to a set of criteria. These criteria usually require that the application be passed by a number of Directorates in the Department, which could be time consuming. This procedure is currently being refined by the Department.

The following uses will be considered in the Crocodile River Catchment (numbers refer to Section 21 of the NWA):

6.2.1 Taking water from a water resource (quantity)

Situation assessments with regard to quantity have been sketched in Part II of this ISP along with strategies to obtain better information. The Water Use & Reconciliation Strategy (**Strategy 1.3**) indicates broadly where water is available in the catchment. Referring also to **Table 3d,** there is surplus water indicated in the Upper Crocodile and Elands catchments. In the case of the Crocodile catchment, the surplus water is located in the Hartbeespoort Dam and can therefore be made available to the Lower Crocodile by releasing water down the Crocodile River, or to the Elands catchment by diverting the flow via the Vaalkop canal. The possibility of making the surplus available to the Pretoria North area has also been mooted, but this will need to be investigated in detail before any decision on this is taken.

In the case of the Elands catchment, the surplus is available in the Bospoort Dam, which is underutilised at present, as well as in the Vaalkop Dam.

Despite the surpluses available in the Crocodile West catchment, water must be allocated with caution, because there are localised shortages throughout the catchment. Each application needs to be carefully considered and, when in

doubt, a detailed water resources evaluation carried out. Due to these localised surpluses, general authorisations are not recommended.

Groundwater is available throughout the catchment, but is mostly only suitable for small scale and/or widely dispersed users, for example rural use. Only in isolated cases, for example, the water supply to Pretoria from the dolomitic aquifers can large volumes of water be supplies, but these aquifers are generally fully utilised.

6.2.2 Storing water

All storage in this catchment needs to be licenced, with the exception of the dam sizes listed in the most recent general authorisations that have been published. These differ from quaternary to quaternary catchment but usually refer to modest size dams associated with storing irrigation water between water turns. Larger storage requirements than this will have to be evaluated on the individual application's merit and dam safety considerations. At this stage, no further major dams are envisaged in the catchment.

6.2.3 Impeding or diverting the flow of water in a watercourse

An Operational Guideline M1.0 for mining activities has been drafted by the Directorate: Water Quality Management. This may need to be adapted for urban and other sectors. Licences are evaluated against the criteria listed in these guidelines and conditions set accordingly. Catchment specific perspectives need to be developed. District and local municipalities must be encouraged to promulgate and enforce bylaws in this regard.

6.2.4 Engaging in a streamflow reduction activity contemplated in Section 36 of the NWA

There is no licenced afforestation in this catchment and this catchment is climatically not suitable for forestry. Licences for forestry will therefore not be issued for this catchment.

6.2.5 Engaging in a controlled activity identified as such in Section 37(1) or declared under 38(1) of the NWA

This refers to: irrigating with wastewater; an activity aimed at modification of atmospheric conditions; hydropower generation altering the flow regime of a water resource; intentional recharging of underground water with wastewater. The Directorate: Water Quality Management is currently drafting a guideline/procedure in this regard.

6.2.6 Discharging waste or water containing waste into a water resource through a pipe, canal, sewer or other conduit

Wastewater discharges from sewage treatment works and sewage spills are a major concern in this catchment, especially in the urban areas in the south and east, Rustenburg and environs, and the GaRankuwa complex (Tlolwane River, where treatment standards have been lowered due to economic considerations). Efforts need to be made to formalise guidelines specific to each treatment works in the catchment and to enforce adequate measures.

6.2.7 Disposing of waste in a manner which may detrimentally impact on water resources

Solid and liquid waste disposal ends up in the rivercouses in the urban areas of this catchment (i.e. industries and informal settlements in the Upper Crocodile River area and the Apies/Pienaars River areas. This causes major water quality problems in the Hartbeespoort Dam. The Directorate Water Quality Management is currently drafting a guideline/procedure in this regard.

6.2.8 Disposing in any manner of water which contains waste from, or which has been heated in, any industrial or power generation process

Same as 6.2.4. There do not seem to be any serious problems associated with these activities in the Crocodile River (West) Catchment.

6.2.9 Altering the bed, banks, course or characteristics of a water course

Same as **Section 6.2.3.**

6.2.10 Removing, discharging or disposing of water found underground, if it is necessary for the continuation of an activity or for the safety of people

The Directorate Water Quality Management is currently drafting a guideline/procedure. It should be noted that the public have raised the concern that the mines along the Brits to Rustenburg axis are dewatering to such an extent that their farming livelihoods upstream of the mines are suffering. This needs to be investigated by the mines.

6.2.11 Using water for recreational purposes

Refer to the **Environmental Strategy (Strategy 6)** for more discussion.

6.3 MANAGEMENT PRIORITIES WHEN ALLOCATING WATER LICENCES

The following priorities are laid down in the NWA and NWRS:

(a) Meeting the **Reserve** will receive first priority. Basic human needs first followed by ensuring ecological integrity. Please refer to Chapter 5 for more information on the Reserve.
(b) **International Obligations** are next in priority. These need to be determined by means of a basin study in the case of the Limpopo River Basin, obligations agreed upon, and a water sharing agreement prepared in line with the SADC Protocol and then ratified.
(c) **Strategic** water uses: limited in the Crocodile River Catchment.
(d) **Domestic** use (including urban industrial): this sector makes up more than half of the water requirements in the Crocodile River Catchment, excluding the Reserve.
(e) **Mining**
(f) **Bulk rural and industrial**
(g) **Irrigation**

In all the above, DWAF's aim is to promote equitable access to water resources. On the one hand DWAF wishes to redress racial and gender imbalances of the past (including poverty eradication), and on the other hand wants to ensure that the most beneficial economic use is obtained from using this water. In all its activities it also wishes to promote efficient, sustainable and beneficial use of this scarce natural resource. Specific policy objectives describing particular and practical goals need to be formulated so as to give guidance to water resource and other planners.

6.4 CONCLUSION

As mentioned at the beginning of this chapter please refer to Chapter 4 of the NWA. All activities (such as trading of water licences) will be conducted in accordance with the NWA and more specifically in line with Section 3.2.3 of the NWRS.

CHAPTER 7 - WATER CONSERVATION AND WATER DEMAND MANAGEMENT (WC/WDM)

The bulk of urban use in the WMA is supplied from the Vaal River system which is supported from the Orange (Lesotho Highlands), the Usutu and the Thukela Rivers. Water Conservation and Demand Management is therefore extremely important in this catchment to delay or obviate the need for very costly augmentation schemes. These WC/DM measures will impact on return flows from northern Johannesburg and Tswane and because these return flows are an important source for possible developments in the catchment, they must be carefully monitored and understood. A study is currently in progress to understand the relationship between water use and return flows in the Crocodile (West) catchment. **Strategy 4** lists the WC/DM strategies.

DWAF encourages all water users to comply with the principles and strategies expounded in WC/WDM literature which it makes available through its Directorate: Water Use Efficiency. Water users must develop WC/DM implementation plans. These authorities should liaise with DWAF to set realistic benchmarks against which the success of WC/WDM can be measured. This is an important aspect and will be taken into account when new applications for water abstractions are evaluated. No new allocations of water will be allowed in the Crocodile River (West) Catchment unless the user can prove to have planned and implemented WC/WDM measures.

The Directorate: Water Use Efficiency is currently producing a National WC/WDM Strategy which should be published for comment in 2004.

A detailed overarching management strategy needs to be developed for all users in the catchment in order to plan, orchestrate and measure success in future.

CHAPTER 8 - ENVIRONMENTAL CONSIDERATIONS

DWAF realises that all human activity will have some form of impact on the environment in which we live. The management objective is therefore to find a balance between economic development and the impact this development might have on the environment.

DWAF also conducts activities that impact on the environment and therefore also has to account for its activities in line with current environmental legislation. The Department has recently published the first edition of its **Consolidated Environmental Implementation and Management Plan (CEIMP)**[10] as required in Chapter 2 of the National Environmental Management Act (NEMA).

The **CEIMP** is primarily intended to align the DWAF's environmental management policies and functions with that of other Government Departments and *vice versa*. This plan shows: how DWAF will manage the environmental impacts associated with its activities; how it will manage impacts caused by external stakeholders activities; and how it is complying with other environmental legislation. DWAF will be audited by the Auditor-General in 2004 in this regard. Clear strategies need to be developed on how the Department is going to meet these legal requirements. DWAF are currently preparing these strategies for inclusion in the next version of this ISP.

By the very nature of these objectives and the broad strategies listed in the CEIMP, it can be deduced that these environmental aspects are cross-cutting over all the management approaches and strategies put forward in this ISP. This environmental approach is intended to ensure all components of the environment (ie social, economic, ecological, *et cetera*) are accorded adequate consideration and that a fully integrated and sustainable result is achieved, that is aligned with current government policy and best international practice (eg Agenda 21).

CHAPTER 9 - INSTITUTIONAL AND LEGAL ARRANGEMENTS

9.1 STRATEGIC AND INTERNATIONAL LEVEL

All aspects mentioned in this ISP are governed by the **Constitution of the Republic of South Africa[2]**. Furthermore, continental level initiatives to foster an African Union similar to the European Union (**NEPAD[14]**), are being developed.

The South African Development Community (SADC) has had a similar initiative going at a sub-continental level since 1992. SADC has promulgated numerous treaties and agreements, with the most significant one being the ratification of the **Southern African Water Vision[15]** (South Africa committed to the vision) for the new millennium, which was presented at The Hague in the year 2000.

Subsequent work in response to the World Summit on Sustainable Development (WSSD) in 2002 gave rise to the Millennium Water Task Force, which has set more specific objectives to the Water Vision by adopting the Millennium Goals agreed upon at the WSSD (eg cutting the number of people who do not have basic levels of water supply by half before the year 2015). South Africa in general is rapidly meeting these goals (eg the above-mentioned goal on basic water supply are targeted to be met within the next seven to eight years). This goal should be met within the next three years in the Crocodile River (West) Catchment. Rehabilitation of old water supply infrastructure and rejuvenation of old groundwater sources still poses the greatest challenge to planners and implementers alike in this catchment. Lots of people may have infrastructure, but do not always have water in taps or have a reliable source of this essential commodity.

The Crocodile River Catchment will form part of the Limpopo River Basin Study that is to be conducted by the Limpopo Watercourse Commission. However, the Regional Office and, later, the CMA cannot address international issues. This is a national prerogative that will be co-ordinated through DWAF's Directorate: International Development and Co-operation.

9.2 NATIONAL LEVEL

DWAF finds itself in a transitional organisational and institutional restructuring phase. The Minister's roles and objectives in this process, which relate to water resources management have been clearly outlined in **Chapter 3, Part 5 of the NWRS**. Also refer to Chapters 6-11, 13, 16 and 17 of the NWA for further definition. It is recommended that more internal co-ordination and communication be encouraged by new and innovative methods (eg electronic newsletters informing other departments/directorates what the organs are currently busy with).

9.3 REGIONAL (CATCHMENT) LEVEL

At time of writing this ISP, the **Catchment Management Agency proposal[16]** for the Crocodile West and Marico WMA had already been submitted to the Minister for consideration. This has been based on years of public participation at Water Forum level. There are nine forums in the catchment that form part of the CMA process. DWAF has also begun to transform existing water institutions (eg Irrigation Boards) to Water User Associations. Please refer to **Paragraph 3.4 in the WRSA Report** for further details of the various institutions, as well as **Paragraph 5.13** of that report for details of known water abstraction allocations in the catchment.

Integration and communication between the Department and various stakeholders (especially provincial, district and local authorities) is imperative. Most people in government planning positions seem to be overloaded with meetings and administration and consequently do not always have time to dedicate themselves to this important form of co-operative governance. Again, some form of novel communication channel championed by at least one person will provide a wealth of benefit to the people in the Crocodile West and Marico WMA. Please refer to **Strategy 5.1** for further discussion on these co-operative governance issues.

CHAPTER 10 – WATER PRICING STRATEGY

DWAF has published a Pricing Strategy[17]. This has been implemented in the WMA and users charged accordingly. A waste discharge system is currently being developed. The charges from this proposed system will be a very important source of income for this WMA. This income will be required for the proper management of the WMA. This system will be implemented as soon as it is published.

CHAPTER 11 - MONITORING AND INFORMATION SYSTEMS

The availability of reliable data and information on all aspects of water resources management is fundamental to the success of strategies to implement the Act. No proper decision on any matter can be made with confidence unless it is supported by reliable, relevant, up-to-date information which complies with certain standards.

A strategy will need to be developed to collate and develop these systems (see **Monitoring and Information Management Strategy [#8]**). Please refer to **Chapter 3: Part 6 of the NWRS** for guidance in this regard.

Apart from the water resource and hydrological systems referred to above, environmental performance (ie are the Reserve Determination tools achieving their objectives?) and environmental compliance systems (ie in terms of current legislation) need to be put in place.

A decision needs to be taken regarding the need and timeframe for updating the ISP.

CHAPTER 12 - PUBLIC HEALTH AND SAFETY

The Department's current commitments are associated with:

- managing floods and drought disasters by direct intervention on the ground.
- by reducing pollution and preventing serious or hazardous pollution events.
- and promoting dam safety.

DWAF's (and the CMA's in some cases) commitments under National Disaster Management Act, which was promulgated in 2003, are:

- DWAF/CMA will be required to become involved in supporting and enforcing disaster management planning by all relevant authorities.
- Drafting a National Flood Management Policy (DWAF).
- Dam safety policy (DWAF).
- Co-operating with the Department of Agriculture on drought relief strategies and policy formulation.
- Pollution of water resources (ie limiting health hazards such as cholera).

Refer to **Strategy 7.4** for more discussion on this topic and the ways in which DWAF intends to tackle this management function.

CHAPTER 13 - INTRODUCTION TO STRATEGY TABLES

Throughout the course of the text, reference has been made to various strategies contained in tables in Part II of this ISP. The strategy tables provide:

- a brief situation assessment to paint the picture;
- the management objective (what we are trying to achieve) adopted by DWAF;
- a broad strategic approach; and the required actions, responsibilities and priorities.

REFERENCES

1. Overview of the Water Resources Availability & Utilisation in South Africa, 1997. Department of Water Affairs & Forestry: Directorate Water Resources Planning.

2. Constitution of South Africa, 1997. Office of the President.

3. National Water Act, Act 36 of 1998. Department of Water Affairs & Forestry.

4. National Environmental Management Act, Act 107 of 1998. Department of Environmental Affairs & Tourism.

5. National Water Resources Strategy 2002 (Draft for Comment). Department of Water Affairs & Forestry.

6. Multi-year Strategic Plan 2003/04 to 2005/06. Department of Water Affairs & Forestry.

7. Consolidated Environmental Implementation Management Plan, 2002. Department of Water Affairs & Forestry: Directorate Social & Ecological Services.

8. Water Resources Situation Assessment: Crocodile West – Marico Water Management Area, 2002. Department of Water Affairs & Forestry: Directorate Water Resources Planning. Report No. P WMA03000/00/0203.

9. Integrated Water Resources Management: Apies/Pienaars River Pilot Study, 2002. DANIDA/ Department of Water Affairs & Forestry: Directorate Water Resources Planning. Draft versions.

10. Hartbeespoort Dam: An Overview of Water Resource Management Issues, 1998. Rand Water (RD Walmsley).

11. Resource Directed Measures Protocol/Implementation Manuals, 1999. Department of Water Affairs & Forestry: Directorate Resource Directed Measures.

12. WARMS. Unpublished database that has recorded water allocation/use registrations.

13. Department of Water Affairs and Forestry (2003); Crocodile West and Marico Water Water Management Area: Overview of Water Resources and Utilisation. DWAF report number P WMA06000/00/0203.

14. NEPAD. Personal Communications with NEPAD Task Force, 2003.

15. Southern African Water Vision, 2000. SADC Water Resource Co-ordinating Unit, Maseru, Lesotho (recently moved to Gaborone).

16. Crocodile West/Marico Water Management Area: Catchment Management Agency Proposal. Unpublished, 2003. Department of Water Affairs & Forestry.

17. Water Pricing Strategy, 2002. Department of Water Affairs & Forestry Website.

LIMPOPO PROVINCE

LIMPOPO WMA

NORTH WEST PROVINCE

WATERBERG DISTRICT MUNICIPALITY (DC36)

BOJANALA DISTRICT MUNICIPALITY (DC37)

METSWEDING DISCTRICT MUNICIPALITY (CBDC2)

City of Tshwane

City of Johannesburg

WEST RAND DISTRICT MUNICIPALITY (CBDC8)

UPPER VAAL WMA

OLIFANTS

GAUTENG PROVINCE

Thabazimbi
Modimolle
Bela Bela
Mokwase
Hammanskraal
Mabopane
Ga-Rankuwa
Brits
Pretoria
Rustenburg
Koster
Krugersdorp
Soweto

Lenkwane
Crocodile
Sand
Bierspruit
Motlhabe
Moretele
Klipvoor dam
Tolwane
Kutswane
Apies
Mankwe Dam
Vaalkop Dam
Madikwe Dam
Elands
Roode-kopjes Dam
Hex
Lindleys-poort Dam
Bospoort Dam
Koster
Koster Dam
Elands
Olifantsnek dam
Hartbees-poort Dam
Magalies
Bon Accord Dam
Roodeplaat Dam
Hennops
Rietvlei Dam
Rietspruit

A24J A24H A24G A24F A24C A24D A24B A24E A24A A23H A23G A23L A23C A23J A23F A23B A32E A32B A31G A22F A22E A22J A22D A22H A22C A22B A22A A21L A23K A21K A21J A21H A23D A23A A21G A21F A21D A21E A21A A21C A23E

27°00' 27°30' 28°00' 28°30'

24°30' 25°00' 25°30' 26°00'

N

10 0 10 20 Kilometers

LEGEND

- Dams
- Catchment Area
- City/Town
- Rivers
- WMA Boundaries
- Primary Drainage Region
- Secondary Drainage Region
- Quaternary Drainage Region
- Provincial Boundary
- District Municipality

LOCALITY MAP

CLIENT:

DEPARTMENT OF WATER AFFAIRS AND FORESTRY

PREPARED BY:

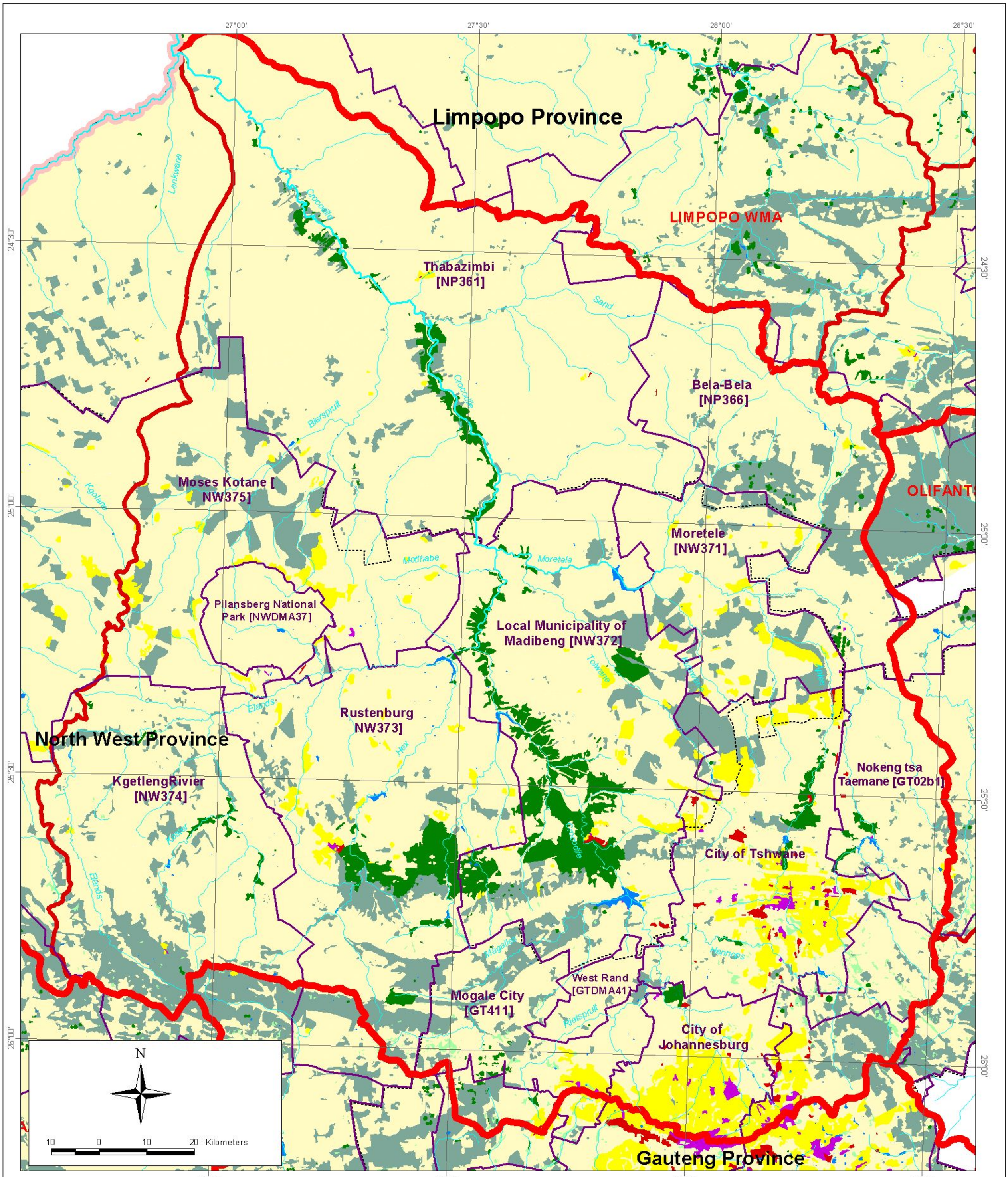
TLOU & MATJI (Pty) Ltd
PO Box 1503
Pretoria
0001
Tel.:(012) 325 8591
Fax.:(012) 324 0212
185 Vosge Street
Ground Floor, SAFU HOUSE
Pretoria
0001
E-Mail: tandm@landm.co.za

