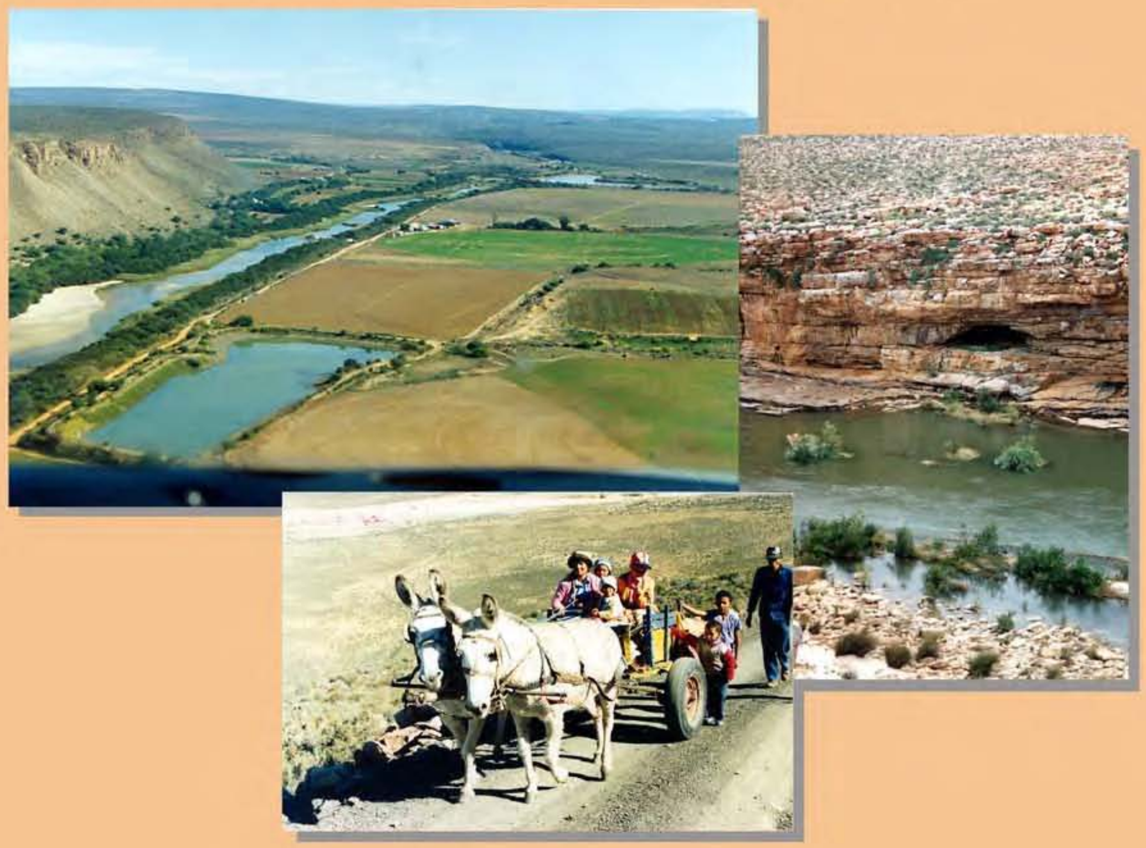
REPORT No : PWMA 17/000/00/0305

DEPARTMENT OF WATER AFFAIRS
AND FORESTRY

OLIFANTS/DOORN
WATER MANAGEMENT AREA

OLIFANTS/DOORN INTERNAL STRATEGIC PERSPECTIVE



VERSION 1

FEBRUARY 2005

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P WMA 17/000/00/0305

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February 2005

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Department of Water Affairs and Forestry
Directorate National Water Resource Planning

DEVELOPMENT OF INTERNAL STRATEGIC PERSPECTIVE
FOR THE
OLIFANTS/DOORN WATER MANAGEMENT AREA (WMA No 17)

APPROVAL

Title	:	Olifants/Doorn Water Management Area: Internal Strategic Perspective
DWAF Report No	:	P WMA 17/000/00/0305
Consultants	:	Ninham Shand in association with Umvoto Africa, Jakoet & Associates, FST and Tlou & Matji
Report Status	:	Version 1, February 2005
Version Controller	:	Mr A. Parker (Catchment Manager Olifants/Doorn WMA)
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INVITATION TO COMMENT

This report will be updated on a regular basis until it is eventually superseded by the Catchment Management Strategy.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

ELECTRONIC VERSION

This report is also available in electronic format as follows:

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

  or from the Version Controller (see box overleaf).

