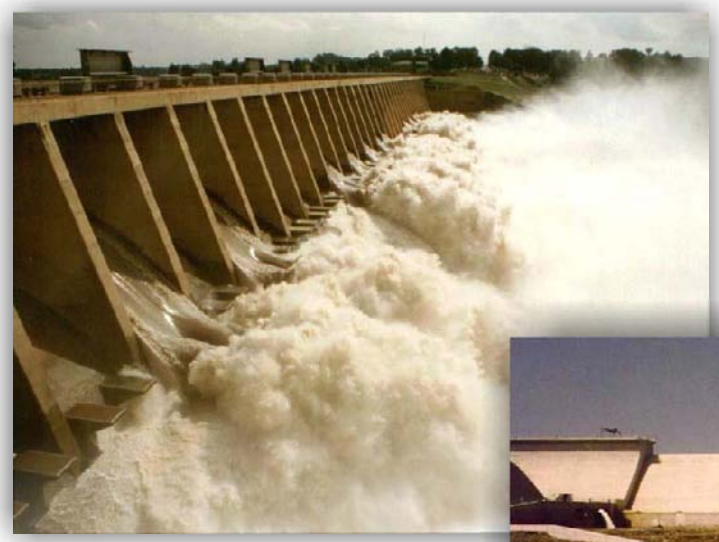
Report Number: P WMA 10/000/00/0304

DEPARTMENT OF
WATER AFFAIRS AND FORESTRY
Directorate: National Water Resource Planning

Internal Strategic Perspective
Lower Vaal Water Management Area



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Department of Water Affairs and Forestry
Directorate National Water Resource Planning

INTERNAL STRATEGIC PERSPECTIVE

FOR THE

LOWER VAAL WATER MANAGEMENT AREA (WMA No 10)

APPROVAL

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INVITATION TO COMMENT

This report will be updated on a regular basis until it is eventually superceded by the Catchment Management Strategy.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

ELECTRONIC VERSION

This report is also available in electronic format as follows:

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

  or from the Version Controller (see page iv)

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

- Lower Vaal WMA Internal Strategic Perspective (*This Report*)
  (Report No: P WMA 09/000/00/0304)
- Vaal River Overarching Internal Strategic Perspective
  (Report No: P RSA C000/00/0103)
- The National Water Resource Strategy, First Edition 2004
- The Lower Vaal WMA - Overview of Water Resources Availability and Utilisation
  (Report No: P WMA 10/000/00/0203)
- The Lower Vaal WMA – Water Resources Situation Assessment
  (Report No: P WMA 10/000/00/0302)

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 below)

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EXECUTIVE SUMMARY

Introduction

The Internal Strategic Perspective (ISP) for the Lower Vaal Water Management Area (WMA) is described in this document, and represents the Department of Water Affairs' (DWAF) view on how Integrated Water Resource Management (IWRM) should be practiced in the WMA.

The emphasis in this document is on aspects that are specific to the Lower Vaal WMA. The Lower Vaal WMA is part of a greater water supply system which includes a number of neighbouring WMAs. The strategies for IWRM for the greater system are presented in the ***Vaal Overarching ISP****. The Lower Vaal ISP should be read in conjunction with the Vaal Overarching ISP to get a complete understanding of the strategies and issues.*

The information in the report has been compiled from past studies, but more importantly, it captures the knowledge of DWAF officials that are active in the different spheres of water resource management of the Vaal River System. In the drafting of the perspectives or strategies contained in this document, cognisance was taken of the legal requirements of the National Water Act and the strategic direction or framework given by the ***National Water Resource Strategy (NWRS)****.*

Water resource management is carried out in a changing environment and it should be recognised that this ISP is based on the prevailing situation and conditions at the time of compiling the document. It is the intention of DWAF to regularly update this document to keep the information and strategies relevant.

Overview of the Lower Vaal Water Management Area

The climatic conditions vary considerably from west to east across the WMA, with the Mean Annual Precipitation (MAP) reducing from 500 mm in the east to 200 mm in the west with an average of 350 mm. This tendency is reversed when considering potential annual evaporation, which increases from 2650 mm in the east to 2700 mm in the dry western parts of the WMA. The land use in the Lower Vaal WMA is characterised by agriculture with the main crops being maize, cotton, groundnuts, vegetables and sunflowers. Agricultural activities is however dominated by livestock farming. There is also extensive diamond mining activities located in the Lower Vaal water management area. These activities are generating substantial return flow volumes in the form of treated effluent from the urban areas and mine dewatering that are discharged into the river system. These discharges are having significant impacts on the water quality in the main stem of the Vaal River in the Lower Vaal WMA.

The Lower Vaal WMA has an average economy, contributing approximately 2% of the GDP of South Africa. It is expected that economic activity will remain relatively static in the medium to long term. Mining and agriculture are important contributors to the economy of the region, and is expected to continue to play an important role in the economy of this WMA.

Due to the extensive development in the Vaal River System , the local surface water resources in all three the Vaal WMAs have been fully exploited, more than three decades ago. It was therefore necessary to augment the supply by developing various transfer schemes importing water from the Thukela and Usutu to Mhlathuze WMAs, as well as from the Kingdom of Lesotho through the Lesotho Highlands Water Project (LHWP).

Water Availability

The surface water availability in the Vaal River System is estimated through a set of water resource models, each fulfilling a particular function in the management of the water resources. Combined, these models serve as a decision support tool that contains a large and comprehensive database of hydrological and physical system characteristics, required to simulate the water resource systems as realistically as possible. Due to the interdependencies, the management and planning of the Vaal River System is undertaken at the national level and not by the Lower Vaal water managers (CMA when it is established, until then the DWAF Regional Office).

The Lower Vaal water managers will be responsible for the assessment of the availability of the local groundwater and surface water resources used to supply local authorities and district councils without access to the Vaal River System water supply infrastructure.

Water Requirements

Water use in the water management area is dominated by irrigation, which represent 80% of the local requirements for water. About 12% of the requirements is for urban and industrial use, 7% for rural domestic supplies and stock watering, and the remainder for mining purposes.

The water requirement projections that are currently used for planning originate from the development of the National Water Resource Strategy (NWRS). The total water requirements in the Lower Vaal WMA is currently 643 million m^3/annum. *The total water requirements for the Lower Vaal are projected to reach 642 million m^3/annum by the year 2025, for the base growth scenario.*

Water Balance Reconciliation

The water balance for the Lower Vaal WMA indicates that for the year 2000, an overall surplus in supply of 30 million m^3/annum was available. With the commissioning of Phase 1b of the LHWP (Mohale Dam and transfer tunnel) during the latter part of the year 2003, an additional 344 million m^3/annum is available to the Vaal river system. This surplus is expected to be gradually depleted over time to supply the growing water requirements in mainly the Upper Vaal WMA. The Lower Vaal system is expected to be in balance for the year 2025 using the base requirement scenarios.

*What is important to recognise is that this estimated excess in supply is qualified as "**conditional**" since it is only available if all the transfers are fully operational. In practice the volume of water conveyed through the Thukela-Vaal Transfer scheme will be determined annually, effectively operating the system such that the water demands are in balance with the supply. The quantity transferred will thus increase over time in line with the growth in the water requirements.*

The possible reconciliation options for the Vaal River System are dealt with in the Vaal Overarching ISP. The role of the Lower Vaal CMA will largely be water conservation and demand management (WC&DM), trading of water allocations and assisting with the water balances of the local authorities and district municipalities who are dependent on local resources for their supply and not the main water supply infrastructure supported by the Vaal River System.

Due to the very low growth rate of the projected water requirements (projected demand curve is flat) the impact of Water Conservation and Demand Management could result in a substantial decrease in water requirements in the Lower Vaal WMA. It must be noted that, due to the lack of system wide planning information on possible future WC&DM measures, the water balance calculations presented above do not allow for the impacts of WC&DM. This was identified as a gap in the current knowledge in the Vaal Overarching ISP and a study is being proposed to collate all planning information on WC&DM. The targets for WC&DM will be set by the Vaal Overarching Study and the role of the Lower Vaal CMA will be to promote WC&DM and encourage the water service providers to achieve their targets.

The allocation of the conditional surplus will be managed by the National Department of Water Affairs and Forestry in accordance with the licensing process and adhering to the conditions that are presented in more detail in **Strategy Table A.3.2** of **Appendix A**.

Water Quality Management

The water quality varies from poor in the highly developed areas to good in the less developed areas. The water quality is impacted on by point discharges from industries, wastewater treatment works, mine dewatering, irrigation return flows and diffuse sources such as runoff from mining and industrial complexes, agriculture and urban areas.

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The current approach adopted in managing water quality is to apply the steps presented below on a sub-catchment basis. The first step is to carry out a situation assessment during which Interim Water Quality Objectives (WQO) are established and water quality variables of concern and sources of pollution are identified. The WQO are based on the water quality requirements of the user sectors as well as from the ecology. The subsequent phases in the process, following the situation assessment, are to develop water quality management plans or catchment management strategies. During this phase water management interventions such as source control, treatment and dilution are assessed. These phases also involve the revisiting of the WQO in an iterative manner to reach a balance between the water user requirements and achievable management strategies that do not impede continued economic growth.

The cascading characteristic of the three Vaal WMAs has the consequence that the water quality of the main stem of the Vaal River in the downstream WMAs is impacted on, not only by the activities in the WMA itself, but also by the water received from upstream. In addition, the water quality in the Vaal River will also impact on the water quality of the Orange River in the Lower Orange WMA. Due to this inter-dependency it was identified that the current process of managing water at sub-catchment level, should be expanded to integrate management activities across sub-catchments, to meet shared water quality objectives in major tributaries as well as in the main stem of the Vaal River. This study has been prioritised as part of the Vaal Overarching ISP. The Lower Vaal CMA will have to revisit existing WQO and carry out future development of sub-catchment strategies within the framework of the Integrated Study.

Institutional Aspects

The role of the Lower Vaal WMA CMA will include:

- *To manage the water quality by setting WQOs and developing a CMS as per the Water Quality Management Strategy. The setting of the WQOs will be within the framework of the Integrated Water Quality Management Plan for the Vaal River System (See details in Strategy A2.2).*
- *The monitoring of the system to provide management information for water quality management, abstraction control and input to the overarching operations and planning processes.*
- *Provide input into the supply of local authorities from local groundwater and surface water resources. This will be in the form of strategic level guidance as to where water can be obtained and the level of study needed to be submitted with the license application.*
- *All water use licences will be issued through the Lower Vaal WMA CMA.*
- *A very important communication role between the Water Users and the utility/DWAF Head Office*
- *Promotion of WC&DM through the water service providers and local authorities/DWAF Head Office to achieve efficient use of water. Only once efficient use has been achieved can further transfers be considered.*
- *Other delegated functions as determined during the process of establishing the CMA.*

Water Infrastructure Management

Due to the inter dependencies of the Vaal WMAs, the operation of the infrastructure has to be undertaken in a coordinated way to achieve the best efficiencies and balance potential among stakeholders. This management will therefore be undertaken at the National level.

The Lower Vaal CMA may, depending on the findings of the Integrated Water Quality Study, be responsible for the management of treatment and reuse infrastructure for mine dewatering and sewage treatment plant return flows.

Monitoring and Information Management

The successful operation of the Vaal River System requires effective monitoring networks and information management systems. There is an extensive network of flow, rainfall and water quality monitoring stations in the catchment. However, studies have highlighted the need to expand the monitoring network to include more gauges to determine river losses, bulk distribution system losses, and to track water requirements. Bio-monitoring should be included to assist with the determination and implementation of the ecological Reserve. A consolidated assessment needs to be made of all the monitoring and data management requirements of the Vaal River System. This process should identify all the water resource management activities that require monitoring information, and should focus on the integration of monitoring systems that are directly under the control of the Department, as well as from other institutions.

The Lower Vaal water managers will be required to co-ordinate all the monitoring and information requirements within the WMA. This will include the compliance and other monitoring requirements of the WMA itself as well as the monitoring requirements of the Vaal River System to be used by the National body carrying out the overarching management.

ISP Implementation Strategy

The ISP is intended to act as DWAF's perspective on how the Lower Vaal WMA water resources should be managed. The final ISP will be published and be open to comments from local authorities, water user associations and other water related forums and interested stakeholders. Mechanisms are to be put in place to capture anomalies and it is intended that formal updates of the document will occur periodically until such time as the Catchment Management Agency is technically functional and a Catchment Management Strategy developed.

Internal Strategic Perspectives (ISPs) for the Central Region:
Lower Vaal Water Management Area (WMA 9)

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LIST OF ABBREVIATIONS

Acronym	Meaning
CMA	Catchment Management Agency
CMS	Catchment Management Strategy
DDG	Deputy Director General
DEAT	Department of Environment Affairs and Tourism
DWAF	Department of Water Affairs and Forestry
EFMP	Environmental Flow Management Plan
EFR	Ecological Flow Requirements
EIA	Environmental Impact Assessment
EMC	Ecological Management Class
EMPR	Environmental Management Plan Report
GWS	Government Water Scheme
IDP	Integrated Development Programme
IFA	Instream Flow Assessment
IFR	Instream Flow Requirements
IRDP	Integrated Rural Development Programme
ISP	Internal Strategic Perspective
IWRM	Integrated Water Resources Management
LHWP	Lesotho Highlands Water Project
MAP	Mean Annual Precipitation
MAR	Mean Annual Runoff
NEMA	National Environmental Management Act
NGO	Non Governmental Organisation
NWA	National Water Act
NWRS	National Water Resources Strategy
ORRS	Orange River Development Replanning Study
OVTS	Orange Vaal Transfer Scheme
RDM	Resource Directed Measures
RDP	Reconstruction and Development Programme
TDS	Total Dissolved Solids
TLC	Town Local Council
VAPS	Vaal Augmentation Planning Study
VRSA	Vaal River System Analysis Study
VRSAU	Vaal River System Analysis Update
WARMS	Water-use Authorisation and Registration Management System
WC/ WDM	Water Conservation/ Water Demand Management
WfW	Working for Water
WMA	Water Management Area
WQM	Water Quality Management
WQO	Water Quality Objectives
WR90	Water Resources 1990 Project
WRSAS	Water Resources Situation Assessment Studies
WSA	Water Services Act
WSAM	Water Situation Assessment Model
WSDP	Water Services Development Plan
WUA	Water Users Association

GLOSSARY OF TERMS

Term	Meaning
Aquiclude	A bed, formation or group of formations essentially impervious to water.
Aquifer	Any strata or a group of interconnected strata comprising of saturated earth material capable of conducting groundwater and of yielding usable quantities of groundwater to borehole(s) and / or springs (a supply rate of 0.1 L/s is considered as a usable quantity). Latin: aqua water and ferre to carry.
Borehole	Drilled hole used to abstract, recharge or monitor groundwater.
Catchment Management	It is the holistic and integrated management of South African water resources at catchment level. Its aim is to achieve a balance between development and the protection of our water resources and to involve people in water resources decision-making processes.
Catchment	An area of land from which any rainfall will drain into the water course or watercourses and flow to a common point, has definable physical boundaries.
Catchment Management Agency **(CMA)**	A water management institution which manages Water Management Area (WMA).
Catchment Management Strategy **(CMS)**	A strategy for a water management institution which manages Water Management Area (WMA).
Department of Water Affairs and Forestry **(DWAF)**	DWAF is the national custodian of South Africa's water and forestry resources. It is primarily responsible for the formulation and implementation of policy governing these two sectors.
Environmental Impact Assessment **(EIA)**	EIA is a project specific process, which looks at how a proposed development might impact on the environment, and at how those impacts might be mitigated.
Environmental Management Frameworks **(EMF)**	The EMF is a spatial inventory, essentially a filing system of information, with a strong focus on biophysical parameters. Specific environmental management parameters are connected to this information.
Geographical Information System **(GIS)**	A GIS is a computer-based tool for mapping and analysing things that exist and events that happen on Earth. GIS technology integrates common database operations such as query and statistical analysis with the unique visualisation and geographic analysis benefits offered by maps.
Groundwater Information Index System **(GIIS)**	The GIIS is essentially a database which contains basic information on the sources of groundwater, related subject matter and provides planners and consultants with a useful tool to source existing geohydrological reports and other relevant data.
Groundwater	All subsurface water occupying voids within a geological stratum.
Integrated Environmental Management **(IEM)**	IEM has become the umbrella term, or toolbox, within which all environmental assessment processes, and environmental management practices, reside. IEM has become a guiding philosophy - the interface for the various environmental management processes and is the umbrella covering EIA, SEA and EMP.
Ventilated Improved Pit-latrine **(VIP)**	A sanitation facility consisting of a stable cover or slab over a pit which is ventilated by a pipe extending above the roof of the top structure, with fly-proof netting across the top. The interior of the top structure is maintained in relative darkness.

Term	Meaning
Working for Water **(WfW)**	It is a multi-departmental public works programme, with the express purpose of dealing effectively with the problem of invading alien plants. It also addresses one of the greatest challenges facing South Africa, that of unemployment.
Water Management Area **(WMA)**	It is an area established as a management unit in the national water resource strategy within which a catchment management agency will conduct the protection, use, development, conservation, management and control of water resources. There are 19 WMAs in SA.
Water Resource Management **(WRM)**	WRM ensures management of our water resources to ensure the sustainable utilisation of a very limited resource.
Water Resources Planning **(WRP)**	Provides broad guidelines as well as details for the reconciling of water use requirements against available water resources.
Water Quality Management **(WQM)**	WQM ensures that the water resources of South Africa are fit for use for humans, recognised users, and ensures that the health of the water environment is protected and improved on a sustainable basis.
Water Services Act (Act 108 of 1997) **(WSA)**	This Act provides for: the rights of access to basic water supply and basic sanitation; the setting of national standards and of norms and standards for tariffs; water services development plans; a regulatory framework for water services institutions and water services intermediaries; the establishment and disbanding of water boards and water services committees and their powers and duties; the monitoring of water services and intervention by the Minister or by the relevant province; financial assistance to water services institutions.
Water Services Authorities **(WSAs)**	Any municipality, including a district or rural council as defined in the Local Government Transition Act, 1993 (Act No. 209 of 1993), responsible for ensuring access to water services.
Water Services Providers **(WSPs)**	Any person who provides water services to consumers or to another water services institution, but does not include a water services intermediary.
Water Services Development Plan **(WSDP)**	A WSDP focuses on water services, the supply thereof and sanitation. The focus of a WSDP is to provide effective water services to the consumers in accordance with the aims of the Government. It is also a tool to ensure effective, sustainable and economical water services that is managed as a business.
Yield	Volume of water per unit of time that can be obtained from a borehole

PART 1 – INTRODUCTION AND OVERVIEW

CHAPTER 1: BACKGROUND TO THE LOWER VAAL WATER MANAGEMENT AREA INTERNAL STRATEGIC PERSPECTIVE

1.1 LOCATION OF THE LOWER VAAL WMA

Figure 1.1 shows the location of the Lower Vaal WMA, which falls within the North West and Free State Provinces.

Figure 1.1: Location of the Lower Vaal WMA

1.2 WATER LEGISLATION AND MANAGEMENT

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

Prosperity for South Africa depends upon sound management and utilisation of our many natural and other resources, with water playing a pivotal role. South Africa needs to manage its water resources optimally in order to further the aims and aspirations of its people. Current government objectives for managing water resources in South Africa are set out in the National Water Resource 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. Furthermore, the way in which the resources are protected, used, developed, conserved, managed and controlled needs to form an integral part of other planning initiatives at provincial, district and local authority level. These relationships are shown in **Figure 1.2** below.

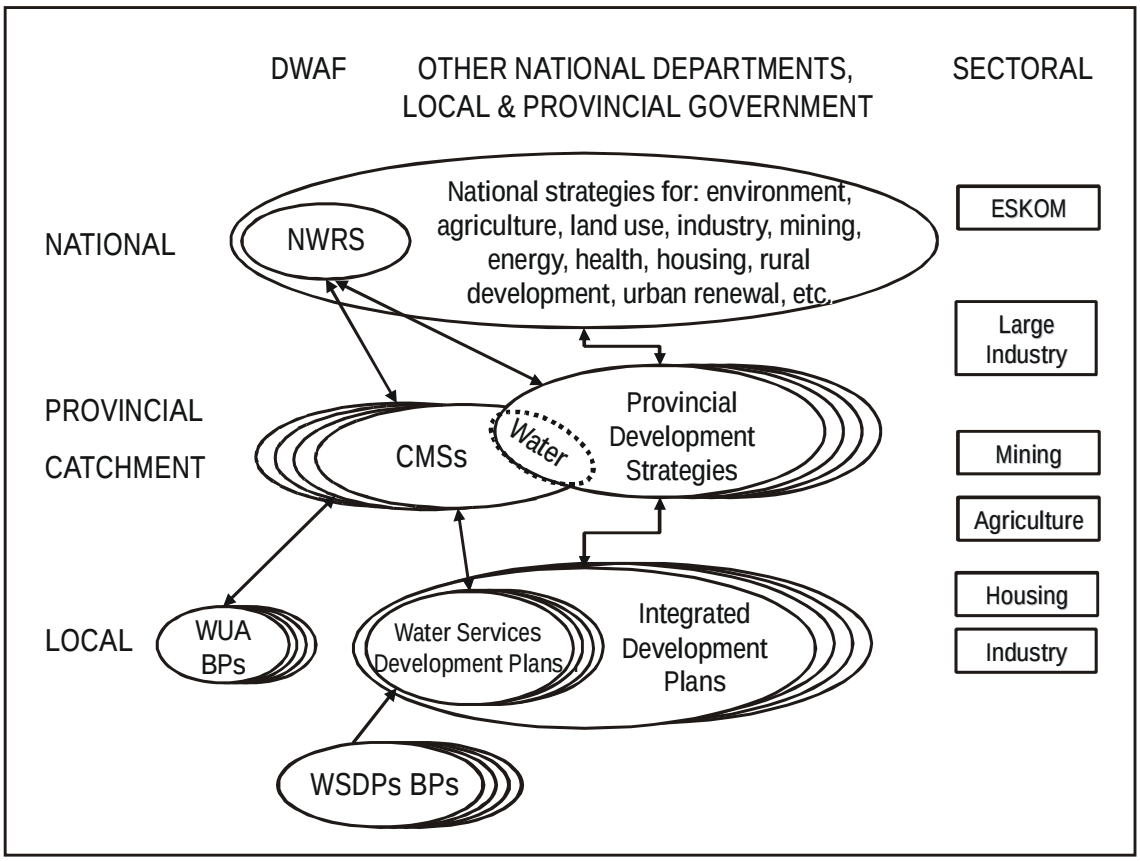


Figure 1.2: Integrated planning approach at various levels of government in South Africa

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 detailed Water Management Area ISPs for the WMAs in the Central Planning Region were preceded with a process where an Overarching ISP was compiled for the Vaal River System. The purpose of the Overarching ISP was to develop strategies that cover issues related to the three Vaal River WMAs and relates to the interdependency that exists among the WMAs due to their geographical locations relative to each other. The overarching ISPs fall in the same category as the NWRS as it guides the management of water resources affecting more than one WMA while the ISPs for each individual WMA fall in the category of a CMS.

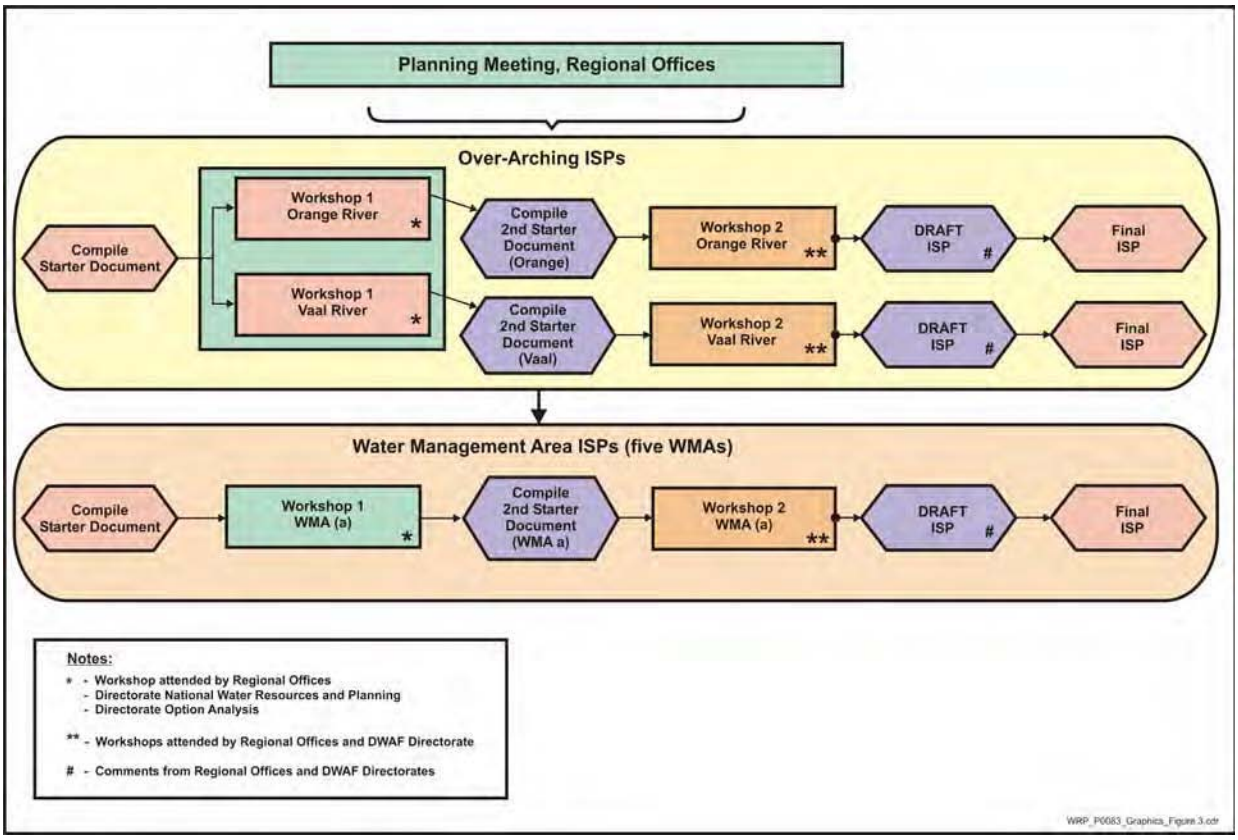


Figure 1.3: Schematic showing ISP development process

The ISP for the Lower Vaal 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 Lower Vaal WMA. This was achieved through interviews with individual members of DWAF's HO in Pretoria 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 and Regional directorates.