INTERNAL STRATEGIC PERSPECTIVE: CROCODILE RIVER (WEST)

DATE: October 2003

MAP REFERENCE: d:/.../jeremy/crocodile.apr

FIGURE 2.1



LEGEND

- WMA Boundaries
- Provincial Boundary
- Municipality Boundaries
- Rivers

Landuse

- Cultivated Land: Irrigated
- Cultivated Land: Dryland
- Commercial Areas
- Industrial Areas
- Residential Areas
- Waterbodies
- Other

LANDUSE IN THE CROCODILE RIVER CATCHMENT

CLIENT:

DEPARTMENT OF WATER AFFAIRS AND FORESTRY

PREPARED BY:

TLOU & MATJI (Pty) Ltd
PO Box 1509
Pretoria
0001
Tel.:(012) 325 6591
Fax.:(012) 324 0212
185 Visagie Street
Ground Floor, SAFU HOUSE
Pretoria
0001
E-Mail: tlandm@landm.co.za

INTERNAL STRATEGIC PERSPECTIVE: CROCODILE RIVER (WEST)

DATE: October 2003

MAP REFERENCE: d:/.../jeremy/landusecrocodile.apr

FIGURE 2.2

LOCALITY MAP:

LEGEND:

- WMA Boundaries
- International Border
- Provincial Boundaries
- Towns
- Rivers
- Dams

Key Area

1	Upper Crocodile
2	Apies/Pienaar
3	Elands
4	Lower Crocodile

Client: DEPARTMENT OF WATER AFFAIRS AND FORESTRY

Prepared by:

TLOU & MATJI (Pty) Ltd

P O Box 1309
Pretoria
0001
Tel : (012) 325 6331
Fax: (012) 324 0212

166 Visagie Street
Ground Floor, SATU HOUSE
Pretoria
0001
E-Mail : tandm@tandm.co.za

KEY AREAS FOR THE CROCODILE CATCHMENT AREA

Drawn by:	C. Engelbrecht	Figure 2.3
Date:	October 2003	
Map:	d:\tlou&matji\jeremy\keyarea.apr	

INTERNAL STRATEGIC PERSPECTIVE: CROCODILE RIVER (WEST) CATCHMENT

PART II

INTRODUCTION TO STRATEGY TABLES

Twenty-five strategies have been grouped together under nine main strategic areas that are associated with the structures of the National Water Act and the National Water Resources Strategy. These are:

1. **Water Balance and Reconciliation**
    - 1.1 Resource availability
    - 1.2 Water requirements
    - 1.3 Water use & reconciliation with water resource availability
    - 1.4 Transfers and reservation of water
    - 1.5 International obligations strategy
    - 1.6 Compulsory licencing
    - 1.7 Supply to district & local municipalities
2. **Water Resources Protection**
    - 2.1 Reserve determination & resource quality objectives
    - 2.2 Water quality management
3. **Water Use Management**
    - 3.1 General authorisations
    - 3.2 Licencing
    - 3.3 Poverty eradication/resource poor farmers
4. **Water Conservation and Water Demand Management**
5. **Institutional Development and Support**
    - 5.1 DWAF & co-operative governance
    - 5.2 Local and catchment level
6. **Integrated Environmental Management**
    - 6.1 Integrated environmental management
    - 6.2 Public involvement
7. **Waterworks Development and Management**
    - 7.1 Infrastructure development
    - 7.2 System management
    - 7.3 Recreation on dams & rivers
    - 7.4 Public health & safety
8. **Monitoring and Information Management**
9. **Implementation**

Each sub-strategy under the above headings is focussed on recording the way in which the DWAF Regional Office, with the support of Head Office Directorates, wishes to manage the water resources of the Crocodile (West) River Catchment in the interim, until such time as a Catchment Management Agency takes over various functions. These sub-strategies are presented in the following format:

- A situation assessment to provide the background
- A broad management objective
- An overall strategic approach that will be implemented

- Specific management actions that will be followed, along with the assigned responsibilities and priorities. These assignments will be programmed and budgeted for by the Regional Office and other Directorates in DWAF.

The main text of the ISP has provided an overall situation assessment as a lead-up to these more specific tables. Both the main text and the strategy tables are intended to provide a common foundation on which Water Resources Managers within DWAF will manage the water resources in the Crocodile River Catchment. Planners and water users alike should gain some insight into how DWAF are managing the resources and especially how they will evaluate water licence applications in the next while. These tables have only captured the current knowledge that could be accessed during the study. Gaps therefore exist. It is hoped that questions will be asked and that further input be included in revisions of these strategic perspectives.

Strategy 1.1

1	WATER BALANCE & RECONCILIATION STRATEGY

1.1 RESOURCE AVAILABILITY

Situation Assessment:

The water availability situation or system yield in the Crocodile River Catchment (using the best available information), has been described in Chapter 4 of the main ISP Report.

A large amount of investigation regarding the surface hydrology and the system yield has been conducted in the catchment over the past two decades. A fair amount of confidence can be placed in these yield results. These yield values are also consistent with those recorded in the National Water Resource Strategy (NWRS). The Ecological Reserve has been considered as a non-consumptive use, which is included in the determination of the availability of the total water resource. The Reserve has been estimated at a desktop level of confidence according to DWAF Directorate: Resource Directed Measures definitions.

With regard to future water availability, some uncertainty still exists regarding the increase in return flows from urban wastewater point sources and diffuse sources (eg irrigation). A recently launched return flow study is intended to provide more detail information regarding point source return flows as well as the influence of water conservation and demand management.

Groundwater investigations have been conducted in the catchment, but according to geohydrologists, this information has not been properly collated and optimally used by Water Resource Planners. It is claimed that in the past groundwater has often been overlooked as a water source by planners and engineers in favour of surface water. This can be ascribed to a poor perception of groundwater, a lack of trust by users, failures in groundwater based supply and the feeling that groundwater is unreliable. This is commonly due to a lack of understanding of the mechanism of groundwater occurrence and mismanagement of the available groundwater resources, e.g. the overpumping of boreholes, absence of monitoring of abstraction schemes, *et cetera*. The situation is exacerbated by a lack of good information. Planners need to know the volume of available groundwater resource, the distance a suitable source is from the intended use and the reliability of the source (assuming active good aquifer management).

Groundwater resources are available throughout the entire catchment, but in varying quantities depending upon the hydrogeological characteristics of the underlying aquifer. It is estimated the overall groundwater recharge to the catchment amounts to some 260 million m^3/annum assuming recharge of approximately 2% of the mean annual rainfall of 450mm. Some 125 million m^3 of groundwater is used annually, theoretically therefore, up to 135 million m^3/annum of annual recharge is still available for exploitation.

The interaction between surface and groundwater is an issue that needs special attention, as not all water resource planners agree that this water is available. They believe that a large portion of this recharge exhibits itself via springs as surface streamflow. This issue has also been raised by farmers that allege their groundwater resources are being depleted by the dewatering of mines just north of the Magaliesberg Mountain Range.

Situation Assessment (Continued):	The actual impact of invasive alien vegetation on the water resources availability of the Crocodile River Catchment is not well understood. The Working for Water Programme and local Water Forums have been very active in removing invasive alien vegetation along watercourses in this catchment. Not enough has been documented regarding water availability during drought cycles and how and where special operating rules and water restrictions have to be imposed. It is believed that groundwater can play a more significant role under these circumstances.
Broad Management Objectives:	• Water Resource Managers' in DWAF require the most up-to-date information regarding the availability of both surface and groundwater resources and how these are linked. This includes: continually striving to obtain the best data and management information; a thorough understanding of treated wastewater return flows back into the Crocodile River system; and the effect of invasive alien vegetation on the resource. • Managers' responsible for issuing licences must be able to determine the impact of a licence application on the river system.
Overall Strategic Approach:	Water resource availability values recorded in the NWRS (the same as in this ISP) will be used as the most up-to-date information until further notice. A more detailed database has been prepared for use by the Regional Office officials. This water balance database is designed at a quaternary catchment resolution and enables officials to determine what impact a proposed water use will have on the river system and users downstream of the area in question. Since groundwater plays a significant role in this catchment (mainly for rural community water supply and irrigation), a better knowledge of this resource and its conjunctive use with surface water resources needs to be obtained. This must be actively addressed by implementing a detailed mapping programme, starting in the most stressed and ecologically sensitive catchments, following the format of the Groundwater Resources Information Project (GRIP) being undertaken in Limpopo Province. This project envisages preparing 1:50 000 scale hydrogeological maps of each quaternary catchment which will depict the groundwater resources, groundwater quality and development potential, based upon the needs of the end user. The GRIP project of Limpopo Province is commencing with a desk study of available information, and will then involve considerable field work to fill in data gaps. Please refer to **Annexure A** for more discussion in this regard. It can be expected that over the next three years, there will be more accurate input regarding water use and availability. The verified lawful water use will be incorporated into more specific water resource yield modelling along with updated information on return flows, ecological management flow regimes, and other water resource management considerations (eg drought strategies, water quality issues and the effect of alien vegetation on water availability). A higher level of confidence may then be attributed to this water resource management decision-making information.

Required Action, Responsibility & Priority	(1.1 Resource Availability Continued/..3) The following management actions have been drafted with the above-mentioned background and approaches in view: 1.1.1 Until further notice, the water availability values given in the NWRS and used in this ISP will be used in water balance calculations and water licence evaluations.	Regional Office Priority 1
	1.1.2 An updated water resource availability or yield model needs to be configured for the Crocodile River (West) Catchment. Initially, a detailed breakdown of the NWRS water availability values should be focussed on and combined with findings of the return flow study that has recently been launched to gain a better understanding of the return flow availability. Better hydrology and yield analyses, including groundwater availability input, can be obtained over the next few years, which includes monitoring exercises (see Strategy 8.1 for more details).	Dir: NWRP (N) Priority 1
	1.1.3 The effects of **drought** could play a major role in the coming years and needs strategic consideration. Proper operating rules need to be instituted.	Regional Office Dir: NWRP (N) Priority 1
	1.1.4 The harvest potentials of groundwater, especially from the dolomites in the upper catchment and the sand aquifer in the lower catchment need to be documented. Information regarding the total volumes of groundwater available, their locations and levels of assurance of supply must be provided. The linkage (interaction) between surface and groundwater also needs to be described. The issues surrounding the dewatering of mines just north of the Magaliesberg must be addressed. The mines will probably have to prove that they are not impacting on the upstream farming activities and the terrestrial environment around the mines.	Dir: Geohydro Priority 1
	1.1.5 The return flows from diffuse sources especially irrigation, need to be researched and summarised in the definitive water resources document. This determination will also entail detailed monitoring where water is drawn into the irrigation schemes and where it returns to the river system (both diffuse and point sources).	Dir: NWRP (N) Priority 2
	1.1.6 There is the need to investigate what the hydrological impact of invasive alien vegetation is on the water resources availability. The clearing of all riverine and other significant populations of these invading vegetation species should be achieved if it is proved to be a viable way in which to free up more water for other users. Otherwise, these dense non-riparian stands should be converted to productive plantations and licenced accordingly.	Working for Water Dir:SFRA Priority 2

Strategy 1.1 Version control:	**Original version:**	Dec 2002
	Date:	Jan 2004
	Author:	T&M

Strategy 1.2

2	WATER BALANCE & RECONCILIATION STRATEGY

1.2	**WATER REQUIREMENTS**
Situation Assessment:	There has always been the anomaly between the volumes of water that have been allocated to users and the actual water that is used. This has been positively emphasised by spot checks on the recent water allocation registration process that has been undertaken for the Regional Offices. Thorough farm to farm analyses have been conducted by the Regional Office in the recent past (ie using orthophotos, satellite imagery and field proofing). In some cases allocations, used in water resource planning analyses, have been shown to yield higher values than actual water used on the ground, and *visa-versa*. The implications of this over/under counting would be that other new users might not be able to use the water because it is "not available". Although this may not be such a major problem in this catchment, when compared with other catchments in South Africa, DWAF is committed to conducting a relatively detailed verification of actual water use and the lawfulness of this use in the Crocodile River Catchment in the near future. Away from the urban areas of Johannesburg and Pretoria many parts of the Crocodile West Catchment are heavily populated and widespread rural communities are a feature of the area, in particular the districts of Moretele I, Odi I and Odi II north and NW of Pretoria, Bafokeng and Mankwe north of Rustenburg. Groundwater is the main source of water supply to these rural communities except for the Odi I and Moretele I where reticulated supplies are available for the more densely populated southern parts of the districts. There is extensive use of the groundwater resources of the dolomite aquifer NE of Johannesburg, (catchment A21A), south of Pretoria, (catchment A21B) and NW of Krugersdorp, (catchment A21D) where reasonably large abstraction for irrigation, domestic, industrial and municipal supply is practiced. Actual quantities abstracted still remain unknown.
Broad Management Objective:	Need to obtain the more accurate estimates of water requirements in the catchment for input to the water balance/yield modelling exercises.
Overall Strategic Approach:	Water use requirements and future projections of growth in this demand will be based on the figures given in the NWRS until further notice. More detailed breakdowns of these figures are to be found in the WMA Report[5]. A thorough water use verification process will need to be conducted with a more accurate water balance in the catchment. Also refer to **Annexure A** for more on groundwater.

Action, Responsibility & Priority:	1.2.1 Verification of existing lawful use and licencing of this water use accordingly. Need to enforce water allocations in certain areas where more water is being used (e.g. riparian irrigation along the Middle and Lower Crocodile River). This data needs to be turned into management information and existing lawful use determined. In other words, the bigger picture needs to be painted with regard to actual water use in the whole catchment.	Regional Office Dir WU Dir:NWRP (Priority 1)
Action, Responsibility & Priority (continued):	1.2.2 Groundwater usage and the linkage of this resource with surface resources needs to be better understood.	Dir: Geohydro (Priority 1)
	1.2.3 Must obtain latest Census data, evaluate it with water boards and district/local authorities and feed it into the planning process.	Dir NWRP (Priority 1)

Strategy 1.2 Version control:	**Original version:**	Dec 2002
	Date:	Jan 2004
	Author:	T&M

Strategy 1.3

1	WATER BALANCE & RECONCILIATION STRATEGY

1.3	**WATER USE & RECONCILIATION WITH WATER RESOURCE AVAILABILITY**
Situation Assessment:	This strategy follows on the detailed background and discussion presented in Paragraph 4.3 in Part I of this ISP. Table 4d in Part I of this ISP shows that water use and water availability in the Crocodile River (West) Catchment is roughly in balance with small surpluses in the Upper Crocodile and Elands Sub-areas. This is mainly due to the relatively large volumes of water that are transferred in from the Vaal River Catchment and the resulting treated wastewater return flows to the system that are gradually used downstream in a cascading fashion. The future water reconciliation scenarios shown in Tables 4e and 4f in Part I indicate that large surpluses will be created due to the return flows that are generated from projected increased water requirements and increased inter-basin transfers into the Crocodile River (West) Catchment in the years to come. The current (2000) significant demands and their respective sources of the different components of the WMA shown in Chapter 4 of Part I of the ISP are discussed below (some of these components are broken down in smaller sub-catchments). ***Rietvlei Dam Catchment (A21A)*** The surface resources of this sub-catchment are made up of imported effluent return flows from A21B and the storage in Rietvlei Dam. A large portion of the sub-catchment is underlain by dolomites that constitute a substantial groundwater resource. The urban requirements in the upper reaches of the catchment (Kempton Park and Tembisa) are met by transfers from the Upper Vaal WMA. This sub-catchment is also a significant resource to the City of Tshwane (Pretoria) both in the form of surface (Rietvlei Dam) as well as groundwater (dolomites). Rietvlei Dam is operated by Tshwane at a very low level of assurance of supply without taking the preliminary Ecological Reserve into account. This results in a significant negative water balance when including the Ecological Reserve. ***Hartbeespoort Dam Catchment (A21B-H)*** The upper reaches of this catchment are densely settled and all the urban as well as most of the industrial demands are met by transfers from the Vaal WMA. Significant return flows are generated by these demands. A large portion of these return flows as well as the surface resources are used for irrigation and to a lesser degree for urban and mining downstream of Hartbeespoort Dam and to supplement the yield of Vaalkop Dam. A small surplus is available in the Hartbeespoort Dam. This surplus will increase as water use, and hence return flows from the urban areas, grow.

Situation Assessment (Continued):

Roodekopjes Dam Catchment (A21J-L)

The irrigation as well as urban demand (Madibeng, formerly Brits and environs) downstream of Hartbeespoort Dam is met by storage from Hartbeespoort Dam. The mining demand is partially met by transfers from the Upper Vaal WMA while the remainder is abstracted from groundwater or supplied from local dams. The Roodekopjes and Buffelspoort dams in this sub-catchment support irrigation activities below these dams. Water is also being transferred from Roodekopjes Dam to Vaalkop Dam via a canal for distribution to domestic, industrial and mining users by Magalies Water. There is a small surplus in this catchment that is essentially the portion of the irrigation return flows. This is allocated to irrigators in the Middle and Lower Crocodile. The contribution of mine dewatering on the surface and groundwater resources is not known. It may be assumed that some form of negative impact on users and the environment could be occurring as a result of these dewatering activities.

Elands catchment (A22)

Large portions of this catchment are tribal areas. Land use here is dominated by stock farming and dry-land agriculture with a little irrigation. Mining is the dominant economic activity in the area with a large number of platinum and other mines. A portion of the urban demands of Rustenburg as well as a portion of the mining demands are met by transfers from the Upper Vaal WMA. The rest of these demands, as well as most of the rural demands, are drawn from Vaalkop Dam. The Bospoort Dam is not being utilised at present due to the perceived poor quality of the water in this impoundment, which is caused by partially untreated effluent return flows from Rustenburg. This results in a surplus in this catchment, assuming that the Bospoort Dam is operated in a way that supports the Vaalkop Dam. The Hex River sub-catchment shows a small deficit which is probably being met from local groundwater resources.

Apies/Pienaars catchment (A23)

The upper and middle reaches of this catchment are densely settled and a significant portion of the urban as well as industrial demand is met by transfers from the Upper Vaal WMA. Significant return flows are generated by these demands, a portion being captured in Roodeplaat Dam. Tshwane is now seriously considering reuse of most of its return flows from the Pretoria area. Resources are also passed downstream to irrigators below of Klipvoor Dam in the Lower Crocodile Catchment. The recently completed water allocation registration process has indicated that there is less irrigation water demand than has been used in the water availability or yield modelling. Furthermore, this registration process shows that a large portion of this irrigation (as high as 40% in places) is supplied from groundwater sources, which is not how it has been modelled. The modelling assumptions accepted that all these water requirements are met from surface resources. This operating rule has been questioned as there may be more surplus available in the Apies/Pienaars River Catchrment than was previously thought. This water could be used for high priority domestic uses in the Western Highveld area (formerly KwaNdebele) for example. Water losses in the Tshwane area have been published as 39.5 million m^3/annum, which is very significant.