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

- Olifants/Doorn WMA Internal Strategic Perspective (*This Report*) (Report No: P WMA 17/000/00/0305)
- The National Water Resource Strategy, First Edition 2004
- The Olifants/Doorn WMA - Overview of Water Resources Availability and Utilisation (Report No: P WMA 17/000/00/0203)
- The Olifants/Doorn WMA – Water Resources Situation Assessment (Report No: P WMA 17/000/00/0101).

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.

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VERSION CONTROL

OLIFANTS/DOORN WMA
INTERNAL STRATEGIC PERSPECTIVE

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

EXECUTIVE SUMMARY

Introduction

The Olifants/Doorn Water Management Area (WMA) is located on the west coast of South Africa, extending from about 100 km to 450 km north of Cape Town. The south-western portion mainly falls within the Western Cape Province, and the north-eastern section falls within the Northern Cape Province. The Olifants/Doorn WMA, one of nineteen WMAs in the country, derives its name from the main river draining it, namely the Olifants River. The word “Doorn”, an archaic form of Doring, was added to the WMA name to distinguish it from the many other “Olifants” rivers in the country, and because the Olifants River’s main tributary is the Doring River.

This document presents the Department of Water Affairs and Forestry's (DWAF's) internal strategic perspective (ISP), or view, on how it intends managing the water resources within the WMA, during the period leading up to the establishment of a fully operational Catchment Management Agency (CMA), and the development of a Catchment Management Strategy (CMS) by the CMA. One of the major goals of the ISP is to obtain a common understanding within DWAF about management objectives and strategies.

After internal approval, the Department will invite comment on the ISP from local authorities, water user associations and stakeholders. Formal updates of the ISP will be undertaken periodically. The collective knowledge of DWAF’s regional and head office water management staff about this WMA is documented in the ISP. The ISP presents a common and consistent approach that can be adopted when addressing water management related issues, problems and queries, and when evaluating water license applications.

The information required to compile the ISP has been obtained from policy documentation, legislation, planning study reports, departmental guidelines, and from interviews and communications with DWAF regional managers and head office staff.

Water law and water management

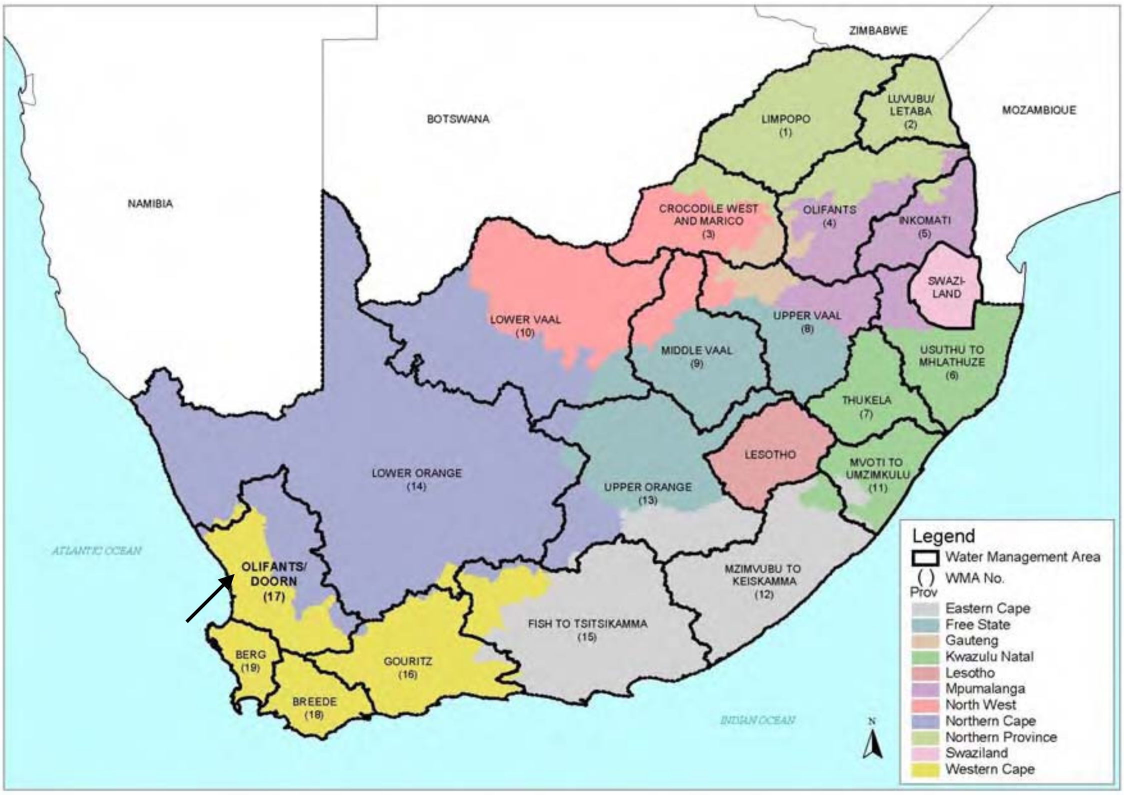
The National Water Act (NWA), is the principal legal instrument governing water resource management in South Africa, and is being incrementally implemented. The NWA is supported by other legislation such as the National Environmental Management Act and other Acts. The NWA does away with some far-reaching concepts but introduces others, which have both economic and social features.