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

As can be deduced from the above this Lower Vaal 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 Central Cluster. The current incumbent is Mr T Radzilani, 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 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 1.4**.

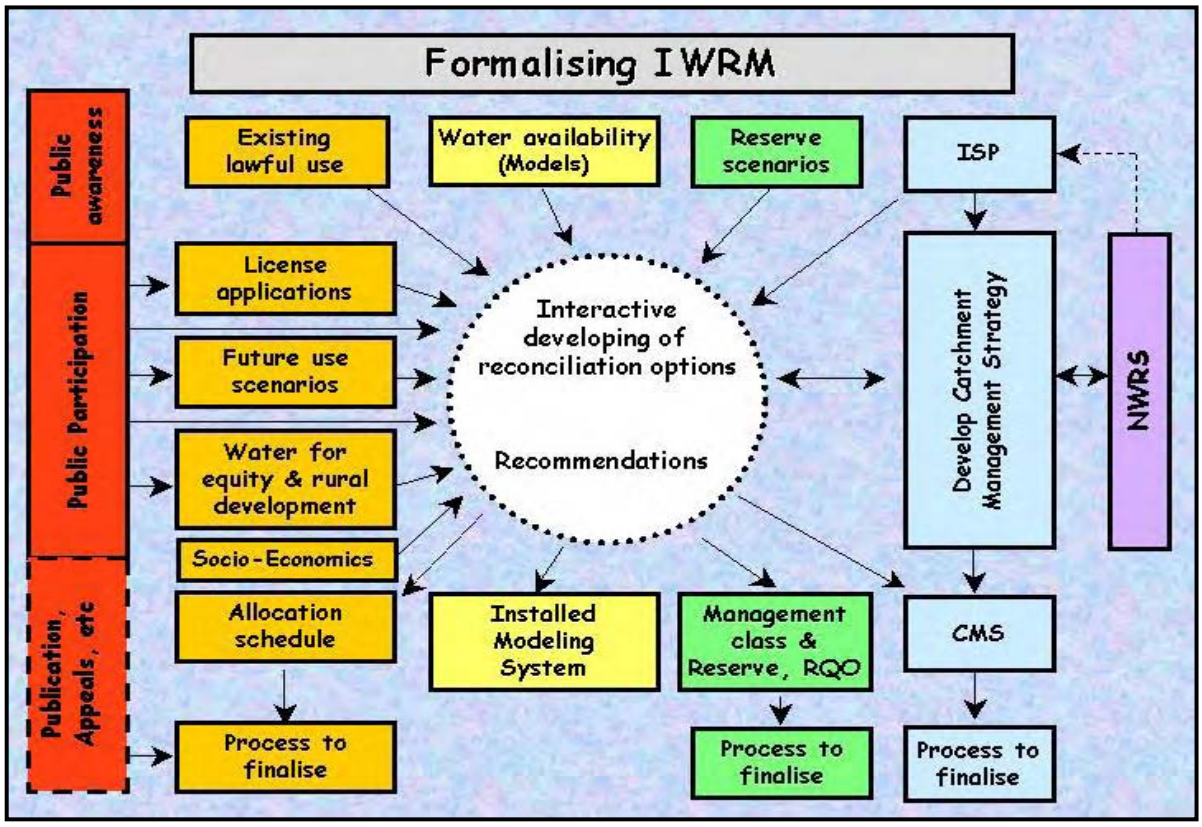


Figure 1.4: Diagram showing DWAF Integrated Water Resources Management approach

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

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

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

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

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

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 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 (**Appendix A**). 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 with which to interact. This is amplified in the Implementation Strategy (**Appendix A: Strategy no. 9**) of this ISP.

1.7 WATER QUALITY MANAGEMENT

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

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

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

less visible than direct discharges of sewage or industrial effluent, but are no less pernicious.

Direct discharges to rivers are licensed and managed on the basis of assimilative capacities of those rivers, and on Receiving Water Quality. Where these limits are exceeded, often through the cumulative impact of diffuse discharges, water becomes unavailable to some, or even all, users downstream. DWAF will license 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 2.1 and 2.2 in Appendix** 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 licences 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.

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 Lower Vaal, 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: BROAD PERSPECTIVE REGARDING THE WATER SITUATION IN THE LOWER VAAL WMA

2.1 Introduction

In this chapter summarised information from the NWRS and the "Overview of Water Resources Availability and Utilisation" reports for the Lower Vaal WMA (DWAF, 2003a) is included to provide the reader with the required background of the water situation in the Lower Vaal WMA. When more detailed background information is required the reader is referred to the NWRS document and secondly to the "Overview of Water Resources Availability and Utilisation" reports for each WMA. These reports should, in general, provide sufficient detail for most readers. Even more detail can be obtained from the "Water Resources Situation Assessment Study" as prepared for each Water Management Area (DWAF, 2002).

The Lower Vaal WMA is part of a larger water supply system which includes adjacent WMAs. This system is referred to in this document as the Vaal River system. A schematic of the system is shown in **Appendix B**. The Vaal Overarching ISP has been developed to deal with the strategies for this system. The Lower Vaal WMA is one of three WMAs in the Vaal River System, which is the drainage area of the Vaal River from its headwaters to the confluence of the Vaal and Orange Rivers. The Lower Vaal ISP should be read in conjunction with the Vaal Overarching ISP (DWAF, 2004b) to gain a complete understanding of the strategies for the WMA.

This chapter is structured to capture the background and related strategies for the Lower Vaal WMA in a logical and descriptive manner. A broad overview of the salient details that were identified in the Lower Vaal WMA workshops is also included. This will at the same time serve as an introduction to the detailed descriptions of the strategies that are presented in **Appendix A.**

The tables in **Appendix A** present the strategies in a structured format which includes management objectives, background information in support of the motivation for the strategies, management actions that are required for the implementation as well as lists of related issues that were raised at the workshops or captured from study reports. The tables also contain cells to indicate the priority or relative importance of each management action as well as which of the DWAF Directorates would be responsible for implementation. A distinction is also drawn between over-arching Vaal River system issues, which will be dealt with by dedicated DWAF Directorates, national issues which will be dealt with by a national department, and regional issues which will be dealt with by the CMA or DWAF Regional Office.

In addition to the water resource system specific issues, listed in **Appendix A**, issues or strategies that were identified for consideration at national level are excluded from this

document and will be dealt with through a separate document that will focus on all the National Issues. These items typically cover aspects that should be under the Minister's control, relate to national policy, or were identified in several other WMAs and therefore require a high level of co-ordination.

2.2 General Catchment Description

2.2.1 Overview

The Vaal River forms the main tributary to the Orange River and originates on the plateau west of the Drakensberg escarpment and drains much of the central highveld of South Africa. Within South Africa, the Orange/Vaal River Basin includes 5 of the 19 Water Management Areas (WMA). These are the Upper Vaal, Middle Vaal, Lower Vaal, Upper Orange and Lower Orange WMAs. The Lower Vaal WMA lies between the Middle Vaal and Lower Orange WMA's, with the Upper Orange WMA to the south of the Lower Vaal WMA and Botswana to the north.

Great differences occur with respect to the hydro-meteorological characteristics as well as nature and level of development in these WMAs. The Vaal River is probably the most developed and regulated river in Southern Africa, while some of the largest dams in Africa have been built in Lesotho and on the main stem of the Orange River. Although linked together by the natural watercourses, a particular characteristic of the Orange/Vaal WMAs is the extensive inter-catchment transfer of water within WMAs as well as interbasin transfers between these and other adjoining WMAs.

The Lower Vaal WMA is dependant on water releases from the Middle Vaal WMA for meeting the bulk of the water requirements by the urban, mining and industrial sectors within its area of jurisdiction, with local resources mainly used for irrigation and smaller towns. Water quality in the Lower Vaal is strongly influenced by usage and management practices in the Upper and Middle Vaal WMA.

Major rivers in the Lower Vaal Water Management Area include the Molopo, Harts, Dry Harts, Kuruman and Vaal rivers. The tertiary drainage areas in the Lower Vaal WMA comprises C31, C32, C33, C91, C92, D41, D42, and D73.

The NWRS describes and discusses the Lower Vaal WMA in three sub-areas, viz. the Molopo, Harts and Vaal River downstream of Bloemhof. The geographical extent of the sub-areas are shown in **Figure 2.1**. The broad overview of the water resource in the Lower Vaal WMA is discussed in terms of the NWRS sub-areas.

Figure 2.1: Layout and location of the Lower Vaal WMA

The Lower Vaal WMA is located downstream of Bloemhof Dam and upstream of Douglas Weir. It extends to the headwaters of the Harts, Molopo and Kuruman River in the north and the Vaal River Downstream of Bloemhof in the south. It covers a catchment area of 51,543 km^2. It lies in the North West and Northern Cape Provinces, with the south-eastern corner in the Free State, and borders on Botswana in the north, as well as on the Crocodile (West) and Marico, Middle Vaal, Upper Orange and Lower Orange water management areas.

2.2.2 Topography

The water in the Lower Vaal WMA flows from the Upper Vaal, across the Middle Vaal, Lower Vaal and Lower Orange WMAs before reaching the Atlantic Ocean near the town of Alexander Bay in the western corner of the country. This cascading characteristic illustrates the interdependence of the 5 WMAs in the Vaal River system and emphasises the need for water resource management to take place across the WMA boundaries.

There are no distinct topographic features in the WMA with most of the terrain being relatively flat. As a result of the generally arid climate, vegetation over the water management area is sparse, consisting mainly of grassland and some thorn trees, notably the majestic camel thorns.

2.2.3 Geology and Soils

Different geological formations occur over the south-eastern part of the water management area, giving rise to a variety of soil types. The northern and western part, which corresponds remarkably well with the catchment of the Molopo River, is mainly underlain by sedimentary formations and covered by Kalahari sands. A large portion of the central and north-east corner of Lower Vaal WMA is underlain by the Transvaal Supergroup consisting of the dolomite, chert and subordinate limestone**.** This area is characterised by a high potential for groundwater with a 50 to 75% probability and accessibility throughout the dolomitic area. The groundwater level is between 8 to 20 metres deep on average. Rich diamond bearing intrusions occur near Kimberly with alluvial diamonds found in the vicinity of Bloemhof. Iron ore and a variety of other minerals are found in the central to south-western parts of the water management area.

A detailed report on the groundwater in the WMA is given in **Appendix D**.

2.2.4 Climate

Climatic conditions are fairly uniform from east to west across the study area. The mean annual temperature ranges between 18.3ºC in the east to 17.4ºC in the west. Maximum temperatures are experienced in January and minimum temperatures usually occur in July.

Frost occurs throughout the study area in winter, typically over the period mid-May to late August. The average number of frost days per year for the study area is 30.

Rainfall is strongly seasonal with most rain occurring in the summer period (October to April). The peak rainfall months are December and January. Rainfall occurs generally as convective thunderstorms and is sometimes accompanied by hail. The overall range of the MAP for the entire WMA is 100 mm to 500 mm.

Humidity is generally highest in February (the daily mean over the study area ranges from 66 % in the east to 62 % in the west) and lowest in August (the daily mean over the study area ranges from 53 % in the east to 57 % in the west).

Average gross potential mean annual evaporation (as measured by Class A-pan) ranges from 2 646 mm to 2 690 mm in the Lower Vaal WMA. The highest A-pan evaporation occurs in December and ranges between 300 mm and 380 mm.

2.2.5 Environmentally Sensitive Areas

An important conservation area in the Lower Vaal WMA is Barberspan which is located in the upper reaches of the Harts River. This off-channel pan is known for its rich bird life. Other areas of importance include pans around Kimberley as well as the Vaalbos National Park.

2.2.6 Demography, Land Use and Development

The total urban and rural population in this WMA is approximately 1,282,000, of which about 718,000 live in urban centres. The largest concentration of urban population is in Kimberley, with an estimated population of 204,000. There are large rural populations in the Lower Vaal, especially in the areas west of Mafikeng, around Kuruman, Pampierstad and Lichtenberg.

Land use within the Lower Vaal WMA is dominated by stock farming. The largest irrigation scheme is the Vaalharts Water Scheme, which is supplied from Bloemhof Dam. The scheduled area of this scheme is 39147 ha with quotas of 9 140 m^3/ha/annum. Including losses, the water use by this scheme is in the order of 500 million m^3/annnum. The following table shows land use and population per sub-catchment.

Table 2.2: Lower Vaal WMA : Population in 1995

Source: Lower Vaal Water Management Area: Water Resources Situation Assessment, November 2002

SUB-CATCHMENT (1)	Area (km^2)					Population		
Description	Irrigation (field area)	Alien vegetation	Urban	Other	Total	Urban	Rural	Total
Molopo River	0.0	384.	30.2	0.0	414.6	79,250	361,947	441 197
Dry Harts	35.7	25.5	21.0	0.0	82.2	44,500	78,160	122 660
Harts	1.0	12.5	19.0	0.0	32.5	111,100	121,000	232 100
Vaalharts	336.	0.3	36.0	0.0	373.2	51,700	89,110	140 810
Vaal d/s Bloemhof	118.	27.9	171.	0.0	317.2	286,900	58,930	345 830
TOTAL IN WMA	492	496	277	0	1265	573,450	718,647	1,282,597

(1) Refer to Figure B2 for layout of Sub-catchments

2.2.7 Economic Characterisation of the WMA

According to the Lower Vaal Water Management Area: Overview of Water Resources Availability and Utilisation Report, the GGP of the Lower Vaal WMA was R9,8bn in 1997. The most important magisterial districts in terms of contribution to GGP in this WMA are shown below:

Kimberley	29,6%
Postmasburg	14,8%
Lichtenburg	9,6%
Kuruman	8,9%
Vryburg	8,3%.

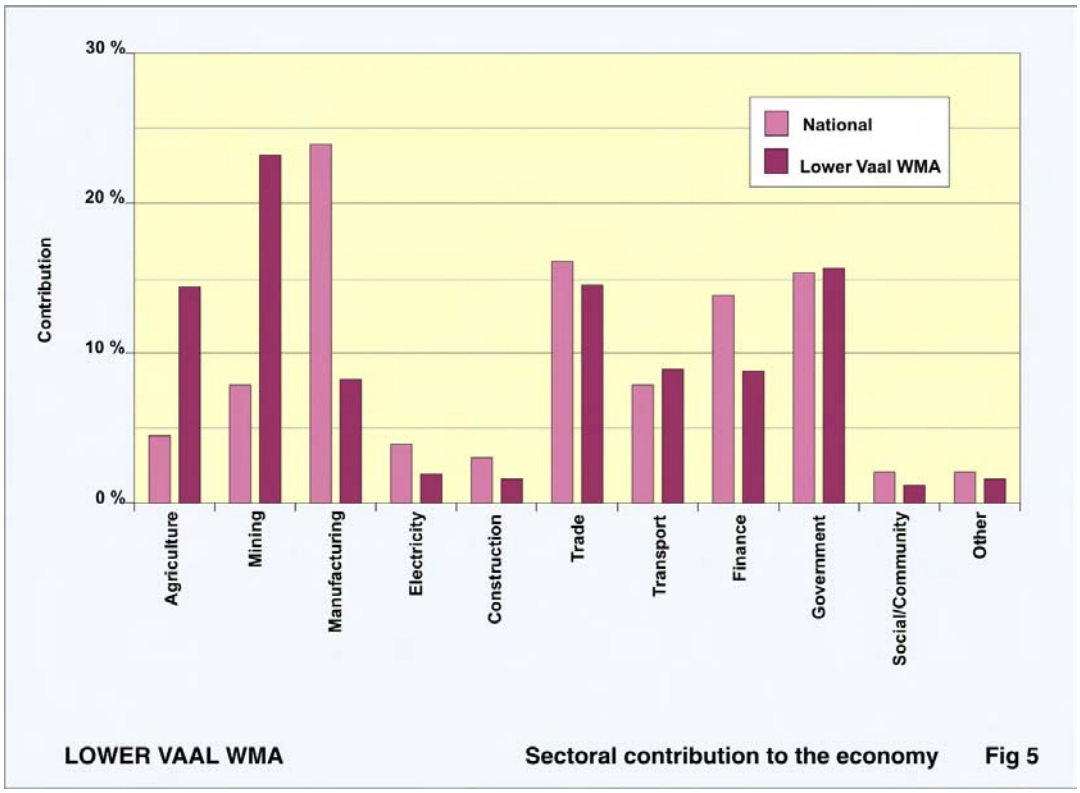
The composition of the Lower Vaal WMA economy is shown in **Figure 2.2** The most important economic activities of the WMA are:

Mining	23%
Government	16%
Trade	15%
Agriculture	14%

The main agricultural activities identified include livestock and dryland cropping. Livestock includes beef and dairy cattle, goats, non-wooled sheep, pigs and ostriches. Crops grown are mainly maize, but also sunflower, cotton, groundnuts and vegetables.

The mining activities in this WMA include mining for diamonds, iron ore, manganese and other minerals such as limestone, dolomite and amphibole asbestos. Kimberlite diamonds are mined at the Finsch Mine at Lime Acres, one of the most important diamond producing

mines of the De Beers Company. Kimberley is also an important diamond mining area, which is known for its high quality diamonds. The Sishen Mine, currently the major supplier of iron ore in the country, is located in the Lower Vaal WMA. This mine has a mineable depth of 30 metres and was opened in 1953 as part of Iscor's expansion strategy. In 1997, it produced approximately 2 400 million ton iron ore per year. An increase in mining and transportation activities can be expected with the construction of the Sishen-Coega railway line that will link Sishen with the Coega initiative near Port Elizabeth. Other important mining areas includes Kudumane (iron, manganese and asbestos etc), Ganyesa (diamonds, mica group clay and salt) and Taung (diamonds, limestone, dolomite and salt).



Source: Lower Vaal Water Management Area: Water Resources Situation Assessment, November 2002

Figure 2.2: Contribution by Sector to Economy of the Lower Vaal WMA, 1988 and 1997 (%)

Since manufacturing production is far less than mining production it can be deduced that only a small percentage of beneficiation is done locally. This implies that a large percentage of raw mining products are exported to other areas for beneficiation. Lichtenburg is the largest manufacturing town in the WMA, where manufacturing includes cement and cheese factories. Kimberley is the second largest manufacturing town, but its output is half that of Lichtenburg.

The trade sector is concentrated in wholesale of primary products and related services to the community. Main products of trade in this WMA are:

1. diamonds (for export)
2. food retail related products
3. ostrich-related products

The importance of the government sector can be attributed to restructuring activities that took place after 1994 when Kimberley became the capital of the Northern Cape Province.

2.3 Water Resource availability

2.3.1 Surface Water

According to the Lower Vaal WMA Overview of Water Resources Availability Report, DWAF (2003a), "As a result of the low rainfall, flat topography and sandy soils over much of the water management area, little usable surface runoff is generated in the water management area. The runoff which does occur, is highly variable and intermittent. Although occasional runoff occurs in the upper reaches of the Molopo River, no record exists of flow having reached the Orange River. Previous recordings of flow in the lower reaches of the Molopo and/or Kuruman Rivers were in 1933 and again in the 1974/5 and 1975/76 seasons."

"Flow in the Vaal River, which is the main source of water in the water management area, virtually all originates from the Upper Vaal and Middle Vaal water management areas. A summary of the mean annual runoff (MAR), together with the estimated requirements for the ecological component of the Reserve, is given in **Table 2.3**."

It must be noted that the 197 million m^3 per annum shown in Table 2.3 is the natural mean runoff for the entire Molopo catchment, including the upper portion of the catchment, which falls outside this WMA, in the neighbouring state of Botswana. The contribution of runoff from the South African portion of the Molopo catchment is negligible as the remaining runoff is lost through evaporation.

Table 2.3: Natural Mean Annual Runoff and Ecological Reserve (million m^3/a)
Source: Lower Vaal Water Management Area: Overview of Water Resources Availability, November 2003

Sub-catchment	Natural MAR (1)	Ecological Reserve (1, 2, 3)
Harts	138	15
Vaal downstream of Bloemhof	43	5
Molopo	197(3)	29
Total	**181**	**49**

(1) Quantities given are incremental, and refer to the sub-catchment under consideration only.
(2) Total volume given, based on preliminary estimates. Impact on yield being a portion of this.
(3) Estimated runoff from catchment, which is lost through evaporation and infiltration before reaching the Orange River. This runoff therefore does not add to the total for the water management area.

"The only lake and wetland of note is at Barberspan in the upper Harts River catchment, which has been given Ramsar status as a wildlife conservation area. There are no commercial forests in the water management area. Infestations of invading alien vegetation occur along some watercourses, and is particularly serious in parts of the Molopo River catchment."

According to the Lower Vaal WMA Overview of Water Resources Availability Report, DWAF (2003a), "It is important to note that the data with respect to the mean annual runoff as well as the ecological component of the Reserve have been taken from national data sources, for the purpose of compatibility of the water management area information in the National Water Resource Strategy. In many instances more detailed studies have been conducted or are under way, from which improved information may be obtained (also on items other than the MAR and Reserve), and which should also be referred to with respect to detail planning and design work. In this respect, the mean annual runoff given for the Molopo River catchment is to be viewed as rather theoretical. In the natural state the quality of surface water in the water management area is of acceptable standard, although typical of high turbidity."

Water quality in the Vaal River is seriously impacted upon by urban and industrial use as well as mining activities in the Upper and Middle Vaal water management areas, and is of relative high salinity.

The Vaalharts irrigation scheme serves the purpose of beneficially utilising lower quality water discharged from the Upper Vaal and Middle Vaal water management areas. However the return flows are of a poor quality due to the poor quality water that is received and used for irrigation. The Bloemhof Dam has the effect of blending the poor quality water received from the Middle Vaal with better quality water from this WMA resulting in marginally improved salinity levels with values typically ranging from 250-350mg/l.

"Water in the Harts River downstream of the Vaalharts irrigation scheme is of exceptional high salinity as a result of saline leachate from the irrigation fields (± 1 100 mg/l salinity), and needs to be carefully managed through blending with fresher water. Water quality in the lower reaches of the Vaal River is also impacted upon by irrigation return flows from the Harts River as well as from the Riet/Modder River further downstream, necessitating further blending with low salinity water from the Orange River at the Douglas weir."

Development of surface water naturally occurring in the water management area has reached its potential and all the water is being fully utilised. The main storage dam are:

- Bloemhof Dam on the Vaal River. The dam wall and outlet works are located within the Lower Vaal water management area immediately where the river enters the water management area from the Middle Vaal water management area. Most of the reservoir basin falls in the Middle Vaal water management area. The yield from the dam, however, is available in the Lower Vaal water management area.

- Vaalharts Weir is a main diversion weir on the Vaal River while the Douglas Weir falls just outside the water management area, immediately upstream of the confluence of the Vaal River with the Orange River.

- Wentzel, Taung and Spitskop Dams on the Harts River.

- No large dams occur in the Molopo sub-catchment.

"The bulk of the surface water found in the water management area is in the Vaal River, most of which is transferred along the river from the Upper Vaal water management area and via the Middle Vaal water management area, to the Lower Vaal water management area."

"There are no feasible options for meaningful further development of surface water resources in the water management area."

2.3.2 Groundwater

Groundwater utilisation is of major importance in the Lower Vaal water management area and constitutes the only source of water over much of the water management area. Groundwater is essentially used for mining, agriculture and domestic use in this WMA. Large dolomitic aquifers occur in the uppermost reaches of the Harts River and Molopo River. These aquifers extend north and eastwards into the Crocodile (West) and Marico, Upper Vaal and Middle Vaal water management areas.

There are quite a number of mining operations in the Lower Vaal WMA, ranging from base-metal mining; diamond mining, limited gold mining in the Kalahari greenstone belt and smaller mining operations such as limetone quarries and diamond diggings in alluvial deposits along the Vaal River and its tributaries.

Groundwater use at most of these sites is limited and should any seepage occur into opencast pits or underground workings, the water is usually pumped and utilized in processes to minimize use of other water sources. The diamond diggings have little impact on water quality. Large amounts of water are abstracted locally during the processing of the diggings with the result that the surface environment and drainage patterns are altered. Currently the Kalahari Goldridge mine supply their own water by circulating water from the pit and sludge lagoons as well as from boreholes (Total 120 Ml/year). It is estimated that the mining activities will affect the boreholes and that an additional amount of 30- 50 Ml/month will be needed in the next 5 years.

Sishen Mine makes use of groundwater abstracted directly from the mining area although it can obtain water from the Vaal River via the 700mm diameter Vaal-Gamagara pipeline. Approximately 1.5 million m^3 of water is abstracted monthly from the mine and it is

anticipated that the groundwater will gradually be depleted and that Sishen Mine will eventually have to import water.

Almost every farm unit in the WMA is dependent on groundwater for domestic use and stock watering. There are however no abstraction volumes available but in terms of quantities of water, stock farming has a relatively small influence on the regional groundwater resource. Large-scale irrigation is developed where aquifer types are suitable. The lithologies from which abstraction for irrigation takes place vary between dolomitic/karstic aquifers, weathered granite and quartzite and at contact or faulting zones. Problems encountered at these irrigation areas are over utilisation of the resources with the associated lowering of water tables.