The Lower Crocodile catchment (A24)

The dominant demand in this catchment is irrigation. This demand is mainly supplied from the Apies/Pienaars catchment. A significant portion is also abstracted from groundwater. The mining water requirements are supplied from Vaalkop Dam. This catchment is in balance.

Broad Management Objectives:	• One of the fundamental roles of Water Resources Managers in the Crocodile River (West) Catchment is to achieve an optimal balance between the use of water by all sectors in our economy, human needs, the biophysical environment and international obligations. We strive for equitable, sustainable, efficient and effective use of this relatively scarce resource. In other words, we want to ensure that all users in the Crocodile River Catchment receive their fair share of water, at the level of risk of failure of supply that they can manage satisfactorily, and at the required quality that is 'fit for their particular use'. Certain priorities of supply, as laid down in the NWA, need to be implemented (eg basic human needs and the Ecological Reserve receive priority over all other uses). • Need up-to-date documentation regarding the operation of all water related infrastructure in the catchment. An accurate water balance and an optimised river system that is in equilibrium (waterwise) is desired. • Groundwater strategies are covered in Appendix A. The overarching strategy relating to groundwater is that it represents an under-utilised resource which should be considered as a first priority when sourcing additional water resources for small-scale use such a rural settlements.
Broad Management Objective (Continued):	• Liaison with the private and public sector must be maintained so that needs can be timeously indicated and the maximum amount of support provided to encourage economic development. • Water allocations for poverty eradication initiatives will be required in future. • Areas experiencing deficits (ie water stressed areas) need to be identified and strategies implemented to either meet these water requirements in these areas or shift the source of the demand. • Reconciliation options need to be identified, described, evaluated and implemented where necessary.

Overall Strategic Approach:	It is realised that water requirements in the A21 to A23 catchments described above are growing rapidly (ie due to growth in urban population and mining development). Growth in water supplies to the urban areas above Hartbeespoort Dam and in the Apies/Pienaars area will continue to be supported from the Upper Vaal WMA at a high level of assurance of supply. Sufficient resources have been provided to meet these demands from the Vaal River system until around the year 2025, after which expensive new augmentation schemes could be developed. Provision of additional allocations in these two areas will be subject to the successful implementation of Water Conservation and Water Demand Management measures by the local authorities (see Strategy 4.1). The City of Tshwane is intending to reuse local return flows to the Roodeplaat Dam, although some of these resources may be reserved for transfers to the Western Highveld (KwaNdebele) for basic human needs. Water requirements to the north of the western part of the Magaliesberg Mountain Range (ie Roodekopjes sub-catchment and the Elands catchment) will not receive further allocations of water transferred from the Upper Vaal WMA until such time as local resources and return flows from upstream are fully and optimally used. In order to meet this need, transfers will need to occur from the Hartbeespoort Dam directly (to the mines en route to Rustenburg and eastwards to Brits and GaRankuwa), or via the Roodekopjes and Vaalkop dam systems, as well as better use of local resources (eg Bospoort Dam and water conservation and water demand savings). Transfers from Klipvoor Dam could also be considered. Water utilisation adjacent to the Lower Crocodile River (mainly for irrigation) is believed to be far in excess of that which has been allocated. Water is freely drawn from the Klipvoor Dam and the riparian (alluvial) aquifer to meet these demands. This situation will require special attention. The current operation of the whole system needs to be maintained until such time as the operating rules for the system (as part of the water resources modelling) are revised. New licences for poverty eradication initiatives or special cases will be evaluated on merit individually, as there are certain areas where surpluses still exist. Water requirements to maintain the ecological integrity of the Crocodile River System need to be determined and implemented over a period of time in a way that does not negatively impact on the socio-economic well-being of the region. The volumes of water for irrigated agriculture need to be limited to present levels except for historically disadvantaged farmers and poverty eradication initiatives. Efforts need to be made to support poverty eradication initiatives where possible (see Strategy 3.3). Few formal emerging farmer irrigation development plans could be found at time of drafting this initial version of the ISP. All efforts have been focussed on establishing these farmers within existing irrigation schemes. Liaison with the Gauteng and North West Province Departments of Agriculture must be maintained in this regard.

<table>
<tr><td>Overall Strategic Approach (Continued):</td><td colspan="2">Existing transfers out of the WMA will be maintained (see Chapter 4 in the main text). A volume of 45 million m³/annum, from the expected increase in return flows, has been reserved in the NWRS for development in the Lephalala (formerly Ellisras) area in the Limpopo WMA.

In summary, reconciliation is dominated by:
• Transfers of water from the Upper Vaal WMA to supply high priority users in the upper part of the catchment;
• The large return flows generated in the upper catchment are able to supply users downstream;
• There is no significant potential for further development of local water resources (ie new dams).

The following strategies will need to be followed:
• Transfers into the Crocodile River (West) Catchment from the Upper Vaal WMA are limited by insisting on the successful implementation of water conservation and water demand management measures in the Crocodile River Catchment, as well as the optimal use of local resources and return flows;
• Water quality considerations will become very important when return flows are re-used.
• It is very important to develop a strategy that will optimise the use of the growing surpluses described in the background above. One obvious use for these surplus return flows would be to reuse it in parts of Johannesburg and Tshwane and to decrease the reliance on transfers from the Vaal. The costs of increase in salinity due to repeated reuse (i.e. cascade effect down the catchment) will however have to be carefully assessed. If mines are end users of this reused water then they could capture the unwanted salts in their slime dams.

There is no immediate need for compulsory licencing.</td></tr>
<tr><td rowspan="3">Required Actions, Responsibility & Priority:</td><td>1.3.1 Continue with the current operation of the system until new information indicates otherwise.</td><td>Regional Office
Priority 1</td></tr>
<tr><td>1.3.2 Develop a strategy that will optimise the use of the growing (return flow) surpluses in the catchment. Water quality issues must be carefully considered.</td><td>Regional Office
Dir NWRP(N)
Priority 1</td></tr>
<tr><td>1.3.3 There is a need to implement and enforce water conservation and demand management measures across all sectors to decrease future water demands. The Directorate: Water Use Efficiency, with the help of other Directorates, must promote water conservation and demand management in the catchment. The actual implementation of water saving measures is the responsibility of local authorities. Liaison with these authorities (eg Water Boards, Water User Associations, Municipalities) should form part of this process.</td><td>Dir WUE
Regional Office
Priority 1</td></tr>
</table>

Required Actions, Responsibility & Priority (Continued):	1.3.4	Ways in which water can be made available to support poverty eradication initiatives should be identified. At this stage in this catchment, poverty eradication efforts related to irrigation have been focussed on resettling emerging farmers on purchased land in the existing irrigation schemes. Other poverty eradication initiatives (in agricultural and other sectors) must be identified and co-operative governance assistance provided with regard to availability of water.	Regional Office Priority 1
	1.3.5	A re-evaluation of the water balance is required once the return flow study is completed (early 2004), as well as when other more accurate information becomes available (for example actual water use figures or the demands of the Ecological Reserve). Levels of assurance of supply need to be addressed for each sector/area.	Regional Office Dir NWRP (N) Priority 2
	1.3.6	After the more accurate water balance has been conducted, identify areas where deficits and surpluses occur. Develop, describe and evaluate reconciliation options based on the bigger natural and economic picture in the catchment. Stakeholder involvement in this evaluation process is imperative.	Regional Office Dir NWRP (N) Priority 2

Strategy 1.3 Version control:	**Original version:**	Dec 2002
	Date:	Jan 2004
	Author:	T&M

Strategy 1.4

1	WATER BALANCE & RECONCILIATION STRATEGY

1.4 TRANSFER & RESERVATION OF WATER

Situation Assessment:

The transfer of water between Water Management Areas (WMAs) and to neighbouring countries resorts under national control.

Local water resources in the Upper Crocodile Sub-area are fully utilised and more than half of the water requirements in these urban areas need to be augmented from the Upper-Vaal WMA. New growth in demand, after all local sources have been optimally used, will be met from this source. It is expected that there will be an increase in treated wastewater return flows due to the increased water usage. Future use of these induced surpluses will need to be investigated.

The above-mentioned regime holds for the Pretoria-Tshwane area as well. There is a surplus water in the Roodeplaat Dam Sub-catchment due to the increased return flows. Tshwane has requested access to this water instead of purchasing more expensive Vaal River system water. Investigations are also being conducted into the potential transfer of a portion of this surplus into the Elands River Catchment in the Olifants WMA for use in the Western Highveld (KwaNdebele) area. Tshwane believes that there will be no surplus left in Roodeplaat after they abstract from Roodeplaat and reuse their return flows here. The Department is however of the opinion that this potential transfer to the Western Highveld still remains an option worth investigating. It also believes that operating assumptions in the Pienaars River system (i.e. releasing surpluses downstream to Klipvoor to support irrigation in the Lower Crocodile) are not in line with the NWA water use priorities which focus on basic human and domestic needs above commercial irrigation requirements. A decision regarding future use of this surplus will need to be made once these studies have been completed.

Water is also transferred from the Roodeplaat Dam out of the catchment northwards to Bela-Bela and Modimollo (formerly Warmbaths and Nylstroom). Local resources at Phagameng (Donkerpoort Dam) do not seem to be optimally used.

A relatively small volume of water is transferred from the Olifants WMA to the Premier Mine at Cullinan in the east of the catchment.

Water is also transferred to the Rustenburg area from the Upper-Vaal WMA. Rand Water are planning to increase these transfers through the construction of an additional pipeline.

A sizeable portion of the Mean Annual Runoff of the Crocodile River (West) Catchment flows into the Limpopo River.

Future coal mining, power generation activities, and the development of natural gas fields in the Lephalala (formerly Ellisras) area is planned in future. Although this area can initially be supported from local resources (e.g. Mokolo Dam and groundwater), extensive development may require expensive water augmentation from the Crocodile River system.

Broad Management Objectives:	• The Minister has to ensure that the volumes of water transferred into the Crocodile River (West) Catchment are limited to the absolute minimum by making sure that local water resources are optimally used before further augmentation is sanctioned. This is to delay expenditure on expensive new augmentation schemes and limit ecological impacts due to large new transfer schemes. • The Minister has the responsibility to reserve certain volumes of water for strategic water uses in future.	
Overall Strategic Approach:	Inter-basin transfers of water remain under the control of the Minister. Water resources are limited in the upper catchment area where a large portion of this water is required. Water has to be transferred from far afield to meet these needs. It is relatively expensive to develop water resources in other river basins (eg Lesotho Highlands on the Senqu/Orange River and the Thukela River) and to transfer this water to the Crocodile Catchment. In order to optimally develop these water resources in line with sound future planning and good governance, it has been necessary to insist that local resources are first used before more water is transferred into the area. This includes water quality considerations (ie taking care of local water resources), implementation of water conservation and water demand management measures, and making optimal use of increasing effluent return flows.	
Required Action, Responsibility & Priority:	1.4.1 All existing transfers into and out of the catchment will remain unaltered until further notice, with the exception of the transfers into the Johannesburg-Tshwane urban areas, where normal growth in demands will be met according to agreements between the Department and second tier bulk water authorities (eg Rand Water). Water Conservation/Water Demand measures are expected to limit the growth in water demand.	Dir NWRP (C) (On-going)
	1.4.2 It has been estimated that an additional 250 million m^3/annum (over and above the year 2000 transfer volumes) will have to be transferred from the Upper-Vaal WMA (and beyond) to the Tshwane-Johannesburg area in future (year 2025). As an upper growth scenario, up to 750 million m^3/annum may be required. This has been recorded in the National Water Resource Strategy. Water resources are available via existing inter-basin transfer schemes (e.g. Lesotho Highlands, Thukela River). This may require the expansion of these existing augmentation schemes towards the end of this planning period depending on actual growth in water requirements in the Vaal River system during this period.	Dir NWRP (C) (On-going)
	1.4.3 Need to investigate potential further abstraction for a new transfer to the Western Highveld area from the Roodeplaat Dam. A decision needs to be taken once the investigations are finished (mid-2004).	Dir OA (N) (Priority 1)

Required Action, Responsibility & Priority (Continued):	1.4.4 It has already been mentioned in Strategy 1.2 that no more Vaal River System water will be transferred north of the Magaliesburg Mountain Range until such time as it can be proven that local water resources are being optimally used. The Department believes that there is still potential for optimising of the use of existing local resources in the catchment. There is a special need to convey this strategy to users in the Rustenburg area, to the Bojanala Platinum District Municipality, Rustenburg Municipality, Rand Water and Magalies Water. The use of Bospoort Dam water for Rustenburg is a point in question that has already been mentioned in strategy 1.2.	Gauteng/ North West Regional Offices Dir NWRP (N) Dir OA (N) (Priority 1)
	1.4.5 Optimise use of local water resources at Bela-Bela and Modimolle and review transfers and ensure that water conservation and water demand measures are successfully implemented.	Regional Office Dir NWRP (N) (Priority 2)
	1.4.6 Surplus effluent return flows which become available are to be reserved for the following priorities: • As a priority, re-use for urban, industrial and mining purposes where this will feasibly contribute to reducing transfers into the catchment. • About 45 million m^3/annum may be required for developments in the Lephalala area. It is expected that these developments will only require Crocodile River water in two decades time. A portion of the future growth of return flows will provisionally be reserved for these purposes. • Small quantities may be required from Roodeplaat Dam via the existing Modimollo pipeline to augment water supplies to Mookgophong (formerly Naboomspruit) in the Limpopo WMA. • Roodeplaat Dam may also form a new source of water augmentation to the Western Highveld area in the Olifants WMA. (see Strategy 1.4.3 above).	Regional Office Dir NWRP (N) (Priority 2)

Strategy 1.4 Version control:	**Original version:**	Dec 2002
	Date:	Jan 2004
	Author:	T&M

Strategy 1.5

1	WATER BALANCE & RECONCILIATION MAIN STRATEGY

1.5	**INTERNATIONAL OBLIGATIONS STRATEGY**	
Situation Assessment:	The Crocodile River is the major tributary of the upper Limpopo River Catchment and therefore provides an important contribution to the mean annual runoff of this river system. Compared to the natural mean annual runoff of 646 million m^3/annum which originates from the Crocodile River Catchment, an estimated average of 549 million m^3/annum still flows out of the catchment into the Limpopo River. It should be noted that return flows (i.e. water sourced from the Vaal River system and further afield) do not form part of the natural hydrology and hence international obligations. There are no water-related agreements on the Limpopo as a whole, although there is an agreement between South Africa and Mozambique (formerly Portugal) relating to the Massinger Dam situated on the Olifants River which is a tributary of the Limpopo River. The Limpopo Basin Permanent Technical committee serves as the forum for all the Limpopo basin countries (South Africa, Botswana, Zimbabwe and Mozambique). A Limpopo River Basin Commission has recently been established (November 2003). This Basin Commission will be responsible for developing a water use agreement for the Limpopo Basin.	
Broad Management Objectives:	In order to manage the flow regime into the Limpopo River, it will be imperative to understand and regularly update water resource data and management information. Some form of on-going co-operation in this regard between the various basin states needs to be established and maintained.	
Overall Strategic Approach:	DWAF is committed to meeting South Africa's international water resource sharing obligations in line the Helsinki Agreement, the SADC Protocol on shared watercourses, and best international practice, and is addressing these needs via comprehensive discussions with Botswana, Zimbabwe and Mozambique. A Joint Limpopo River Basin Commission has recently been established (November 2003) and will investigate the full water cycle in the broader Limpopo River Basin, which includes the Crocodile River Catchment.	
Action, Responsibility & Priority:	1.5.1 Negotiate a water sharing agreement with the Limpopo co-basin states. 1.5.2 Implement the terms of this agreement.	Dir Int Liaison Priority 1 R O

Strategy 1.5 Version control:		
	Original version:	Dec 2002
	Date:	Jan 2004
	Author:	T&M

Strategy 1.6

1	WATER BALANCE & RECONCILIATION STRATEGY

1.6	**COMPULSORY LICENCING**	
Situation Assessment:	At this stage, it seems that the water resource availability and water usage of the Crocodile River System is roughly in balance with small surpluses in places. New requirements will probably be met from increasing return flows in future as well as various other sources. As such, it seems that compulsory licencing is not a priority in this catchment	
Broad Management Objective:	To identify any needs for compulsory licencing that may be identified in due course, and to ensure that the process is introduced if and when necessary.	
Overall Strategic Approach:	It is believed that adequate provision has been made for the Ecological Reserve in the Crocodile River (West) water balance. Furthermore, no major water use over-allocations or major poverty eradication water requirements have been identified that may require that compulsory licencing be immediately implemented to achieve equity. It is believed that water requirements to achieve equity can be accommodated within the willing buyer-willing seller principle, from water savings caused by the implementation of water conservation and water demand measures, and from increasing return flows to the system. As such, compulsory licencing can and should be postponed in this catchment. Every effort should be made to limit wasteful and unproductive use of water (i.e. mainly on irrigation of crops that do not yield a high enough return). This water may be better used in some other form of economic activity. Water conservation and water demand management must be extended to all economic sectors that use water. A few areas in the catchment may need attention though. One specific example is the irrigation area downstream of the Roodekopjes Dam down past Thabazimbi, where it has been realised that water usage may exceed allocations by a significant volume each year. One of the ways to start in this area is to verify existing lawful water use and to restrict use in these irrigation schemes to what has been allowed for in their licence conditions. There was insufficient evidence at the workshops to identify further areas with confidence.	
Action, Responsibility & Priority:	1.6.1 Verify existing lawful irrigation water use in the middle and lower Crocodile River and start on an implementation programme to enforce compliance with licence allocations here.	Regional Office Priority 1
	1.6.2 Investigate the need for compulsory licencing after the existing lawful use determination, identification poverty eradication scheme initiatives, the return flow study, and better resource modelling has started. Feed this information back to the Directorate: Water Allocations. Formal policy, regulations and guidelines are required.	Dir: NWRP (N) Priority 3

Strategy 1.6 Version control:	Original version:	Dec 2002
	Date:	Jan 2004
	Author:	T&M

Strategy 1.7

1	WATER BALANCE & RECONCILIATION STRATEGY

1.7	**SUPPLY TO DISTRICT & LOCAL MUNICIPALITIES**
Situation Assessment:	DWAF oversees the larger storage units and transfer schemes that supply water to the Crocodile River (West) Catchment area. In most cases water for domestic purposes is sold from these resources to water boards (eg Rand Water, including subsidiary Odi Water, and Magalies Water in this region). The District Municipality and its Local Municipalities (see Figure 2.1 in the main report for location of these municipalities) remain responsible for purchasing this water from these water boards or utilisation of water from their own storage dams. Irrigation boards (currently being formed into Water User Associations) also purchase water from the Department. ***Upper Crocodile River Sub-area*** The Upper Crocodile Sub-area is mainly made up of well-established urban areas with high levels of service (Johannesburg, Soweto, Mogale City, Mid-Rand, Centurion). Provision of better services to historically disadvantaged townships as well as new housing developments are increasing in this area. It is envisaged that this expansion of services and population growth will steadily increase in this area with the consequent increase in water requirements. ***Elands River Sub-area*** Rustenburg has developed at a rapid rate over the past decade, mainly due to the mining development that has sprung up around this area. Rustenburg and the mines have received the bulk of their water from the Vaal River system and the Vaalkop Dam. The municipality has stopped using the Departmental water treatment works at the Bospoort Dam (just downstream of Rustenburg) due to the perceived poor quality water in the dam. The quality has deteriorated due to poor effluent treatment in the various town sewerage works upstream. The town and surrounding semi-urban areas is in major need of new resources in the near future. All rural settlements in the Elands River Catchment rely either on local groundwater resources or on bulk water that is pumped from the Vaalkop Dam via an extensive network of pipelines operated by Magalies Water. Rural community water supply coverage is good, with communities wishing to move towards higher levels of service (i.e. at least yard connections) where the water resource will allow this expansion. ***Apies/Pienaars River Sub-area*** The southern portions of this sub-area are home to the large urban populations of Pretoria and Mamelodi. A large portion of the areas to the north of Pretoria are densely populated urban and semi-urban settlements that were historically disadvantaged, and consequently have reasonably low levels of service. Tshwane Municipality is busy redressing these imbalances of the past and intends to draw large volumes of water from the Roodeplaat Dam to meet the associated growing water requirements. Currently water is sourced from dolomitic groundwater compartments (The Fountains, south of Pretoria), from the Rietvlei Dam, and the bulk of its supplies from the Vaal River system.