The National Water Resource Strategy (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 which 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.

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

- Determination of existing lawful use;
- Determination of water availability at acceptable confidence levels;
- Determination of ecological water requirements at high confidence levels and
- Development of the regional management strategies, the ISPs.

An iterative and interactive process will then follow where public participation (preferably through the CMAs) will play a role in determining water resource and water-use reconciliation options.



Map showing the WMAs of South Africa (Olifants/Doorn -WMA 17)

Locality and physical features

Refer to the ISP sub-areas map on page xii.

The major river in the WMA is the Olifants River, of which the Doring River (draining the Koue Bokkeveld and Doring areas) and the Sout River (draining the Knersvlakte) are the main tributaries. The WMA incorporates the E primary drainage region and components of the F and G drainage regions along the coastal plain, respectively north and south of the Olifants River estuary, covering a total area of 56 446 km^2.

The Olifants River rises in the mountains in the south-east of the WMA and flows north-west. Its deep narrow valley widens and flattens downstream of Clanwilliam until the river flows through a wide floodplain downstream of Klawer. The Doring River is a fan shaped catchment. The main river rises in the south and flows in a northerly direction. It is first joined by the Groot River and then by the Tra-Tra River flowing from the west and the Tankwa River from the east, before flowing in a westerly direction to its confluence with the Olifants River just upstream of Klawer.

The north of the WMA is flatter and much of the basin lies between 500 and 900 m above sea level. In the east there are significant mountain ranges, the Hantam near Calvinia and the Roggeveld to the south, which rise to about 1 500 m above sea level. West of Nieuwoudtville lies the Bokkeveld Mountains escarpment, where the plateau elevation of about 700 m drops to about 300 m. The rolling hills and plains of the 30 to 40 km wide strip along the coast from the southern boundary of the WMA to the estuary of the Olifants River are known as the Sandveld. The deep sandy deposits overlaying the bedrock in this area are "primary" aquifers which provide a significant groundwater resource.

Climatic conditions vary considerably as a result of the variation in topography. Minimum temperatures in July range from –3 ºC to 3 ºC and maximum temperatures in January range from 39 ºC to 44 ºC. The area lies within the winter rainfall region, with the majority of rain occurring between May and September each year. The mean annual precipitation is up to 1 500 mm in the Cederberg mountains in the south-west, but decreases sharply to about 200 mm to the north, east and west thereof, and to less than 100 mm in the far north of the WMA. Average gross mean annual evaporation (as measured by Symons pan), ranges from 1 500 mm in the south-west to more than 2 200 mm in the dry northern parts. Due to the diverse soil types and variance in rainfall distribution, vegetation is varied and includes at least six veld types and several thousand plant species. Karoo and Karroid Types, False Karoo Types, Temperate and Transitional Forest Types, Scrub Types, and Sclerophyllous Bush Types occur in the Olifants/Doorn WMA.

Important conservation areas include the Tankwa-Karoo National Park, the Verlorevlei wetland in the Sandveld (which enjoys Ramsar status), the Cederberg Wilderness Area, and the northern section of the Groot Winterhoek Wilderness Area. The Olifants River and its tributary, the Doring River are important from a conservation perspective because they contain a number of species of indigenous and endemic fish that occur in no other river systems, and that are endangered. In addition, reaches of some of the tributaries are virtually unspoiled by human manipulation and are of high to very high ecological importance. The Olifants estuary is one of only three permanently open estuaries on the west coast of South Africa. It therefore represents a critical habitat to many estuarine-associated fish species. The estuary also supports at least 86 species of estuarine waterbirds and has a wide range of habitats. It plays an important role in bird migration and is considered to be in the top ten South African locations of importance for conservation of waterbirds. The coastal wetlands of Verlorevlei, Die Vlei (Wamakervlei), Wadriftsoutpan and Lambert's Bay in the Sandveld are vulnerable due to the pressure placed on the groundwater resource by over-utilisation and pollution.