Several local municipalities are dependent on groundwater as a source of bulk supply. The water is supplied from boreholes within the municipal grounds. The main aquifers exploited are from dolomites and weathered fractured crystalline rocks such as andesitic lavas and granites. Some of the towns' water supply is augmented by surface water supply e.g. Vryburg. The total population dependant on groundwater in urban areas is estimated to be 140 000 residents. Some groundwater utilisation for small rural settlements takes place in the western portion of the WMA from primary or porous aquifers from the Kalahari group, but the quality and yields are often variable and not good.

The natural occurring water quality in the WMA is generally good in the dolomitic/karstic and fractured/crystalline aquifers. In the western portion of the WMA in the Kalahari group primary (sand/gravel) aquifers and clay formations, the quality is often naturally poor with TDS values ranging from 1500 mg/l and higher.

Activities related to urban areas can result in localized or even diffuse pollution of groundwater. Poor management of sewage treatment works can contribute to the groundwater pollution as can landfill sites, on-site sanitation (especially in informal settlements) and spills resulting from accidents or leaking underground tanks.

Agricultural activities are also a major source of diffuse water contamination. The contribution of each farm on a local scale is often fairly small but the contribution on a catchment scale needs to be included in assessing any pollution situation. Feedlots contribute to the organic nitrates in groundwater and can be far more problematic. Other contaminants of concern are pesticides and herbicides. The contribution of these to groundwater contamination is very difficult to quantify on a catchment scale. Site-specific data relating to likely loading and/or application volumes, soil profiles and local geohydrology are required in order to quantify the impact of pesticides and herbicides on groundwater contamination.

A study was conducted by Ellington, Usher and van Tonder in 2003 (*Refer WRC Report No. 1322/1/04*) to determine the impact of the irrigation on the aquifer underlying the Vaalharts

Irrigation scheme. The study found that the TDS of groundwater has increased at a rate of 13 mg/l/annum in the Vaalharts area. The increase in leaching of approximately 100000 t/annum was found to be the main source of this TDS increase. Simultaneously, the main contributor to the salt load within the Vaalharts Irrigation Scheme was found to be the incoming canal water from the Vaal River at Warrenton. Whereas fertilizers contribute only 50000 t/annum, the incoming Vaal River water contributes 130000 t/annum of salts. These salts are moving towards the Harts River at a rate of approximately 5million t/annum.

There are a total of approximately 180 monitoring points throughout the Lower Vaal WMA. The monitoring points serve both the National and Regional levels of groundwater monitoring. The monitoring includes water levels and ambient water quality.

The main challenges facing DWAF in this WMA is with regard to the management and allocation of the groundwater resources at the high-abstraction irrigation areas. Constitutions have been drawn up, and are awaiting approval by the minister, for the following Water User Associations (WUAs): Stella, Coetsersdam/ Louwna, Tosca and Molopo. Sixty six applications have been received for new licence applications which entails approximately 10 million m^3/annum additional abstraction from the resource. Currently the Harvest Potential maps (Vegter, 1996) are used when making recommendations with regard to allocations.

In order to aid the government's initiative with regard to mineral development especially for small-scale mining operations, DWAF could play an active role in the water licensing process. Similarly, emerging farmers can also benefit by the exploitation of groundwater especially in areas where potential for irrigation development from groundwater resources in the WMA is high. However, careful consideration needs to be taken of existing water rights and the possible over allocation of the resource.

Groundwater-surface water interaction has not been studied sufficiently in the WMA. According to some studies there is seldom groundwater contributing to base flow in rivers. However surface water recharge has been observed in normally dry riverbeds. Current quality problems experienced in the Vaal and Orange rivers, waterlogging experienced with irrigation along these riverbanks indicate interaction. Therefore a study is currently motivated by DWAF Geohydrology to investigate Groundwater-surface water interaction in the Vaal and Orange rivers.

A groundwater report for the Lower Vaal WMA is included as **Appendix D** to this report.

2.3.3 Overall Water Availability

The total water available for use in the Lower Vaal water management area at the year 2000 development levels, is summarised in **Table 2.4**.

Table 2.4: Available water in year 2000 (million m³/a)

Sub-catchment	Natural resource		Usable return flow			Total local yield (1)	Transfers in	Grand Total
	Surface water	Ground-water	Irrigation	Urban	Mining and bulk			
Harts	51	40	45	0	0	136	419	555
Vaal downstream of Bloemhof	(107)	54	7	0	0	(46)	545	499
Molopo	2	31	0	0	2	35	4	39
Total	(54)	125	52	0	2	125	500	625

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

(2) This table has been adapted from the Lower Vaal WMA Overview of Water Resources Availability Report. Amendments have been made to the table as per the explanation provided on Page 2-31 of this report

The Lower Vaal water management area is heavily dependent on water from the Upper and Middle Vaal water management areas. In total, 80% of the current water available in the water management area, is from upstream water management areas. There are also significant transfers of water within the water management area, most notably with respect to the Vaalharts irrigation scheme.

The quality of surface water in the Harts and Vaal Rivers is highly impacted upon by irrigation return flows as well as by water use in the Upper and Middle Vaal water management areas, which limits the usability of water in the lower reaches of these rivers.

Due to the intermittent nature of surface runoff in the water management area, provision for the ecological component of the Reserve has no impact on the yield from local resources.

2.4 Water Requirements

Current requirements (year 2000)

"Water use in the water management area is dominated by irrigation, which represent 80% of the local requirements for water. About 12% of the requirements is for urban and industrial use, 7% for rural domestic supplies and stock watering, and the remainder for mining purposes. A summary of the sectoral water requirements in each of the sub-areas is given in **Table 2.5**. All the requirements are given at a 98% assurance of supply."

Table 2.5: Year 2000 Water Requirements (million m³/a)

Source: Lower Vaal Water Management Area: Overview of Water Resources Availability, November 2003

Sub-area	Irrigation	Urban (1)	Rural (1)	Mining and bulk industrial (2)	Power generation (3)	Affore-station (4)	Total local require-ments	Transfers out	Grand Total
Harts	452	23	19	0	0	0	494	45	539
Vaal downstream of Bloemhof	25	32	8	0	0	0	65	423	488
Molopo	0	13	17	6	0	0	36	0	36
Total	477	68	44	6	0	0	595	0	595

(1) Includes component of Reserve for basic human needs at 25 ℓ/c/d.
(2) Mining and bulk industrial water uses which are not part of urban systems.
(3) Includes water for thermal power generation only. (Water for hydropower, which represents a small portion of power generation in South Africa, is generally available for other uses as well.)
(4) Quantities given refer to impact on yield only.

According to the Lower Vaal WMA Overview of Water Resources Availability Report, DWAF (2003a), "Over 90% of the requirements for irrigation are in the Harts sub-area, mainly at the Vaalharts irrigation scheme, with the balance being along the Vaal River. Requirements for water in the Molopo sub-area are relatively small and constitute only 6% of the total water requirements within the water management area. Only limited irrigation from groundwater is practised in this sub-area."

"Because of salinisation problems experienced at the Vaalharts irrigation scheme an efficient subsurface drainage system was installed, resulting in large quantities of irrigation effluent being returned to the river and which could potentially be re-used downstream. The resultant balance at the downstream end of the water management area is reflected as a surplus for the Lower Vaal water management area, and not as a transfer to the Lower Orange water management area."

"A substantial proportion of water used in the urban and industrial sectors is used non-consumpatively and again becomes available as effluent. At the larger centres, most or all of the effluent is discharged back to the rivers after appropriate treatment, from where it can potentially be re-used. Effluent from smaller towns typically evaporates from maturation ponds, or may be absorbed by irrigation and infiltration."

"There are many factors which influence the requirements for water. These include climate, nature of the economy (i.e. irrigated agriculture, industrialised) and standards of living. Of these, climate is relatively stable, while in most cases control can be exercised over the growth in irrigation water requirements. Population and economic activity, however, have their own inherent growth rates which are dependent on a wide spectrum of extraneous influences. Population growth and economic growth, which also relates to socio-economic standards, are therefore regarded as the primary determinants with respect to future water requirements."

"Based on the scenarios for population and economic growth, initial estimates of possible future water requirements were made for the period until 2025. In addition, provision was made for known and probable future developments with respect to power generation, irrigation, mining and bulk users as described under the respective sub-areas where applicable. (Specific quantities, rather than a general annual growth rate, were allowed for in these sectors.)"

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

"A possible upper scenario of future water requirements, is also given, based on the assumption that there will be high population growth and a high standard of services (socio-economic development); together with a strong increase in the economic requirements for water, where the public and business use of water would increase in direct proportion to the gross domestic product. The purpose of the upper scenario is to provide a conservative indicator in order to prevent the occurrence of possible unexpected water shortages. No adjustments have been made for reflecting the impacts of increased water use efficiency."

"Due to the negligible to negative population growth and economic growth in the water management area, a small decrease in the domestic (urban and rural) and industrial requirements for water is expected in the Lower Vaal water management area. No change is foreseen with respect to the water requirements for irrigation. Water requirements for mining purposes, which are more of localised importance, are also expected to remain relatively unchanged."

Table 2.6: Year 2025 base scenario water requirements (million m³/a)

Source: Lower Vaal Water Management Area: Overview of Water Resources Availability, November 2003

Sub-area	Irrigation	Urban (1)	Rural (1)	Mining & industrial (2)	Power generation (3)	Affore-station (4)	Total local require-ments	Transfers out	Grand Total
Harts	452	25	19	0	0	0	496	43	539
Vaal downstream of Bloemhof	25	31	8	0	0	0	64	423	487
Molopo	0	10	18	6	0	0	34	0	34
Total	477	66	45	6	0	0	594	0	594

(1) Includes component of Reserve for basic human needs at 25 ℓ/c/d.
(2) Mining and bulk industrial water uses which are not part of urban systems.
(3) Includes water for thermal power generation only. (Water for hydropower, which represents a small portion of power generation in South Africa, is generally available for other uses as well.)
(4) Quantities given refer to impact on yield only.

Table 2.7: Year 2025 high scenario water requirements (million m³/a)

Source: Lower Vaal Water Management Area: Overview of Water Resources Availability, November 2003

Sub-area	Irrigation	Urban (1)	Rural (1)	Mining & industrial (2)	Power generation (3)	Affore-station (4)	Total local require-ments	Transfers out	Grand Total
Harts	452	33	19	0	0	0	504	35	539
Vaal downstream of Bloemhof	25	77	8	0	0	0	110	423	533
Molopo	0	17	18	6	0	0	41	0	41
Total	477	127	45	6	0	0	655	0	655

(1) Includes component of Reserve for basic human needs at 25 ℓ/c/d.
(2) Mining and bulk industrial water uses which are not part of urban systems.
(3) Includes water for thermal power generation only. (Water for hydropower, which represents a small portion of power generation in South Africa, is generally available for other uses as well.)
(4) Quantities given refer to impact on yield only.

2.5 Water balance

A reconciliation of the available water and total requirements for the years 2000 and 2025, including transfers between WMAs, is quantified in **Tables 2.8 and 2.9** respectively. It must be noted that the water balances as reported in the "*Overview of the Water Resources Availability and Utilisation*" report for the Lower Vaal WMA have been changed to derive the water balances that are presented in this ISP. Explanations for these changes are given at the end of this section of the report.

Table 2.8: Reconciliation of requirements and available water for year 2000 (million m³/a)

Sub-catchment	Available water			Water requirements			Balance
	Local yield	Transfers in	Total	Local requirement	Transfers out	Total	
Harts	136	419	555	494	45	539	16
Vaal downstream of Bloemhof	(46)	545	499	65	423	488	11
Molopo	35	4	39	36	0	36	3
Total	125	500	625	595	0	595	30

(1) Brackets around numbers indicate negative balance. Surpluses are shown in the most upstream sub-catchment where they first become available.
(2) Transfers into and out of sub-catchments may include transfers between sub-catchments as well as transfers between WMAs. Addition of the transfers per sub-catchment therefore does not necessarily correspond to the total transfers into and out of the WMA. The same applies to Tables 2.5.2 and 2.5.3.

An excess supply exists for the Harts River sub-area with the excess available in the Taung Dam. The irrigation potential downstream of Taung Dam has not been fully developed and surplus yield from this dam is being used in lieu of using the full transfer capacity from the Vaal River. The surplus with respect to the Vaal River sub-catchment is a reflection of the estimated irrigation return flows to the lower Vaal River. A small surplus is also shown for

the Molopo sub-catchment, which relates to mine pumpage which is not being beneficially utilised.

The surplus of 16 million m^3 per annum in the Harts sub-catchment is available in the Taung and Spitskop dams. The surplus of 11 million m^3 per annum in the Vaal River downstream of Bloemhof Dam is not used within this WMA and is currently transferred to Douglas for irrigation purposes. The surpluses in the Harts and Vaal River downstream of Bloemhof are currently utilised by Douglas farmers as there is no other use for this surplus at present. There is consequently the need to confirm exactly what the surplus is and how the surplus should be allocated, possibly to resource poor farmers or alternatively to address water quality problems.

A perspective on the possible future situation is given by **Table 2.9** for the base scenario, and **Table 2.10** as representative of a possible high water use scenario. The base scenario shows a small decline in water requirements which corresponds to the projected decline in population, while irrigation and mining activities are assumed to remain at the current levels. Should the high scenario materialise, a moderate increase in the requirements for water can be experienced as a result of the expected stronger economic activity. In both cases it can be assumed that water transfers will be adjusted according to the requirements.

Table 2.9: Reconciliation of water requirements and availability for the year 2025 base scenario (million m³/a)

Sub-catchment	Available water			Water requirements			Balance
	Local Yield (1)	Transfers in	Total	Local require-ments (2)	Transfers out	Total	(3)
Harts	137	419	556	496	43	539	17
Vaal downstream of Bloemhof	(45)	543	498	64	423	487	11
Molopo	35	4	39	34	0	34	5
Total	127	500	627	594	0	594	33

*(1) **B**ased on existing infrastructure and under construction in the year 2000. Also includes return flows resulting from growth in requirements.*

(2) Based on normal growth in water requirements as a result of population growth and general economic development.

(3) Assumed no general increase in irrigation.

(4) Brackets around numbers indicate negative balance.

Table 2.10: Reconciliation of water requirements and availability for the year 2025 high scenario (million m³/a)

Sub-catchment	Available water			Water requirements			Balance
	Local yield (1)	Transfers in	Total	Local require-ments (2)	Transfers out	Total	
Harts	137	419	556	504	35	539	17
Vaal downstream of Bloemhof	(45)	589	544	110	423	533	11
Molopo	35	4	39	41	0	41	(2)
Total	127	554	681	655	0	655	26

(1) Based on existing infrastructure and infrastructure under construction in the year 2000. Also includes return flows resulting from growth in requirements.

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

(3) Brackets around numbers indicate negative balance.

Changes made to the reconciliation balances for the year 2000

The following changes were made to derive the water balances that are presented in this ISP report. The original balances were obtained from the "*Overview of the Water Resources Availability and Utilisation*" report for the Lower Vaal WMA (**DWAF, 2003c**).

Change 1: Due to the revised boundaries of the Lower Vaal WMA the water balance of the Vaal downstream of Bloemhof sub-area were changed by reducing both the "Transfers-in" and the "Local requirements" by 48 million m^3/annum. The change in the boundary has resulted in Douglas falling outside the Lower Vaal WMA.

Change 2: The transfer out of the Harts Sub-area to the Vaal downstream of Bloemhof sub-area was reduced from 62 million m^3/annum to 45 million m^3/annum. This change is due to an over estimation of the contribution of the return flows from the Vaalharts Irrigation Scheme to the system yield.

Description	Available water			Water requirements			Balance
	Local yield	Transfers in (2)	Total	Local require-ments	Transfers out (2)	Total	(1)
Changes affecting the Vaal downstream of Bloemhof sub-area:							
Figures given in the DWAF, 2003c	(46)	610	564	113	423	536	28
Change 1	-	-48	-48	-48	-	-48	-
Revised figures (Change 1)	(46)	562	516	65	423	488	28
Change 2	-	-17	-17	-	-	-	-17
Revised figures (Change 1&2)	(46)	545	499	65	423	488	11
Changes affecting the Harts sub-area:							
Figures given in the DWAF, 2003c	136	419	555	494	62	556	(1)
Change 3	-			-	-17	-17	17
Revised figures (Change 3)	136	419	555	494	45	539	16

2.6 Water Reconciliation

The water balance in the Lower Vaal is one of a surplus as indicated in Table 2.8 and is expected to remain this way as no major growth is predicted for this WMA. The surplus is discussed under the following sub-headings:

1. Excess in Harts sub-area
2. Conditional surplus in Vaal River system
3. Intervention measures

2.6.1 Excess Supply in Harts sub-area

The Harts catchment has an excess supply with the excess available in Taung and Spitskop dams. The surplus (See table 2.8) is not used within this WMA and is currently transferred to Douglas for irrigation purposes as there is no other use for this surplus at present. The strategy for dealing with this excess should be as follows:

- Confirm volume of excess.
- Using the excess for poverty alleviation purposes.
- Use the excess to address water quality in the interim.

2.6.2 Allocation of Conditional Surplus

The water reconciliation situation in the Vaal River system is one of a conditional surplus until 2025. The future schemes needed to augment the water resources of the Lower Vaal WMA will be derived from the Upper Vaal WMA which will largely be decided at the National Level with the development of the next augmentation scheme. The management of the surplus is discussed in more detail in the Vaal Overarching ISP report (Report No.: RSA C000/00/0103).

2.6.3 Intervention Measures

Although no growth is anticipated in the WMA in the near future, the following options are available should the demand for water increase :-

- If the larger towns such as Kimberley experiences major growth, water can be made available from the conditional surplus in the Vaal River.

- If growth occurs in smaller towns, water can be made available from the surplus in the Vaal River, from groundwater resources and/or by implementing water conservation and demand management measures:

- The implementation of Water Conservation and Demand Management (WC&DM). The water requirements that are used in the development of the WMA water balance do not include WC&DM. A study quantifying the reduction in the water requirements, return flow volumes and the changes in return flow water quality of implementing WC&DM has been identified and prioritised in the Vaal Overarching ISP. However Regional Office/CMA must play an active role together with the Water Service providers in the WMA to ensure the implementation of WC&DM.

- Further development of groundwater. Although the exact quantity of the exploitable groundwater is uncertain, groundwater represents a large potential resource particularly in areas that are distant from the main river system. Due to the fact that the availability of groundwater is largely dependent on localised sub-surface characteristics, estimates of the potential of the resource should be area specific.

2.6.4 Necessity for Compulsory Licencing

Given that there is a conditional surplus in the Vaal River, there is no immediate need for compulsory licensing in the Lower Vaal WMA along the main stem of the Vaal River. The Harts River also has a surplus and will consequently not require compulsory licensing at this stage. However, certain areas, particularly in the Molopo sub-area may need intervention in terms of compulsory licensing, eg Tosca has been earmarked for compulsory licensing (See **Compulsory Licensing Strategy A1.5 in Appendix A**). The approach to be adopted in addressing the issues in these areas is to fully understand the issues, as a first step, and to use the available regulations and communication with the water users to resolve the issues before compulsory licensing is pursued.

2.6.5 Reserve Determination

The determination of a Comprehensive Reserve is an important prerequisite for compulsory licensing. To date only low confidence Desktop estimates of the Ecological Reserve have been undertaken for the purpose of developing the National Water Resources Strategy (NWRS). Although no urgent Reserve issues were identified during the workshops, the above factors point to the need for careful planning and implementation of the Ecological Reserve to balance, among other things, the economic consequences and ecological benefits. Due to the interdependencies of the tributaries with the main stem of the Vaal River, the determination of the Reserve must be undertaken in an integrated way, balancing tributary contributions with the flow requirements of the main stem.

2.7 Water Quality Management

The water quality situation of the Vaal River main stem and the tributaries are discussed below. The water quality of the main stem of the Vaal River is not only affected by the water quality of the flow from the tributaries within the WMA but also by the water quality of the

water received from the upstream Upper and Middle Vaal WMAs. The water quality received from the Upper Vaal WMA is considered to be poor. Despite the blending practiced in the Upper Vaal WMA, with releases from Vaal Dam used to maintain the TDS concentration in the Vaal Barrage at 600 mg/L, salinity has been reported as a problem in the Vaal River main stem. Salinity levels in the Lower Vaal WMA have been increasing over the years as a result of high salinity inflows from upstream WMAs. This trend is expected to continue to increase in the future. However salinity levels are more acceptable downstream of Bloemhof Dam as a result of inflows from the Rhenoster, Vals, Sand and Vet sub-catchments.

The land uses in the WMA are largely agriculture, mining and urban areas with the larger urban centres located in the mining areas. There are several areas under irrigation in the WMA. The sources of supply are both surface and groundwater. The return flow volume and qualities from the irrigation areas are not well quantified. The main challenges for water quality management in the Vaal River System will involve mitigating the impacts of further growth in land-use, particularly with respect to urban and industrial activities, as well as managing potential decants from decommissioned diamond mines.

There are extensive diggings in parts of the catchment which impact largely on the river courses. Sections of the Harts River upstream of Taung Dam and Bamboespruit are severely impacted on by digging activities.

Groundwater serves as an important source of water for domestic use. It is therefore important to protect the water quality of the groundwater and groundwater management plans and the setting of Resource Quality Objectives for groundwater.

Many of the sewage works and sanitation systems of the towns in the WMA are inadequate and are in a poor state. The reasons for this are both management and the overloading of the plants and reticulation systems. The overloading is sometimes due to the replacement of pit latrines with water borne sewerage systems without upgrading the sewage works.

Water quality management will have to intensify in future with the aim of protecting the water resource to ensure utilisation under growing urban, industrial and mining land use activity. The impacts of pollutants such as microbiological organisms, nutrients and salinity on the Vaal River System have been quantified and monitored to date. The downstream effects of these pollutants on the Vaal River System are water quality issues to be considered.

The approach adopted by the Department of Water Affairs and Forestry in managing the water quality in the Vaal River catchment is to set water quality objectives (WQO) for the sub-catchments. The WQO are based on the water user requirements in the catchments. The WQO include ideal, tolerable and unacceptable objectives for the water quality variables. A phased approach has been adopted for the development of strategies to manage the water quality in the sub-catchments of the Vaal River Catchment. The first phase is a situation assessment, which is followed by further phases to develop catchment management

strategies. These plans will result in the setting of WQO, model development, identification of pollution sources, waste load allocations and monitoring programs.

Due to the inter-dependency of the Vaal River WMAs in terms of the impacts that upstream WNAs have on downstream WMAs, it was identified that the current process of managing water at sub-catchment level should be expanded to integrate management activities across sub-catchments to meet shared water quality objectives in major tributaries and in the main stem of the Vaal River. To this end Integrated Water Quality Management Plans (IWQMP) for the Vaal and Orange River systems will be developed. The CMSs developed for sub-catchments in the Lower Vaal WMA must be integrated with the IWQMP for the Vaal River.

2.8 Infrastructure System Management

Due to the interlinked configuration of the water resource components in the Vaal River System the responsibility of the operation and management of the main elements will be a function of a dedicated DWAF operations division or a possible Utility. The operation and management of tributary catchments in each WMA will be the responsibility of the CMA. The operation and management of tributary dams such as Wentzel, Taung and Spitskop will be the responsibility of the CMA in terms of floods, droughts and normal operation.

There is a well-established set of hydrological and water use databases as well as water resource analysis models available for the analysis of the Vaal River System. Annual operating runs are undertaken using the models and decisions made on system operation. The description of these systems is given in the Vaal Overarching ISP. These models are run at the national level with the decisions being passed to the Lower Vaal WMA for implementation.

Losses in this WMA are relatively high with evaporation accounting for losses of 80 million m^3 per annum and operational losses as high as 100 million m^3 per annum. It is therefore imperative that system operations be improved to reduce operational losses. A tracking system to monitor mass balances is required to improve the understanding and control of the releases.

2.9 Monitoring and Information Systems

The Lower Vaal water managers will be required to co-ordinate all the monitoring and information requirements within the WMA. This will include the compliance and other monitoring requirements of the WMA itself as well as the monitoring requirements of the Vaal River System to be used by the National body carrying out the overarching management.

2.10 Institutional Aspects

The Lower Vaal WMA is part of a larger supply system which includes adjacent WMAs. The Lower Vaal WMA acts as a conduit for the transfer of water from the Middle Vaal WMA to the Lower Orange WMA. Due to this interdependence, the operations and planning of the Vaal

River system will not be undertaken by the Lower Vaal CMA or Regional Office but at the national level by the Department's Head Office or a utility which may be established to undertake these tasks. The management at this level is described in the Vaal Overarching ISP and includes, among others, Water Reconciliation and Water Quality Strategies.

The role of the Lower Vaal WMA CMA will be:

- To manage the water quality by setting WQOs and developing CMS as per the Water Quality Management Strategy (A2.2) included in **Appendix A**. The setting of the WQOs will be within the framework of the Integrated Water Quality Management Plan for the Vaal River System.
- The monitoring of the system to provide management information for water quality management, abstraction control and input to the overarching operations and planning processes.
- Provide input into the supply of municipalities from local groundwater and surface water resources. This will be in the form of strategic level guidance as to where water can be obtained and the level of study needed to be submitted with the license application.
- A very important communication role between the Water Users and the utility.
- Promotion of WC&DM through the water service providers and local authorities/DWAF Head Office to achieve efficient use of water. Only once efficient use has been achieved can further transfers be considered.
- Management and control of water abstractions.
- Management of groundwater and local surface water resources.
- Management and Operation of Local dams, viz. Wentzel, Taung and Spitskop dams.

2.11 ISP Implementation Strategy

The implementation of the Lower Vaal ISP is expected to take place through the Lower Vaal Catchment Management Agency.