	Lower Crocodile River Sub-area Only localised urban water requirements (e.g. the town of Thabazimbi). The main water user in this sub-area is irrigation.
Broad Management Objective:	Within the next few years, to ensure that all local and other authorities in the Crocodile River Catchment have adequate bulk supplies of water on the one hand, but on the other hand to ensure that they are optimally utilising their local resources.
Overall Strategic Approach:	Most of the district and local municipalities in this catchment have prepared Water Service Development Plans (WSDP's). At time of writing this ISP, only some of these have already been submitted to DWAF. The WSDP's are supposed to outline their current and future water requirements and where they intend to source their water supplies. This ISP study has not analysed these WSDPs' in detail. It is imperative that there be a co-ordinated approach to sourcing water in the catchment. For example, it just does not make good sense to import more water from the Vaal River System to the Rustenburg area (which will exacerbate the need for expensive transfer schemes from Lesotho or the Thukela rivers), when the local resources are not being used, or when water conservation and water demand measures have not been fully implemented. This is not in the financial interest of the country as a whole, which would have to foot the bill for these expensive transfer schemes, or in line with sound governance or international best practice. The Department should discuss the following matters with the various district and local municipalities: • DWAFs view of where they should source their water from (i.e. within the bigger catchment perspective); • DWAFs possible role in assisting municipalities to identify all viable sources of water; • To plan well ahead to avoid water shortage crises during drought periods; • The need for authorities to first optimise the use of local resources; • To accurately determine actual usage; and • To implement water conservation and water demand measures before new sources of water are developed. The next version of the ISP should provide a more detailed perspective of the water each authority in the Crocodile River (West) Catchment. In the interim a broad perspective is provided below. ***Upper Crocodile River Sub-area*** The expected growth in water demand in the Johannesburg metropolitan area and environs will be augmented with from the Vaal River system (Rand Water) which should be able to meet these needs up until approximately 2025, after which one or more of the existing inter-basin transfer schemes will have to be expanded. The town of Brits to the north of the Magaliesburg Mountain Range will need to make full use of their allocations from the Hartbeespoort Dam. It is recommended that this town construct a new regional water treatment plant below the dam and that it then supplies the semi-urban and mines towards Rustenburg from this local source. These new works can also be extended to supply the semi-urban settlements to the east of Brits, reaching as far as Ga-Rankuwa.

Overall Strategic Approach (Continued):	***Apies/Pienaars River Sub-area*** The southern portions of this sub-area (Pretoria and Mamelodi) will continue to source their water from Rietvlei Dam, other local sources and Vaal River water. The expected upgrading of water services in the areas to the north of Pretoria (Mabopane, Hammanskraal, Temba and environs) will source their water from the Roodeplaat Dam, Vaal River transfers and the reuse of return flows from Pretoria. ***Elands River Sub-area*** Before any further water is transferred into the Rustenburg area from the Vaal River System (i.e. Rand Water), the Bojanala Platinum District Municipality and the Rustenburg Local Municipality will need to prove that it is utilising its local resources to the fullest extent (e.g. from Bospoort Dam and Hartbeespoort Dam return flows) and that it has successfully implemented water conservation and water demand management measures. This holds true for all the mines and surrounding municipalities. Conjunctive use of surface and groundwater in the more rural areas must be encouraged so that use of these local resources are optimised. Once the local groundwater resources are fully utilised, then these rural settlements (mainly situated around the Pilansberg), as well as mines in the area could then source further water supplies from the Vaalkop Dam (Magalies Water as the water service provider). The resources of the Vaalkop Dam may need to be augmented from the main stem of the Crocodile River via the Roodekopjes-Vaalkop Dam transfer.

Required Actions, Responsibility & Priority	As stated above, visit the various authorities to confirm the actual urban and other requirements; to discuss the most suitable sources of water (in the interest of the catchment and Limpopo River users) that they should draw on; and what strategies should be adopted with regard to future requirements. Needs to be documented!	Regional Office Dir NWRP (N) Priority 1

Strategy 1.7 Version control:	**Original version:**	Dec 2002
	Date:	Jan 2004
	Author:	T&M

Strategy 2.1

2	WATER RESOURCE PROTECTION STRATEGY

2.1	RESERVE DETERMINATION & RESOURCE QUALITY OBJECTIVES	
Situation Assessment:	As mentioned throughout this ISP, it is important that we on the one hand optimise the use of water to stimulate economic growth in the area, and on the other to make sure that we do not compromise the health of our environment that could impact on other users including the natural environment. The NWA makes specific reference to the importance of our natural riverine ecosystems and their role in supporting all forms of life. The need for the so-called Reserve (basic human needs and ecological water requirements) has been promulgated to reflect this importance. A Desktop Reserve Study has been conducted for the whole catchment. This desktop level ecological water requirement flow regime was then used to determine the available yield and the yield balance in the whole Crocodile River (West) Catchment as has been reflected in the NWRS. At this stage there was no simple way of determining if the flows in the system were complying with the desktop Reserve Determination requirements. Since water use and yield of the system are in balance with small surpluses in parts of the catchment, the general opinion of the various Departmental Officials interviewed at the workshops was that the river system was not stressed. Relatively large volumes of return flows are now entering the system which were not there historically. Water quality and salinity problems might be a problem. A number of streams rise in the pristine Magaliesberg mountains and Reserve determination of these streams may be required to protect these important resources.	
Broad Management Objective:	The main question that should be asked here is whether there is a need for a Comprehensive Reserve Determination and if so, where and when will it be required.	
Overall Strategic Approach:	When water licence applications are evaluated by the Department, ad hoc and localised Reserve Determinations are conducted by the Directorate: Resource Directed Measures to determine the impact on the riverine environment. Once Compulsory Licencing becomes necessary (see Strategy 1.6), only then will a Comprehensive Reserve be determined. A full Comprehensive Reserve Determination will not be conducted in the near future in this catchment as it is not a priority here.	
Action, Responsibility & Priority:	2.1.1 Conduct appropriate level of Reserve Determination for each water use application that is submitted.	Dir: RDM (Priority 1)
	2.1.2 Conduct a Reserve determination on the streams which rise in the Magaliesberg Conservation area in order to protect this important ecological resource.	Dir: RDM (Priority 3)

	2.1.3 Since there could be water quality problems in the river system, it will be necessary to set Resource Quality Objectives (RQO's) as part of the Reserve Determination process. This information can then be used to evaluate licence applications in light of their impact on water quality. Setting RQO's will require public participation.	Dir: RDM Dir WQM Regional Office (Priority 5)

Strategy 2.1 Version control:	**Original version:**	Dec 2002
	Date:	Jan 2004
	Author:	T&M

Strategy 2.2

2	WATER RESOURCE PROTECTION STRATEGY

2.2	WATER QUALITY MANAGEMENT

Situation Assessment:

The biggest impactors on water quality of the Crocodile River (West) Catchment are the large scale water and land users. The sprawling urban areas in the south-east of the catchment, with their undersized wastewater systems (in places) and large solid waste pollution problems (litter and dumping along river courses) contribute to the poor water quality downstream in the Hartbeespoort Dam. Other contributors such as compost-making factories, industries and old discarded mines (acid mine drainage) also proliferate in this area. Although new mines in the Rustenburg area are strictly controlled by their Environmental Management Plans (EMPs), the potential still exists for future pollution once these mines close. Agrichemicals (fertilisers and pesticides) also have negative impacts in the catchment though these are not well known. Treatment standards at certain sewerage works have been lowered because of the financial constraints of local authorities. In similar fashion, the very groundwater resources, that some rural settlements depend on, are being polluted by poor sanitation facilities in villages. Otherwise, groundwater quality is usually good, satisfying DWAF water quality guidelines and is suitable for domestic and agricultural supply.

Rietvlei Dam Catchment (A21A)
Sewage from the western side of Kempton Park is treated at the Hartbeesfontein plant and the effluent is discharged into the Sesmylspruit, about 6km upstream of the Rietvlei Dam. If the treatment is not done according to specification it could have serious implications for the water quality of the Rietvlei Dam, which is used as a source of water supply to Tshwane.

The Hennops catchment, adjacent to the Rietvlei catchment, has a water quality problem due to uncontrolled urban development. There is a risk of illegal settlement occurring in the Rietvlei catchment which would exacerbate the water quality situation. The Rietvlei catchment has significant dolomitic groundwater resources and informal settlements could lead to the contamination of this important water resource.

Hartbeespoort Dam Catchment (A21B-H)
A number of factors, such as informal settlements without access to sanitation, sewage spills from poorly maintained or overloaded sewage networks (Sandton and Alexandria), industrial and agricultural pollutants have led to the build up of nutrients in the rivers of the Hartbeespoort catchment and the dam itself has been eutrophic for many years. This has a serious negative impact on the recreational use of the dam due to algal blooms. The impact on downstream users is that benthic algae grows profusely in the canals of the Hartbeespoort irrigation scheme that need to be cleaned out regularly. The treatment process installed at Vaalkop and Brits also needs to be very sophisticated to deal with the taste and odour problems associated with the algae.

Decant from old gold mines and leachates from their mine dumps in the Mogale City (Krugersdorp) area also pose a water quality threat to the catchment. Pollution of water in the dolomitic compartments that span the Crocodile and Upper Vaal WMAs needs to be better understood.

Situation Assessment (Continued):	Groundwater pollution (ecoli, nitrates) is occurring as a result of poor sanitation services in informal settlements and other rural communities. This is a problem where communities rely on groundwater as their main source of supply. The problem is especially prevalent around Hartbeespoort Dam and the area north of the Magaliseberg mountain range. **Elands catchment (A22)** The water quality in the Vaalkop catchment is generally good. The exception is the A22H catchment in which the Bospoort Dam is located. Poorly treated sewage effluent from the Rustenberg waste water treatment works flows into the Bospoort Dam with the result that this resource has become unusable for urban consumption. Land use practices and natural erosiveness of soils in the Elands River (south of Sun City) area lead to a high siltload that flows into the Vaalkop Dam. **Apies/Pienaars Catchments (A23)** The Apies and Pienaars river catchments receive effluent discharges from Pretoria and the whole catchment experiences poor water quality. All dams in the catchment are eutrophic. The Temba, Klipdrift and Walmansthal treatment plants, which treat water from these catchments for potable use, make use of a sophisticated process that removes taste and odour. Although expensive, this process is very necessary. The salt content of the groundwater is elevated in some of the areas north of Pretoria in catchments A23F and A23J where conductivities above 150mS/m occur naturally in Karoo strata, especially close to the granite contact. Fluoride values >1.5mg/l are locally present in the groundwater in the granitic area east of the Klipvoor Dam. **Lower Crocodile Catchment (A24)** The Lower Crocodile River Catchment ultimately receives all the return flows from the upper catchments which all have water quality problems to a greater or lesser degree. However, the water in the Lower Crocodile is used almost exclusively for irrigation and the quality of the water does not appear to be a serious problem. There is some evidence of salinisation of the soil along the Lower Crocodile but whether this is due to the poor water quality or poor irrigation practices is not known. Some of the nine Water Forums in the Crocodile River (West) Catchment are very active in monitoring water quality and work together with DWAF in this regard.
Broad Management Objective:	The Department has a mandate to manage water resources in a sustainable manner. It is understood that in the pursuit to stimulate development and socio-economic growth, there will be a negative water quality impact on the environment. The main objective is therefore to ensure a sound and reasonable balance between development impacts and the protection of the resource. Fitness for use by all users (especially those downstream ones in the Crocodile River System) and protection of the natural ecosystems must be used as the basis for strategy development. Limited levels of pollution will only be allowed were the river reach can absorb it. It is important that the various water quality strategies and approaches be documented so that planners, local authorities, and evaluators of licence applications can have guidelines to work towards.

Overall Strategic Approach:	In order to enforce compliance with water quality standards in the Crocodile River (West) Catchment, it will be necessary to make sure that the DWAF Regional Office is adequately resourced. Co-operative governance initiatives with local and district municipalities, and new and existing working relationships with other public bodies, needs to be encouraged to produce a more concerted effort to addressing existing and potential water quality problems in this catchment. People need to be made aware of the broader water quality picture and how it will impact them. A big public campaign, using various channels (e.g. Water Forums, Water User Associations, *et cetera*), should be conducted to "clean up the Crocodile" and to promote water quality management. One option is where water polluters are identified, a form of public pressure could be used to force compliance (e.g. black-listing of offenders).
Action, Responsibility & Priority:	2.2.1 There is a need to develop a concise user guide within the next few years, that sets out a clear water quality management strategy and indicates the current water quality status in the Crocodile River (West) system. This guide should state what must be done to address specific problems (caused by users and natural phenomena), or where potential problems could occur given the development scenarios that could play out in future. The impact of groundwater pollution from mining and waste disposal can be controlled and remedied according to the requirements of DWAF. EMPR's, EIA and closure plans which will identify and put preventative and remediation measures, including monitoring, will remain mandatory. Pollution emanating from settlements, especially informal settlements, is more difficult to control. Elevated nitrate levels (NO_3 >10mg/l) in groundwater are frequently found in water supply boreholes in the traditionally settled areas of the catchment. In particular the following must be considered: • Groundwater pollution occurs when latrine density is high. This results in a pollution plume of increased salinity and nitrate around the settlement. • Abstraction from boreholes for water supply located within plumes has to be terminated, i.e., water quality monitoring must be implemented to determine when and if there is an unacceptable deterioration in groundwater quality. • Groundwater must be abstracted from outside possible impacted areas, i.e., boreholes and wellfields have to be located well away from potential pollution sources. • Education about the need for, and ways of, protecting the groundwater resources is required. • Standards for borehole positioning, construction and protection, as specified by DWAF and SABS, must be enforced. Waste disposal sites offer a serious potential hazard throughout the region due to poor management and lack of operating controls. This pollution risk from the waste disposal throughout the region needs to be assessed and remedied. In so doing, better water quality management information should be collected through collation of existing data and study information, monitoring, research (e.g. into diffuse source pollution), a better understanding of the role of releases from the various dams for dilution purposes. Funding support to all the public roleplayers mentioned above must be seriously considered if this concerted effort is to be successful.

	2.2.2 Numerous water quality guidelines have been developed by DWAF for use in the evaluation of various kinds of water use licences. The practical application of these guidelines needs to be developed for the Crocodile River Catchment. This would provide land use and other project planners with sufficient insight to how this specific water resource should be protected. It would also save financial and other resources that may be expended on studies that are not relevant.	Dir WQM (Priority 2)
	2.2.3 The encouragement of local authorities to promote greenbelts along our rivers is extremely important. This will assist in improving water quality due to the eradication of practices of cultivating land down to the river banks, illegal dumping (stiffer penalties need to be imposed), diversions of the river for development sake, and building in floodplains.	Regional Office Dir WQM Dir SES (Priority 2)
	2.2.4 There are already comprehensive water quality management strategies in place for certain tributaries and reaches of the Crocodile River (eg Jukskei forum and the Apies Pienaars). Support needs to be provided to these organisations by the Department to assist it in managing the resources of the catchment.	Regional Office Dir WQM (Priority 1)
	2.2.5 The recycling of water must be carefully considered from a water quality perspective since this can lead to the build up of high salinity levels in this resource. For example, if Tshwane is to use water from Roodeplaat Dam, the effluent from this use must not be returned to the dam. Reuse of these return flows will have to be subject to stringent controls and release of this water back into the river will be closely monitored.	Regional Office Dir WQM (Priority 2)
	2.2.6 The water quality situation of the Bospoort Dam needs to be studied and a workable solution found.	Regional Office Dir WQM (Priority 1)
	2.2.8 The salinity build-up problem along the Lower Crocodile catchment needs to be investigated and a strategy developed to deal with the problem.	Regional Office Dir WQM (Priority 2)
	2.2.9Groundwater quality must be investigated and recommendations made regarding ways in which to preserve this valuable resource. This is especially important in the dolomitic areas which are susceptable to pollution. Specific Crocodile River Catchment recommendations in this regard are outlined in **Annexure A** of this ISP.	Dir: Geohydro (Priority 2)

Strategy 2.2 Version control:	**Original version:**	Dec 2002
	Date:	Jan 2004
	Author:	T&M

Strategy 3.1

3	WATER USE MANAGEMENT STRATEGY

3.1	**GENERAL AUTHORISATIONS**	
Situation Assessment:	The NWA also makes provision for general authorisations which lighten the administrative load when it comes to water use licencing. There can be general authorisations for abstraction, storage (e.g. small storage dams on irrigation schemes), discharge, *et cetera*. Full details of such authorisations are listed in Government Gazette No. 25367 of 22 August 2003. Two examples of such general authorisations in the Crocodile River (West) Catchment are as follows: • The whole catchment is excluded from the General Authorisation for surface water abstraction. In other words all non-Schedule 1 abstractions need to be licenced. • Groundwater abstraction zones have been identified per quaternary catchment. Abstraction rates vary from zero to 150 m³/hectare/annum (see Government Gazette for details). There are a number of activities that still need licences which should be generally authorised (eg septic tanks, stream channel modifications). Investigations need to be conducted and recommendations made that are not contradictory to the NWA and NWRS.	
Broad Management Objective:	To optimise the use of these authorisations in the Crocodile River (West) Catchment with a view to cutting down on unnecessary administrative time associated with certain water use activities that do not actually require water use licences. This will also save time consuming and resource intensive investigations where the activity will not have a major impact on the resource (eg water quality and quantity).	
Action, Responsibility & Priority:	3.1.1 Revisit water uses in the catchment, identify all existing general authorisations, and see which other water uses can be moved to general authorisation status. 3.1.2 Water use will need to be policed to ensure that water uses without formal authorisations do indeed fall into the General Authorisation categories.	Regional Office (Priority 1)

Strategy 3.1 Version control:	**Original version:**	Dec 2002
	Date:	Jan 2004
	Author:	T&M

Strategy 3.2

3	WATER USE MANAGEMENT STRATEGY

3.2	**LICENCING**
Situation Assessment:	The DWAF Regional Office considers each water use licence on its own merit. The applications are passed through a number of Directorates within the Department before a final decision is made to issue a licence or reject the application. Current estimates indicate that there is some surplus in the Crocodile River (West) catchment. This is the Hartbeespoort and Bospoort Dams. There were surpluses in the Apies/Pienaars sub-area at the time of compiling the NWRS, but these have now been allocated to the Tswane Metropolitan Council. The Regional Office has recently completed a process of water use registration. Based on this database, existing lawful use will be determined for the Crocodile River Catchment. Once this process is completed it will be possible to revise the reconciliation of water requirements and water resource availability. If there is still an excess of water in the system after this revised reconciliation, this may be allocated. This is to be reserved for high-value use (eg mines and urban requirements of Rustenburg) and redressing inequities. This surplus will increase over time as return-flow increase, and these return flows could be allocated for re-use. Conversely, if it is found that there is a serious deficit, it will be necessary to implement compulsory licencing (i.e. reduction of allocations to lower priority water users).
Broad Management Objective:	DWAF Managers' must obtain a thorough understanding of the water balance in the Crocodile River Catchment. This includes an accurate assessment of existing lawful use and the water availability surplus/deficit in the catchment. Based on this management information it will be possible to develop and implement a strategy to either be able to allocate a surplus to new users, or to cut back on all, or certain, users to achieve a sustainable water balance. A further need is to streamline the licencing process (ie one stop shop) to speed up licence approvals in order to allow economic activities to proceed as quickly as possible. The onus is also on the applicant to timeously submit his/her applications so that there is no hold-up in the development process. The excellent public awareness and education campaign must continue.
Overall Strategic Approach:	Licencing of water use in this catchment may be separated out into three stages. The first stage is the determination of existing lawful use which is now commencing in the Crocodile River Catchment. The second stage will be to enter this more accurate water use information (including more accurate estimates of the Ecological Reserve) into the water resource system modelling process to determine the extent (volumes and their spatial distribution) of water availability in the whole catchment (see **Strategy 1.3**). In the case of a water resource surplus in certain areas, a clear statement will need to be issued (i.e. in a later version of this ISP) on where new allocations and licences may be considered. New supplies could also be drawn from the Vaal River system, but the costs involved, including new augmentation schemes), will have to be carefully weighed up against the most beneficial use of this water. In the case of a deficit and no further transfers of water into the catchment, a compulsory licencing process will have to be engineered.