The DWAF Directorate: Resource Directed Measures (RDM) commissioned a Comprehensive Reserve Determination Study (2003-2005) for the WMA. A separate Groundwater Reserve Study was undertaken in the Sandveld (Conrad, 2003). The formal public process to decide the Management Class and Reserve will be undertaken at a later stage.

The WMA was divided into six sub-areas[1] or "management units", corresponding to the current divisions used in surface water resource management by the Regional Office of the DWAF.

ISP sub-areas

ISP Sub-area	Catchments
Upper Olifants	E10A to E10G
Koue Bokkeveld	E21A to E21L
Doring	E22, E23, E24A-M, E40A-D
Knersvlakte	E31A-H, E32, E33A-F, F60
Lower Olifants	E10H-K, E33F-E33H
Sandveld	G30A (part) to G30H

Demography

The Olifants/Doorn WMA is the least populated WMA in the country with approximately 0.25% of the national population residing in the area. Approximately 113 000 people live in the WMA. More than half of the population live in urban or peri-urban areas, and the rest in rural areas. About 65% of the population is concentrated in the south-western portion of the WMA in the Koue Bokkeveld, Upper and Lower Olifants and Sandveld sub-areas. The population growth expected for the area appears to follow the general trend of decreasing rural populations which can be attributed to the lack of strong economic stimulants, migration of young people and the impacts of HIV/ AIDS (NWRS, 2004). There is strong in-migration of seasonal workers during the harvest and planting seasons.

International links and links with other WMAs

The WMA borders on the Lower Orange WMA to the north and east, the Gouritz, Breede and Berg WMAs in the south, and the Atlantic Ocean in the west. The only inter-water management area transfer is a transfer of 2.5 million m^3/a from the Breede WMA (quaternary H20C) via the Inverdoorn canal for irrigation purposes. No water transfer from this WMA to other WMAs is taking place nor is any planned.

Economic development

The contribution from the Olifants/Doorn WMA to the national Gross Domestic Product (GDP) is the lowest of any WMA in the country, however the WMA agriculture sector does contribute about 5% to the GDP. In this WMA, the agricultural sector contributes far more to the local economy (43%) than any other sector. Whilst emphasising the importance of agriculture in the regional economy of the WMA, this also highlights the relatively low level of activity in other sectors.

[1] The Olifants Doorn WMA was divided into only five sub-areas in the National Water Resource Strategy (NWRS). The Olifants River sub-area as defined in NWRS has been spilt into two for the purpose of this ISP (Upper Olifants and Lower Olifants). It was recognised that the two sections of the river have distinctly different water resource management characteristics.

The significance of the agricultural sector can be attributed to the variety of products cultivated in the area, mostly under irrigation. Two of the other more important economic sectors, namely trade and manufacturing, are strongly linked to the agricultural sector, with a large proportion of their activities involving the sale or processing of agricultural products. The agricultural sector showed a growth of 3.7% per annum between 1988 and 1997, indicating that this sector has an important role in the future of this WMA.

Of the total labour force of 58 600 people, 8% is unemployed, which is much better than the national average of 29%. Approximately 75% of the labour force is active in the formal economy. A total of 50% of the formally employed labour force worked in the agricultural sector, 20% in the government sector and only 9% in trade. The agriculture-dominated economy of the WMA is marked by inequality in income distribution along racial, gender and urban/rural divides. A skewed age and skills profile exists with decreasing numbers of young educated people remaining in the area. Security of tenure, adequate housing and access to productive land are the key development needs amongst the disadvantaged majority. The northern and eastern parts of the WMA are characterised by high unemployment, are sparsely populated, have poor infrastructure and high poverty levels.

The only major mine in the area is the Namakwa Sands heavy minerals mine which is situated on the coast in the north-west of the WMA. There are also several granite-quarrying operations in the vicinities of Vredendal and Vanrhynsdorp. Dredging for marine diamonds occurs offshore. Industries in the WMA are small and the majority of them are concerned with the processing and packaging of agricultural products. Approximately only 4 million m^3/a of water is currently required by the mining and industrial sectors. Small commercial timber plantations, totalling 10 km^2, are established in the mountainous high rainfall areas in the south-west of the WMA, with very little impact on the water resource (total use is 1 million m^3/a).