The ISP is intended to act as DWAFs perspective on how the Vaal River catchment's water resources should be managed, in particular the Lower Vaal WMA. The final ISP will be published and be open to comments from local authorities, water user associations and other water related forums and interested stakeholders. Mechanisms are to be put in place to capture anomalies and it is intended that formal updates of the document will occur periodically until such time as the Catchment Management Agency is technically functional and a Catchment Management Strategy developed.

REFERENCES

DWAF (2004a) Department of Water Affairs and Forestry, **National Water Resource Strategy, First Edition**

DWAF (2004b) Department of Water Affairs and Forestry, Report No. P RSA C000/00/0103. **Internal Strategic Perspective : Vaal River System : Overarching**, 2004.

DWAF (2003a) Department of Water Affairs and Forestry, Report No. P WMA 10/000/00/0203, **Lower Vaal Water Management Area: Overview of Water Resources Availability and Utilisation**.

DWAF (2002) Department of Water Affairs and Forestry, Report No. P WMA 10/000/00/0302, **The Lower Vaal WMA – Water Resources Situation Assessment.**

DWAF (2001) Department of Water Affairs and Forestry, Report No. P C000/00/22502 , **Continuous Investigations (Phase 2), Revision of the augmentation requirements for the Integrated Vaal River System**.

DWAF (1999) Department of Water Affairs and Forestry, Report No. P C000/00/21599, **Report for the Vaal River Irrigation Study.**

APPENDICES

Appendix A: Lower Vaal WMA Strategy Tables

Appendix B: Maps and Figures

Appendix C: List of Towns in Lower Vaal WMA

Appendix D: Groundwater Report

Appendix A: Lower Vaal WMA Strategy Tables

Lower Vaal Water Management Area Strategies

Strategies Table of Contents

INTRODUCTION TO STRATEGY TABLES

The first 2 chapters of the Lower Vaal WMA Internal Strategic Perspective (ISP) describe the ISP process, paint a broad perspective of the water situation in the WMA, and describe the key issues that have to be dealt with. The crux of the ISP is located in a series of strategy tables presented in **Appendix A**. The strategy tables for each area present the management objective (what we are trying to achieve); an assessment of the situation along with a motivation as to why the strategy is required; the required actions; responsibilities; priorities; and relevant supporting references. A version control is attached for future versions of this ISP.

Certain issues are clearly applicable to all WMAs in the country and for these a national policy to guide the strategy needs to be developed. These issues and aspects were identified and flagged, during the development of this ISP, for consideration at **National Level**.

The table below provides a brief description of the elements contained in the strategy tables.

Definitions of terminology used in the Strategy Tables

Management Objective	Description of what DWAF is trying to achieve
Situation assessment	Description of the current situation and related issues and motivations to support the management actions.
Management actions (M)	The actions which need to be taken to resolve issues and tasks identified in the situation assessment.

A1. WATER BALANCE AND WATER RESOURCE RECONCILIATION STRATEGIES

A1.1 RESOURCE AVAILABILITY

Management objective:	Ensure reliable estimates of the water resources (surface and groundwater) are available to effectively conduct Integrated Water Resources Management. The factors impacting on the water resources needs to be clearly defined and understood.
Situation Assessment:	**OVERVIEW** The water in the Lower Vaal WMA flows from the Upper Vaal, across the Middle Vaal, Lower Vaal and Lower Orange WMAs before reaching the Atlantic Ocean near the town of Alexander Bay in the western corner of the country. This cascading characteristic of the three Vaal WMAs has the consequence that the water availability in the main stem of the Vaal River is determined by the availability of water in the Vaal River System. In addition, the water availability in the Vaal River will also impact on the water availability of the Orange River in the Lower Orange WMA. This inter-dependency between the Vaal River WMAs, and the roles of the CMA and DWAF National, is described in detail in the Overarching ISP ***[Ref 3]***. A model is in place for the Lower Vaal WMA and there is sufficient hydrology available for this WMA. The water resources availability figures for the Vaal River System as a whole is covered in the overarching ISP and is associated with a high level of confidence. Consequently the water resources availability figures for the main stem of the Vaal River in this WMA also has a high confidence level. There are however uncertainties in water resources availability in the Harts sub-catchment, specifically in Spitskop and Taung Dams. In order to facilitate detail discussions and data representation, the Lower Vaal WMA was divided into three sub-areas, namely the Molopo, Harts and Vaal D/S of Bloemhof Dam. These sub-divisions are similar to those used in the NWRS for comparison purposes. A map is provided in **Appendix B (Figure B2)** illustrating layout of the sub-areas within the Lower Vaal WMA. The Vaal D/S of Bloemhof Dam will be discussed under the Main Stem of the Vaal River and the remaining sub-areas will be discussed under Sub-catchment-specific aspects. **SURFACE WATER RESOURCES** *MAIN STEM OF THE VAAL RIVER* Although the storage basin of Bloemhof Dam lies in the Middle Vaal WMA the full yield from the dam is available for the Lower Vaal WMA. Approximately 500 million m^3 per year is transferred as yield from the Middle Vaal WMA to the Lower Vaal WMA at present. As an upper scenario this figure could increase to 555 million m^3 per year. The Lower Vaal WMA is a component of the extended Vaal River System for which an integrated system's model has been compiled to account for the complex inter - dependencies that exist due to connectivity of the three Vaal WMAs. This model is currently used to assess the available water resources and is referred to as the Water Resource Planning Model (WRPM). ***[Ref 2]*** The existing (February 2003) Integrated Vaal River System Model contains a hydrological database that covers the period 1920 to 1995 (water years) and includes re-calibrated water quality (Total Dissolved Solids - TDS) modules that

were compiled as part of the *Vaal River System Updated Study* (VRSAU) **[Ref 2]**.

Given the comprehensive level of detail of the VRSAU study there is sufficient knowledge and a high level of confidence in the water resource availability and water quality TDS information that is available to provide decision support information for the management of the water resources for the main stem of the Vaal River.

The existing water resource network system covers the entire catchment of the WMA and simulates all the major dams individually. However, certain users and small dams were combined in order to simplify the system configuration. Although these simplifications are acceptable for the purpose of modelling the larger Sub-systems, finer resolution definition network configurations could be required to accurately model water resources availability at a local level. It is proposed that more detailed analysis be undertaken in situations when specific licence applications need to be assessed or where local water supply problems need to be resolved.

As shown in Table 2.4, the return flows in the WMA represents a significant proportion of the total local surface water yield. The biggest portion of the return flows is from the agricultural sector. The impact on the water resource availability in terms of water quality is an important issue that is discussed in more detail in the Water Quality Management Strategy A2.2.

The future volumes and qualities of the return flows are not known at this stage particularly with the implementation of WC&DM and direct re-use of discharges.

This sub-catchment is dominated by the releases from Bloemhof Dam to support the diversion of water from Vaalharts Weir to the Vaalharts Irrigation Scheme. Releases are also made from Vaalharts Weir into the river to support the water requirements of downstream users. Significant quantities of river losses are associated with the releases from Bloemhof Dam consisting of both consumptive (evaporative) and operating losses.

Due to the nature of the open surface conveyance conduits (the Vaal River and canal systems), it is inevitable that significant volumes of losses are incurred in the system. Broadly, the losses consists of consumptive (evaporative and seepage) losses as well as operating losses that are due to the long conveyance conduits. Preliminary assessments indicate that consumptive losses in the Vaal River is estimated at about 80 million m^3/annum and operating losses as much as 100 million m^3/annum. It is noted that these estimations were determined from basic mass balance calculations using readily available flow gauge data and model simulation results. These figures need to be substantiated with higher resolution data and possibly higher resolution modelling in order to improve estimates of the water balance.

SUB-CATCHMENT SPECIFIC ASPECTS

The Molopo sub-area

The Molopo sub-area does not form part of the model for the Vaal River System as drainage of surface water from the Molopo sub-area occurs in the direction of the Orange River and not the Vaal River. Large evaporative losses through pans and wide river beds in the lower Molopo River has the effect that limited flow, only in very extreme flood events, reaches the Orange River. However, flows from the Molopo River have not reached the Orange River in recorded history and the Molopo sub-area is therefore considered to be an endoeric area. The surface water resources in the Molopo sub-area has therefore not been studied

in any detail and it is unlikely that detailed studies will be undertaken in this sub-area as there is an absence of economic activity in the area. However, it is noted that groundwater may be an important resource in this area should the need arise for increased water supply in this area.

Harts sub-area:
Wentzel, Spitskop and Taung dams provide regulating storage in the Harts River.

The Harts sub-area can be divided into 2 sub-catchments, namely:
1. Taung Dam sub-catchment
2. Harts d/s of Vaalharts

Taung Dam sub-catchment
The Taung Dam sub-catchment is characterised by relatively good quality water which can be used for irrigation purposes. It is believed that this sub-catchment has a surplus in water availability but this needs to be verified and appropriately allocated.

Harts downstream of Vaalharts
This sub-area is dominated by irrigation activities of the Vaalharts Irrigation Scheme which generated significant volumes of return flows upstream of Spitskop Dam. The catchment downstream of Vaalharts is highly affected by return flows from the Vaalharts scheme resulting in a high Total Dissolved Solid (TDS) content in the Lower Harts sub-cathment. However this flow (return flows) forms an important resource in the Lower Harts River sub-catchment.

Due to the long and open nature of canals in the Vaalharts system, evaporation and seepage loses are relatively high. It is estimated that these losses are as much as 45 million m^3/annum in the Vaalharts canal system.

The surface water resource availability in the Harts sub-catchment is not well quantified. There is a need to verify the yield at Taung and Spiskop Dams and to consider different allocation scenarios. More detailed hydrological analyses and monitoring of the resources are required to better assess the availability of water in these areas to meet the local water requirements.

GROUNDWATER RESOURCES

General
Groundwater resources are of major importance in the Lower Vaal WMA, supporting the dispersed rural communities and urban centres. Therefore, the management of the groundwater resources is of utmost importance in this sub-catchment. It is very important that yield determinations are undertaken to identify potential groundwater yields to supplement the surface water resources, particularly at a local level.

An understanding of ground and surface water interaction is required, specifically in the heavily-utilised areas of Kuruman and Lichtenburg. There is a possibility that the yield at Wentzel Dam may diminish as a result of development of the Kuruman Eye. However, this can only be verified if the interaction between ground and surface water is better understood.

There is also the potential for deep water groundwater abstraction in the Harts sub-catchment for areas such as Schweizer Reneke. However the availability has not been quantified as yet.

As actual groundwater use generally gives an indication of water resource availability, it is important to note that groundwater is used in this WMA for :
1. Agriculture
2. Mining
3. Domestic use

Refer to Strategy A1.2: Water Requirements for details of these key groundwater users.

Groundwater Quality

The natural occurring water quality in the WMA is generally good in the dolomitic/karstic and fractured/crystalline aquifers. In the western portion of the WMA in the Kalahari group primary (sand/gravel) aquifers and clay formations the quality is often naturally poor with TDS values ranging from 1500 mg/l and higher. Water to the western parts of the WMA are therefore supplied from the Vaal River system.

A better understanding is required of the impact of irrigation return flows on the quality of groundwater resources.

Groundwater monitoring and management

There are a total of approximately 180 monitoring points throughout the Lower Vaal WMA (***See Table 3 in Appendix D***). The monitoring points serve both of the levels of groundwater monitoring, namely level 1 or national monitoring network and level 2 or regional. The monitoring includes water levels and ambient water quality. There are automatic data loggers at some stations. The aim is to expand the network but the required equipment and personnel is currently not available.

The need for data on the availability of groundwater be driven by the need for water in particular areas. Any application for the use of groundwater must be accompanied by a first order study showing that the impact on the water resource is acceptable.

MANAGEMENT ACTIONS		
	M1. Water Balance modelling downstream of Bloemhof Dam is required, taking the following into account: o Quantify and determine the causes of losses and/or illegal water uses that are associated with losses from Bloemhof Dam. (Need improved flow measurements in the system to do this) o Finer resolution modelling (calculations) is required for releases from Bloemhof Dam to the Vaalharts weir to ensure that water is supplied in accordance with the specific requirements of water users in the Vaalharts area. o All elements impacting on the river flow water balance needs to be better understood and quantified.	NWRP (Priority 1) Regional Office (Priority 1)
	M2. The hydrological models and methodologies that should be applied to address the resource availability in areas of the catchment where information is required, will be developed during a pilot study to be undertaken on the Mhlathuze River catchment. o These more rigorous models and calculation methodologies should be used to analyse the resource availability of areas where water resource problems exist. o In the short term, until the above study is completed, the existing WRYM system configurations can be refined when needed to develop local reconciliation options.	NWRP (Priority 1)

	M3. Monitoring information is required at a higher level of confidence to accurately model irrigation return flow volumes and associated water quality. Refer also to **Strategy A.8** : Monitoring and Information Management	Regional Office (Priority 1)
	M4. Determine the interaction between groundwater and surface water, specifically in the Kuruman area, which is located in the Harts river catchment.	Regional Office (Conditional Priority)
	M5. Yield analyses are required for the smaller water supply systems mainly to determine the water availability and to identify shortages and surpluses within these smaller sub-systems. This will be undertaken only on a needs basis or in reaction to licence applications. An urgent need exists for System Yield Analyses in the Harts sub-area in the Wentzel Dam/ Taung Dam area.	NWRP (Conditional Priority)
	M6. Determine the feasibility of deep aquifers as a viable water source, especially for local water requirements in stressed catchments.	Regional Office (Priority 1)
	M7. A groundwater availability map should be updated for the WMA. The map should be used to identify areas where groundwater is available to meet local demands and estimate the volume of groundwater that is available to meet water requirements. If a higher degree of confidence is required in certain areas more rigorous analysis should be undertaken. Groundwater quality should also be considered.	NWRP (Priority 1)
	M8. Guidelines are required for evaluating resource options for issuing of licences for water use from groundwater resources.	NWRP (Priority 1)
Interfaces:	**References:** 1. DWAF report number P WMA 10/000/00/0203. Lower Vaal Water Management Area: Overview of Water Resources Availability and Utilisation. 2. DWAF report no : PC000/00/18496 "Vaal River System Analysis Update : Integrated Vaal River System Analysis: 3. DWAF report no : P RSA C000/00/0103 "Vaal River System: Overarching Internal Strategic Perspective.	

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A.1.2 WATER REQUIREMENTS

Management objective:

Ensure that the knowledge base on the water requirements in the WMA is realistic and updated on a regular basis. Furthermore, maintain and update water requirement projection scenarios for planning and management purposes.

Situation Assessment:

Water Requirements:

Information presented in Chapter 2 shows that for the year 2000 development level more than 80% of the total local water requirements in the WMA is for irrigation. Water use by urban centres such as, Kimberley, Lichtenburg, Kuruman, Taung and Vryburg is the second largest water user sector at about 11% of the total.

It is expected that the future water requirements for the irrigation and mining sectors will remain about the same. A small decrease in the water requirements are expected in the domestic sector for the base scenario [**Ref 1**] due to the expected negative growth in the population.

The water requirements (and abstractions) directly from the river by individual users is uncertain and needs to be verified.

The water requirement scenarios currently used for planning originate from the National Water Resources Strategy. The most probable scenario is based on the so-called "**Ratio Method**". In short this method uses the same ratio between the domestic portion and the remaining portion (commercial, industrial and other) as observed in 1995 to project the urban water requirement into the future (see **[Ref. 2]** for a summarised description of the scenario generation method).

Sub-catchment	Water requirements for 2000		
	Local requirement	Transfers out	Total
Harts	494	62	556
Vaal downstream of Bloemhof	113	422	535
Molopo	36	0	36
Total	643	0	643

Source: *Lower Vaal WMA: Overview of Water Resources Availability and Utilisation*

Water use data:

The actual water use data are collated from the different DWAF offices and bulk users on an annual basis and is currently captured in a spreadsheet database. This information is compared with the projected water requirements in order to make adjustments (over the short-term) for use in the annual operating analysis. Actual water use data is not available for the irrigation users that abstract water directly from the river. These irrigation users are mainly located along the Vaal River and are estimated at about 100 million m^3/a **[Ref 3]**. In order to improve the understanding of the operating losses, improved data on the actual water use (or realistic estimates) will be required.

Registration of water use:

This process has largely been completed and the process of verification of actual water use and classification in terms of lawfulness is in progress. Preliminary results indicate that there are large discrepancies between actual water use and registered water use, indicating operating losses and possible illegal use of water.

Situation Assessment:
(Continued)

Groundwater Use:

Agriculture

Agriculture plays a major role in terms of economic development in the WMA. Almost every farm unit in the WMA is dependent on groundwater for domestic use and stock watering. There are however limited abstraction volumes available but in terms of quantities of water, stock farming has a relatively small influence on the regional groundwater resource.

Large-scale irrigation is developed where aquifer types are suitable. Problems encountered at these irrigation areas are over- utilisation of the resources with the associated lowering of water tables.

Mining

There are several mining operations in this WMA. These activities vary from base-metal mining; diamond mining and even limited gold mining in the Kalahari greenstone belt. Groundwater use at most of these sites is limited and should any seepage occur into opencast pits or underground workings, the water is usually pumped and utilized in processes to minimize use of other water sources. This pumping often causes localized dewatering and is most pronounced at Kumba Resources Sishen Mine and at Beeshoek Mine.

Domestic

Several local municipalities are dependent on groundwater as a source of bulk supply. The main aquifers exploited are from dolomites and weathered fractured crystalline rocks such as andesitic lavas and granites. Some of the towns water supply is augmented by surface water supply e.g. Vryburg. The total population dependant on the source in urban areas is estimated to be 140 000 residents. **Table 2** in **Appendix D** gives a breakdown of groundwater consumption estimated for 1996.

Some groundwater utilisation for small rural settlements, takes place in the western portion of the WMA from primary or porous aquifers from the Kalahari group, but the quality and yields are often variable and not good.

Factors having significant impacts on water requirements in this WMA include:

- Current water requirement projections do not account for the impacts of WCDM (see the WCDM Strategy for more details).
- There is a lack of actual water use data for irrigation use. Improved irrigation use data will improve our understanding of operating losses in the system.
- Once the water use has been verified, it should be compared with the data applied in the models. The model database should be updated where appropriate.
- The Department of Agriculture should get involved in education of farmers on efficient irrigation methods. (**See WC/WDM Strategy**)
- Pricing strategy for irrigation needs to create incentives for farmers to conserve water and/or to trade their water. (**See Pricing Strategy**)
- The water use and return flows should be monitored on a continuous basis and checked against the water requirement projections. Appropriate intervention measures should be commissioned if the use differs substantially from the demand.
- The water requirement projections for the WMA should be updated in conjunction with the other Vaal WMAs. This task requires coordination across WMA and will have to be undertaken at a Cluster or National Level.

MANAGEMENT ACTIONS (Water Requirements)		
Required actions, responsibilities and priorities:	**M1.** **(a)** The process of verification of existing lawful use should be completed. **(b)** Comparisons should be made between the lawful use and the water use data applied in the water resource system models.	Regional Office NWRP (Priority1)
	M2. The current practice of annual updates of water use and adjustments to water requirement projections should be continued.	Regional Office (on-going)
Interfaces:	**References** 1. Lower Vaal Water Management Area: Overview of Water Resources Availability and Utilisation. DWAF report number P WMA 10/000/00/0203. 2. DWAF report no: PC 000/00/22502, "Vaal River: Continuous Investigations (Phase 2), Revision of the augmentation requirements for the Integrated Vaal River System (2001)". 3. DWAF report no : PC000/00/18496 "Vaal River System Analysis Update : Integrated Vaal River System Analysis:	

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A.1.3 WATER BALANCE RECONCILIATION

Management objective:

Manage the water resources to maintain a surplus or balance between the available water resources and the water requirements through progressive implementation of management measures. The aim is to schedule and implement low cost measures first, whereby the most costly measures (usually large capital intensive developments) are postponed.

Situation Assessment:

The following table provides a breakdown of the water balance in each of the sub-areas of the Lower Vaal WMA for the year 2000.

Sub-area	Available water (2000)			Water requirements (2000)			Balance (2000)
	Local yield	Transfers in	Total	Local requirement	Transfers out	Total	
Harts	136	419	555	494	45	539	16
Vaal downstream of Bloemhof	(46)	545	499	65	423	488	11
Molopo	35	4	39	36	0	36	3
Total	125	500	625	643	0	595	30

Note: The figures provided here are different from the figures provided in the Lower Vaal WMA Overview of Water Resources Avaliability – See explanation on page 2-2, Chapter 2 of this ISP

MAIN STEM ASPECTS

The Lower Vaal WMA as a component of the extended Vaal River System has been the subject of various studies in the past, which had the purpose of quantifying the water resources availability and/or evaluating measures to augment the water resources. For more information on the water balance situation in the whole of the Vaal River System please consult the Vaal Overarching ISP document.

The Lower Vaal WMA receives most of its water from the Middle Vaal WMA. There is a total water requirement of 643 million m^3/annum and a total available supply of 673 million m^3/annum. The small excess available in the WMA is due to the irrigation return flows that are not used in the catchment.

In the Lower Vaal WMA, no growth in water demand is expected. However should a demand for high value use occur in this WMA, the conditional surplus that is available in the Vaal River System will be used to supplement local water resources.

The operating losses from Bloemhof Dam is currently benefiting the Douglas scheme in terms of wate quality, that is, if releases/ losses from Bloemhof are minimised, then the water quality at the Douglas will deteriorate.

The reconciliation of the water requirements indicates that there is currently a surplus of 30 million m^3 / annum which is expected to remain relatively constant into the future. Currently surpluses are shown at Spitskop and Taung which need to be appropriately allocated. There is no further potential for the development of local surface water resources although there is potential for development of groundwater resources.

	The water balance currently and in the future is dependent on the transfer of water into the WMA from the Middle Vaal WMA. Water transfers from the Middle Vaal and Upper Vaal WMAs resort under national control. Currently these amount to 500 million m^3/a, and may as an upper scenario increase to about 555 million m^3/a during the period of projection. The transfer of 18 million m^3/a from the Upper Orange WMA to Douglas Weir in the Lower Orange WMA will also remain under national control. Poor water quality from the Upper Vaal WMA and the added salinity of the irrigation in the Lower Vaal WMA has a negative impact on the usability of the water resources. Impacts of alien vegetation on the groundwater resources were identified as a concern. *SUB-CATCHMENT-SPECIFIC ASPECTS* *Harts Sub-catchment:* The above table indicates that the Harts sub-catchment has surplus yield. This surplus is available at Taung and Spitskop dams. At Taung Dam, the water quality is relatively good but Sptskop Dam has poor quality water in terms of TDS. The options available for utilisation of the surplus are: 1. allocate Taung yield for irrigation use by emerging farmers, 2. replace some of the transfer from the Vaal River, resulting in more water being available from Vaal Dam to Rand Water 3. blend Taung water with Spitskop water to reduce the TDS concentration (as an interim measure) The North West Provincial Department of Agriculture has strong initiatives for the yield from Taung Dam. These plans need to be reviewed and supported by DWAF if appropriate for addressing water requirements of emerging farmers. *Molopo sub-catchment* Although this sub-catchment has a small overall surplus, it is known that deficits occur in loaclised areas due to over-abstraction of groundwater. According to Reference **[Ref 1]**, the bulk of the water used in this sub-catchment is from groundwater. Management intervention is required to prevent the over-exploitation of groundwater experienced in localised areas (notably Tosca). De-watering of mines and possible pollution of groundwater through mining activities need to be carefully managed, based on appropriate scientific investigations and compliance monitoring. Consideration should be given to the possible beneficial utilisation of excess water from the de-watering operations. The impacts of farm dams and of invasive alien vegetation on the groundwater resources need to be investigated. Joint management of the trans-border aquifers with Botswana is to be addressed at a national level.

MANAGEMENT ACTIONS		
Required actions, responsibilities and priorities:	**M1.** System analysis is required for the smaller water supply systems mainly to determine the water availability and to identify shortages and surplus within these smaller sub-systems. This will be undertaken only on a needs basis or in reaction to licence applications.	Regional Office (As Reqd.)

	M2. A strategic approach to the allocation of surplus water from the following areas is required : **(a)** Spitskop (possibly allocate to Resource Poor Farmers) **(b)** Taung (possibly allocate to Resource Poor Farmers) **(c)** Groundwater (as required)	Regional Office (Priority 1)
	M3. Conduct discussions with Northern Cape and North West departments of Agriculture regarding the allocation of surplus water, possibly to emerging farmers.	Regional Office (Priority 1)
	M4. Monitor the supply situation through annual operating analysis to ensure that the required management measures are implemented on time.	NWRP (on-going)
	M5. Identify sites where potential exists for future problems due to infestation and direct Working for Water to the most effective targets. Issues at specific sites to be documented.	Regional Office WfW (Priority 1)
Interfaces:	**References** 1. Lower Vaal Water Management Area: Overview of Water Resources Availability and Utilisation. DWAF report number P WMA 10/000/00/0203.	

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A.1.4 TRANSFER AND RESERVATION OF WATER

Management objective:	Reserve adequate water resources to support the transfers out of the WMA and secure internal transfers as well as the water supply to existing users within the borders of the WMA.
Situation Assessment:	**Existing transfers into the Lower Vaal WMA *(See Overarching ISP)*:** There is one transfer into the WMA, namely: (a) 500 million m^3/annum from the Middle Vaal WMA. **Existing transfers within the Lower Vaal WMA.** There are three major transfers within the WMA as listed below: 1. The bulk of the water requirements in the Harts Sub-catchment (mainly the Vaalharts Irrigation Scheme) are supplied from the Vaal Downstream of Bloemhof Sub-catchment. 2. The Vaal Downstream of Bloemhof Sub-catchment transfers 5.7 million m^3/annum water to the Molopo sub-catchment through the Vaal Gamagara and Kalahari Water Supply Schemes. 3. Return flows from the Harts Sub-catchment also contributes to the water resources of the Vaal Downstream of Bloemhof Sub-catchment. **Future transfers:** No further transfers are envisaged in the future for the Lower Vaal WMA. However, it is possible (by reversing the existing Gamagara Scheme infrastructure) to augment water resources from groundwater in the Molopo sub-catchment back into the Vaal sub-catchment, if required. As already indicated, if large urban growth is experienced, then water can be allocated from the "conditional surplus". This will constitute an additional transfer.