Overall Strategic Approach (Continued):	The surplus water is located in the Hartbeespoort Dam and can therefore be made available to the Lower Crocodile by releasing water down the Crocodile River, or to the Elands catchment by diverting the flow via the Vaalkop canal. The possibility of making the surplus available to the Pretoria North area has also been mooted, but this will need to be investigated in detail before any decision on this is taken. In the case of the Elands catchment, the surplus is available in the Bospoort Dam, which is underutilised at present, as well as in the Vaalkop Dam. Despite the surpluses available in the Crocodile West catchment, water must be allocated with caution, because there are localised shortages throughout the catchment. Each application needs to be carefully considered and, when in doubt, a detailed water resources evaluation carried out. Due to these localised surpluses, general authorisations are not recommended. Groundwater can be allocated for small scale and/or widely dispersed users, for example rural use. Water licences for basic human needs will be considered throughout the catchment, while the surplus in the Elands and upper Crocodile could be used for poverty eradication projects.	
	3.2.1 Trading of water licences will be allowed within specific areas in the catchment. Definitions and protocols must be developed for this catchment.	Regional Office (Priority 2)

Strategy 3.2 Version control:	**Original version:**	Dec 2002
	Date:	Jan 2004
	Author:	T&M

Strategy 3.3

3	WATER USE MANAGEMENT STRATEGY

3.3	**POVERTY ERADICATION / RESOURCE POOR FARMERS**

Situation Assessment:	It is quite evident that the water needs of the poor go beyond basic water supply for domestic purposes. Water for livelihoods and supporting basic levels of socio-economic growth is a critical element in our attempt to eradicate poverty. Identifying sources of water for the establishment of resource poor small-scale farmers is another intervention that could have more of an impact on the water resources of the Crocodile River (West) Catchment. DWAF is committed to work together with other government departments, authorities and private sector initiatives to identify water resources and other water related inputs.
	
	At the time of drafting this ISP, little was known about the status of these poverty eradication initiatives other than the resettlement of emerging farmers within existing irrigation schemes. Since very little information could be gleaned from the Department of Agriculture and Land Affairs for this area, it was soon realised that a more detailed investigation would be required to develop a strategy for DWAF's involvement.
	
	In brief though, numerous low-income populations of people surround the bigger cities and towns in this catchment. The possibility does exist for intensive market gardening or small-industries in these areas, of which the impact on the water resources is currently unknown. Poverty levels in the rest of the area, relative to other parts of the country, may be considered low. This is mainly due to the large numbers of people that are employed in the mainstream of the economy (e.g. mining, industry) in this area. The scope for improvement is not known as yet. Linking resource poor farmers with existing commercial farmers has been mooted as a sustainable solution.
	
	The use of groundwater usually does not play a big enough role in these initiatives. Development of the available groundwater resources could lead to:
	• an increase in water supply
	• the provision of a clean water supply to alleviate health problems
	• the time saved in collecting water is available for economic activity, such as:
	  ➢ vegetable gardening
	  ➢ stock watering
	  ➢ chicken rearing
	  ➢ brick making

Broad Management Objective:	To ensure that water for productive use at the household level is made available to the poor. The productive use of water at household level can be regarded an economic and social good. To identify specific initiatives in the Crocodile River Catchment (through co-operative governance and other means), and in so doing to see in what way the Department can support these initiatives.
Overall Strategic Approach:	More management level information is required. This investigation, conducted in collaboration with other government departments should provide the following type of information:

	• Demographic trends regarding poverty in this catchment. • Land ownership • How many initiatives exist and how many are still operational? What were the reasons for unsuccessful schemes? • Where could potential schemes be initiated and what water resources are available to support these projects? Is there a demand from resource poor farmers for large volumes of water? • A strategy to support and optimise water use in eradicating poverty.	
Action, Responsibility & Priority:	3.3.1 DWAF should continue supporting municipalities technically by identifying and securing water resources (where necessary) and financially in delivering basic water supply services. It will be important for water resource managers to assess the impact of the scale of such activities on the water resource.	Regional Office Municipalities Dir: Water Services (Priority 1)
	3.3.2 Support Local Authorities and the Departement of Agriculture in promoting productive use of water for livelihoods (e.g. fruit and vegetable production, brick making and building, small industry).	Regional Office
	3.3.3 Water for resource poor farmers would either have to come from existing farmers (trading of licences or joint ventures), or from new allocations that may be available from increasing return flows. Assessments are required to determine where water is needed and available.	Regional Office

Strategy 3.3 Version control:	**Original version:**	Dec 2002
	Date:	Jan 2004
	Author:	T&M

Strategy 4.1

4	WATER CONSERVATION & WATER DEMAND MANAGEMENT STRATEGY

4.1	**WATER CONSERVATION & WATER DEMAND MANAGEMENT (WC/WDM)**
Situation Assessment:	On the one hand there is a lot of scope for water conservation and demand management in this catchment. On the other hand, return flows make up a significant portion of the water resource that is utilised by downstream water users. It should therefore be borne in mind that return flows could be reduced by the implementation of WC/WDM measures. Although very little is known at this stage about this relationship, return flows in the Crocodile River Catchment are currently being studied by the Directorate: National Water Resources Planning. Results are expected by early 2004. The irrigation sector, known for its inefficient use of water, uses about 35% of the water in the catchment and a large saving in this sector would have a big impact on the total water requirement. The losses on the Hartbeespoort Irrigation Scheme are known to be in the order of 50% while large losses also occur due to releases from Roodekopjes and Klipvoor Dams for irrigation along the lower Crocodile River. These losses are not well understood because of the presence of aquifers which are probably recharged in part by releases from the upstream storage units. The largest water user, the urban sector, uses about 43% of the total requirement. The City of Johannesburg have been applying WC/WDM measures with success, but on a limited scale. These initiatives need to be extended to other areas. It is uncertain what plans, if any, Tshwane and the surrounding urban areas have made to reduce losses. Large industrial use and mining only make up a small portion of the total water use. This sector is thought to be reasonably efficient. Another area of possible inefficient water use is the Rustenberg area. Poorly treated effluent from Rustenberg flows into Bospoort Dam. The quality of the water in this dam is now perceived by Rustenburg Municipality to be so bad that it imports its water from Rand Water and from Vaalkop Dam rather than using their own local resource. The mines have shown an interest in utilising these return flows at Bospoort Dam instead of them drawing it further downstream at Vaalkop Dam.
Broad Management Objective:	To make **more efficient use** of the existing available water resources in all water user sectors. This will enable the catchment management to "free up" additional water, which can possibly be put to beneficial use elsewhere in the catchment or used to meet the ecological water requirements in the river system.
Overall Strategic Approach:	WC/WDM is a major, and conflicting, strategy in this catchment that also relies on return flows that are dependent on the lack of WC/WDM and the consequent wastage of water. It could not be ascertained whether any formal DWAF strategy exists for this catchment as a whole. In lieu of this it is suggested that a strategy be developed which starts focusing on areas/activities where return flows are insignificant or where these are lost or wasted. This investigation can then be expanded to other sectors/activities. The strategy needs to look at the impact of WC/WDM as a whole and the dependence of water users on return flows. The "recycling" of water as it proceeds down the river system and related water quality issues need to be considered as well.

	The consequences of certain municipalities deciding to fully utilise their return flows (e.g. Tshwane is seriously considering this option) must be well understood to avoid water quality and supply problems.	
Action, Responsibility & Priority:	4.1.1 Local resources must be used optimally before using water transferred in from other catchments. A comprehensive WC/WDM strategy is therefore required for the whole Crocodile River (West) Catchment that focuses on the issues listed above.	Dir WUE (Priority 1)
	4.1.2 The Hartbeespoort Irrigation Scheme and urban use in the upper catchment should be targeted as a top priorities for WC/WDM. Water savings are probably also possible in the lower Crocodile River. The potential savings here need to be better understood.	Dir WUE (Priority 2)
	4.1.3 The water use from Bospoort Dam and the Rustenburg area needs to be investigated from a WC/WDM perspective to strive towards the optimal use of local resources. As mentioned previously, no new additional transfer allocations from the Vaal River system will be made to the Rustenburg area unless WC/WDM measures are successfully implemented and local resources are optimally utilised first. The water quality aspects of the situation need to be investigated in parallel with the WC/WDM issue.	Dir WUE Dir NWRP (N) (Priority 2)

Strategy 4.1 Version control:	**Original version:**	Dec 2002
	Date:	Jan 2004
	Author:	T&M

Strategy 5.1

5	INSTITUTIONAL DEVELOPMENT & SUPPORT STRATEGY

5.1	**DWAF & CO-OPERATIVE GOVERNANCE**	
Situation Assessment:	Certain water resource management functions remain with the Minister of Water Affairs and Forestry and will be administered by the Regional Office(s). Co-ordination at a national level will always remain necessary, especially at policy and regulation level.	
Broad Management Objective:	Co-operative governance (ie liaison and integration of planning between government departments, district and local authorities) is an essential ingredient in integrated water resources management to ensure a compounded benefit to all users in the catchment. The roles of the Minister of Water Affairs and Forestry and his/her Department need to be clearly defined in the context of the Crocodile River Catchment.	
Broad Strategy, Responsibility & Priority:	5.1.1 Referring to **Annexure A** and various sections of the NWA, the Regional Office needs to define it roles in the Crocodile River Catchment and then plan how it will deal with the following requirements: General powers of the Minister; access to and rights over land; appeals and disputes; offences and remedies; general and transitional provisions; Schedule 7; staffing and employment equity; skills development; environmental auditing; restructuring of water resources and water services components in the Regions; the development of the transitional plan; asset management; and a detailed structure for developing and managing the water resources in the Crocodile River (West) Catchment. All these aspects where not identified at the workshops and will need to be addressed in the next version of the ISP. Resourcing (human and financial) is an important consideration as well (refer to implementation strategy 9.1 below).	Regional Office Dir SES (Priority 1)
	5.1.2There is a need to co-ordinate and encourage communications between the various government and regional and local authorities. A communication strategy and innovative means of communicating current and planned activities must be developed.	Regional Office (Priority 1)
	5.1.3 There are a number of water-related problems which cannot be resolved only through DWAF intervention. For example, Livestock overgrazing, soil erosion and high sediment loads are prevalent in the lower Elands River catchment south of the Pilansberg and this could become a problem in the long-term as it will reduce the yield of the Vaalkop Dam. This needs to be resolved through cooperative governance with the Department of Agriculture.	Regional Office (Priority 1)

Strategy 5.1 Version control:	Original version:	Dec 2002
	Date:	Jan 2004
	Author:	T&M

Strategy 5.2

5	INSTITUTIONAL DEVELOPMENT & SUPPORT STRATEGY

5.2	LOCAL AND CATCHMENT LEVEL
Situation Assessment:	A portion of the Johannesburg Metropolitan Council area and almost all of the Tshwane Metropolitan area lies within the Crocodile River (West) Catchment. Water supplies in Johannesburg are controlled by the municipality's subsidiary called Johannesburg Water which purchases water from the Vaal River via Rand Water. Rand Water purchases water from DWAF at the Vaal Dam. Johannesburg Water is a well established institution who has produced a Water Services Development Plan (WSDP). DWAF will continue to enjoy a good relationship with Johannesburg Water. Tshwane also purchases its water from the Vaal River system via Rand Water but also has access to local resources (i.e. significant ones being Rietvlei Dam, Fountains springs and Roodeplaat Dam). Tshwane is well established as a water authority and close liaison between DWAF and the municipality is maintained. Tshwane is currently opposed to any further water abstraction from the Roodeplaat Dam as it wishes to utilise this water for expansion of higher levels of water supply in the middle and lower portions of the Apies and Pienaars river catchments. This may not be in the interest of other water users in the region. This issue will need further consideration. Other local and district authorities in the catchment have severe financial and human resource constraints since they have only recently been established. WSDPs' have been produced but lack adequate reference to water resource matters. No extraordinary schemes have been catered for in these plans that could have a major effect on water availability in the region. DWAF will need to provide more input into these local-planning processes. Liaison between the various institutions also needs to be encouraged in the interest of integrated water resources management in the Crocodile River Catchment. Catchment Forums (of which there are nine in the catchment) have been the most longstanding public bodies in the current water resource institutional structure. They are made up of interested and concerned citizens and are very active in the practical review and implementation of the various water resource management plans in the catchment. Some forums (eg the Jukskei) have sophisticated networks and information systems (eg early warning and action for sewage or other spills; monthly water quality montoring together with DWAF and other authorities). Irrigation boards are currently being transformed to Water User Associations. This process will continue and these bodies will fulfil their roles in line with the NWA, the NWRS and functions listed in **Annexure A**. At time of writing of this version of the ISP, the proposal to establish the Catchment Management Agency (CMA) in this catchment has been forwarded to the Minister for his comment and/or approval. In other words, it is envisaged that the CMA management framework could be established within the next year. It could become fully functional within three to four years time. The delegation of responsibilities and the whole establishment process is contained in the **CMA's Proposal.**
Broad Management Objective:	The Regional Office(s) need to take institutional control of all Water Resource Management functions and will be supported by DWAF Head Office Directorates.

	Their main objective is to manage the water resources of the Crocodile River Catchment in the interim until such time as the Catchment Management can take over some of the functions.	
Broad Strategy, Responsibility & Priority:	5.2.1 The Regional Office and the Directorate: National Water Resources Planning should maintain contact with all the various District and Local Municipality roleplayers and work with them to identify water resources that can be utilised. Long-term planning to avert water shortage crises must be encouraged. Capacity building and support to the district and local municipalities must intensify as more responsibility (especially water services link with water resources) is shifted from national government.	Regional Office Dir:NWRP (N) (Priority 1)
	5.2.2 Continue with the establishment and empowerment of the local water resource management authorities (CMA and Water User Associations). More support (especially basic financial) needs to be given to the various forums, since they fulfil a key role in the establishment of these institutions.	Regional Office (Priority 1)

Strategy 5.2 Version control:	**Original version:**	Dec 2002
	Date:	Jan 2004
	Author:	T&M

Strategy 6.1

6.1	INTEGRATED ENVIRONMENTAL MANAGEMENT
Situation Assessment:	Although discussions were held with the old DWAF Directorate: Social and Ecological Services, it was realised that not enough has been documented within DWAF regarding the environmental issues in the Crocodile River Catchment and their integration into the broader water resources planning picture. Numerous individual studies have been completed. Further collation work would be required to produce specific environmental strategies. A broad approach was therefore adopted in this version of the ISP. In broad terms, the rivers in the upper Crocodile River Catchment have been significantly impacted on by urban development (e.g. concrete lining and severe pollution events). Raised flood levels as a resulted of the paved surfaces also cause problems. Old mines that decant poor quality water have been noted but not enough is known of this water's impact on the river systems and underground dolomitic compartments. Unsound land practices and other activities in the Hartbeespoort Dam catchment result in poor quality water in this dam which has an economic and psychological effect on the local inhabitants that live next to the dam or use water from this source. Water resources in the more rural areas are effected by overgrazing, erosion and sedimentation which could have a severe reduction in the storage capacities of dams in future (e.g. Vaalkop Dam especially). DWAF has been very proactive over the years regarding the institution of international best practice in the field of Integrated Environmental Management. The Department has recently published a Consolidated Environmental Implementation and Management Programme[10] and is currently developing specific strategies, policies, and tools to implement processes that will take due consideration of all impacts that water resource and other water management activities will have on our broader environment in which we live. It must be noted that these environmental issues and strategies are cross-cutting through all aspects and approaches adopted in this ISP.
Broad Management Objective & Strategic Approach:	The ultimate aim is to ensure a balance between development in the Crocodile River (West) Catchment (i.e. including all activities undertaken by DWAF) and the need to protect the natural and social environment for the benefit of all. There is a need to identify all environmental issues in the catchment and to address each of these according to priority. This attention should also take current and future water resources planning into account. Ensure that all linkages with NEMA (including the new NEMA currently being drafted) and other legislation (including co-operative governance initiatives) and the activities of DWAF are adhered to in the catchment, and that related implementation strategies are developed with the view of being audited by the Auditor-General in 2004. Planning of proper reporting procedures must be included in these strategies. DWAF must ensure environmental functioning in all activities it is related to in the Crocodile River Catchment. This includes the adoption of proper integrated environmental management processes, auditing and compliance monitoring in the planning, design, and construction phases of all projects. DWAF must also ensure environmental compliance of outside stakeholders in terms of its own legislation.

Strategy, Responsibility & Priority:	6.1.1 Water resources management calls for certain developments that have an impact on the environment (whether positive or negative). These environmental impacts need to be understood and addressed where necessary. Identification and a clear description of all the environmentally sensitive areas in the Crocodile River (West) Catchment needs to take place. This would help water resource managers when evaluating current and future developments in these areas. Guidelines and bylaws may need to be prepared to assist local authorities (refer to Water Quality Strategy).	Dir: WRPS Dir NWRP (N) (Priority 1)
	6.1.2 Develop policies, guidelines and strategies in line with the CEIMP. Of particular importance will be the cross-cutting linkages between the strategies in this ISP, NEMA and other legislation. This was not specifically discussed within the workshops, and the Dir: WRPS will produce these strategies for the next version of the ISP. A typical **table** that will be populated is shown at the end of this Strategy.	Dir: WRPS (Priority 1)
	6.1.3 Develop integrated Resource Directed Measures strategies. Refer to Chapter 5 in the main text for more details.	Dir: RDM (Priority 2)
	6.1.4 Wetlands need to be accorded more attention as they form a vital link in the sustenance of natural life and can act as water quality filters. Little information on the wetlands of the Crocodile River Catchment could be gleaned when this ISP was prepared in 2002. This needs to be investigated and a specific strategy prepared.	Dir: WRPS (Priority 2)
	6.1.5 Mine dewatering along the Brits-Rustenburg platinum corridor has been mentioned as a major concern amongst some stakeholders. Farmers contend that their groundwater reserves are being drawn down by the new mines that are dewatering in order to be able to mine. This could also have a major impact on the natural vegetation in this area. The mines are releasing this water downstream into the river systems. These contentions will either have to be disproved by the mines (in terms of current law) or some form of compensation (ie pumping this water back up to the farmers and rural settlements) to make good for this perceived loss of water and hence loss of livelihoods. The Ecological Reserve must be factored into this equation as well.	Regional Office (Priority 2)
	6.1.6 Tourism: Assist the Department of Environmental Affairs and Tourism with broad monitoring of water quality and quantity in certain conservation and tourism areas of the catchment. Appropriate water related actions might need to be taken to conserve these environments for the benefit of the local economies. Areas include the: Kromdraai Conservancy; Cradle of Mankind; Crocodile River Ramble; Hartbeespoort recreational area and residential areas affected by the poor water quality in the dam; Magaliesberg Nature conservation area; various nature and game reserves.	Regional Office Dir: WRPS Dir WQM (Priority 1)

	6.1.7 Co-operative governance and institutional aspects: authorities should provide an enabling environment to promote economic growth as well as to protect the environment for the benefit of all life forms in the catchment.	Regional Office All Directorates (Priority 1)
Strategy, Responsibility & Priority (Continued):	6.1.8 Land use impacts: arguably one of the most serious environmental impact consideration in this catchment. These include: solid and other types of waste seeping into the river system from urban areas; overgrazing and silting; effluent return flows and salination of water sources; groundwater pollution from rural settlements and industrial/agricultural activities; positive and negative aspects of poverty eradication efforts; *et cetera*. These have been referred to in other strategies, but need to be monitored and actions co-ordinated to ensure a sustainable environment.	Regional Office Dir: WRPS (Priority 1)
	6.1.9 Invasive alien vegetation: need to understand the extent of the infestation in this catchment, what is being done by Working for Water, and the development of a strategy (together with Working for Water) to annihilate these invasives where practically possible and where they have a threat of recolonising in future.	Regional Office Working for Water (Priority 2)
	6.1.10 Identify and implement strategies being developed in the CEIMP process.	Dir: WRPS Regional Office and all Directorates (Priority 2)
Motivation:	An integrated approach to environmental management considerations needs to be adopted. This with a view to conserving and protecting our environment for the benefit of all life forms. DWAF has a mandate (via other government departments as well) to act as a custodian in our whole environment to ensure a healthy balance between development, social upliftment and protection, and preserving our biophysical environment and natural heritage.	