Tourism is an important and growing component of the WMA economy. The coastal towns, Clanwilliam Dam and the Cederberg Wilderness Area support numerous tourism-based businesses. The coastal towns suffer from water shortages over the summer tourist season due to peak demand.

Land use and ownership

The mean annual precipitation over much of the WMA is less than 200 mm, with the result that, except in the wetter south-west, the climate is not suitable for dryland farming on a large scale. Consequently, more than 90% of the land in the Olifants/Doorn WMA is used as grazing for livestock, predominantly for sheep and goats. An estimated 2 190 km^2, or some 4% of the land area is cultivated for dryland farming.

Approximately 497 km^2 is under irrigation, of which almost 50% lies within the Upper and Lower Olifants sub-areas. Irrigated citrus, deciduous fruits, grapes and potatoes are grown on a large scale in the WMA and provide the mainstay of this WMA's economy (NWRS, 2004). In addition to the intensive irrigation practised along the Olifants River, significant irrigation also takes place in the Koue Bokkeveld, along the rivers and from groundwater in the Sandveld sub-area.

Urban areas are small, covering a total land area estimated at only 31 km^2. There are a few small rural settlements, but they occupy an insignificant area of land. Commercial farmers dominate the ownership of land. Resource-poor farmers have limited access to good quality agricultural land and have been historically sidelined in terms of access to water. This WMA is water stressed and there is no surplus available from existing sources. Additional water resource developments will be required for any further irrigation development. Although the local authorities and the provincial departments of land and agriculture have programmes in place to actively transform the land ownership pattern, progress has been slow.

Waterworks

Olifants River (Vanrhynsdorp) Government Water Scheme

The Olifants River (Vanrhynsdorp) Government Water Scheme includes the Clanwilliam Dam, Bulshoek Weir and a canal system to irrigate land extending along the Olifants River. Clanwilliam Dam and Bulshoek Weir are state-owned. Bulshoek Weir and the canal is operated and maintained by the Lower Olifants River Water User Association (LORWUA). A dam safety inspection found that the Clanwilliam Dam wall requires strengthening by 2010 to meet the national safety requirements. A study is being undertaken at present to investigate the feasibility of raising the dam at the same time.

Water is released from Clanwilliam Dam (live storage 122 million m^3) into the river to flow to Bulshoek Weir (live storage 5.7 million m^3), some 30 km downstream. Downstream of the weir water is distributed by a canal system consisting of main and distribution canals totalling 186 km in length. The combined 1:50 year yield of Clanwilliam Dam and Bulshoek Weir is 154 million m^3/a. It is estimated that canal conveyance losses are of the order of 28%. The scheduled area under the canal system is 11 500 ha, with an irrigation quota of 12 400 m^3/ha/a. The canal system is used for irrigation, domestic and industrial supplies for towns, and to the Namakwa Sands Mine, as well as a number of small mining activities. Recently, irrigation supplies have frequently been curtailed. Other than Clanwilliam Dam and the Bulshoek Weir, there are no other large state-owned dams in the WMA. There are numerous farm dams throughout the upper Olifants and Doring catchments.

Other Irrigation Schemes

There are a large number of privately owned irrigation schemes, namely:

- In the Koue Bokkeveld and in the Agter Witzenberg area (upper reaches of the Olifants River) numerous farm dams have been constructed for the irrigation of deciduous fruit and vegetables. The total irrigated area is approximately 8 600 ha;
- At the confluence of the Tankwa and Doring Rivers water is abstracted from the Doring River for the irrigation of 350 ha of land from the water works of the Elandskaroo Irrigation Board;
- Oudebaaskraal Dam on the Tankwa River (quaternary E23F) is the largest privately owned farm dam in South Africa, with live storage of 34 million m^3. It seldom fills completely and supplies water irregularly to approximately 320 ha of land, irrigated by the farmer on a semi-opportunistic basis;
- Along the Olifants River upstream of Clanwilliam Dam there are numerous small individual private schemes with various abstraction systems, including pump stations, small diversion weirs, canals and off-channel dams mainly to irrigate citrus. The total irrigated area is approximately 10 700 ha.