Interfaces:	**References** 1. Lower Vaal Water Management Area: Overview of Water Resources Availability and Utilisation. DWAF report number P WMA 10/000/00/0203. 2. Water Resources Situation Assessment : Lower Vaal Water Management Area DWAF Report No. P03/000/00/0101

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A.1.5 COMPULSORY LICENSING

Management objective:	Ensure equitable sharing of the available water resources for the Reserve and to redress social inequities (both of which have priority calls on water) and activities to maintain the economic and social structures that rely on the water resources of the Lower Vaal WMA.
Situation Assessment:	**Compulsory Licensing Principle:** Considering the three variables (Reserve, Over-allocations and Equity Adjustments), as discussed in the Vaal Overarching ISP, there is no immediate need to undertake a compulsory licencing process for the Vaal River System in terms of: a. Equity b. Water Balance c. Ecological Reserve These principle variables are discussed in detail in the Overarching ISP **[Ref 3]**. In principle, compulsory licesing will only take place if there is a need to address Equity, to ensure that the system is balanced in terms of water availability and requirements, and to meet the need of the ecological reserve, as necessary. **Main Stem Issues:** In terms of water balance, the system has a surplus in terms of water availability and water requirements and any additional water requirements can be made available from the surplus or through releases from the Middle Vaal WMA as a result of the conditional surplus that exists in the Vaal River System. Therefore, in terms of the water balance of the system compulsory licencing is not a priority within this WMA. In terms of the ecological reserve, the economic activities supported by the water resources in the Vaal River System are recognised as the economic engine of South Africa and the Vaal River is considered to be a "work horse" river. However the Ecology of the river should be managed to prevent further degradation and improve areas where unacceptable ecological conditions exists without causing a significant reduction in the water availability (Refer also to the **Vaal River System Analysis Update Study *[Ref 2]*** with regard to Ecological Reserve Management). There are no sensitive areas downstream of the main dams within the Lower Vaal WMA implyng that there is no urgent need for the determination of a Comprehensive Reserve and full implementation thereof. **Sub-catchment Issues:** Although the above status indicates that Compulsory Licensing is not an immediate priority in this WMA, it may be required in selected sub-catchments where specific issues were raised at the workshops, for example, Tosca experiences problems due to over-exploitation of water resources. There have also been reports of groundwater over-utilisation in the Mafikeng area. However it is considered that other interventions (such as verification of lawful use, implementation of WC/WDM, use of groundwater, etc) must be explored to address the specific problems before a compulsory licensing programme is pursued.

MANAGEMENT ACTIONS		
Required actions, responsibilities and priorities:	**M1**. Regularly evaluate the priority of compulsory licensing for localised stressed catchments.	Regional Office (Priority1)
	M2. Implement compulsory licensing in Tosca	Regional Office (Priority1)
Interfaces:	**References** 1. Lower Vaal Water Management Area: Overview of Water Resources Availability and Utilisation. DWAF report number P WMA 10/000/00/0203. 2. Water Resources Situation Assessment : Lower Vaal Water Management Area DWAF Report No. P03/000/00/0101. 3. DWAF report no : P RSA C000/00/0103 “Vaal River System: Overarching Internal Strategic Perspective.	

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A.1.6 SUPPLY TO DISTRICT AND LOCAL MUNICIPALITIES

Management objective:	Ensure that local and other authorities have sufficient water resources to supply their requirements and implement measures for efficient utilisation of the available resources. The objective with water supply to local authorities should be to implement economical feasible supply options with acceptable environmental impacts.
Situation Assessment:	**Appendix C** provides a list of all towns within the Lower Vaal WMA and their water sources. **Surface water resources:** • Water is distributed from the Vaal River by pipeline to the towns on the western areas of the Molopo catchment in the Lower Vaal WMA. • The water requirements for the Lower Vaal WMA are considered as part of the water balance of the Integrated Vaal River River System. However, a second supply situation exists where the towns rely partially or fully on local water resources. • There are only two water service providers in the Lower Vaal WMA, the Kalahari East Water User Association and the former North West Water Supply Authority (absorbed by Sedibeng Water). The Kalahari East WUA receives water from Vaal Gamagara and distributes this to farmers in the Kalahari for stock-watering and domestic use. • Schweitzer Reinecker would like to get water from Bloemhof Dam. However, there is groundwater available in this area but specific investigations are required in this regard, specifically in respect of exploring deep aquifers. Funding for this investigation is required and will probably be provided on condition that proper groundwater management plans are in place. • As a general rule DWAF will not initiate new surface water schemes for local authorities unless all other options have been exhausted, such as water conservation & water demand management, exploitation of groundwater, etc. **Groundwater:** It is expected that sufficient groundwater resources are available to supply the needs of small towns. It is however critical that the groundwater resource is properly managed to ensure its sustainability. Where water resources are stressed, the following options must be considered: 1. WC&DM (DWAF can influence but it is a LA responsibility) 2. Investigate local ground and surface water resources 3. Consider trading of water rights 4. Transfers from further afield <u>Water Conservation/ Demand Management</u> An important role that the Department/CMA must pursue is the promotion of effective WC&DM measures amongst local authorities in the WMA. This must be pursued both with the local authorities and water service providers. <u>Investigate Local Water Resources</u> The approach to be adopted with the towns reliant on local water resources, is that the Department/CMA together with Water Service Providers, where appropriate, will give guidance on the approach to follow and the possible supply options that should be investigated. The towns will then apply for a

	licence through the normal channels. In addition, consideration must be given to investigating transfer of water resources from areas adjacent to the towns in question to determine whether water requirements of these towns can be sourced from the adjoining areas. <u>Trading of Water Rights</u> Local Authorities within the WMA can also consider trading of water rights. Water rights can be traded from other users and/or adjacent sub-catchments before consideration is given to augmentation of water from the Vaal River System at full cost.

MANAGEMENT ACTIONS		
Required actions, responsibilities and priorities:	**M1**. o A list of municipalities with water supply problems needs to be identified. (Table in Appendix C to be updated). o Enter into discussions with individual municipalities to identify the best solution/s to their water supply problems. o Provide water resource availability assessments for areas where extensions to the water resources are required. The need for this information should be identified in the WSDP development process and the results should be included in the WSDP reports.	Regional Office (Priority 1)
	M2. Promote and encourage the utilisation of groundwater resources for local water supply. Water Service Development Plans and feasibility studies (business plans) should indicate what groundwater supply options were considered for development. This investigation must not be restricted to the boundaries of the specific town.	Regional Office (Priority 1)
	M4. Promote the implementation of WC&WM measures within local authorities. In support of WC/WDM, provide guidelines for the proper operation of boreholes for municipalities.	Regional Office (As required)
Interfaces:	**References** 1. Water Resources Situation Assessment : Lower Vaal Water Management Area. DWAF Report No. P03/000/00/0101.	

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A.2 WATER RESOURCES PROTECTION STRATEGY

A.2.1 RESERVE AND RESOURCE QUALITY OBJECTIVES

Management objective:	A Comprehensive Reserve determination needs to be undertaken for the Vaal River catchment and strategies for implementation developed.
Situation Assessment:	*The following situation assessment has been summarised and adapted from the Overarchng ISP **[Ref 4]**.* The Vaal River and it's tributaries are generally accepted as "workhorse" rivers to support the water requirements of the hub of South Africa's economy. As indicated in the Vaal Overarching ISP report, the Vaal River Catchment has sub-catchments whose natural flow and water quality regimes are significantly changed from natural conditions, whilst others are close to natural. The impacted river systems in the Vaal River catchment are highly regulated by major and small dams. The natural flow patterns in many of these river reaches have been substantially modified by return flows from wastewater treatment plants, mine dewatering, agricultural return flows and releases of water from transfer schemes into the river systems. It is expected that the ecosystems have largely adapted to the changed flow and water quality regimes. There are also substantial areas of the Vaal River catchment where land use development is low and the flow patterns are therefore largely unimpacted. A Comprehensive Reserve has not been determined for the Vaal River Catchment. However, as part of the VRSAU study an Environmental Flow Management Plan was developed for the main stem of the Vaal River **[Ref. 3]**. The products from the study were basic definitions of flow requirements and preferred operating regimes. Currently applied reservoir release and transfer operating rules do not explicitly contain the flow requirements defined in the abovementioned study. Furthermore, the Resource Directive Measures (RDM) Directorate is also determining low confidence desktop estimates of the Reserve for catchments where it is needed for the issuing of licences. The water resources of the Vaal River System are augmented by transfers into the catchment from other WMAs. The Reserve still needs to be determined for many of the catchments supplying the Vaal River System. The implementation of these Reserves and the Vaal River System Reserve will affect water availability in the Vaal River System. The impact of the implementation of the Reserves for the various augmentation schemes in the Vaal River System will have to be derived and an implementation schedule determined. The current operating rules of the Vaal River System has been applied for a long time without having major negative effects on the ecology. (No serious ecological problems were highlighted at the workshops). An environmental Flow Management Plan has been developed for the main stem of the Vaal River and the implementation thereof will be an overarching function for the National Department **[Ref 3]**. Given the above-described situation, there is no urgent need to implement the Reserve in the Lower Vaal WMA. However, in areas where compulsory licensing is being considered, there may be a need to determine the reserve, for example, in the Tosca area.

	At present, a formally published river classification system for the ecology does not exist and a national system is currently being developed. None of the rivers in the Lower Vaal WMA have Water Quality Objectives in place. These are urgently required for proper management of the quality of water in the Lower Vaal WMA. *The following requirements and guidelines have been identified in terms of Resource Directed Measures at the ISP workshops :* **1.** Reserve determination investigations are required for the following purposes: • To determine the share of water availability required for the Reserve. • For issuing of licences. • To determine when the next large augmentation scheme has to be implemented. **2.** It has been identified that the planning activities for the implementation of the Reserve in the Integrated Vaal River System should be undertaken across WMA boundaries (as described in the **Overarching Vaal ISP, Strategy A.2.1 : Reserve and Resource Quality Objectives**). This approach is necessary to ensure the combined impact of the Reserve in the different water resources (located in different WMAs) is taken into consideration in the Reserve determination process. **3**. The impact of the revised EWR's on the supply capability of the Integrated Vaal River System needs to be determined. This issue is addressed in the Overarching ISP. (See **Strategy Table A2.1 : Reserve and Resource Quality Objectives**). **4**. In most instances a rapid reserve determination must be carried out while an intermediate reserve will be undertaken only in selected areas. **5.** Groundwater reserve table is available from the Directorate : Resource Directed Measures. The Directorate : Resource Directed Measures has developed a database of all areas where groundwater Reserves have been determined. This information should be used to direct the procedure that has to be followed when assessing licence applications.

MANAGEMENT ACTIONS		
Required actions, responsibilities and priorities:	**M1**. The time schedule for determining the Comprehensive Reserve is needed for the Vaal River. A committee needs to be established to assess if the Reserve for the entire catchment and or system needs to be determined or only sections of the catchment and when should this determination take place. This determination should be co-ordinated with catchments augmenting the Vaal River System and the determination of the Orange River Reserve. It is dealt with in the **Vaal River Overarching ISP**.	NWRP (Priority 1)
	M2. Water Quality Objectives for all rivers in the Lower Vaal need to be set.	Regional Office (Priority 1)

Interfaces:	**References** 1. Lower Vaal Water Management Area: Overview of Water Resources Availability and Utilisation. DWAF report number P WMA 10/000/00/0203. 2. Water Resources Situation Assessment : Lower Vaal Water Management Area DWAF Report No. P03/000/00/0101. 3. DWAF report no : PC000/00/18496 "Vaal River System Analysis Update : Integrated Vaal River System Analysis. 4. DWAF report no : P RSA C000/00/0103 "Vaal River System: Overarching Internal Strategic Perspective.

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A.2.2 WATER QUALITY MANAGEMENT STRATEGY

Management objective:	DWAF is responsible for the management of South Africa's water resources in a sustainable manner. This implies that in its pursuit to stimulate development and socio-economic growth, that there will be a negative water quality impact on our 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 downstream users) and protection of the natural ecosystems is an important management objective.
Situation Assessment:	The water quality situation in the Lower Vaal WMA is discussed in terms of the main stem of the Vaal River, which runs through the WMA and the tributaries discharging to the Vaal River. **Vaal River Main Stem** The Vaal River catchment is a cascade of three WMAs. The water quality of the main stem of the Vaal River in the downstream WMAs is therefore impacted on, not only by the activities in the WMA itself, but also by the water received from upstream. The water quality in Vaal River will also impact on the water quality of the Orange River in the Lower Orange WMA. A water quality management strategy can therefore not be developed in isolation for individual WMAs but the entire Vaal River System will have to be considered in an integrated manner. Integrated Water Quality Management Plans will therefore be developed for the Vaal and Orange Rivers. The management actions related to the development of these plans are discussed in the **Vaal and Orange Overarching ISPs**. The approach adopted by the Department of Water Affairs and Forestry in managing the water quality in the Vaal River catchment is to set water quality objectives (WQO) for the sub-catchments. The WQO are based on the water user requirements in the catchments. The WQO includes three categories of water quality variables, viz. ideal, tolerable and unacceptable. A phased approach has been adopted for the development of strategies to manage the water quality in the sub-catchments of the Vaal River Catchment. The first phase is a situation assessment, which is followed by further phases to develop catchment management strategies. The approach adopted for the management of the water quality in the WMA is on a sub-catchment basis. Water Quality Management Strategies (WQMSs) need to be developed for the individual sub-catchments, where necessary. These plans involve the setting of water quality objectives (WQO), identification of pollution sources, modelling and the development of management actions. These plans for the individual areas need to be linked to an assessment of the overall water quality management of the Vaal River. According to the limited analysis carried out as part of this WRSA study, the water quality in the Vaal River is reasonable. However, the water quality in the lower Harts River is marginal due to saline return flows from the Vaalharts irrigation scheme. Water quality management will have to intensify in future with the aim of protecting the water resource to ensure utilisation under growing urban, industrial and coal mining land use activity. The impacts of pollutants such as Microbiological organisms, Nutrients and Salinity on the Vaal River System have been quantified and monitored to date. The downstream effects of these pollutants on the Vaal River System are water quality issues to be considered. **Harts Sub-area** The water quality in the Harts River is affected by concentrating the salts in the return flows from the irrigation schemes in the catchment and by evaporation while the return flows from the Vaal Harts Scheme are stored in the Spitskop Dam. The

TDS concentration of the intake water to the Vaal Harts Scheme is generally good and ranges from 250mg/l to 350 mg/l.

The salts in the return flows from the Vaal Harts Scheme are concentrated to about 1000mg/l to 1500mg/l. There is a further concentrating of salts in the Spitskop Dam due to evaporation. Once back in the Vaal River, the salinity load is diluted before being used in further irrigation schemes downstream in the Lower Orange River. Water quality problems have been reported at the Douglas weir.

A salt mass balance has been undertaken for the Vaal Harts Irrigation Scheme. Not all the mass could be accounted for. A recent study undertaken by the IGWS showed that there is an increase in TDS concentrations in the groundwater at the Vaal Harts irrigation scheme. This increase in groundwater concentration could explain the unaccounted for mass.

In addition to the concentration effect in the return flow, fertilisers are also applied, which add to the nutrient load in the return flows. The nutrients have resulted in the growth of algae in the Spitskop Dam. The Spitskop Dam has been cited as the source of algae, in particular blue green algae found in the main stem Orange and Lower Vaal WMA.

The above situation points to the need for pro-active management of the Harts River sub-catchment with particular focus on the Vaal Harts Irrigation Scheme. This may include a review of the drainage system to also address the possibility of a rising water table (See Management Action M1 below).

In addition, due to the interdependencies of the water quality in the different WMAs, an integrated water quality management tool modelling nutrients and salinity is needed to allow for the development of an integrated water quality management plan for the Vaal River catchment.

Molopo Sub-area

The Morokweng area currently experiences problems with the quality of groundwater. Nitrate pollution from agriculture and sewage pollution from domestic sources are evident in the area. The effects of nitrate pollution and domestic sewage on groundwater in the Morokweng area need to be curbed. It is important that the groundwater protocol is adhered to and good farming practices are implemented to protect the quality of groundwater resources. It is noted that the reserve will need to be determined if compulsory licensing to be pursued.

WMA Issues

Mining-related issues

There are extensive diggings in parts of the catchment which impact largely on the river courses. Sections of the Harts River upstream of Taung Dam are severely impacted on by digging activities, which causes sedimentation. An approach needs to be developed to manage the diamond diggers.

The mines in the WMA could also be impacting on groundwater quality. There is however very little monitoring data available to determine the extent of the groundwater pollution.

Municipal Sewage Treatment Issues

Many of the sewage works and sanitation systems of the towns in the WMA are inadequate and are in a poor state. The reasons for this are both poor management and the overloading of the plants and reticulation systems. The overloading is sometimes due to the replacement of pit latrines with water borne sewerage

	systems without upgrading the sewage works. This results in the overloading of sewage plants and the consequent discharge of poor quality effluent into the downstream rivers. Problems in meeting required water quality standards from the Bloemhof, Christiana and Warrenton sewage treatment works was identified as a problem that impacts on the water quality in the Vaal River. The reason cited for the problem is the lack of capacity at municipalities and the need for integrated planning with regard to the installation of waterborne sewerage systems and the associated upgrading of sewage treatment plants. It has been proposed that the Municipal Infrastructure Grant (MIG) Funding programme should be used to address this problem.

MANAGEMENT ACTIONS		
Required actions, responsibilities and priorities:	**M1** A water quality management strategy needs to be developed for the Harts River. The WQMS should include the setting of WQO's, management systems on irrigation schemes and the use of surplus water in the catchment.	Regional Office (Priority 1)
	M2. An integrated water quality management plan needs to be developed for the Vaal River System. The terms of reference for the study need to be developed. (Refer to the Over-arching ISP for the Vaal River)	NWRP (Priority 1)
	M3. The Environmental Management Plan Report (EMPR) and licensing process should be used to ensure monitoring and reporting is practised by the mines on groundwater.	Regional Office (on-going)
	M4. The EMPR and licensing process, together with best practice guidelines from DWAF, should be used to manage the "diggers".	Regional Office (on-going)
	M5. More stringent controls over municipalities are required to prevent the occurrence of sewage overflows and spillage. Funding and control of the problem should be addressed through the MIG programme.	Regional Office (on-going)
	M6. An education/communication campaign is required to make farmers aware of the negative impacts that poor agricultural practices can have on groundwater.	Regional Office (Priority 1)
Interfaces:	**References** 1. Lower Vaal Water Management Area: Overview of Water Resources Availability and Utilisation. DWAF report number P WMA 10/000/00/0203. 2. Water Resources Situation Assessment : Lower Vaal Water Management Area DWAF Report No. P03/000/00/0101. 3. DWAF report no : P RSA C000/00/0103 "Vaal River System: Overarching Internal Strategic Perspective.	

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A.3. WATER USE MANAGEMENT STRATEGY

A.3.1 GENERAL AUTHORISATIONS & SCHEDULE 1 STRATEGY

Management objective:	To optimise the use of these authorisations with a view to cutting down on unnecessary administrative efforts of water use activities that can be allowed without individual water use licences. Both the DWAF and the users falling in the General Authorisation category would save resources (time and money) by not having to apply for and process licenses for certain water use activities.
Situation Assessment:	**General Authorisations** The local water resources in the Vaal River System is limited with the result that local water resources are augmented by large scale transfers from the Thukela–Vaal Scheme and the LHWP. Consequently there are no general authorisations for the following water uses: Abstraction of surface water along the main stem of the Vaal River Abstraction of water from Bo-Molopo Groundwater Scheme In terms of Section 39 of the NWA, General Authorisations are permitted for the following in the Lower Vaal WMA **[Ref 1]**: a. Surface water abstraction, at a maximum rate of **6000m^3** per hectare per annum for irrigation or **100m^3/day** for uses other than irrigation, in quaternary catchments C31A,B,C,D,E,F, C32A,B,C,D, C33A,B,C, D41B,C,D,E,F,G,H,J,K,L,M, D42C, D73A,C. (See **Appendix B** for Map indicating quaternary catchments). b. Groundwater abstraction, at a maximum rate of **60m^3** per hectare per annum, in quaternary catchments C31F, C32A,B,C, C91A,B,C,E, D73A. c. Storage of up to 50 000m^3 water provided that storage exceeding 10 000m^3 is registered. d. Groundwater abstraction, at a rate of **300m^3** per hectare per annum, in quaternary catchments C31A,B,C,D,E, C32D, C33A,B,C, C92A,B,C. e. Irrigation with wastewater of up to 500 m^3/day provided that rirrigation with wastewater exceeding 50m^3/day is registered , except within the Bo-Molopo Groundwater Scheme located in drainage region D41, where irrigation with groundwater is prohibited. f. Treated effluent up to a maximum of 2 Ml/day is permitted provided that certain quality limits and monitoring requirements are met. g. Disposal of domestic sewage up to 1Ml/day provided that certain conditions and limits are satisfied, except within the Bo-Molopo Groundwater Scheme located in drainage region D41. h. Removal of groundwater (for purposes such as mining) up to a maximum volume of 50 Ml/day. All other activities are not covered by general authorisations but applications are currently being considered to permit GA's for the following: a. Impeding or diverting flow up to certain limits. b. Altering the shape of the river bank (with limits). The following requirements have been identified in terms of General Authorisations*:* **1**. Smaller feed lots need to be included under General Authorisations. The

	bearing capacity of the property needs to be taken into account. There is currently a process underway at a National Departmental level to develop the criteria for this water use. **2.** General Authorisations need to be reviewed on a regular basis. **3.** Pick and shovel diggers on the Vaal main stem should be allocated water not exceeding 9170m^3 per hectare per annum. This provision should be renewed annually. In conclusion, it is recommended that the responsibility for the reviewing and future publication of General Authorisations should be the function of the CMA, currently the Regional Office. The implementation of this delegated responsibility is currently being considered by the National Department for application in all WMA's.

MANAGEMENT ACTIONS		
Required actions, responsibilities and priorities:	**M1.** Refine the conditions specified for General Authorisations to incorporate the abovementioned requirements and other necessary adjustments.	Regional Office (Priority 1)
	M2. Water use in the WMA should be monitored to ensure that water uses without licenses do indeed fall in the General Authorisation categories. (Also see Strategy A.8 : Monitoring & Information Management)	Regional Office (Priority 1)
Interfaces:	**References** 1. General Authorisations in terms of Section 39 of the National Water Act, 1998 (Act No. 36 of 1998). Government Notice No. 1352 dated 12 November 1999. 2. Water Resources Situation Assessment : Lower Vaal Water Management Area DWAF Report No. P03/000/00/0101.	

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A.3.2 LICENSING STRATEGY

Management objective:	Licensing of water use (as defined in the National Water Act) should be considered on a continuous basis when applications are received. The licences should be considered in accordance with the framework as presented below:
Situation Assessment:	Although there is little or no growth expected in this WMA an important water resource issue facing the WMA is the licensing of current water users and the licensing of water discharges (e.g. urban effluent returns, mines decanting ground water etc) into the surface water system. This issue needs to be resolved as the issuing of new licences is dependent on whether existing and future water resources can meet the existing and future requirements as well as ecological and social reserve requirements. It is recommended that a study to compile a comprehensive and reliable licence database be undertaken as soon as possible. Verification of water use in the Lower Vaal WMA is yet to take place. There are current plans to verify water use along the main stem of the Vaal River but the process has not yet started. **Considerations for water user licences:** Due to the "conditional" excess water available in the Vaal River System (see **Strategy A.1.3**) the issuing of licences for water abstraction could be considered under specific conditions as indicated in the Overarching ISP **[Ref 1]**. This opportunity for new licences is made possible only as a result of the transfer of water into the system, which implies that the full cost of the water will have to be charged for the intended user. Because water is transferred into the system and is available not only to users in the Vaal WMAs, but also to users in other WMA's, the allocation of the surplus will remain under DWAF's national control. *Directives and guidelines to apply when evaluating new licences to be allocated from the conditional surplus (Refer to Overarching ISP **[Ref 1]**)*: • Existing lawful use must be verified. • No new licence application will be considered unless water conservation and demand management is satisfactorily practiced and proved. This will apply to all users. • An applicant with indirect access to transferred water will be able to receive a licence for water abstraction at a cost to be determined by the impact of the abstraction on the water resource. • An applicant will be able to receive a license for water abstraction at the applicable pricing structure provided that one can prove the availability of the resource. • Water quality impacts of any new licence must be considered. • When the trading of water rights is considered, the net impact of the water users involved needs to be taken into consideration . The existing trading policy on in- sectoral trading should be applied. A draft trading policy and mechanism has been developed for inter sectoral trading and across WMA trading, and is awaiting approval from the Director General. • Included in draft trading policy is that trading of water rights should only be

	allowed in cases where the water resource is clearly shared by trading users and, should they have different reliability requirements, that they be based on equal impact on the water resource. • The allocation of water needs to be reviewed and amended to ensure the optimal allocation and beneficial use is being maintained. A process needs to be set up and reviewed after 5 years.

MANAGEMENT ACTIONS		
Required actions, responsibilities and priorities:	**M1.** Apply the administrative and principal licensing rules as outlined in the situation assessment above.	Regional Office (Priority 1)
Interfaces:	**References** 1. DWAF report no : P RSA C000/00/0103 "Vaal River System: Overarching Internal Strategic Perspective. 2. Water Resources Situation Assessment : Lower Vaal Water Management Area DWAF Report No. P03/000/00/0101.	