Strategy 6.1 Version control:	**Original version:**	Dec 2002
	Date:	Jan 2004
	Author:	T&M

Relationship between the NEMA principles and the ISP Strategies
A Template to be Used by the Directorate: Water Resources Planning Systems

NEMA Principles	ISP STRATEGIES									
	Water balance and Reconciliation	Resource Protection	Water Use Management	Water Conservation & Water Demand Management	Institutional development & Support	Water works & development	Information Systems	Auditing & Monitoring	Implementation	NEMA Ref
Social, ecological and economically sustainable development										2,3,4(a,p)
Integration of environmental considerations in decision-making										4(b,e,l,o)
Participation, empowerment, transparency in decisions										4(f,g,h,k,o,q)
Co-ordination (National and international with Governments and NGO's)										4(l,n,p,m)
Environmental justice and equity										4(c,d,o)
Maintain ecological integrity										4(r)

Strategy 6.2

6	INTEGRATED ENVIRONMENTAL STRATEGY

6.2	**PUBLIC INVOLVEMENT**	
Situation Assessment:	The current Internal Strategic Perspective, as its name implies, has been intended to achieve a common water resources management approach within the Department before going out to stakeholders. Interaction has been limited to stakeholder awareness regarding this ISP development process. It is envisaged that the finally accepted Crocodile River ISP will be circulated to water user associations, forums and other pertinent stakeholder groups to inform them of the way in which DWAF wants to manage the water resources of the catchment. Stakeholder comment will then be requested. This effort may need community education with a view to empowering these stakeholders to fully understand DWAF's perspective and in so doing to be capacitated to yield constructive comment. The ISP is intended to provide DWAF's input to the development of the Catchment Management Strategy, which will involve a thorough public participation process. This process could commence within the not too distant future in the Crocodile River (West) Catchment depending on the approval of the Catchment Management Agency establishment proposal by the Minister.	
Broad Management Objective:	To gradually phase in an appropriate public involvement process in parallel to the establishment of the Catchment Management Agency and the drafting of the Catchment Management Strategy.	
Action. Strategy, Responsibility & Priority:	6.2.1 Initially circulate the finalised Crocodile River ISP to water user associations, forums and other pertinent stakeholder groups to inform them of the way in which DWAF wants to manage the water resources of the catchment. Incorporate stakeholder comments in the revised ISP.	Regional Office Dir: NWRP Dir: Comp. Licencing Dir: Catchment Management
Motivation:	Public participation is crucial for the successful implementation of any strategy.	

Strategy 6.2 Version control:	**Original version:**	Dec 2002
	Date:	Jan 2004
	Author:	T&M

Strategy 7.1

7	WATERWORKS DEVELOPMENT & MANAGEMENT STRATEGY

7.1	**INFRASTRUCTURE DEVELOPMENT**
Situation Assessment:	Local water resource development in the catchment has reached its maximum potential. No further viable major developments in this regard are expected in future (ie no more major dams). Water supplies to the urban areas in the south eastern portion of the Crocodile River Catchment will need to be augmented from the Upper-Vaal WMA, which receives the bulk of this water from the Lesotho Highlands, the Thukela River and other smaller transfer schemes. Not all water infrastructure in this catchment is operating properly. This is partially due to a lack of technical management and resources to accomplish routine maintenance. This infrastructure belongs to various institutions. No detailed and consolidated inventory of this infrastructure, including the state of these assets, is readily available. Apart from the large water infrastructure that will have to be put in by water boards to augment water supplies from the Vaal River system, it has already been noted that local resources are not being fully utilised. This means that there is scope for Local and District Municipalities to develop conveyance infrastructure to make use of these resources.
Broad Management Objective:	Provision of adequate water resource development (storage) and bulk water supply infrastructure to sustain and encourage social and economic growth in the Crocodile River Catchment.
Overall Strategic Approach:	To encouraged water boards, local and district municipalities to invest in water infrastructure that optimises the use of local water resources first. Examples of bulk water infrastructure are as follows: • In order to make the best use of the current Madibeng Local Municipalities allocation (which is not fully utilised), it is recommended that this municipality construct a new treatment works below the Hartbeespoort Dam to supply the needs of the new and existing mines between Brits and Rustenburg (major pipeline required). This pipeline could also be linked to the groundwater that is pumped out of the mines in their dewatering processes to supply water to settlements (eg Majakaneng, Modderspruit/Bapong) and the farmers along this corridor. • Another development option is the increase in the canal capacity between the Roodekopjes and Vaalkop dams. New bulk infrastructure would need to be constructed by Magalies Water to convey this water to where it is needed (ie Rustenburg area and rural settlements and mines in the Pilansberg area). • No further major aqueducts conveying water from the Vaal River System (Rand Water) will be considered north of the Magaliesberg Mountain Range until such time as the local resources (including increasing urban return flows) are optimally used and water conservation and water demand management measures are successfully implemented. • The yield of the Klipvoor Dam could be harnessed to supply water to the immediate environment of rural settlements, or the water could be pumped back to augment water supplies to the Tshwane Metropolitan area. • Studies are being conducted with regard to the possible transfer of water from the Roodeplaat Dam into the Western Highveld (former KwaNdebele) area in

	the Olifants WMA.	
Action, Responsibility & Priority:	7.1.1 Identify the optimum bulk water storage and supply infrastructure layout that will make optimal use of the local water resources in the Crocodile River Catchment.	Dir OA (N) Dir NWRP (N) (Priority 2)
Motivation:	It makes good economic sense to initially utilise local water resources before importing water from the Vaal River System (and beyond). The Vaal River water requires that very expensive augmentation/interbasin transfer schemes be built. By developing and optimising the use of local resources it will be possible to delay those capital expenditures.	

Strategy 7.1 Version control:	**Original version:**	Dec 2002
	Date:	Jan 2004
	Author:	T&M

Strategy 7.2

7	WATERWORKS DEVELOPMENT & MANAGEMENT STRATEGY

7.2	SYSTEM MANAGEMENT
Situation Assessment:	The Crocodile River system has been modelled extensively. Regular updates of the water resources yield and planning models are conducted to obtain a better perspective regarding the availability of water and levels of assurance of supply in the system. Since the assumed operating rules are reasonably complex they will not be recalled here. For details please refer to the DWAF reports **P A200/00/352000** entitled "**Crocodile River (North-West) System Analysis – 1998**" and **P A200/00/362000** entitled "**Annual Operating Analysis of the Crocodile River (West): Planning Analysis –1999**". In practice, implementation of these operating rules may not be conducted. For example, irrigators in the Middle and Lower Crocodile River irrigation areas draw as much water from Klipvoor Dam and the rest of the system as they require.
Broad Management Objective:	In combination with Strategy 7.1, implement a policy of optimisation of existing water resource and supply infrastructure, in order to "squeeze" more water out the system. Monitoring of the actual flow regime should be improved and this data turned into water resource management information.
Overall Strategic Approach:	DWAF Officials believe that improvements can be made to the way in which the whole water resource and supply system in the Crocodile River Catchment is operated. By doing this it may be possible to enhance the overall yield of the system. For example, Bon Accord Dam's yield can be increased significantly if water is drawn from this reservoir, instead of it being left full all the time. Will need to begin at a scheme or localised level and then move wider to encompass the whole Crocodile River System. Co-ordinated efforts will also be necessary to ensure that hand-over of water resource and supply assets to water user associations or other organisations occurs smoothly and that those operations are optimised. Strict maintenance programmes will have to be adhered to obtain the most benefit from the systems. Tariff structures could have an impact on the way in which water is used. Once the real value of water is charged it is believed that water users will start using this resource frugally. Monitoring of system operations to inform the investigations referred to above, will need to receive appropriate consideration. A strategy in this regard will need to be developed (see Strategy 8.1 below).

Action, Responsibility & Priority:	7.2.1 After obtaining accurate values regarding return flows and availability of water in the system as well as accurate water requirements, conduct a thorough investigation into the current status of the operation of each component and the whole of the Crocodile River System. The main aim of the investigation is to determine how the correct operation and maintenance of the whole system (and all its components individually) can contribute to the improvement of water availability in the system.	Dir NWRP (N) Regional Office (Priority 2)

Strategy 7.2 Version control:	**Original version:**	Dec 2002
	Date:	Jan 2004
	Author:	T&M

Strategy 7.3

7	WATERWORKS DEVELOPMENT & MANAGEMENT STRATEGY

7.3	RECREATION ON DAMS & RIVERS	
Situation Assessment:	Urban and other economic centres need to offer their citizens affordable recreational outlets. These dams are normally located within travelling distance of such centres and therefore provide an opportunity to meet these social requirements. The surface and shores of dam reservoirs in South Africa have traditionally been used for all forms of recreation (e.g. powerboating, yachting, fishing). In most cases DWAF, through its Directorate: Social and Ecological Services, develops zoning plans for the way in which the reservoirs are used by the public. DWAF has fairly sophisticated processes to determine and manage these impacts and therefore promotes recreation and tourism within realistic frameworks around this water resource infrastructure. Allowance is also made for the ecology (i.e nature reserves or sanctuaries are usually created where the river enters the dam). More recently, DWAF has started considering ways in which jobs can be created around these recreational facilities as a means of reducing poverty levels of local inhabitants.	
Broad Management Objective:	To provide a balance between recreational use, nature and the nuisance factor to local inhabitants on water bodies in the catchment; and to provide an environment at dams in the catchment that encourages recreational opportunities. This includes taking steps to improve the quality of water at the Roodeplaat, Hartbeespoort and Bospoort Dams.	
Strategy, Responsibility & Priority	7.3.1 Prepare an inventory of recreational assets and opportunities.	Dir: SES (Priority 2)
	7.3.2 Collate all information on the water quality in the various dams and the various recommendations already put forward to address these problems (e.g. Bospoort Dam). Continue to support forums that have initiated such rehabilitation programmes (eg Kwena Water Forum at the Hartbeespoort Dam).	
	7.3.3 Provide an environment at the dams that is conducive to recreational development. Specific action plans will need to be developed in conjunction with the various tourism authorities to optimise this form of economic use. Job creation strategies should feature prominently in these plans. Affordability of access to these recreational activities for all citizens must also be considered.	

Strategy Version control:	Original version:	Dec 2002
	Date:	Jan 2004
	Author:	T&M

Strategy 7.4

7	WATERWORKS DEVELOPMENT & MANAGEMENT STRATEGY

7.4	**PUBLIC HEALTH & SAFETY**
Situation Assessment:	The Department's current commitments are associated with: • managing floods and drought disasters by direct intervention on the ground. • by reducing pollution and preventing serious or hazardous pollution events. • and promoting dam safety. ***Floods*** Floods in the whole Crocodile River Catchment have proved to be very devastating in the past. People in Alexandria Township in Johannesburg used to stay within the floodplain of the Jukskei River and have suffered some serious consequences during flood events, including loss of life. The year 2000 floods destroyed large areas of riparian farming practices in the middle and lower catchment and caused all sorts of infrastructure damage. ***Droughts*** This catchment regularly experiences a series of years of lower than average rainfall (usually in a 7 to 10 year cycle, for a few years in a row). Farming activities are usually very hard hit with severe local economic consequences. For example, in the early 1990's drought a local farmer in the Buffelspoort area had to buy-in Vaal River water at great cost to keep his citrus trees alive until such time as his groundwater resources recovered. Rural communities rely mainly on groundwater resources which at times during drought cycles do dry up. Emergency action plans (water bowsers are trucked in) are then implemented by the Water Service Provider responsible for the area (mainly Magalies Water in this catchment). Urban and other users suffer less risk of shortages due to the fact that water is transferred from large inter-basin transfer schemes. These users usually only experience certain water saving restrictions during times of drought. ***Public Health and Water Quality*** Water Resource Managers are responsible for securing adequate quantities of water, at the right quality, for all water users. Water quality in the large storage units in the Crocodile River Catchment have gradually been deteriorating. Hartbeespoort Dam used to suffer from an overgrowth of water hyacinth. This dam now suffers from large concentrations of algal blooms and the resultant problems (e.g. toxicity and odours that effect local residents). Upstream urban wastewater, industrial and agricultural pollutants are blamed for these water quality problems. The old nuclear facility at Pelindaba just upstream of the Hartbeespoort Dam has water storage dams, the quality of which is unknown. A cholera threat was reported in certain informal settlements in the central catchment in 2001. DWAF was able to provide emergency water supply schemes (mainly from groundwater) to meet these needs. Pollution of groundwater resources as a result of poor sanitation facilities in these settlements may create new health problems (eg nitrate poisoning – reports of "Blue Baby Syndrome" have been experienced just east of Brits in the village of Ratau). See Strategy 2.2 for water quality strategies.

Situation Assessment (Continued):	***Dam Safety*** Also related to flood events, this management function rests entirely with the Department who has its own Dam Safety Office, which monitors the various large dam structures with a view to potential failure. Smaller dams (ie higher than 5m wall height) have to be registered and approved with this office. A number of illegal dams or dams that don't comply with safety criteria exist in the catchment, which could cause flooding problems to downstream inhabitants if they fail. Every effort is being made by the Department to ensure compliance with safety regulations.
Broad Management Objective:	We need to ensure that users in the Crocodile River Catchment are safe from the effects of poor water quality that can create health problems (eg cholera). We must ensure that strategies are put in place to deal with floods and droughts. All dams (especially large farm and mining dams) must be safe from failure and pose very little threat to people and infrastructure downstream.
Overall Strategic Approach:	DWAFs (and the CMAs in some cases) future commitments under National Disaster Management Act which is to be promulgated in 2003 will be: • DWAF/CMA will be required to become involved in supporting and enforcing disaster management planning by all relevant authorities. • Drafting a National Flood Management Policy (DWAF). • Dam safety policy (DWAF). • Co-operating with the Department of Agriculture on drought relief strategies and policy formulation. • Preventing pollution of water resources (ie limiting health hazards such as cholera). ***Floods*** The type of planning and implementation work done on the Jukskei River should be continued. Other areas have different problems (e.g. in the Middle and Lower Crocodile River irrigation activities usually suffer the brunt of the floods. Although these are natural events over which we have very little control, some measures could be put in place to limit certain flood peaks (e.g. upstream flood retention structures in urban areas, operating dam reservoir levels to "catch" floods). Early warning systems also need to be in place to avoid disaster in future. ***Droughts*** At time of writing this ISP it seems that the Crocodile River Catchment is being subjected to another drought sequence that could last for another few years. Drought relief plans should be timeously developed by the Regional Office, in collaboration with local authorities, to avert any drought crisis in future. A detailed strategy must be developed in this regard. ***Public Health and Water Quality*** Again there is a dire need to collate all existing information pertaining to this subject into a thorough situation assessment, and to develop a plan of attack to deal with all problems that fall within the ambit of DWAF's mandate. Other problems that are identified need to be passed onto an appropriate authority for further action. ***Dam Safety*** A situation assessment regarding the state of dams (including large farm and mining dams) should be prepared by the Department and a strategy developed

	to deal with problems according to a priority list. Manpower constraints in this regard may need to be addressed as well.	
Strategy, Responsibility & Priority	7.4.1 A specific person in the Regional Office should be tasked to set up a plan of action and to co-ordinate all the activities mentioned above. This Office must be supported by other Directorates in DWAF in preparing the various situation assessments and strategies.	Regional Office (Priority 1)

Strategy 7.4 Version control:	**Original version:**	Dec 2002
	Date:	Jan 2004
	Author:	T&M

Strategy 8.1

8	**MONITORING & INFORMATION STRATEGY**
Situation Assessment:	Accurate data and reliable water resources management information is imperative in making well-informed and sound management decisions. Appropriate monitoring mechanisms, evaluation of data, and the correct conversion of this data into information is crucial in both saving money when developing schemes and maintaining them later. A general opinion has been expressed by DWAF staff members that senior management within the Department do not allocate enough financial and human resources to this critical component of water management in South Africa. Adequate expenditure here will save many times this later on down the line. The National Water Act requires the Minister to establish national monitoring systems for water resources to collect appropriate data and information necessary to assess: - The quantity, quality and use of water in water resources; - The rehabilitation of water resources; - Compliance with resource quality objectives; - The health of aquatic ecosystems; - Atmospheric conditions which may influence water resources; and - Other data and information, which may be necessary. A wealth of water resources related information is stored in numerous databases both within and outside of DWAF. Although a centralised, one stop, database is not practical, there is a need for a "roadmap" to be prepared to navigate though the maze of information. To meet this requirement for integrated information the Department has already started reviewing, and revising where necessary, all data-acquisition, and monitoring and information systems. The situation in the Crocodile River Catchment may be summed up as follows: • *Baseline information and national databases*: A wealth of information exists. A portion of this information has been collated and documented in the WMA reports[13] and the Water Resources Situation Assessment[8]. As mentioned above, not enough is known as to how and where all the information is stored. • *Surface water flow*: The flow gauging network in the catchment is adequate with the exception of the river system upstream of the Hartbeespoort Dam and the Apies/Pienaars River Catchment. This holds true for the flood gauging and rainfall monitoring as well. The flow gauging stations on the main stem of the Crocodile River downstream of the Moretele (Apies/Pienaars) River Catchment and just upstream of the confluence of the Limpopo River provide very good data. This information is crucial for accurately determining water availability and water use in the catchment.

Situation Assessment (Continued):	• *Groundwater*: Monitoring does occur and information is housed within the Directorate: Geohydrology. Groundwater maps are available but this information is not easily available to water resource planners and managers. It is believed that not enough attention is paid to the use of this resource in this catchment and that much more effort can be expended to better utilise this resource. Section 2.6 of **Annexure A** is dedicated to management and monitoring requirements associated with groundwater. • *Water Quality*: Information is available and various studies have been conducted. National water quality monitoring networks include the: – Chemical Water Quality Monitoring Network – Microbial Monitoring Network – Eutrophication Monitoring Programme – River Health Programme – Toxicity Monitoring Programme Others, such as the Estuarine and the Radioactivity Monitoring Programmes, are either being planned or tested. The format and availability of this information needs better accessibility. • *Water use control*: Limited person-power exists within the Regional Offices to give proper attention to water use control. This probably remains the most important function that DWAF can conduct if it is not to loose credibility as a regulatory organisation. • *Disaster management*: The individual local municipalities have disaster management plans in place. The effectiveness of the implementation of these plans in flood/drought conditions or when pollution spills occur is largely unknown. • *Reserve related baseline and ongoing monitoring*: At this stage no dedicated or specially tailored Reserve related monitoring is conducted. • *Water Conservation and Demand Management purposes*: Unsure of the extent to which the effectiveness of these actions are monitored and evaluated. • *Water balance calculations for large impoundments*: These are conducted by the Department along with regular assessments of the levels of siltation in the dam basins.
Broad Management Objective:	To collate an inventory of monitoring activities and sources of water related information for the Crocodile River Catchment and to address all the needs mentioned in the situation assessment.

Action, Responsibility & Priority:	8.1.1 Develop a comprehensive monitoring systems which is integrated into existing systems within the Department. Synergy with other government departments information systems is also a requirement.	Dir: NWRP (N) Dir: Hydro R O
Motivation:	This Strategy is considered necessary to meet the requirement for integration of decision support information.	

Strategy 8.1 Version control:	**Original version:**	Dec 2002
	Date:	Jan 2004
	Author:	T&M

Strategy 9.1

9	**IMPLEMENTATION STRATEGY**

Situation Assessment:	Within the new dispensation of the National Water Law, the two DWAF Regional Offices (Gauteng and North West) are responsible for the practical hands-on management of the water resources of the Crocodile River (West) Catchment. DWAF Head Office provides policy direction and any other support required by the Regional Offices. The Regional Offices are currently too under-staffed and under-funded to be able to completely fulfil the roles and responsibilities set out in this ISP. Restructuring within the Department is also proceeding, which creates uncertainty and a process of adjusting to new roles. It is therefore expected that the implementation of these water resource management functions will be gradually instituted with a view to handing over some of these functions to the Catchment Management Agency that is soon to be established.
Broad Management Objective:	The strategies and approaches described in this ISP need to be implemented in future depending on priority. The work needs to be picked up by the responsible Regional Office or Directorate, specific people assigned and a budget and time scale connected to the task/strategy. There needs to be a well co-ordinated implementation plan to ensure that work is conducted and that shows water users that every effort is being made by the Regional Office to manage the water resources of the catchment, especially in the light of the levying of water resource management charges.
Overall Strategic Approach:	DWAF intends to hand over number of water resource management functions to the Catchment Management Agency (CMA) that is to be established soon. The transitional process outlined in the CMA Business Plan submitted to the Minister needs to be discussed and a plan of implementation formally adopted. **Annexure A** provides a list of CMA functions (i.e. the Regional Office in the interim) that have been put forward by DWAF. The structure of the Regional Offices is such that the responsibility for these functions is assigned to specific people, who usually have people assisting them. A co-ordinator, or champion, must be tasked to give effect to the implementation process as DWAF must show that it means business if it is already collecting water resource management levies. This co-ordinator must set up an activity list using the ISP as starting point. These activities must be prioritised. The scope of work of each activity, or assignment, must be clearly spelt out and compared with the bigger picture to ensure its relevance before it is further developed or implemented. A detailed implementation plan can then be prepared. As these plans are being drafted and implemented, further input must be incorporated in the ISP so that a more detailed and up to date perspective can be provided. It is hoped that this document will then be used by the CMA as DWAF's input into the development of a Catchment Management Strategy.

Action, Responsibility & Priority:	9.1.1 Assign a co-ordinator to champion the water resource management process in the Regional Office on a full-time basis. This person can be supported by other managers in the Regional Office and in Head Office.	Regional Office
	9.1.2 Ensure that there is co-ordination of who is doing what between the two Regional Offices responsible for this catchment.	Directors of NW and Gauteng.
	9.1.3 Set up comprehensive implementation plan linked to budgetary requirements.	Regional Office

Strategy 9.1 Version control:	**Original version:**	Dec 2002
	Date:	Jan 2004
	Author:	T&M

ANNEXURE A: GROUNDWATER REPORT FOR THE CROCODILE RIVER (WEST) CATHMENT

TABLE OF CONTENTS

INTERNAL STRATEGIC PERSPECTIVE

CROCODILE WEST WMA

GROUNDWATER OVERVIEW

1. INTRODUCTION

The Crocodile West WMA covers a total area of 29 320 km^2. The catchment drains to the NW and joins the Marico River downstream of Thabazimbi. The Limpopo River commences at the confluence.

This catchment includes the major urban areas of Johannesburg and Pretoria, plus several large towns including Brits, Rustenburg, Thabazimbi and Warmbaths (now renamed Bella Bella). Large parts of the catchment comprise the communal land areas of the ex-Bophuthatswana; Moretele 1, Odi 1, Odi 2, Bafokeng, and Mankwe Districts.

The distribution of the various quaternary catchments and urban settlements within the Crocodile West WMA is shown on Fig. 1.

2. CATCHMENT-WIDE ISSUES

Groundwater resources are available throughout the entire catchment, but in different quantities.

2.1. GUIDING PRINCIPLES

- The 1998 NWA gives equal weight to groundwater and surface water.
- Water demands must be matched to available resources. Only if groundwater is proved to be inadequate should surface water be considered as a source.
- Groundwater resources form an integral part of integrated water resources development planning.
- Conjunctive use of surface and groundwater should be encouraged where feasible to maximise the optimal use of available resources.

2.2. AVAILABILITY OF INFORMATION

In the past groundwater has often been overlooked as a water source by planners and engineers in favour of surface water. This can be ascribed to a poor perception of groundwater, a lack of trust by users, failures in groundwater based supply and the feeling that groundwater is unreliable. This is commonly due to a lack of understanding of the mechanism of groundwater occurrence and mismanagement of the available resources,

e.g., overpumping of boreholes, absence of monitoring of abstraction schemes, etc.

The situation is exacerbated by a lack of good quality information. Planners need to know the volume of available groundwater resource, the distance a suitable source is from the intended use and the reliability of the source (assuming active good aquifer management).

Information needs to be presented in a format readily understandable to planners and engineers and this information needs to be readily available. General background information is available on the published 1:2 500 000 Groundwater Resources of the Republic of South Africa prepared by J.R. Vegter (1995). Regional information is available from the published 1:500 000 hydrogeological map of Johannesburg 2526 and also the 1995 Pietersburg 2326 map which is presently being revised. More detailed information for certain areas can be obtained from DWAF. As a minimum hydrogeological maps need to be prepared for each quaternary catchment or group of quaternary catchments preferably at a scale of 1:50 000, to provide planners and engineers with quantified and visual information.

The difficulty of obtaining readily available area specific data in a quantified format is a major hindrance to optimal development of groundwater resources. Currently there are no up-to-date area specific data available for the aquifers within each Quaternary catchment, with the important exception of those rural areas served by community water supply schemes. Some information, especially for the rural areas, is available on the DWAF National Groundwater Data Base, and also on the Provincial Groundwater Data Base which is maintained and updated on behalf of DWAF by GPM Groundwater Project Managers, Polokwane.

This major shortcoming to development planning requires to be actively addressed by implementing a detailed mapping programme, starting in the most stressed and ecologically sensitive catchments, following the format of the Groundwater Resources Information Project (GRIP) being undertaken in Limpopo Province. This project envisages preparing 1:50 000 scale hydrogeological maps of each quaternary catchment which will depict the groundwater resources, groundwater quality and development potential, based upon the needs of the end user. The GRIP project of Limpopo Province is commencing with a desk study of available information, and will then involve considerable field work to infill data gaps.

2.3 GROUNDWATER RESOURCES

As noted above groundwater resources are available throughout the entire catchment, but in varying quantities depending upon the hydrogeological characteristics of the underlying aquifer. Globally it is estimated the overall groundwater recharge to the catchment amounts to some 260 million m^3/annum assuming recharge of approximately 2% of the mean annual rainfall of approximately 450mm. Some 125 million m^3 of groundwater is used annually, theoretically therefore, up to 135 million m^3/annum of annual recharge is still available for exploitation.

Away from the urban areas of Johannesburg and Pretoria many parts of the Crocodile West catchment are heavily populated and widespread rural communities are a feature of the area, in particular the districts of Moretele I, Odi I and Odi II north and NW of Pretoria, Bafokeng and Mankwe north of

Rustenburg. Groundwater is the main source of water supply to the rural communities except for the Odi I and Moretele I where reticulated supplies are available for the more densely populated southern parts of the districts.

There is extensive use of the groundwater resources of the dolomite aquifer NE of Johannesburg, (catchment A21A), south of Pretoria, (catchment A21B) and NW of Krugersdorp, (catchment A21D) where large abstraction for irrigation, domestic, industrial and municipal supply is practised.

2.4. GROUNDWATER USE

Groundwater use can be categorised as follows:

Domestic: individual boreholes for primary water supply (village hand pumps), this is feasible within a reasonable distance of the user almost everywhere (except in rugged terrain).
small scale reticulation schemes for rural villages, schools, clinics, hospitals. This is feasible in most areas with a source available within a reasonable distance, (2 –5km).
larger schemes based on several boreholes, often feasible but depends on the hydrogeological conditions of the area

Bulk water supply: wellfields comprised of several high yielding boreholes. Important bulk water supply is available in the dolomite aquifer NE of Johannesburg, south of Pretoria and NW of Krugersdorp.

Agricultural: individual boreholes (for stock watering, vegetable gardening), feasible virtually everywhere.

Irrigation: generally larger schemes requiring well developed groundwater resources, e.g. the dolomite of catchments A21A, and D, the northern part of A23K and eastern part of A24A.

Industrial (and mining): medium to large sized reticulation schemes based on several boreholes. Locally this is often feasible, depending upon available resources, demand and management practise, e.g., in the Olifantsfontein area (catchment A21B).

As noted above, current groundwater use is estimated as 90 000 000 m^3/annum, compared to the theoretical recharge of 260 000 000 m^3/annum. Overall the available groundwater resources within the catchment are under utilised although this clearly depends both on the groundwater occurrence and the demand requirement. Even weaker groundwater occurrence areas can often provide more than the RDP level of 25 litres per head per day.

2.5. GROUNDWATER QUALITY

2.5.1. NATURAL

Regionally the natural groundwater quality is usually good, satisfies the DWAF water quality guidelines and is suitable for domestic and agricultural supply.

The salt content of the groundwater is elevated in some of the areas north of Pretoria in catchments A23F and A23J where conductivities above 150mS/m occur locally in Karoo strata, especially close to the granite contact. Fluoride values >1.5mg/l are locally present in the groundwater around the Pilansberg Complex.

2.5.2. POLLUTION

Groundwater pollution is an increasing threat. Pollution of groundwater can result from:

- domestic use
- agriculture
- mining
- waste disposal

The impact of groundwater pollution from mining and waste disposal can be controlled and remediated according to the requirements of DWAF. Mines and waste disposal sites must prepare EMPR's, EIA and closure plans which will identify and put preventative and remediation measures, including monitoring, in place.

Pollution emanating from settlements, especially informal settlements, is more difficult to control. Elevated nitrate levels (NO_3 >10mg/l) in groundwater are frequently found in water supply boreholes in the traditionally settled areas of the catchment. In particular the following must be considered:

- Groundwater pollution occurs when latrine density is high. This results in a pollution plume of increased salinity and nitrate around the settlement.

- Abstraction from boreholes for water supply located within plumes has to be terminated, i.e., water quality monitoring must be implemented to determine when and if there is an unacceptable deterioration in groundwater quality.

- Groundwater must be abstracted from outside possible impacted areas, i.e., boreholes and wellfields have to be located well away from potential pollution sources.

- Education about the need for, and ways of, protecting the groundwater resources is required.

- Standards for borehole positioning, construction and protection, as specified by DWAF and SABS, must be enforced.

Waste disposal sites offer a serious potential hazard throughout the region due to poor management and lack of operating controls. This pollution risk from

the waste disposal throughout the region needs to be assessed and remediated.

2.6. MANAGEMENT AND MONITORING REQUIREMENTS

Effective groundwater management and monitoring is essential for long term sustainability of the supply and to protect the resource.

A monitoring programme needs to be implemented for each groundwater or conjunctive use scheme, involving regular measurements of:

- water levels,
- abstraction, and
- quality.

Underdeveloped areas, i.e., areas with unutilised groundwater resources development potential can be identified and earmarked for future development. Likewise areas where the available resources are overdeveloped should be identified and alternative water sources considered to alleviate abstraction stress and to augment the groundwater.

The DWAF operates a sparse monitoring network within the region, in particular in the dolomite areas of A21A, A21B, A21 D, G & H.

Groundwater development projects should be undertaken by recognised professional hydrogeologists. All contracting works should be undertaken according to a proper technical specification and bill of rates to ensure:

- correct drilling technique,
- borehole construction meets the DWAF and SABS specifications for longevity and pollution protection,
- adequate testing procedures are followed,
- water quality is determined by analysis in an accredited laboratory,
- management recommendations for the optimum long term sustainable use of the groundwater resource are prepared and implemented.

2.7. POVERTY ALLEVIATION

Groundwater has an important positive role in poverty alleviation. Development of the available resources leads to:

- an increase in water supply
- the provision of a clean water supply
- the time saved in collecting water is available for economic activity, such as
    - vegetable gardening
    - stock watering
    - chicken rearing
    - brick making

The Department of Agriculture is implementing a project to encourage the development of 1 – 2 ha plots for food production as part of poverty alleviation. Abstractions for these projects will need to be licensed if the anticipated water use exceeds the general authorisation. This project must be integrated with other water use initiatives as part of overall integrated water resources planning and management within the catchment.

3. OVERVIEW OF GROUNDWATER THROUGHOUT THE WATER MANAGEMENT AREA

The overview of the groundwater resources and associated issues is discussed according to groups of quaternary catchments sharing similar lithology and morphological characteristics. The distribution of the lithologies of the region with respect to hydrogeology is illustrated on the simplified lithostratigraphical map of Fig. 1.

Groundwater occurrence is controlled by the prevailing lithology of any given area. The entire WMA is underlain by hard rocks with aquifers developed in secondary features associated with weathering pockets and structure. Structural features are important and higher borehole yields are generally associated with these features. Well developed groundwater resources and high borehole yields are associated with the southern outcrops of dolomite between Johannesburg and Pretoria and in the Crocodile River fragment in the central part of the WMA.

Minor occurrences of alluvial deposits form primary aquifers in certain localities, e.g., immediately downstream of the Hartbeespoort dam wall and in the vicinity of the confluence of the Crocodile and Moretele rivers in A24A.

3.1. THE SOUTH EASTERN, CENTRAL, NE AND FAR NW AREAS UNDERLAIN BY GRANITE – (QUATERNARY CATCHMENTS A21C & E, SW PORTIONS OF A21A & B AND EASTERN PORTION OF A21D AROUND JOHANNESBURG, AND PORTIONS OF CATCHMENTS A21J, K, & L, A22F, J, A23B, A23E, A23F, A23J, K & L, A24B, C, G, H & J).

Granite underlies a considerable portion of the WMA, forming 4 distinct geographical areas with differing topography and use. In general groundwater occurrence is controlled by weathering and structure. Groundwater occurrence is widespread but generally low, borehole yields are usually < 0.5 l/s but sustainable yields up to 2 l/s are locally available.

THE SOUTHERN OUTCROPS UNDERLYING JOHANNESBURG AND THE NORTHERN SUBURBS.

The granite underlying the southern, watershed quaternary catchments of A21C & E and parts of A21A & B forms a high gently undulating plateau with remnants of the African erosion surface. Here relatively widespread aquifers are developed within the weathering associated with the African erosion surface. Much of this area is urban and peri-urban and there is widespread groundwater abstraction from boreholes yielding 0.5 – 5 l/s for domestic supply, garden watering and small scale industrial purposes. Boreholes tend to be 40 – 150m deep and water tables vary from <20m to >50m depending upon topographic position.

Groundwater quality is generally suitable for potable use, however, pollution is a growing problem in areas of informal settlements and poor agricultural practises.

Issues

This area represents the source of the highest tributaries of the Crocodile River.

- Groundwater pollution is locally problematic from informal settlements and poor agricultural practises. Base flow in the drainage, e.g. Jukskei River, can be heavily polluted, and contributes to the algal blooms occurring in the Hartbeespoort dam.

- Groundwater quality could be seriously impacted from the uncontrolled growth of informal settlements.

THE CENTRAL EAST - WEST ZONE, (A21J, K, & L, A22F, J, A23B, A23E, A23F, A23J, K AND A24E)

The broad east - west trending band of granite and associated rocks from Hammanskraal in the east to the Pilansberg in the west, and north towards Northam forms mostly undulating to hilly terrain, with the Pilansberg Complex forming rugged hills in the west. Most of the area is Bushveld with ranching and some agriculture. The communal land areas of Odi 1, Odi 2 and Mankwe, with widespread dependence on groundwater for water supply lie within this granitic area. The Pilansberg forms a game reserve.

Groundwater occurrence tends to be limited with sustainable borehole yields varying from <0.5 – 2 l/s, from boreholes between 40 and 100m deep. Water tables average 20 – 40mbgl.

Groundwater quality is generally good. However, zones of elevated TDS (conductivity >150mS/m) are present in catchment A23J & K in the Karoo/granite contact aquifer at depths of 80 – 120m. Areas of elevated fluoride are found in the granite in Moretele 1 and in and around the Pilansberg Complex.

Issues

In the communal land areas of Odi 1, Odi 2, and Mankwe (A23F,K, A22J, A22F and A24E):

- Availability of water during drought. Difficult to deal with in areas of low resources. Educate people on water conservation and implement water demand management where practical.

- Pollution of the resources from latrines and increasing population, with elevated TDS and NO_3. Implement strategy of education and training to protect borehole head areas from water spillage, damage by cattle drinking, etc. Position new boreholes well away from settlements, and pipe water to the settlement, where the groundwater resources are suitable to do this.

- Equipping of boreholes for domestic use with elevated NO_3, TDS and F.

- Groundwater quality could be impacted from agricultural activities, especially in those valley areas where irrigation is practised and fertiliser application is poorly managed.

In the Pilansberg Game Reserve Area

- Much of the area was impacted by previous agricultural activities. However, these impacts have mostly been reversed and much of the area is now pristine and ecologically sensitive. Any widespread or large scale development will impact on the pristine nature of the resources. Isolated game management and water supply boreholes for tourist lodges are not considered a threat since any impact will be minimal.

THE NE AREA (CATCHMENTS A23H, L, A24B, G & H)

This area is characterised by generally hilly terrain, and much of the area is remote. The area is sparsely populated and land use is mostly ranching and game farming.

Groundwater is widely used on a small scale for homesteads and stock watering. Borehole yields are between <0.5 and 2 l/s. Boreholes tend to be 50 – 120m deep and the depth to the water table varies from 30 – 50m. Groundwater quality is generally good.

The limited nature of the groundwater in these areas reduces the adverse impacts of poor groundwater management or undesirable agricultural activities.

THE FAR NW AREA (A24J)

This is the downstream quaternary between Thabazimbi and the confluence with the Marico River. The area is flat to undulating Bushveld characterised by poor to marginal groundwater resources, with yields <0.5l/s. The area is remote and sparsely populated. Groundwater is used for stock watering. Adverse impacts from these activities are unlikely. Groundwater quality is generally good.

Some irrigation is practised along the lower reaches of the Crocodile River. Water is obtained from sand storage in the river bed via pits dug in the sand of the river bed or well pointing systems.

3.2. THE SOUTHERN DOLOMITE OUTCROP, (PARTS OF CATCHMENTS A21A, B, D, F, G, H).

This area comprises the hemispherical outcrop of dolomite to the east, north and west of the granite underlying Johannesburg. It encompasses the Rietvlei dam in A21A, and the World Heritage Site centred on Sterkfontein Caves in A21D.

The dolomite forms mostly flat ground to the east and NE of Johannesburg with extensive dry land agriculture and some irrigation, especially around Bapsfontein where a total of approximately 12km^2 is irrigated To the north and NW of Johannesburg the topography is more varied with rolling countryside becoming hilly. West of Johannesburg south of Krugersdorp the area is flat with extensive irrigation (approximately 69km^2) in the Tarlton area.

Borehole yields can be >40l/s from boreholes up to 250m deep. Average borehole yields vary from 2 – 10 l/s. Water tables vary from <10m in vlei areas to 50m.

Groundwater use (1995 figures) is estimated to amount to 21.9 million m^3, this is mostly abstraction for urban supply from the dolomite aquifer in the Centurion area and irrigation abstraction in the Bapsfontein and Tarlton areas.

As seen by the widespread abstraction, the dolomite represents an important aquifer with significant groundwater resources. The potential for additional exploitation of the groundwater resources within this catchment may be considerable, this aspect requires detailed investigation to quantify the volume of water held in storage within the dolomite aquifer. The aquifer also contributes to base flow of the surface drainage flowing into the Hartbeespoort dam. Development will need to be properly managed to minimise the impact of current and future exploitation on spring flow, base flow and reserve requirements.

Groundwater quality is generally good. However, the dolomites are vulnerable to pollution, especially where karst conditions are present, and groundwater protection forms an important part of the catchment management in the dolomite areas.

Issues

A range of issues require attention:

- The dolomite aquifer crosses the catchment boundary into the Upper Vaal and Olifants WMAs.

  In the east the dolomite strike trends to the SE and crosses the catchment boundary under a thin cover of Karoo strata into the Upper Vaal and Olifants WMAs. In the west the strike is to the SW and the dolomite crosses the catchment boundary into the Upper Vaal WMA west and south of Randfontein. Abstraction from the dolomite aquifer within the catchment could impact on the resources available within the Upper Vaal and Olifants WMAs, and visa versa.

  Whether or not this is a real issue is unclear at this stage. An investigation is required to determine regional groundwater flow directions, distribution of aquifers within the dolomite rock mass, compartmentalisation due to dolerite dyke intrusions and impact of abstraction.

- The water requirements of the area are increasing due to the spread of settlements and irrigation demands, especially in catchments A21A and A21D. The available information indicates that the groundwater resources are approximately 85% utilised and that surface water is fully accounted for.