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A.3.3 PRICING STRATEGY

Management objective:	Implementation of the water resource use charge as well as other types of charges (e.g. polluter pays charges) as a means of funding water resource management and development in future.
Situation Assessment:	DWAF has established a "Pricing Strategy for Raw Water User Charges" which sets out procedures for determining and implementing charges for water resource management, development of water works and charges for economic incentives and/or disincentives in order to promote the equitable and efficient allocation of water. DWAF is currently developing a waste discharge charge system. This system needs to explore different tariffs for different catchments or rebates for downstream catchments that are affected by waste discharges from upstream catchments. These tariff adjustments will be incorporated into the Pricing Strategy which is currently being updated.

MANAGEMENT ACTIONS		
Required actions, responsibilities and priorities:	**M1.** Continue implementing the National Pricing Strategy which will finance necessary water resource development and activities of WMAs on a sustainable basis, encourage greater efficiency of use and facilitate the provision of affordable basic services to everyone.	Regional Office (Priority 1)
Interfaces:	**References** 1. Lower Vaal Water Management Area: Overview of Water Resources Availability and Utilisation. DWAF report number P WMA 10/000/00/0203. 2. Water Resources Situation Assessment : Lower Vaal Water Management Area DWAF Report No. P03/000/00/0101.	

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A.4 WATER CONSERVATION & WATER DEMAND MANAGEMENT STRATEGY

Management objective:	1. To improve efficiency of water use by developing and implementing targeted measures to monitor and control water use efficiency. 2. To make more effective and efficient use of the existing available water resources in all water user sectors. This will enable the Catchment Management Agency (and indeed DWAF) to conserve this scarce resource and avoid expensive schemes for transfers and storage when these may not be necessary if demand is properly managed.
Situation Assessment:	**General** Evidence of inefficient water usage can be found in all water use sectors throughout the country and the value of water seems largely unrecognised by many water users. South Africa is a developing country that is water stressed and requires improved management of its limited water resources. The implementation of water conservation and water demand management principles is essential in meeting the national goals of basic water supply for all South Africans and the sustainable use of water resources. Based on experience elsewhere in South Africa an overall sustainable reduction in water use of up to 25% can be expected without having a detrimental effect on users. **Municipalities** As urban/industrial uses is a relatively small component in this WMA, Water Conservation and Demand Management Programs or strategies for urban centers would have a small impact on the overall water resources in the WMA as a whole. However, focussed WC/WDM initiatives could have significant impacts in some of the localised sub-catchments. The benefits of introducing WC&DM measures are with respect to improving local availability, postponing capital expenditure (to extend bulk distribution systems), reducing water supply operating costs and (potentially) decrease the costs of wastewater treatment due to lower volumes of return flow. These factors have a direct benefit to the financial situation of municipalities implying that WC&WDM must therefore be promoted in this WMA. There are currently several initiatives by Local Authorities and Service Providers around the country to implement Water Conservation and Demand Management (WC&DM) measures and it is perceived that large savings could be achieved in the gross demand of the urban sector. These programs need to resolve issues related to conveyance losses, to Unaccounted for Losses, to re-use and to return flows. These programs must include surface water and groundwater pollution mitigation strategies that will require monitoring by the CMA. The programs should set best practice norms and minimum requirements.

	Agriculture Irrigation is the main water user in this WMA and. The agricultural sector is the largest consumer of water in the Lower Vaal WMA with irrigation accounting for a large portion of water use. It is therefore important that water conservation and demand management should be focussed on this user group to obtain maximum savings. Farmers should be encouraged to: • Conserve water by implementing WC&DM measures. • Use allocations beneficially for agriculture. • Sell unused allocations of water. Significant savings can also be obtained by reducing conveyance losses in canals, proper irrigation scheduling, metering and pricing of irrigation water and the improvement of irrigation systems. **Mining** A DeBeers mining operation in Kimberley has expressed the need for further water allocation. Currently the option of indirect use of treated wastewater discharged into a pan is being investigated. This practice is considered to be a sound water conservation/ water demand management measure and should be encouraged in al municipal areas.

MANAGEMENT ACTIONS		
Required actions, responsibilities and priorities:	**M1.** In the Over Arching ISP the need was identified for a study to determine how the projected water requirements and return flows would be affected by WC&DM measures.	NWRP (Priority 1)
	M2. Creating awareness of the benefits of WC&DM measures among Local Authorities as well as at the various Forums that are active in the Vaal River System.	Regional Office (Priority 1)
	M3. WC&DM must be promoted in the agricultural sector. Farmers must be encouraged to save water by demonstrating to them that WC&DM has several benefits for them. (eg. increase in irrigation area with same quota or trade their water savings.)	Regional Office (Priority 1)
	M4 For effective WC&DM measures to be implemented, reliable information on conveyance losses is required. With this information it would be possible to set initial targets for WC&DM. *(Refer also to Strategy A.8 : Monitoring and Information Management)*	Regional Office (Priority 1)
	M5. Applications for abstraction licences must demonstrate Water Conservation and Demand management initiatives and the first priority of solving water deficit problems should be to implement WC&DM. Augmentation options should only be considered if it is proved that WC&DM will not improve the situation.	Regional Office (Priority 1)
	M6. Identify areas where alien vegetation needs to be removed for highest impact in terms of conserving water.	Working for Water (Priority 1)

Interfaces:	**References** 1. Water Resources Situation Assessment : Lower Vaal Water Management Area DWAF Report No. P03/000/00/0101. 2. DWAF Report no : P RSA C000/00/0103 "Vaal River System: Overarching Internal Strategic Perspective.

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A5. INSTITUTIONAL DEVELOPMENT & SUPPORT MAIN STRATEGY

A.5.1. LOCAL AND CATCHMENT LEVEL STRATEGY

Management objective:	The Regional Office (as the interim CMA) needs to take institutional control of all Water Resource Management functions and will be supported by DWAF Head Office Directorates. Their main objective is to responsibly manage the water resources of the Lower Vaal WMA in the interim until such time as the Catchment Management Agency can take over some of the functions.
Situation Assessment:	**General** There are 3 sub-areas in the Lower Vaal WMA, and no established catchment management forums are present in the area. Forums are generally established on a project/study basis and dissolved on completion of the project/study due to lack of interest. These forums are normally made up of interested and concerned citizens, as well as the major water users, and play an active role in the practical review and implementation of the various water resource management issues in the catchments. Problems with representivity at these forums generally threaten their effective existence. It is proposed that these forums are established on a district municipality or WSA basis to ensure continuity in its activities. Institutions at District and Local Municipal level are relatively new on the scene and water resource and water service capacity is slowly being built in these institutions. The responsibilities of WSAs and CMAs are currently being debated with a position paper being prepared by SALGA. Liaison between the various institutions needs to be encouraged in the interest of integrated water resources management in the Lower Vaal WMA. Government water schemes (GWS) have recently been transformed to Water User Associations. This process will continue and these institutions will fulfil their roles in line with the NWA , WSA and the NWRS. The situation with the current water user association must be assessed. There are currently no forums established in the WMA, however the Regional Office is in the process of first consulting with the water use sectors, including the district and local municipalities, agricultural unions and tribal authorities, regarding water issues.

MANAGEMENT ACTIONS		
Required actions, responsibilities and priorities:	**M1.** Continue assisting SALGA and CBO's in the establishment and empowerment of the local water resource management authorities. More support (especially basic financial support) needs to be considered to the founding of forums, since they fulfil a key role in the establishment of these institutions. Promotion of these forums is crucial in order to ensure that the forums are representative of all the role players / stakeholders in the catchment.	Regional Office (Priority 1)

Interfaces:	**References** 1. Lower Vaal Water Management Area: Overview of Water Resources Availability and Utilisation. DWAF report number P WMA 10/000/00/0203. 2. Water Resources Situation Assessment : Lower Vaal Water Management Area, DWAF Report No. P03/000/00/0101.

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A.5.2. POVERTY ERADICATION

Management objective:	The main objective is to contribute to the eradication of poverty through the provision of basic Community Water Supply and creation of employment in developing Community Water Supply and Sanitation Infrastructure. Due to the mostly rural composition of the population and dependence on agriculture, make specific allowances for irrigation water to resource poor farmers.
Situation Assessment:	DWAF has identified the need to implement programmes to eradicate poverty as part of government's overall objective of addressing poverty in South Africa. The Department is attempting to achieve this by making water easily available to poor communities/ farmers, and in many cases redressing imbalances in water allocations. There are certain schemes that have been initiated but need to be revitalised, particularly the Taung Scheme in the Lower Vaal WMA. It is evident that these schemes need to be coordinated with other relevant authorities, such as the Department of Land Affairs and the Department of Agriculture, in order to ensure the successful implementation of these poverty eradication initiatives. To this end the recently established Coordinating Committee of Agricultural Water (CCAW) should be made aware of the potential excess water in the WMA and assistance to Resource Poor Farmers should be promoted through this forum. The exact amount of water available for this purpose should, however, first be determined through detail water resource assessments. The utilisation of sustainable groundwater resources for food gardens, particularly in rural areas, should be encouraged and DWAF will continue to assist other government departments with those initiatives. In this regard, the following requirements to alleviate poverty have been identified : **1.** The Department must identify opportunities (specifically groundwater as well as water from Taung and Spitskop dams) and facilitate the transfer of water rights from the commercial irrigation sector to RPF. **2.** The Department of Social Services and the Department of Agriculture should be contacted to find out if they have any plans, which the Department can support. In addition, DWAF needs to give assistance in terms of making available information on water availability in certain catchments. **3.** Resource Poor Farmers need to be encouraged to form WUAs in order to obtain subsidies from DWAF. 4. Implement standard poverty eradication principles in the managing and administrating of water supply schemes funded by DWAF. 5. Poverty Eradication should be included, as far as possible, in any new developments funded by DWAF.

MANAGEMENT ACTIONS		
Required actions, responsibilities and priorities:	**M1.** Actively pursue the implementation of sustainable poverty eradication initiatives in the process of providing water supply and sanitation systems in rural areas.	Regional Office (on-going)
	M2. If poverty eradication schemes are shown to be feasible, the Department should encourage and facilitate the submission of the necessary licence applications and formation of the required institutional structure early in the process.	Regional Office (on-going)
	M3. Collaboration with the Departments of Land Affairs and Agriculture in terms of schemes relating to Equity farmers.	Regional Office (Priority 1)
	M4. Encourage RPFs to associate with or form WUAs in order to qualify for subsidies and incentives in the pricing policy.	Regional Office (Priority 1)
Interfaces:	**References** 1. Lower Vaal Water Management Area: Overview of Water Resources Availability and Utilisation. DWAF report number P WMA 10/000/00/0203. 2. Water Resources Situation Assessment : Lower Vaal Water Management Area, DWAF Report No. P03/000/00/0101.	

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A.6. ENVIRONMENTAL STRATEGY

A.6.1. ENVIRONMENTAL MANAGEMENT STRATEGY

Management objective:	Ensuring that there is a balance between the need for development (i.e. including all activities undertaken by DWAF) and the need to protect the natural and social environment for the benefit of all.
Situation Assessment:	DWAF has been very proactive over the years regarding the institution of international best practice in the field of Integrated Environmental Management. The Directorate: Water Abstraction and Instream Use has recently published the Department's Environmental Implementation and Management Programme and is currently developing specific strategies 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. There is a current drive to determine the Reserves and Resource Quality Objectives of all rivers in the WMA in order to facilitate the licencing process as well as effective water management. There is also a need to operationalise the Reserve and Resource Quality Objectives once they have been determined. In addition, 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. Wetlands, in particular, 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. Therefore all the environmentally sensitive areas in the Lower Vaal WMA needs to be identified and a clearly described in order to place Water Resource Managers in an informed position when evaluating current and future developments in these areas. In an effort to properly manage the environment, all the mines are forced to have an EMP in place for their on-going operations as well as for mine closures. EMPs are also required for the small diamond digging operations. The lack of waste management and licensing in the areas of Warrenton, Schweizer Reneke, Amalia, Danielskuil, Bloemhof, and Christiana is worrying as the effluent from these unmanaged waste sites is harmful to the environment. These are arguably the most serious environmental impact considerations in the catchment. These include: • solid waste and wastewater 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; etc.

	The following actions are required in terms of environmental management in the Lower Vaal WMA: • Proper receiving stream mitigation planning needs to be undertaken in future in cases where water is transferred into small river systems • Solid waste management in the area must be investigated to identify problem areas for improvement and upgrading. • Removal of alien vegetation is vital in the Kuruman River as the river system is blocked with the potential that a flood will result in a change in river course. • Monitoring of activities that have an impact on the environmental. • Barberspan, located in the C31D quaternary catchment in the Harts River catchment is a declared RAMSAR site and should be managed to maintain its current ecological function. • The Kuruman and Polfontein Eyes located in the Molopo sub-catchment re potentially vulnerable water resources which requires judicious utilisation and management practices.

MANAGEMENT ACTIONS		
Required actions, responsibilities and priorities:	**M1.** Identification and a clear description of all the environmentally sensitive areas (especially wetlands) in the Lower Vaal WMA needs to take place in order to place Water Resource Managers in an informed position when evaluating current and future developments in these areas. Typically the available resource needs to be quantified and the water quality situation has to be described.	Regional Office (Priority 1)
	M3. 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. A communication strategy needs to be developed that allows for optimum governance in this regard. Innovative forms of communication to meet the needs of overloaded officials need to be implemented. Alignment with other laws and policies (eg NEMA) needs to be carried out.	Regional Office (On-going)
	M4. Environmental Impact considerations need to be monitored and actions co-ordinated to ensure a sustainable environment.	Regional Office (On-going)
Interfaces:	**References** 1. Lower Vaal Water Management Area: Overview of Water Resources Availability and Utilisation. DWAF report number P WMA 10/000/00/0203. 2. Water Resources Situation Assessment : Lower Vaal Water Management Area, DWAF Report No. P03/000/00/0101.	

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A.7 WATER SUPPLY INFRASTRUCTURE DEVELOPMENT & MANAGEMENT STRATEGY

A.7.1 INFRASTRUCTURE DEVELOPMENT & SUPPORT STRATEGY

Management objective:	Provision of adequate water resource development infrastructure (storage) and bulk water supply infrastructure to sustain and encourage social and economic growth.
Situation Assessment:	**General** There are no major industries or operational power generation facilities in this WMA The primary economic activity in this WMA is mining and agriculture, with livestock farming being the most important agricultural activity **[Ref 1]**. The general trend in the Lower Vaal Water Management Area is the continued concentration of economic development and population in the urban centres and mining districts, and a decline in rural population. Mining water requirements have also decreased due to a general decline in mining activity in some areas and more efficient water use by mines in other areas. The net result is an expected decline in water use in the catchment. The Lower Vaal WMA is part of the Vaal River System. This system is supported by water supply infrastructure located in surrounding WMAs and countries. Any future growth in the water requirements of the Lower Vaal WMA will be met by transfers. The planning of the future infrastructure development and implementation is discussed in detail in the Vaal and Orange Overarching ISPs. For details these reports should be consulted. **Planning approach:** A holistic planning effort will be required to identify the optimum bulk water storage and supply infrastructure layout that will make optimal use of the local water resources in the Lower Vaal WMA. This needs to be done in conjunction with the National Water Resources Planning Directorate. This is essential to ensure that control of national water resources is not in the hands of a WMA. Operational issues relating to blending, releases, etc. are overarching in nature and therefore should be controlled by National Government. The operation and management of local resources, such as tributary dams and groundwater resources, will be the responsibility of the CMA. There are currently no plans for further dams or large pipelines in this WMA. Infrastructure will be restricted to the operational level, eg. Construction of weirs, monitoring stations, etc. to improve system operations.

MANAGEMENT ACTIONS		
Required actions, responsibilities and priorities:	**M1**. It is required to regularly review the augmentation requirement of the Vaal River System, particularly when information is received that the water balance is negatively affected. (Refer to Vaal Overarching ISP)	NWRP (On-going)

Interfaces:	**References** 1. Lower Vaal Water Management Area: Overview of Water Resources Availability and Utilisation. DWAF report number P WMA 10/000/00/0203. 2. Water Resources Situation Assessment : Lower Vaal Water Management Area, DWAF Report No. P03/000/00/0101.

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A.7.2 SYSTEM MANAGEMENT STRATEGY

Management objective:	Implement system management measures to optimally utilise the available water resources, in terms of short-term benefits and to maintain the reliability of supply over the long-term. The aim is to postpone the need for the development of new costly infrastructure for as long as possible into the future while saving operating costs over the short-term.
Situation Assessment:	***Vaal Main Stem*** This cascading characteristic of the three Vaal WMAs has the consequence that the operational requirements of the main stem of the Vaal River is impacted on by the operations in the Vaal River System. In addition, the strategic operations in the Vaal River will also impact on the water availability and operational requirements of the Orange River in the Lower Orange WMA. Due to this inter-dependency it was identified that the current process of managing water at sub-catchment level should be expanded to integrate management activities across sub-catchments to meet shared water resources in the main stem of the Vaal River. Operational issues relating to blending, releases, etc. are overarching in nature and therefore should be controlled by National Government, with the necessary collaboration with CMAs. ***Sub-catchment Issues*** The operational requirements of the tributaries, including Wentzel, Taung and Spitskop dams, will be managed by the CMA as a local resource. **Vaal Downstream of Bloemhof** Problems are currently experienced at Bloemhof Dam in terms of water levels being lower than the lowest model projections. It is also important to note that although Douglas is not located within the lower Vaal WMA, Douglas benefits from the operating losses at Bloemhof Dam in terms of water quality. Should these operating losses be reduced, then the water quality situation at Douglas will deteriorate. Douglas does, however, have access to Orange River water, which has a cost consequence as water from the Orange River will need to be pumped to Douglas.

MANAGEMENT ACTIONS		
Required actions, responsibilities and priorities:	**M1.** Undertake annual operating analysis to determine the operating rules to apply as defined in the Situation Assessment Above (overarching strategy).	NWRP (Priority 1)
	M2. Document and implement drought allocation rules for Vaal River tributaries, Specifically Taung and Spitskop dams. This will result in restrictions in supply during drought periods. (Vaal main stem will be done by NWRP)	Regional Office (Priority 1)
	M3. Investigate hydraulic modelling to control system losses.	Central Cluster (Priority 1)

	M4. Alert local authorities to the proper management of their groundwater resources. Management guidelines for groundwater use have been developed through the NORAD project and these guidelines should be used by municipalities.	Regional Office (Priority 1)
	M5. Monitor the supply situation through annual operating analysis to ensure that the required management measures are implemented on time.	Regional Office (on-going)
	M6. Promote and encourage the correct utilisation of groundwater resources for local water supply, including borehole management. Water Service Development Plans and feasibility studies (business plans) should indicate what groundwater supply options were considered for development.	Regional Office (On-going)
Interfaces:	**References** 1. Lower Vaal Water Management Area: Overview of Water Resources Availability and Utilisation. DWAF report number P WMA 10/000/00/0203. 2. Water Resources Situation Assessment : Lower Vaal Water Management Area, DWAF Report No. P03/000/00/0101	

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A.7.3 RECREATION ON DAMS & RIVERS STRATEGY

Management objective:	To regulate recreation on all water bodies in the catchment, but also to restrict access to water bodies at water levels that negatively impact on the natural environment or on the local population. Developments must adhere to guidelines and criteria specifically prepared for recreational purposes. These developments must be evaluated on a consistent basis taking into account the need for such a development as well as the implications on the environment, current water users and public safety.
Situation Assessment:	All the water bodies are important for recreational purposes. There are several recreational sites located in the Lower Vaal WMA which range from historical, cultural and heritage sites to holiday destinations. Resorts are present at Christiana, Riverton and Barkley West. The following dams are of particular significance in the Lower Vaal WMA: Taung Dam Spitskop Dam Wentzel Dam Vaal Harts Weir Kuruman Eye No serious problems are encountered at these facilities at present. The Directorate: Social and Ecological Studies have fairly sophisticated processes to determine the impacts of recreation on water bodies and to promote recreation and tourism within realistic frameworks. The impact of pollution on the river systems is of particular significance to users of rivers and dams for recreational purposes and requires regular monitoring. The following requirements have been identified: **1**. It is important that the dam sites located in the Lower Vaal be utilised for recreational use. **2**. The rezoning of these sites for recreation and the investigation of mechanisms for development is required, eg. Privitisation, Concessions, etc.

MANAGEMENT ACTIONS		
Required actions, responsibilities and priorities:	**M1**. DWAF needs to encourage the use of existing dam sites for recreational use by making these sites available to the tourism and leisure industry.	Regional Office (Priority 1)
	M2. DWAF needs to develop guidelines for safety when using water bodies for recreational purposes.	Regional Office (Priority 1)

Interfaces:	**References** 1. Lower Vaal Water Management Area: Overview of Water Resources Availability and Utilisation. DWAF report number P WMA 10/000/00/0203. 2. Water Resources Situation Assessment : Lower Vaal Water Management Area, DWAF Report No. P03/000/00/0101

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A.7.4 PUBLIC HEALTH & SAFETY STRATEGY

Management objective:	The water resource needs to be protected, and it must be ensured that users in the Vaal River Catchment area are safe from the effects of poor water quality that can create health problems (e.g. cholera), and it must be ensured that strategies are in place to deal with floods and droughts as these impact on the socio-economic environment.
Situation Assessment:	In the Lower Vaal, the primary concerns regarding public health and safety are: • Water quality problems in the main stem of the Vaal River • Lack of emergency preparedness plans for flooding of dam as well as operation and maintenance manuals for all dams in the catchment. The Department's current commitments are associated with: • Managing floods and drought disasters by direct intervention on the ground. • Reducing pollution and preventing serious or hazardous pollution events and promoting dam safety. • 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.

MANAGEMENT ACTIONS			
Required actions, responsibilities and priorities:	**M1.**	Compliance with the above-mentioned requirements.	Regional Office (Priority 1)
	M2.	Clarify roles and delegated responsibilities regarding flood management control and disaster management rules. Warning systems for hazardous events, such as spills, are required. The issues related to flood management are dealt with in the Vaal Overarching ISP.	Regional Office (Priority 1)
	M3.	Water quality management must be implemented in areas where water bodies are used for recreational purposes in order to ensure that public health is not jeopardised	Regional Office (Priority 1)
	M4.	The O&M manuals for dams in the Lower Vaal are in the process of being updated. The contents of the updated manuals must be communicated and implemented.	Regional Office (Priority 1)
	M5.	Communication between authorities must be developed and maintained.	Regional Office (Priority 1)

Interfaces:	**References** 1. Lower Vaal Water Management Area: Overview of Water Resources Availability and Utilisation. DWAF report number P WMA 10000/00/0203. 2. DWAF report no : P RSA C000/00/0103 "Vaal River System: Overarching Internal Strategic Perspective.

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A.8 MONITORING AND INFORMATION MANAGEMENT STRATEGY

Management objective:	The design and implementation of effective monitoring networks and repository databases to ensure adequate quantification of the balance between sustainable water use and protection for surface freshwater bodies and groundwater.
Situation Assessment:	**Water use control** Irrigation is by far the main water user in this WMA and almost no data is available on the actual water use by and return flow from irrigation, as irrigation abstractions are not gauged. **Monitoring networks and data capturing.** Resources currently available for monitoring are generally inadequate throughout all existing systems. However it is considered that the responsibility for monitoring should rest with local authorities and water user associations. Some notable issues in the ISP-area are briefly discussed below: ▪ Groundwater monitoring is focused at the towns and groundwater user areas but is not adequate for the affected areas such as informal mining and new irrigated areas. Groundwater quality samples are taken every six months as part of a National program. Various studies are underway in the catchment to better understand the groundwater resources in the region. ▪ Inadequate monitoring of water quality throughout the catchment with data not continuous enough to determine trends and pollution sources. Ad-hoc monitoring generally occurs downstream of sewage treatment plants but is not adequate for water quality management. ▪ Compliance monitoring by the Department of Mineral and Energy Affairs and the mines exist for Sishen and Blackrock mines and did not show any elevated elements or TDS problems. ▪ Streamflow monitoring is focused at the major rivers with real-time data available at key point in the system. Upgrading of the Douglas weir is required to allow for the monitoring of flows in the range of 8 to 100 m^3/s. Douglas weir has been surveyed but funding has not been allocated for the upgrade. ▪ A study defining the data requirements to support the system analysis model was undertaken as part of the Vaal River System Analysis Update Study. The main recommendations from the study report with the title "*Data Inventory: Vaal Water Supply System Area"* should form the point of departure for the identification of all monitoring needs. ▪ As the irrigation sector is the largest water user in many sub-catchments, and at the same time has the poorest available data regarding water use and return flows, it is recommended that projects should be initiated to obtain better information regarding irrigated areas and the monthly irrigation water usage as well as irrigation return flows. **Information Management** **(**To be considered at National Level) Information Management in the Lower Vaal WMA is problematic due to the difficulties experienced with the existing information management systems, viz. WMS and NGDB (National Geohydrological Database). Water use control is an issue on the whole of the Vaal and can be managed better if more information is available and if more attention is given to data capture and storage. It is important to continue monitoring, specifically regarding water quality. This issue has to be dealt with at a regional level and needs to be in accordance with National policy.

Situation Assessment (Continued):

A study defining the data requirements to support the system analysis model was undertaken as part of the Vaal River System Analysis Update Study. The main recommendations from the study report with the title "*Data Inventory: Vaal Water Supply System Area"* should form the point of departure for the identification of all monitoring needs.