  A strategy to deal with the increased water demand should include:

  i) The registration of all water abstractors to determine the actual water use within the catchment.
  ii) The Regional Offices/CMA should issue general licenses for domestic abstraction and village level irrigation plots. Such water can be considered part of the reserve.
  iii) Further studies are required into the groundwater resources of the dolomite aquifer before quantified decisions concerning applications for commercial licenses can be made.

iv) An integrated plan of action should be put in place to ensure the optimal use of all the available local resources.

- The dolomite aquifer is an important strategic water resource that requires active management to ensure long term sustainability of both quantity and quality. Knowledge of the volume of the groundwater resources available, and the impact of existing use, contribution to spring/surface water flow and the reserve requirements is essential before decisions concerning further abstraction can be made. This requires the implementation of a catchment wide monitoring programme of both quantity and quality involving regular measurement of abstraction volumes, water levels and periodic water quality analysis. Monitoring is part of the groundwater management strategy necessary for the CMS.

- Is artificial recharge of the dolomite aquifer an option as part of water resources management? Artificial recharge of aquifers is a recognised technique for preserving and managing groundwater resources. The dolomite aquifer could be targeted for artificial recharge of, for example, excess runoff during floods and purified effluent from the Kempton Park sewage works. The high permeability of the dolomite would theoretically enable dedicated boreholes to be used for this purpose.

  Artificial recharge means that 100% of water placed into the aquifer is stored, none is lost to evapotranspiration.

  In view of the increasing demands being placed on the dolomite aquifer, especially in catchments A21A and A21D, the feasibility of an artificial recharge scheme should be investigated. This would require the selection of a suitable site, appropriate borehole design, and, importantly, determination of the water quality needed to recharge the dolomite aquifer.

- Abstraction from the dolomite aquifer is reported to have caused sinkholes to develop. Areas where the ground is already unstable and water levels are allowed to fluctuate regularly are particularly vulnerable to sinkhole development.

  i) The present distribution of sinkholes should be mapped to indicate the extent of this reported problem.
  ii) Measures will be required to limit the impact of abstraction on the formation of sinkholes, particularly in areas where housing and settlements are present.
  iii) Land use planning should prohibit/restrict the development of settlements in dolomitic areas.

- The effluent discharge from Kempton Park Sewage Works, the growth in settlements, especially in the A21A, and the widespread agricultural use of A21A and A21D in particular could lead to pollution of the dolomite groundwater resources.

  The effluent from the Kempton Park sewage works is discharged into the surface drainage system which flows across the dolomite outcrop into the Rietvlei dam. In periods when the sewage works is not operating correctly this can lead to pollution of both the surface and, more seriously, the groundwater system.

Informal settlements with a lack of adequate water and sanitation services will impact on the quality of groundwater, (e.g., e-coli, nitrates and salinity).

i) Control over the operation of the sewage works and quality of effluent.
ii) The adequate provision of water and sanitation services in tandem with formal township planning and establishment. In the short-term it may be necessary to provide new VIPs with lined pits.
iii) Discourage settlements in dolomitic areas.

- Impact of mine closures

  Concern has been expressed about the impact closure of the gold mines in the southern part of the catchment could have on the quality of the groundwater resources of the dolomite aquifer north of Randfontein. It is reported, for example, that SO_4 rich groundwater is entering the dolomite compartment within which the Sterkfontein Caves are present.

  The Regional Office/CMA should investigate the long term plans of the mines and ensure that mine closure plans and strategies are in place to deal with any pollution caused by decant of poor quality water into the surface and groundwater environment.

- Groundwater Pollution from Agriculture

  The impact of agriculture and agricultural practise on groundwater pollution needs to be addressed, particularly since dolomite aquifers are potentially vulnerable to the rapid ingress and spread of pollutants due to the high permeability.

  Eutrophication of Hartbeespoort Dam is a serious problem leading to high treatment costs for water and unpleasant recreational facilities. Much of the eutrophication may be due to pollution from fertilisers being washed/leached into the surface and groundwater systems.

  Undertake investigations into the pollution caused by (overuse of) fertilisers to determine whether overuse contributes to water pollution. Prepare strategy to educate farmers in reducing fertiliser use, improve irrigation practise, etc.

- Management Control of the Malmani Dolomite Aquifer.

  The dolomite represent a strategic water resource. As presently envisaged the outcrop falls into several CMA's even though the boundaries of the dolomite aquifers and compartments do not coincide with the surface catchment boundaries. Should a separate CMA be formed to deal specifically with the dolomite aquifer?

3.3. THE NORTHERN DOLOMITE OUTCROP (PARTS OF A24D, F, H & J).

Malmani dolomite forms a narrow SW - NE trending outcrop to the west of Thabazimbi. The topography is gently rolling to hilly. The groundwater resources of these dolomites are mostly limited (borehole yields <2 l/s) although yields of >5l/s are locally reported, e.g. in the northern portion of

Mankwe District at Mokgalwaneng where conditions are favourable. Karst development is mostly absent or localised and groundwater occurrence tends to be structurally controlled.

Groundwater quality is good. Parts of this area are remote, groundwater quality is pristine and the area ecologically sensitive.

Issues

- Sections of this area are remote and ecologically sensitive. Any development will impact on the pristine nature of the resources.
- No development/licensing can be authorised without knowledge of the impact on spring flow and the reserve.
- Pollution of groundwater by mining effluent and agricultural activities in the Thabazimbi area.
- Impacts caused by mining need to identified and remediated if necessary. Prevention measures must be put in place. EMPR's need updating, closure plans required for mining to assess impacts of decant. Monitoring programmes to be established/maintained.
- In the communal land areas the availability of water during drought. Difficult to deal with in areas of low resources. Educate people on water conservation and implement water demand management where practical.
- Pollution of the resources from latrines and increasing population, with elevated TDS and NO_3. Implement strategy of education and training to protect borehole head areas from water spillage, damage by cattle drinking, etc. Position new boreholes well away from settlements, and pipe water to the settlement, where the groundwater resources are suitable to do this.

3.4. THE DOLOMITE OF THE CROCODILE RIVER FRAGMENT (PARTS OF CATCHMENTS A23K, A24A & B).

This is an area of dolomite lying between ridges of quartzite across which the Crocodile River flows. The confluence between the Moretele River and Crocodile River is in this area. Assen is the main settlement. The dolomite forms relatively flat ground with widespread agriculture and irrigation. Irrigation water is drawn from alluvial deposits alongside the course of the Crocodile River as well as from the dolomite.

Borehole yields are can be >10l/s, especially from the shallow primary alluvial aquifer. Aquifers in the dolomite are areally limited and restricted to structural features and zones of deeper weathering and karst development. Groundwater levels in the alluvial aquifer are between 5 – 10mbgl, increasing to 20m in the dolomite aquifer.

The groundwater quality is good. The potential for elevated NO_3 due to agricultural activities is high and the aquifers are vulnerable to pollution.

Issues:

- Groundwater quality could be impacted from agricultural activities, especially along the Crocodile river where irrigation is practised and the application of fertiliser is poorly managed.

3.5. THE SOUTHERN BELT UNDERLAIN BY QUARTZITE AND SHALE, WITH MINOR ANDESITE IN THE WEST, OF THE PRETORIA GROUP, (FROM EAST TO WEST PARTS OF CATCHMENTS A23A, B, D & E, A21H, J, G, F & K, A22G, H, C, B, A, D & E).

Quartzite and shale underlie a broad east – west trending zone from A23A in the east to A22A & E in the west. It includes the prominent Magaliesberg Range. Hartbeespoort Dam lies in A21H on shale behind the dam wall built on the Crocodile River where it traverses the quartzite. The large urban areas of Pretoria lie within this zone, together with several smaller towns to the west including Koster and Swartruggens.

Use is characterised by extensive small holdings close to the urban areas. Widespread dry land farming with maize and cattle ranching is practised further to the west. Much of A22E in the west comprises communal land with widespread dependence on groundwater for water supply, vegetable gardening and stock watering.

Apart from the Magaliesberg range the topography is mostly flat to gently undulating.

Aquifers developed within these Pretoria Group lithologies are associated with weathering and fracturing of the bedrock. Groundwater resources are widespread but areally limited. Borehole yields are generally <0.5 l/s to 2.0 l/s. Water levels are 20 – 30mbgl. There is considerable abstraction from the alluvial aquifer immediately downstream of the Hartbeespoort dam wall for irrigation.

Groundwater quality is generally good and suitable for domestic, stock watering and irrigation uses. Elevated chlorides downstream of the Hartbeespoort Dam wall pose problems for tobacco farmers, these chlorides are derived from the surface water recharging the alluvial aquifer.

Issues

- Availability of water during drought in the communal areas of A22E. Difficult to deal with in areas of low resources. Educate people on water conservation and implement water demand management where practical.

- Pollution of the resources from latrines and increasing population, with elevated TDS and NO_3. Implement strategy of education and training to protect borehole head areas from water spillage, damage by cattle drinking, etc. Position new boreholes well away from settlements, and pipe water to the settlement, where the groundwater resources are suitable to do this.

- Impacts of overgrazing on groundwater recharge, soil erosion and surface runoff need to be addressed.

- Impacts of agricultural practise on groundwater quality must be assessed, especially with regard to over use of fertilisers, and surface runoff of nitrate and phosphate rich water entering drainages and the groundwater resources which then provide base flow.

- Impact of alluvial aquifer recharge from surface water with elevated chloride levels on agricultural activities.

3.6. THE SW - NE BELT UNDERLAIN BY INTERBEDDED QUARTZITE, SHALE, ANDESITE AND BANDED IRONSTONE OF THE PRETORIA GROUP, (PARTS OF CATCHMENTS A23D, F, G & H) AND ALSO PARTS OF A23L, A24A, B & C.

This area comprises a strip of hilly and rugged terrain stretching from west of Northam NE to Thabazimbi and then east towards Warmbaths, and the areas centred on Rooiberg. The western areas (A24D) are comprised of communal land (Mankwe District) with the remainder cattle ranching and game farming. Apart from the communal land areas, these lithologies mostly occur in sparsely populated and remote areas. Thabazimbi iron ore mine occurs in A24H, as does the now closed Rooiberg Tin mine.

There is widespread dependence on groundwater in A24D for domestic supply and stock watering, elsewhere groundwater abstraction is limited to isolated homesteads and stock and game watering. Groundwater occurrence is controlled by zones of deep weathering and structural features such as faults and fracture zones and geological contacts. Aquifers tend to be localised. Sustainable borehole yields average <0.5 – 2 l/s. The water level depth is variable depending upon topographic position and ranges from 15 – 50mbgl.

The groundwater quality is good. However, localised elevation of NO_3 is reported in the communal areas and there is a continuing pollution threat from the mining activities at Thabazimbi. Impacts from agriculture are unlikely due to the localised nature of the aquifers and sparse abstraction.

Issues:

- Pollution of groundwater by mining effluent and agricultural activities in the Thabazimbi area.

- Impacts caused by mining need to identified and remediated if necessary. Prevention measures must be put in place. EMPR's need updating, closure plans required for mining to assess impacts of decant. Monitoring programmes to be established/maintained.

- Availability of water during drought, especially in communal land areas. Difficult to deal with in areas of low resources. Educate people on water conservation and implement water demand management where practical.

- Pollution of the resources from latrines and increasing population, with elevated TDS and NO_3, especially in areas of informal settlement. Implement strategy of education and training to protect borehole head areas from water spillage, damage by cattle drinking. Position new boreholes well away from settlements, and pipe water to the settlement, where the groundwater resources are sufficient to do this.

3.7. THE SOUTH CENTRAL E - W TRENDING AND NORTH WESTERN SW - NE TRENDING AREAS UNDERLAIN BY NORITE AND GABBRO OF THE BUSHVELD IGNEOUS COMPLEX, (FROM E IN A CLOCKWISE DIRECTION QUATERNARY CATCHMENTS A23E, A21J & K, A22H, J, F & E, A24D, E, F & C).

These catchments are characterised by flat to gently undulating topography. The northern suburbs and industrial urban areas of Pretoria, Brits and Rustenburg and the smaller town of Northam are within these catchments. The communal areas of Odi 1, Odi 2, Bafokeng and Mankwe are also underlain by these lithologies. Agriculture is widespread.

There are numerous platinum and chrome mines between Brits and Rustenburg, west of the Pilansberg Complex and north towards Northam. Mining activities have a significant impact on the groundwater resources due to dewatering and the potential for groundwater pollution. Significant potential for conflict between farming communities and local inhabitants and the mines exists due to mining impacts on groundwater.

Groundwater within these lithologies is widespread and borehole yields of 0.5 – 2 l/s are common, with >5 l/s locally available. Water tables tend to be shallow, often <15mbgl. There is extensive reliance on groundwater to supply the domestic needs of the rural communities of the communal lands, and for homesteads and stock watering.

Groundwater quality is generally good. However, the groundwater quality has been impacted in many places due to industrial and mining pollution, pollution from agriculture and the growth of settlements.

Issues

- Conflicts between the demands of the local population, and dewatering and quality impacts are occurring and can be anticipated to occur in the future. The mines need to undertake sympathetic and responsible development to minimise impacts on the groundwater resources.

- Groundwater pollution from mining activities can be anticipated. Ensure compliance with EMPR's and mine closure plans.

- Groundwater pollution from industrial activities is occurring and can be anticipated. Remediation strategies need to be agreed and implemented.

- Availability of water during drought, especially in communal land areas. Difficult to deal with in areas of low resources. Educate people on water conservation and implement water demand management where practical.

- Pollution of the resources from latrines and increasing population, with elevated TDS and NO_3, especially in areas of informal settlement. Implement strategy of education and training to protect borehole head areas from water spillage, damage by cattle drinking. Position new boreholes well away from settlements, and pipe water to the settlement, where the groundwater resources are sufficient to do this.

- Pollution of groundwater from agricultural practice.

3.8. THE EASTERN AREAS UNDERLAIN BY MOSTLY ARGILLACEOUS STRATA OF KAROO AGE, PARTS OF CATCHMENTS A23C, F, G, H, J & K.

This area is the western extent of the Springbok Flats and comprises flat to gently undulating topography. Most of the area is comprised of the communal lands of Moretele 1 and Odi 1 districts and is heavily populated in the southern areas of A23F, J and K. There is widespread dependence on groundwater for domestic supply and stock watering, except for the larger settlements in the southern areas which have piped water schemes sourced from surface water. Elsewhere dry land agriculture and cattle ranching is practised.

These catchments are mostly underlain by marls and clays of the Upper Karoo with low groundwater development potential. Sustainable borehole yields <0.5 l/s are the norm. Towards the NE and the basalt the Clarens Formation sandstone outcrops. Here the groundwater development potential is enhanced with sustainable borehole yields of 1 – 2 l/s sometimes feasible. Water levels are generally 20 – 30mbgl.

Groundwater quality is variable with DWAF Class 2 or 3 water frequently encountered due to naturally elevated TDS associated with the low permeability marls. As noted above elevated TDS is present in the contact zone with the underlying granite in the south and west. Groundwater quality is, however, good in the Clarens sandstone outcrop areas, with DWAF Class 0 or 1 the norm.

Issues

- Availability of water during drought in areas reliant on groundwater for domestic supply and stock watering. Difficult to deal with in areas of low resources. Educate people on water conservation and implement water demand management where practical.

- Pollution of the resources from latrines and increasing population, with elevated TDS and NO_3. Implement strategy of education and training to protect borehole head areas from water spillage, damage by cattle drinking, etc. Position new boreholes well away from settlements, and pipe water to the settlement, where the groundwater resources are suitable to do this.

- Groundwater quality could be locally impacted from agricultural activities

3.9. THE NE AREA UNDERLAIN BY BASALT OF KAROO AGE (PARTS OF CATCHMENTS A23C, G & H).

These basalts form the Springbok Flats south of Warmbaths (Bella Bella). The area is characterised by extensive agriculture with significant irrigation abstraction. Borehole yields of 10 l/s or more are common from aquifers developed within deep weathering and well developed fracturing. Over abstraction in the past 20 years or so has led to a reduction in the number of centre pivots in the area.

Groundwater quality is often impacted by elevated NO_3.resulting from fertiliser application and poor agricultural practise.

Issues:

- Issuing of licenses for irrigation abstraction. A study to determine the available groundwater resources is required. Once the available resources and current use are known, licensing for additional abstraction or reduction in abstraction can be undertaken.

- The impact of over abstraction for irrigation needs to understood, although this is self regulating to some extent since farmers reduce irrigation if borehole yields decline to below economic volumes due to lowering of water levels.

- The impact of agricultural practise on groundwater quality must be assessed.

3.10. VARIOUS RELATIVELY SMALL AREAS UNDERLAIN BY RHYOLITE/FELSITE, (PARTS OF CATCHMENTS A23B & G, A24B & G).

These areas are characterised by rolling countryside. They are entirely agricultural with very limited groundwater resources and marginal groundwater development potential. Aquifers are associated with local structural features. Sustainable borehole yields are always <0.5l/s, but often sustainable yields are not feasible even at low discharges. Groundwater levels are highly variable 20 – 60 mbgl depending upon topographic position from boreholes which are between 70 – 150m deep.

Groundwater quality is good. Development is very limited. Adverse quantity and quality impacts from agriculture will be areally limited due to the isolated nature of the aquifers.

3.11. THE NORTHERN AND NE AREAS UNDERLAIN BY MAINLY ARENACEOUS STRATA OF WATERBERG AGE, (PARTS OF CATCHMENTS A23G AND A24G AND H).

This comprises the area north of Warmbaths (Bella Bella) and the Waterberg Mountains north and east of Thabazimbi underlain by a sequence of mainly coarse grained sandstone and conglomerate. The area is structurally complex with numerous major faults and fracture zones and is characterised by a rugged and mountainous terrain with steep sided valleys.

This area comprises mostly agricultural land and game farms.

Groundwater resources are generally limited with sustainable borehole yields often <0.5l/s, although higher yields (>3l/s) are found along fault and fracture zones.

The groundwater quality is good and much of the area is pristine. The Waterberg Mountains are an important recharge area and groundwater provides important baseflow to surface drainage.

Issues

- Much of the area is pristine and ecologically sensitive. Any widespread or large scale development will impact on the pristine nature of the resources. Isolated game management and water supply boreholes for tourist lodges are not considered a threat since any impact will be minimal.

- Groundwater quality could be impacted from agricultural activities, especially in those valley areas where irrigation is practised and fertiliser application is poorly managed.

- Groundwater quality could be seriously impacted from the uncontrolled growth of informal settlements around the existing settlements.

3.12. RIVER BED SAND AQUIFERS.

The sand deposits of drainage channels are often used to obtain water, either directly from the surface flow of the river, or from sand abstraction schemes constructed in the river bed sediments.

Wellpoints offer a means of abstracting water from rivers from the subsurface flow and storage within the sand aquifers after the visible flow has ceased. Usually these schemes operate until the subsurface flow has diminished and the water level has declined to such an extent that the volume of water delivered is no longer viable for the intended use.

Numerous wellpointing schemes are installed along the Crocodile River and its tributaries where sand deposits are suitably developed. It is considered that sand abstraction schemes are over utilising the available resources and licences for new schemes are not being issued at present.

PTO

4. GROUND WATER/SURFACE WATER LINKAGE

Groundwater contributes to base flow throughout the catchment via sub surface seepage and springs. The dolomite outcrop, Magaliesberg Range and the southern belt of Pretoria Series strata in the south of the WMA, and the Waterberg Range in the north, are important areas for groundwater recharge and base flow. It is estimated that the groundwater contribution to base flow in the entire Crocodile River catchment amounts to 95 770 000m^3/annum. A large proportion of this base flow comprises spring flow from the dolomites in catchments A21A, A21B, A21D, A21F and A21G and A21H.

The relationship between groundwater, base flow, and river flow is reasonably well understood where hydrographs are available. However, the impact of groundwater abstraction on surface water resources is less well understood and this is an aspect that warrants study especially in sensitive catchments such as Rietvlei (A21A) and Krugersdorp (A21D) where large scale abstraction from the dolomite aquifer occurs

Recharge of the groundwater system from river flow, especially during flood events, is important particularly in the dolomite aquifers and the primary alluvial aquifers associated with the Crocodile River downstream of the Roodekoppies Dam and the confluence with the Moretele River in catchments A23K, A23L, A24A and A24B.

GRAHAM HUBERT
GOLDER ASSOCIATES AFRICA
26th March 2003