The following gaps have been identified in the knowledge base in terms of system monitoring:

- Limited, almost no observed data available with regards to irrigation water use. Quaternary-based irrigation data is unreliable. A need exists to determine crop distribution and type on a quaternary catchment scale.
- Regular water quality monitoring by DWAF and the water boards is required to improve the data records of the water quality in the WMA. A fuller record of water quality is required for this WMA.
- Streamflow and channel monitoring is inadequate in some of the areas. The measurement of flow at Douglas weir is of regional importance.
- Groundwater monitoring is inadequate for selected areas, in terms of yield, quality, contamination, etc.
- There is a need to develop an integrated monitoring and information management plan. The plan must assess requirements, priorities, costs and provide motivation for funding.
- The exact position of new flow gauging points has not been identified and must form part of discussions. Douglas weir has, however, been surveyed and is yet to be constructed.
- Compliance monitoring of EMPR by mines.

The following actions are required in this WMA in terms of monitoring:

- Details of the various data related problems and shortcomings is given the recommendations of the relevant study reports and should be consulted to evaluate and prioritise the monitoring needs.
- 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.
    - Other data and information, which may be necessary.

This effort needs to be co-ordinated with regional offices to ensure that information is managed in a consistent manner. As part of the Overarching ISPs a need was identified to undertake an assessment of all the monitoring needs to support Integrated Water Resource Management in the Vaal and Orange river catchments. The most important needs are given in the situation assessment of this strategy. Details of the monitoring needs must be obtained from the recommendations given in the relevant study reports.

MANAGEMENT ACTIONS		
Required actions, responsibilities and priorities:	**M1.** Develop a strategy and action plan to identify all monitoring needs and to co-ordinate all monitoring in the region, specifically identifying roles and responsibilities of National and Regional officials in terms of monitoring requirements. Flow gauging facilities are required at abstraction points as well as effluent discharge points in order to provide adequate data for calibrating and verifying the water quality models.	Regional Office (Priority 1)
Interfaces:	**References:** 1. Lower Vaal Water Management Area: Overview of Water Resources Availability and Utilisation, DWAF report number P WMA 10000/00/0203. 2. Water Resources Situation Assessment : Lower Vaal Water Management Area, DWAF Report No. P03000/00/0101 3. "Vaal River System Analysis Update : Integrated Vaal River System Analysis**:** DWAF report no : PC000/00/18496	

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	Author:	ISP Study

A.9 IMPLEMENTATION MAIN STRATEGY

Management objective:	The above-mentioned strategies and approaches need to be implemented in future depending on priority. The work needs to be carried out by the designated responsible party, either the Regional Office or National Directorate. The activities in the ISP should be included in the annual budget cycles of the relevant directorates. Detailed scheduling of activities should be undertaken through the normal business planning human resource scheduling of DWAF. To gradually phase in a thorough public involvement process in parallel with the establishment of the Catchment Management Agency and the drafting of the Catchment Management Strategy. It should be communicated to the public and stakeholders that the ISP is DWAF's initial input to the formulation of the Catchment Management Strategy.
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 and the intention is that the document will be made available to stakeholders once the first version is completed. Interaction has been limited to stakeholder awareness regarding this ISP development process. It is envisaged that the finally accepted Lower Vaal WMA 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 the Department of Water Affairs and Forestry'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 a year or three (to be debated at the workshop) after the Lower Vaal WMA ISP depending on the approval of the Catchment Management Agency establishment proposals by the Minister.

MANAGEMENT ACTIONS		
Required actions, responsibilities and priorities:	**M1**. List of strategies that need to be tackled along with the bigger picture and assign responsible persons. These officials may need to employ others depending on the scale of the assignment.	Regional Office (Priority 1)
	M2. Design a public involvement/participation process (using current forum structures) that will eventually lead up to the formulation of a Catchment Management Strategy.	Regional Office (Priority 1)
	M3. Submit proposal to DWAF National for approval.	Regional Office (Priority 1)

	M4. Communicate to Catchment Management Forums, Bulk Users, Provincial Liaion Committees, Municipal Managers, etc. Initially circulate the finalised Lower Vaal WMA 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. Stakeholder comment will then be requested.	Regional Office (Priority 1)
	M5. To get feedback from stakeholders in terms of reviewing the ISP. Incorporate comments and revise accordingly.	Regional Office (Priority 1)
	M6. Preparation of presentation material for strategic decision-makers, as well as operational managers. Develop toolkit for presentation of ISP's to the various stakeholders and roleplayers.	Regional Office (Priority 1)
	M7. Undertake presentation "roadshow".	Regional Office (Priority 1)
Interfaces:		

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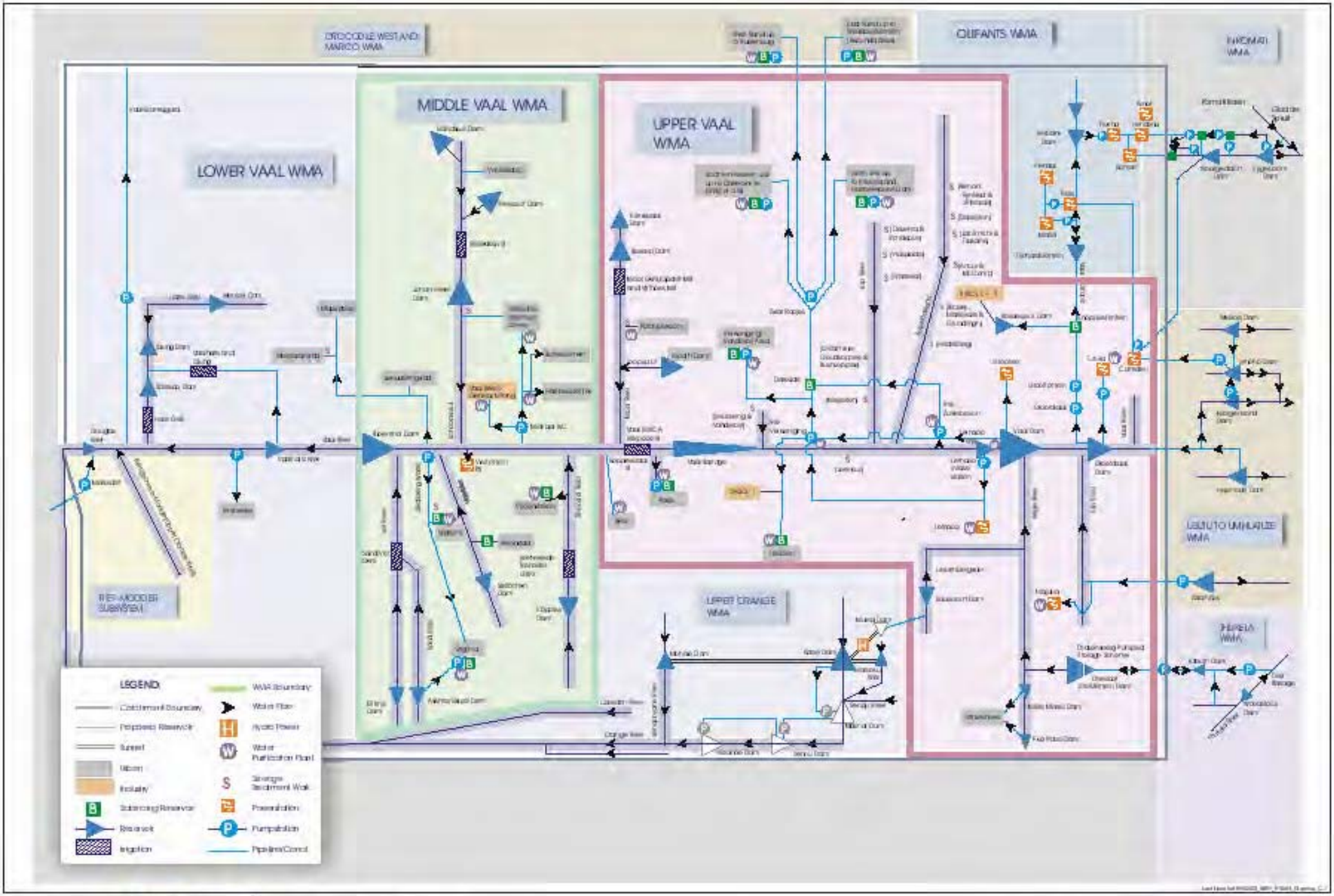
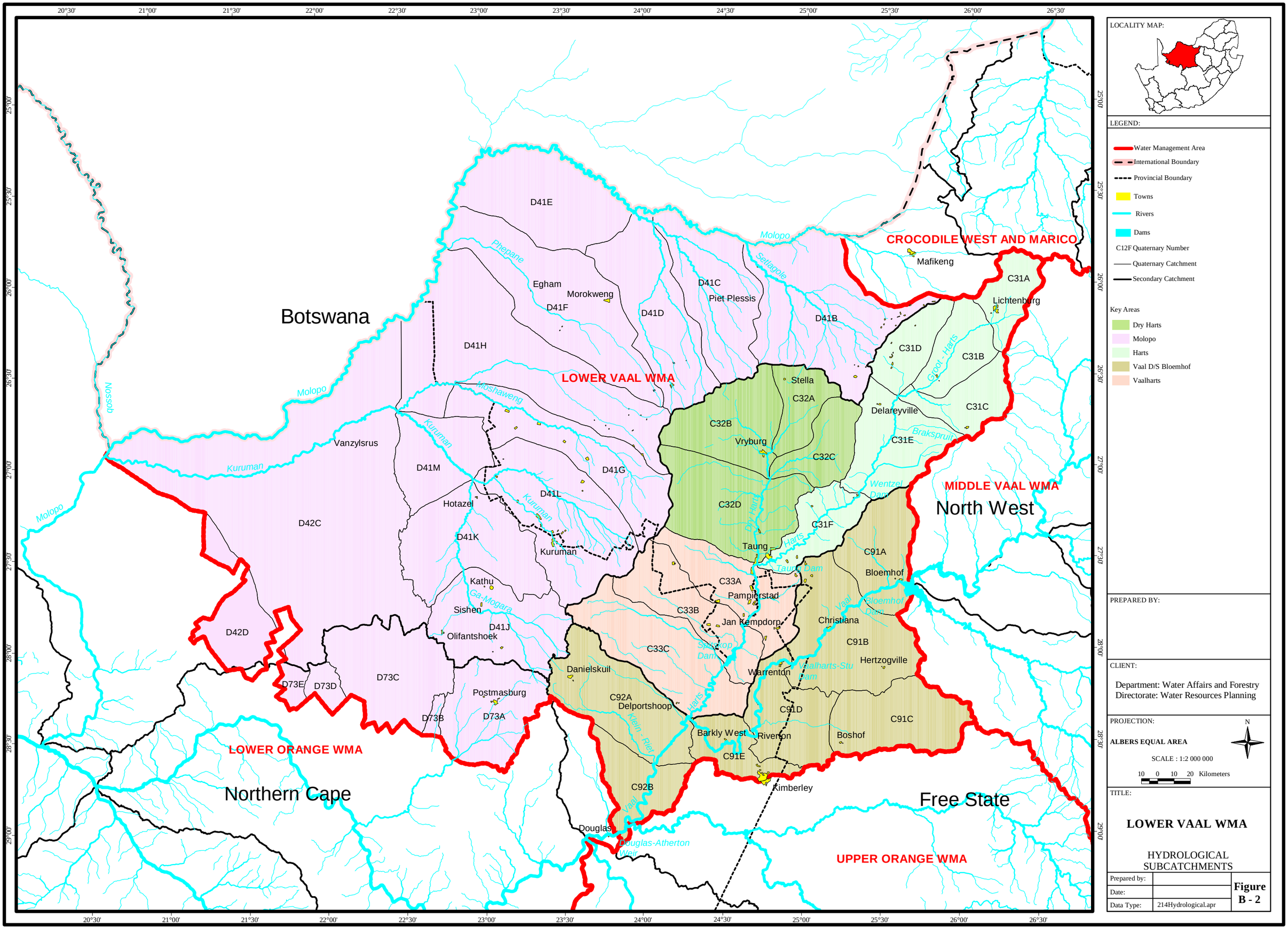
	Date:	October 2004
	Author:	ISP Study

Appendix B: Maps and Figures


CROCODILE WEST AND MARICO WMA
OLIFANTS WMA
INKOMATI WMA
MIDDLE VAAL WMA
LOWER VAAL WMA
UPPER VAAL WMA
UPPER ORANGE WMA
USUTU UMHLATUZE WMA
PHONGOLA WMA
LEGEND
WMA Boundary
Catchment Boundary
Water Plant
Perennial Reservoir
Hydro Power
Tunnel
Water Purification Plant
Mines
Sewage Treatment Work
Industry
Balancing Reservoir
Pressurization
Reservoir
Pumpstation
Irrigation
Pipeline/Canal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UPPER ORANGE WMA
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D41C
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C92A
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Phepane
Egham
Morokweng
Piet Plessis
Molopo
Sellagole
Mafikeng
Lichtenburg
Stella
Delareyville
Groot - Harts
Brakspruit
Nossob
Moshaweng
Kuruman
Vanzylsrus
Hotazel
Vryburg
Wentzel Dam
Dry Harts
Taung
Taung Dam
Harts
Bloemhof
Bloemhof Dam
Vaal
Pampierstad
Jan Kempdorp
Christiana
Hertzogville
Spitskop Dam
Vaalharts-Stu Dam
Warrenton
Kathu
Ga-Mogara
Sishen
Olifantshoek
Danielskuil
Postmasburg
Delportshoop
Klein - Riet
Barkly West
Riverton
Boshof
Kimberley
Douglas
Douglas-Atherton Weir
Vaal
LOCALITY MAP:
LEGEND:
Water Management Area
International Boundary
Provincial Boundary
Towns
Rivers
Dams
C12F Quaternary Number
Quaternary Catchment
Secondary Catchment
Key Areas
Dry Harts
Molopo
Harts
Vaal D/S Bloemhof
Vaalharts
PREPARED BY:
CLIENT:
Department: Water Affairs and Forestry
Directorate: Water Resources Planning
PROJECTION:
ALBERS EQUAL AREA
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LOWER VAAL WMA
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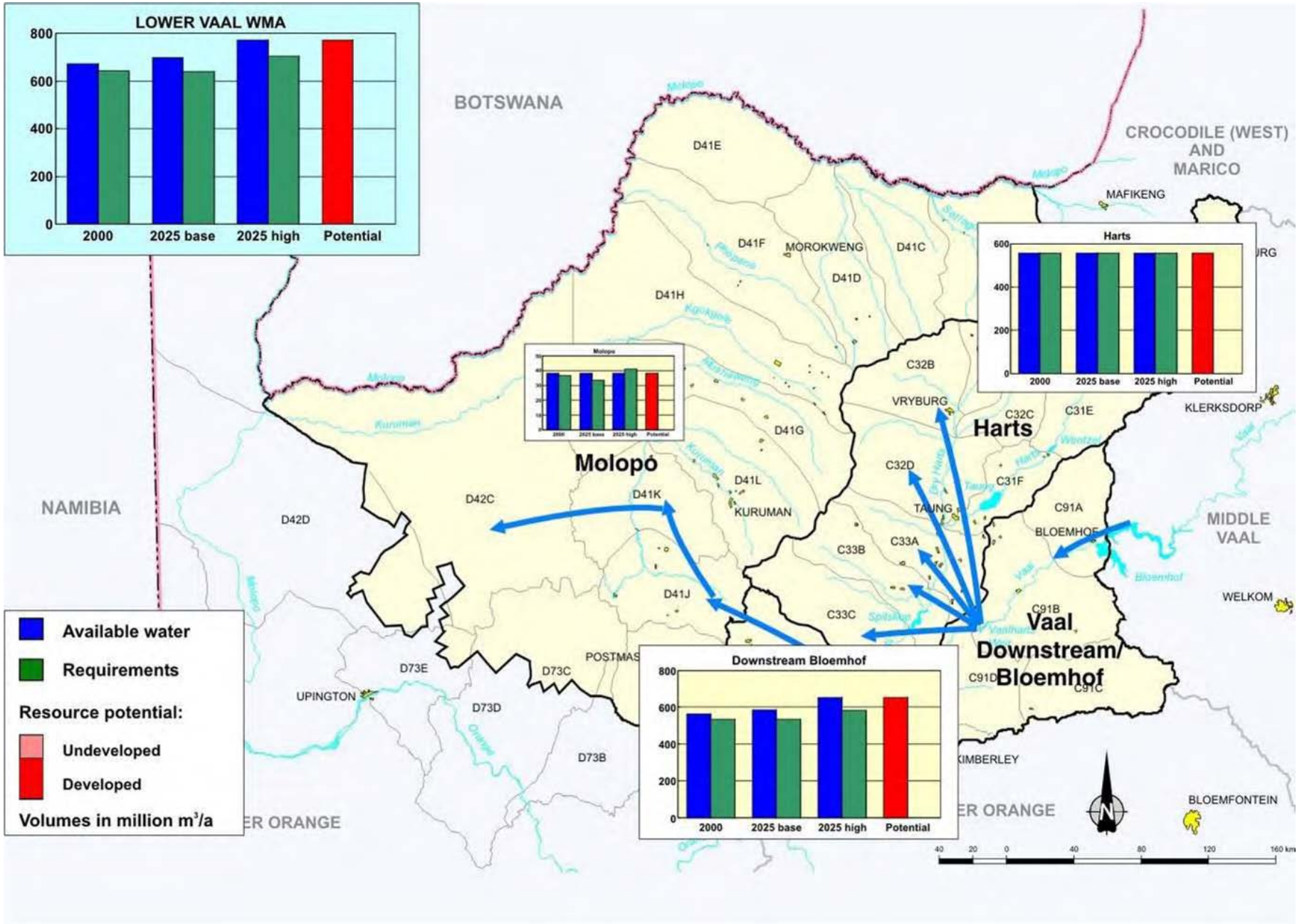
LOWER VAAL WMA
800
600
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Potential
BOTSWANA
CROCODILE (WEST) AND MARICO
MAFIKENG
D41E
D41F
MOROKWENG
D41C
D41D
D41H
Harts
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NAMIBIA
D42C
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D41J
C33C
C91B
Vaal Downstream/ Bloemhof
WELKOM
POSTMAS
D73E
D73C
C91D
C91C
UPINGTON
D73D
D73B
KIMBERLEY
BLOEMFONTEIN
Downstream Bloemhof
Available water
Requirements
Resource potential:
Undeveloped
Developed
Volumes in million m³/a
N
40 20 0 40 80 120 160 km

Appendix C: List of Towns in Lower Vaal WMA

APPENDIX C 1

LOWER VAAL WATER MANAGEMENT AREA : TOWNS

	TOWN	SOURCE OF WATER SUPPLY
1	Schweizer Reneke	Wentzel Dam and Groundwater sources
2	Morokweng	Groundwater
3	Piet Plessis	Groundwater
4	Stella	Groundwater
5	Vryburg	Borehole & Vaal River (Vaalharts WUA)
6	Delareyville	Groundwater
7	Lichtenburg	Groundwater
8	Moshaweng	Groundwater (Sedibeng Water)
9	Van Zylsrus	Groundwater
10	Hotazel	Groundwater & Vaal Gamagara pipeline
11	Sishen	Groundwater & Vaal Gamagara Pipeline
12	Olifantshoek	Vaal Gamagara Pipeline
13	Postmansburg	Groundwater & Vaal Gamagara Pipeline
14	Danielskuil	Groundwater
15	Delportshoop	Vaal Gamagara Pipeline
16	Douglas	Orange River (Orange Riet Irrigation Board
17	Jan Kemp Dorp	Vaal River (Vaalharts WUA)
18	Barkley West	Vaal River
19	Riverton	Vaal River
20	Kimberley	Vaal River
21	Warrenton	Vaal River and Main canal (Vaalharts WUA)
22	Christiana	Vaal River
23	Hertzogville	Groundwater
24	Boshof	Groundwater
25	Pampierstad	Boreholes & Vaal river (Vaalharts Canal)
26	Taung	Vaal river (Vaalharts WUA)
27	Bloemhof	Vaal River
28	Kieseville	Groundwater
29	Sannieshof	Groundwater
30	Ottosdal	Groundwater
31	Tosca	Groundwater
32	Heuningvlei	Groundwater
33	Migdol	Groundwater
34	Pomfret	Groundwater

DEVELOPMENT OF INTERNAL STRATEGIC PERSPECTIVES

GROUNDWATER OVERVIEW FOR LOWER VAAL CATCHMENT MANAGEMENT AREA

Prepared by:
JA Pretorius and I Dennis
Darcy Groundwater Scientists and Consultants
Bloemfontein

Prepared for:
Directorate Water Resource Planning
DWAF
Private Bag X313
Pretoria

NOVEMBER 2003

TABLE OF CONTENTS

1 Overarching Issues

The following is a brief description of the major groundwater issues in the Lower Vaal Water Management Area (LVWMA). For more detailed information please refer to the references and data sources referred to in Section 1.

1.1 Availability of groundwater information in the catchment area

The following data sources with regard to groundwater are available:

- NGDB database
- WARMS data base
- DWAF Geohydrology Northern Cape
- GH Reports
- 1: 5000 000 Geohydrological maps and brochures
- Consultants reports and other academic reports

The NGDB is heavily populated with groundwater data for the WMA. There are over 400 points currently being monitored throughout the Northern Cape (including the Lower Vaal WMA). Most of the data are related to water supply and irrigation schemes, and ambient water quality monitoring.

The WARMS database contains valuable information with regard to large-scale abstraction for water supply schemes and irrigation. Verification of data still has to be performed.

The geohydrology offices in the Northern Cape have good data on groundwater utilization and the natural quality of groundwater due to the close relationship with ongoing water supply projects and other groundwater investigations. Another vast source of information is from GH reports (more than 500) and the 1: 500 000 geohydrological maps completed for the region by the Geohydrology Directorate.

Several consultant reports and academic reports are also available. PD Toens and Associates have been involved in ongoing monitoring of groundwater resources in the Northern Cape for a number of years.

1.2 Overview of groundwater resources and use throughout the catchment area

1.2.1 Industrial and mining

There are quite a number of mining operations in the LVWMA. These activities vary from base-metal mining; diamond mining and even limited gold mining in the Kalahari greenstone belt. Groundwater use at most of these sites is limited and should any seepage occur into opencast pits or underground workings, the water is usually pumped and utilized in processes to minimize use of other water sources. This pumping often causes localized dewatering but the only mine where this effect is pronounced is ISCOR's Sishen Mine. The following is a brief description of the main mining activities with some description of impacts on the groundwater regime.

The North Cape manganese deposits lie to the north and west of Kuruman. They are known to cover an area of at least 1 100 km^2 and are the largest manganese deposits in the world. It is estimated that more than 80% of the worlds known manganese reserves are situated in the North Cape Deposits. They stretch from Black Rock in the north to Postmasburg in the south and effectively form two distinct ore bodies namely the Kalahari Manganese Field and the Postmasburg Manganese Field.

The first and most famous manganese mine was established in 1926 in the Kalahari Manganese Fields and known as the open cast Black Rock mine. Unfortunately all operations ceased by the early 1930's. In 1934 operations re-started under the name of Assmang. The Smartt mine was opened in 1954, which was followed soon after, by the Hotazel Mine and many others (http://www.dwaf.gov.za/orange).

ISCOR's Sishen Mine was established in 1953 and is situated in the Northern Cape approximately 280 km north-west of Kimberley. It is one of the seven largest open cast mines in the world with an open pit of approximately 11 km long, 1.5 km wide and almost 400 m deep. The haematite ore at Sishen occurs in beds of varying thickness. Interbedded impurities, such as shales occur as bands in laminated ores, with iron enrichment at the contact zones.

Although the Sishen Mine can utilise Vaal River water via the 700mm diameter Vaal-Gamakara pipeline, it currently makes use of groundwater abstracted directly from the mining area (http://www.dwaf.gov.za/orange). Approximately 1.5 million m^3 of water is abstracted monthly from the mine of which approximately 0.9 million m^3 is used for the mining operations or the towns housing the mine employees and their families (Dingleton, Kathu and Sesheng). The remainder is distributed to other mines in the area including Hotazel and Olifantshoek via the Vaal-Gamagara pipeline. It is anticipated that the groundwater will gradually be depleted and that Sishen Mine will eventually have to import water.

Assmang operate the Beeshoek iron ore operations, located near Sishen. Both Beeshoek North and South mines are opencast operations. The ore is mined from various different pits. The run-of-mine product is processed by a crushing, washing and screening plant.

Pering Mine is a lead (Galena) and zinc (Sphalerite) mine that is located in the southwestern portion of the North West Province close to the border with the Northern Cape Province. The nearest town, Reivilo is 20 km south west of the mine. Vryburg is 70 km north east of the mine. The majority of the mine's 191 employees and seventeen contractors come from Reivilo (including Boipelo), which is part of the Greater Taung Municipality and of Greater Taung and Kuruman. The mine is an open pit, truck and shovel operation. Lead (Galena) and zinc (Sphalerite) concentrates are produced by means of a conventional crushing, milling and flotation process from a low grade Mississippi type ore body. The Pering Mine ore body is rapidly approaching depletion after being in operation since late 1986. It is estimated that 8 million m^3/annum of groundwater is abstracted at Pering (Van Dyk, 2003).

The Finsch diamond mine, located 160 km north west of Kimberley, is one of De Beers' seven South African operations. Discovered in 1961 during exploration for asbestos, the deposit was first developed as an open pit. Since 1991, production has come from the underground mine beneath the old pit. Finsch is a classic diamondiferous kimberlite pipe, which has a surface expression of around 17.9ha. The country rocks consist of banded ironstones overlying dolomites and limestones, the pipe itself consisting of weathered kimberlite (yellow ground) to a depth of around 100m with unweathered material (blue ground) beneath. Pumping controls groundwater seepage from the overlying strata of dolomite and limestone. No volumes are available.

Smaller mining operations include a limestone quarry at LimeAcres, Kalahari Goldridge Mine (opencast mine with heap leach extraction) near Mmabatho and several diamond diggings in alluvial deposits along the Vaal and smaller tributaries. The diamond diggings have little impact on water quality; huge amounts of water are abstracted locally during the processing of the diggings and surface environment and drainage patterns are altered. Currently the Kalahari Goldridge mine supply its own water by circulating water from the pit and sludge lagoons as well as from boreholes (Total 120 Ml/year). It is estimated that the mining activities will affect the boreholes and that an additional amount of 30- 50 Ml/month will be needed in the next 5 years (Africon, 2002).

1.2.2 Agriculture

As previously stated in the ISP document agriculture plays a major role in terms of economic development in the WMA. Almost every farm unit in the WMA is dependent on groundwater for domestic use and stock watering. There are however no abstraction volumes available but in terms of quantities of water, stock farming has a relatively small influence on the regional groundwater resource.

Large-scale irrigation is developed where aquifer types are suitable. The lithologies from which abstraction for irrigation takes place vary between dolomitic/karstic aquifers, weathered granite and quartzite and at contact or faulting zones (see Section 2).

Table 1 gives estimated annual abstraction volumes for the large-scale irrigation areas with the associated geological lithologies.

Problems encountered at these irrigation areas are over utilisation of the resources with the associated lowering of water tables. Disputes regarding water allocation have become a major concern of the regional DWAF management (Van Dyk, 2003).

Table 1: Estimated abstraction volume for irrigation in the WMA from groundwater resources with associated geological formations (DWAF, 2003)

Name	Estimated abstraction	Geological Formation
	million m^3/annum	
Coetzersdam/ Louwna	40	Weathered pegmatite granite (Zz)
Kuruman	5	Dolomite (Va)
Sishen	17	Dolomite (Va)
Bestwood	1	
Tosca	18	Contact banded iron /dolomite (Va)
Pering/ Lykso	8	Dolomite (Va)
Kudumane	2	Dolomite (Va)
Danielskuil	1	Dolomite (Va)
Stella	1	Contact zone (Zk and Zz)
Sannieshof	2	Weathered lava (Rk)
Ottosdal	2	Weathered lava (Rk)
Delareyville	5	Contact lava (R-val) and granite (Zz)
Totals	**102**	

1.2.3 Domestic

Several local municipalities are dependent on groundwater as a source of bulk supply. The water is supplied from boreholes within the municipal grounds. The main aquifers exploited are from dolomites and weathered fractured crystalline rocks such as andesitic lavas and granites. Some of the towns water supply is augmented by surface water supply e.g. Vryburg. The total population dependant on the source in urban areas is estimated to be 140 000 residents. Table 2 is a breakdown of groundwater consumption estimated for 1996 (Africon, 2002).

Some groundwater utilisation for small rural settlements, takes place in the western portion of the WMA from primary or porous aquifers from the Kalahari group, but the quality and yields are often variable and not good.

Groundwater Utilisation of local municipalities		
Town	Residents	Annual Abstraction 1996 Million m^3
Bankara Bodulong	5520	0.19
Danielskuil	2700	0.12
Dibeng	300	0.01
Groenwater	300	0.01
Holpan	100	0.00
Jennhaven	200	0.01
Kathu	5192	0.64
Kono	200	0.01
Kuruman+WW	11000	2.02
Majeng	300	0.01
Postmasburg	32100	0.86
Schmidtsdrift	500	0.01
Amalia		0.21
Schweizer Reneke		0.90
Gamotlatla		0.04
Lichtenburg		4.20
Itsoseng		2.20
Ottosdal	18000	0.88
Sannieshof	15000	0.25
Stella		0.12
Vryburg	20000	4.38
Delarey	20000	1.80
Reivilo	5000	0.10
Setla-Kgobi North		0.37
Setla-Kgobi South		0.60
Ganyesa/Kudumane		2.30
Total	136412	33.24

Table 2: Groundwater utilization for domestic use – Local Municipalities

1.3 Groundwater quality in the catchment area

1.3.1 Natural

The natural occurring water quality in the WMA is generally good in the dolomitic/karstic and fractured/crystalline aquifers. In the western portion of the WMA in the Kalahari group primary (sand/gravel) aquifers and clay formations the quality is often naturally poor with TDS values ranging from 1500 mg/l and higher (See Figure 1).

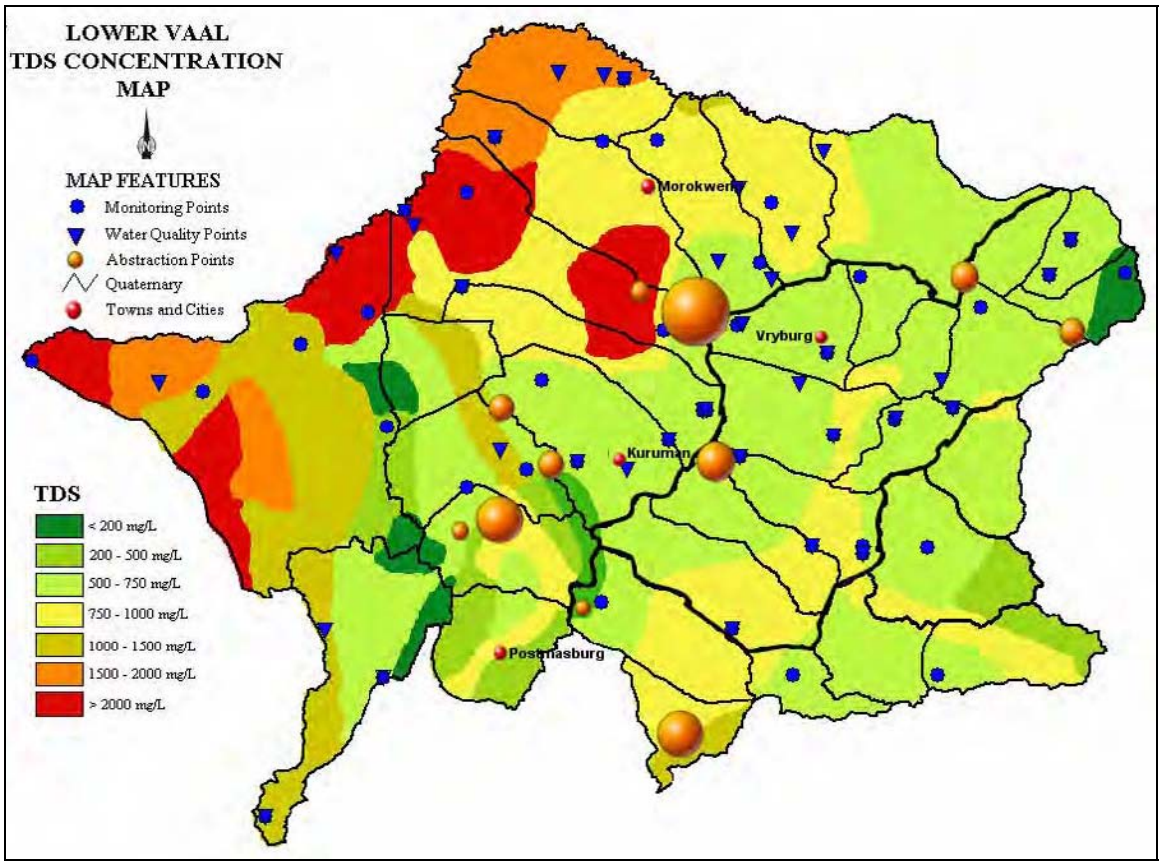

Figure 1: Total dissolved solids for the WMA with main abstraction and water quality monitoring points.

1.3.2 Point and diffusive pollution

Agricultural activities are a source of diffuse water contamination. The contribution of each farm on a local scale is often fairly small but the contribution on a catchment scale needs to be included in assessing any pollution situation. Most findings regarding this issue can only be assessed in a generic way due to the lack of data in the WMA. Nitrates are the contaminant of most concern, since they are very soluble and do not bind to soils, nitrates have a high potential to migrate to groundwater. Because they do not evaporate, nitrates/nitrites are likely to remain in water until consumed by plants or other organisms. Generally on a local scale the areas of intense cultivation are the major contributors in terms of inorganic nitrates. The primary inorganic nitrates, which may contaminate drinking water, are potassium nitrate and ammonium nitrate both of which are widely used as fertilizers. Feedlots contribute to the organic nitrates in groundwater and can be far more problematic. For most farming activities organic nitrate is not a serious problem in South Africa. Other contaminants of concern are pesticides and herbicides. The contribution of these to groundwater contamination is very difficult to quantify on catchment scale. Site-specific data relating to likely loading/application volumes and history, soil profiles and local geohydrology are required.

During 2003 a study was funded by the WRC (Ellington, 2003), which investigated the effects of the high density cultivation at the Vaalharts surface water irrigation scheme on the underlying aquifer. The scheme was established during the 1930's, although it was only firmly established during the 1950's. The irrigated area is 32000ha, comprising of the North and West Canal areas. Water is furrowed to the Scheme from the Vaal River at Warrenton.

The aims of the project were to construct a suitable conceptual model for the Vaalharts Irrigation Scheme and the aquifer underlying it. In order for the conceptual model to have basis, the

characteristics of the aquifer needed to be studied. Seventeen boreholes were drilled by DWAF during 2003 within the North Canal area to gain access to the groundwater and cement the construction of the conceptual model. The final aim of the project was to determine the impact of the irrigation on the aquifer underlying the Vaalharts Irrigation scheme.

Based upon literature and studies conducted during this project, it was found that the TDS of the groundwater has increased at a rate of 13 mg/l/annum. The leaching addition of approximately 100000 t/annum was found to be the main source of this TDS increase. Simultaneously, the main contributor to the salt load within the Vaalharts Irrigation Scheme was found to be the incoming canal water from the Vaal River at Warrenton. Whereas fertilizers contribute only 50000 t/annum, the incoming Vaal River water contributes 130000 t/annum of salts. These salts are moving towards the Harts River at a rate of approximately $5Mm^3$/annum. The path towards the Harts River, however sees the rainfall having a dilution effect on the concentration, and thereby reducing the groundwater TDS concentrations on its path towards the Harts River, and therefore too the concentration of salts entering the Harts river.

Similar studies should be considered to determine the effects of high groundwater abstraction and salination of underlying soils and aquifers, in areas where groundwater is utilized for high-density cultivation.

Activities related to urban areas can also result in localized or even diffuse pollution of groundwater. Poor management of sewage treatment works can contribute to the groundwater pollution as can landfill sites, on-site sanitation (especially in informal settlements) and spills resulting from accidents or leaking underground tanks.

There are many impacts on the environment dealing with the water quality and waste disposal from metal mining. As described in Section 1.2.1, mining activities in the WMA covers a range of metal and diamond ores. The following is a brief generic description of possible effects from metal mining that could occur, due to the lack of more site-specific data.

These adverse water quality impacts are caused primarily by land disposal practices that fail to contain wastes, by run-on and run-off controls that are inadequate to prevent surface water from flowing through impoundments, or by groundwater infiltrating surface impoundments. Open-pit and underground mining methods can also cause disturbances that can lower the water table in an area, causing water shortages, land subsidence and fracturing. However due to the low rainfall in some of the areas the impacts on the groundwater quality are less than expected and very localized. The volume of solid waste generated, including tailings from processing, is one of the main pollution concerns in the mining industry. The overburden (waste-to-ore) ratio for surface mining of metal ores generally ranges from 2:1 to 8:1, depending on local conditions. The ratio for solid wastes from underground mining is typically 0.2:1. Where concentration or other processing of the ore is done on site, the tailings generated also have to be managed.

Ores with a low metal content, say, less than 0.4%, generate significant quantities of tailings. In certain mines where ores have high sulphur content, drainage from mine workings and waste heaps can become highly acidic and can contain high concentrations of dissolved heavy metals. This acid mine drainage (AMD) can have a pH of 3 or lower; sulphate levels of 800 – 1800 mg/l; copper levels up to 50 mg/l; iron levels up to 1000 mg/l; lead levels up to 12mg/l; zinc levels up to 1700 mg/l; and cadmium levels of several milligrams per liter, depending on the contents of the ore. Effluent from tailings ponds may contain concentrations of chromium of several milligrams per liter. Base metal mining tailings decant may contain high concentrations of thiosalts. Chemicals used in flotation and other metal concentration processes could create toxicity problems when released in effluents. Surface runoffs may also pose significant environmental problems through erosion and carryover of tailings and other mining residues.

As discussed in Section 1.2.1 impacts on groundwater quality from the diamond mining industry in the WMA is negligible.

1.4 Groundwater management and monitoring requirements in the catchment area

1.4.1 Current groundwater monitoring and management

There are a total of approximately 180 monitoring points throughout the Lower Vaal WMA (See Table 3). The monitoring points serve all two of the levels of groundwater monitoring namely level 1 or national monitoring network and level 2 or regional. Some points are shown of Figure 1. The monitoring includes water levels and ambient water quality. There are automatic data loggers at some stations. The aim is to expand the network but the required equipment and personnel is currently not available. The required expansion as well as reporting and individual user reporting could be solved with the establishment and involvement of WUAs.

Table 3: Groundwater monitoring points in the WMA (DWAF, 2003)

Place	W / sample	Waterlevel	Orphimedes	Thalimedes
Barkly West	1			
Bestwood	20	19		
Boshoff	1			
Christiana	2			
Danielskuil	8	5		
Delareyville	1			
Ganspan	2	3	1	
Gerdau	1			
Ghaapplato	28	29	3	1
Griekwastad	7	7		
Groenwater/Skeyfontein	2			
Hartsvalleiskole	2			
J/Kemp Vaalharts Irrig	1			
Jan Kempdorp	1			
Kathu	9	8		
Koopmansfontein	1			
Kudumane	1			
Kuruman	18	18	6	5
Lichtenburg	1			
Majeding	1			
Majeng	2			
Manyeding Oog	1			
Niekerkshoop	4	1	1	
Peringmyn		5	1	
Peringmyn Scheurfontein	1		5	1
Postmasburg	5	5		
Sannieshof	1			
Schmidsdrif	3	3		
Schweizer Reneke	2			
Sishen	1	3	3	
Stella	1			
Taung	1			
Taung Dry Harts	1			
Ulco	1			
Vryburg	1			
Witsand	1		3	
Witsand	11	3		
Total	**145**	**109**	**23**	**7**

The main challenges facing DWAF in this WMA is with regard to the management and allocation of the groundwater resources at the high-abstraction irrigation areas. Constitutions have been drawn up, and are awaiting approval by the minister, for the following Water User Associations (WUAs): Stella, Coetsersdam/ Louwna, Tosca and Molopo.

Sixty six applications have been received for new license applications which entails an approximate 10 million m^3/annum additional abstraction from the resource. Currently the Harvest Potential maps (Vegter, 1996) are used when making recommendations with regard to allocations. In areas where over exploitation of the aquifer is taking place (e.g. Tosca), drastic measures such as reversing of water rights are necessary. This is causing many legal complications for management in the regional DWAF office.

The following reserves have been requested and completed: C91E, D41B, C32B, D41C, C31E, C31F, C91A, C91C, D41L, D56B, D41C+D, D41C+D and D41F.

1.4.2 Current (quality and quantity) requirements

No formal quality and quantity requirements have been set to date but DWAF is in the process of addressing the issue.

1.5 Poverty eradication and the role groundwater can play in the catchment

Often groundwater is an inexpensive resource to develop for domestic water supply for communities that are located far from existing surface water bulk supply systems. However cognizance has to be taken of the groundwater quality and exploitability when the level of sanitation is considered. DWAF Geohydrology is actively involved in water supply schemes for domestic use from groundwater resources in the WMA.

Emerging farmers can also benefit by the exploitation of groundwater especially in areas where potential for irrigation development from groundwater resources in the WMA is high. However, careful consideration needs to be taken of existing water rights and the possible over allocation of the resource.

In order to aid the government's initiative with regard to mineral development especially for small-scale mining operations, DWAF could play an active role in the water licensing process.

2 Groundwater according to geolithological units and catchments associated or enclosed with the units (1: 1000 000 geology)

The Lower Vaal WMA is underlain by diverse lithologies. Several broad lithostratigraphic units fall within the boundaries. A simplified geological map of the WMA is presented in Figure 2. From oldest to youngest, the units which are important in terms of groundwater occurrence comprise the following:

- **Swazian:** The oldest formations are the meta-sediments from the Kraaipan Group (Zk) which consist mainly of quartzite, chert, slate, phyllite and schist. The unnamed basement granite and gneiss (Zz) covers a large portion to the north east of the WMA. The rocks are the products of high-grade metamorphism.
- **Randuim:** Overlying the granite and gneiss are the quartzites, conglomerates, lavas and sediments of the Dominion Group (Rd). The Klipriviersberg Group (Rk) consisting of well jointed basaltic lava covers a large area to the east.
- **Vaaluim:** Lithologies of this age vary between meta-argillaceous rocks (slate, siltstone and dolomite of the Vryburg Group (Vry)); dolomites, limestones and related sedimentary rocks (often iron or manganiferous ore bearing, e.g. banded iron formations) of the Ghaap (Va) and Chuniespoort Groups (Vh); meta arenaceous quartzite from the Volop Group (Vv), basal diamictite, and basaltic and adensitic lava interbedded with chert and jasper from the Postmasburg and Pretoria Groups (Vp).
- **Carboniferous-Permian:** Karoo Sequence represented by the Ecca Group and Dwyka Formation (C-Pd), comprises of thick successions of sedimentary rocks covers a portion of the area to the south-east. Sedimentary rocks range from mudrocks through coarser varieties (sandstones, conglomerates) to diamictites and rhythmites (pleistocene

deposits). Karoo or Jurassic dolerite is fairly common throughout the sequence and also frequently intrudes older rocks.

- **Tertiary-Quaternary:** Undifferentiated inland deposits of unconsolidated to semi-consolidated sediments including sands, calcrete, aeolianite, gravel, clay and silcrete make up the Kalahari Group (T-Qk) to the north-west and far west of the WMA.

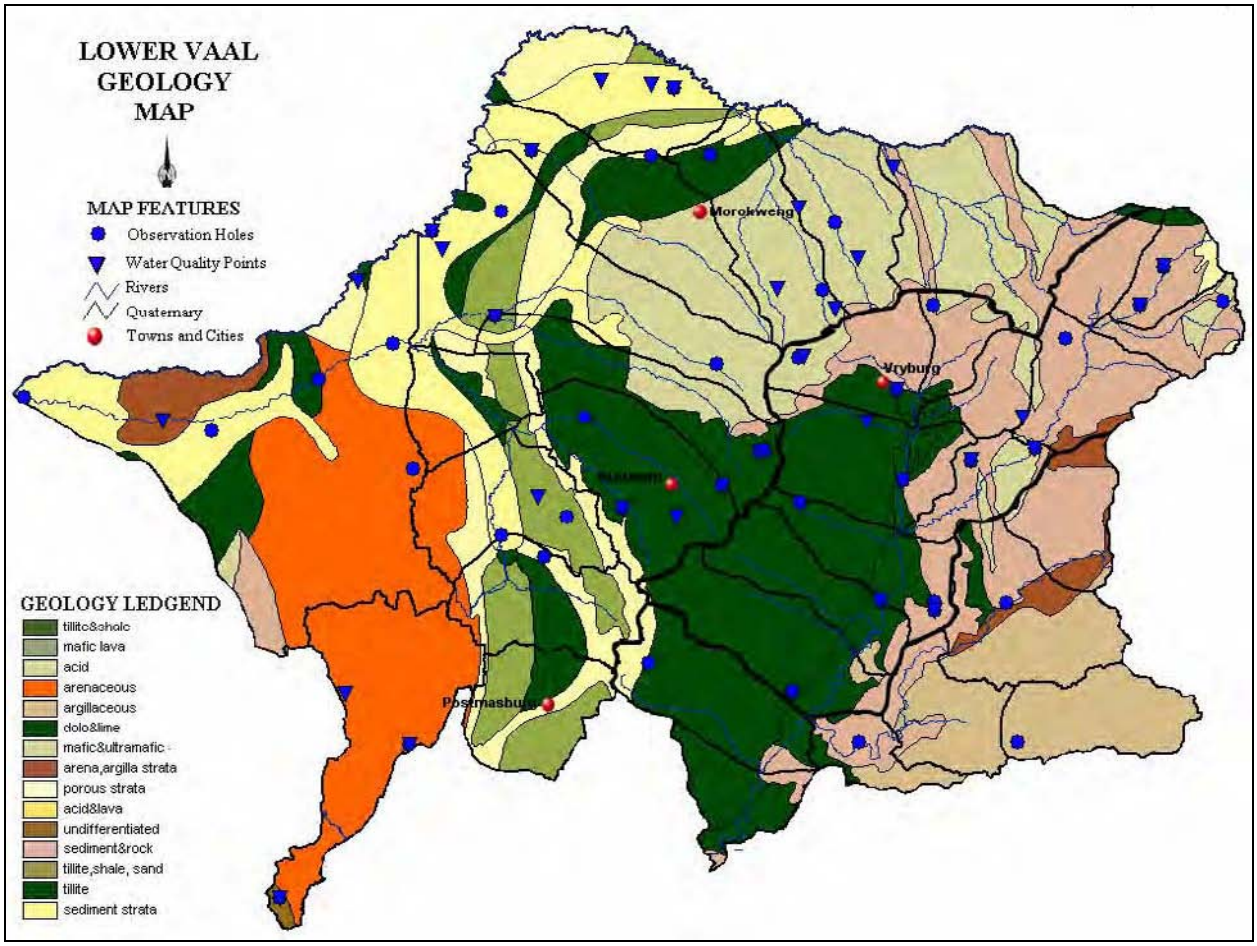

Figure 2: Generalised Geology of the WMA

Three aquifer types are present in the WMA: Intergranular and fractured, karstic and fractured. The following is a brief geohydrological description of the main exploitable aquifers in the WMA from the Vryburg and Kimberley geohydrological maps (DWAF, 2000).

The ability of granite and gneiss units to host groundwater is enhanced by the presence of fractures and dykes and the associated weathering. The aquifers can be divided into weathered, intermediate and fractured bedrock zones. Borehole yields vary across the unit depending on the waterbearing features. In the Louwna area the weathered pegmatitic granite yields are generally greater than 5 l/s as well as at the contact zone of the Kraaipan Group and the granite (Stella area). In the Delareyville area the contact between the Allanridge formation and the granites can be targeted for exploitable water. In the Schweiser Reneke area yields of up to 2l/s can be drilled in weathered ones of the granite.

Groundwater yields of 2 l/s – 5 l/s is found in fractured and weathered lavas of the Klipriviersberg formation (Sannieshof area).

The andesitic lava of the Allanridge formation can yield groundwater in excess of 2 l/s in fractures associated with faults or intrusions.

Solution cavities in dolomitic rocks of the Ghaap Group and Chuniespoort group often develop in association with diabase dykes and faults, contain large quantities of exploitable groundwater (yields > 5 l/s). Some dykes isolate compartments, which may be dewatered during overexploitation (e.g. Tosca). The contact between the banded iron formation and the dolomite is transitional with alternating shale and dolomite bands. This zone is a well-developed aquifer in association with faults and dykes.

Joints and fractures in the Volop quartzite and the whole of the Postmasburg Group can be targeted for boreholes with yields of up to 2 l/s. Yields in the Dwyka and Ecca sediments associated with fractures and intrusions, are not very high (0.1-0.5 l/s) and often the groundwater is associated with poor quality.

3 Riverbed Sand Aquifers

Little is known regarding true riverbed sand aquifers in the WMA. General characteristics of riverbed aquifers can be summarized as:

- Coarse gravels and sands are more typical of alluvial deposits. However, flood plains consist mainly of fine silt. Towards the end of a river's course, the river slows down dumping some of the heavier materials on these flood plains. Boreholes drilled into these types of formations normally have higher yields. It is important to note that borehole design is plays an important role in the yield of boreholes drilled into riverbed aquifers.
- Alluvial deposits grain size varies considerably, fine and coarse materials are intermixed. The hydraulic conductivities vary between 10^{-3} to 10^{3} m/d and their porosities vary between 25 – 70%. However, flood plain porosities usually range 35 – 50% and the hydraulic conductivities vary between 10^{-8} – 10^{-1} m/d.
- In general riverbed aquifers are high recharge areas and often recharge deeper underlying aquifers and are unconfined in nature.

The surface-water groundwater interaction is often intermittent (depending on the elevation of the water level, groundwater may recharge the surface water body or the surface water may recharge groundwater). This is normally dependent on the rainfall cycle (see Figure 3).

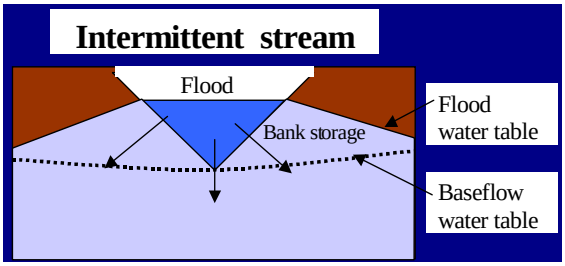

Figure 3 Intermittent interaction

The lower Vaal's gradient has lessened, suggesting that the suspended load and bedload are not only reduced in volume but are also smaller in particle size. As the river meanders back and forth sediments accumulate on the flood plains. Boreholes drilled here will almost always be successful because the sediments are of similar size and the river provides continuous recharge to the sediments. The design of boreholes along these rivers is extremely important to prevent clogging.

4 Groundwater-Surface Water Linkage

Groundwater-surface water interaction has not been studied sufficiently in the WMA. According to records documented by Van Tonder and Dennis (2003), under natural conditions there is seldom groundwater contributing to base flow in rivers. However observed surface water recharge in normally dry riverbeds. Current quality problems experienced in the Vaal and Orange rivers, waterlogging experienced with irrigation along these riverbanks indicate interaction. Therefore a study is currently motivated by DWAF Geohydrology to investigate Groundwater-surface water interaction in the Vaal and Orange rivers (Van Dyk, 2003).

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