Local water supply schemes

Surface Water Supplies

The towns in the Olifants/Doorn WMA are all relatively small and most are supplied from local surface and groundwater sources via infrastructure owned and operated by local authorities. There are a few exceptions, such as Klawer, Vredendal, Vanrhynsdorp, Lutzville, Ebenhaezer, Strandfontein and Doringbaai which are supplied from the Lower Olifants Government Water Scheme. The towns of Citrusdal and Clanwilliam obtain water directly from the Olifants River. Clanwilliam also abstracts from the Jan Dissels River, upstream of its confluence with the Olifants River.

Groundwater Urban and Rural supplies

Towns that are dependent or partially dependent on groundwater supplies are Loeriesfontein, Calvinia, Nieuwoudtville, Vanrhynsdorp, Bitterfontein-Nuwerus, Doringbaai, Lamberts Bay, Graafwater, Leipoldtville and Elandsbaai. Citrusdal supplements its summer water supplies with groundwater.

Southern Namakwaland Government Water Scheme

The Southern Namakwaland Government Water Scheme supplies desalinated groundwater from boreholes to the small towns of Bitterfontein and Nuwerus. This was implemented because of the severe shortage of suitable sources of surface water in those areas and groundwater of unfit quality. This scheme has recently been extended to supply the Rietpoort and Molsvlei communities.

Water resources availability

The table on the following page shows water availability in the WMA.

The water resources are not evenly distributed over the WMA. The highest runoff is from the relatively small southern central mountainous area of the WMA, notably the Upper Olifants, Doring and Koue Bokkeveld sub-areas, with limited runoff emanating from the arid remainder. The total natural mean annual runoff (MAR) of 1 068 million m^3 has been significantly reduced by abstractions, mainly for irrigation.

The fractured-rock aquifer systems in this WMA include the TMG Aquifers in the *Cederberg sub-province*, and parts of the Witteberg Group in the *Tankwa Karoo sub-province*. Another fractured-rock system is represented by Karoo dolerites in the *Hantam sub-province* on the eastern side of the WMA. Primary intergranular (porous sandy) aquifers occur most extensively in the western coastal (*Knersvlakte sub-province* and western Cederberg) and northern parts of the WMA. In the northern parts of the WMA (Knersvlakte and Hantam), these primary aquifers are related to alluvial deposits. Borehole distribution, in all except in the alluvial and TMG aquifers, does not reflect good groundwater sources. The spread of boreholes indicates a relatively high level of summer-season groundwater dependence. The groundwater resource has not been systematically explored and developed, and its monitoring is uneven.

The recharge to the TMG aquifers is highest in the high mountains along the southern catchment boundary divide, around the Koue Bokkeveld and southern Cederberg ranges. In contrast to this, the estimated recharge in the northern part of the WMA, and over a wide area of the Tankwa Karoo in the rain shadow east of the Cederberg ranges, is less than 10 mm/a. The yields obtained to date and the recharge distribution together indicate that the TMG fractured-rock aquifers should be the main groundwater exploration targets in this region.

Available yield for the year 2000 at 1:50 year assurance (million m^3/a)

Sub-area	Natural resource		Usable return flow		Total local yield (1)	Transfers in (2)	Total available
	Surface water	Ground-water	Irrigation	Urban			
Upper Olifants	169	20	8	0	197	0	**197**
Koue Bokkeveld	59	5	3	0	67	0	**67**
Doring	8	3	0	0	11	3	**14**
Knersvlakte	1	3	0	0	4	4	**8**
Lower Olifants	18	1	4	2	25	94 (3)	**119**
Sandveld	2	30	0	0	32	0	**32**
Total for WMA	**257**	**62**	**15**	**2**	**336**	**3**	**339**

1) After allowance for the impacts on yield of: ecological component of the preliminary Reserve, river losses, invasive alien plants, dry land agriculture and urban runoff.
2) Transfers into sub-areas may include transfers between sub-areas as well as transfers between WMAs. Addition of the transfers therefore does not necessarily correspond to the total transfers into the WMA.
3) Transfers into the Lower Olifants sub-area of 94 million m^3/a for irrigation, mainly via the Lower Olifants River canal.

The water availability is influenced by the following:

- The Reserve requirement has yet to be comprehensively determined and the yield balance is currently based on Rapid Reserve estimates only;
- The preliminary Reserve estimates do not include the estuarine or wetlands Reserve requirements, as these have yet to be determined;
- The possible effect of climate change has not been allowed for in the ISP. There have been predictions that the effects of global warming could cause a possible 10-15% reduction in streamflow in the Western Cape by 2015.

Water requirements and use

The agricultural sector is by far the largest water-use sector with estimated requirements of about 95% (356 million m^3/a) of the total requirements. The table on the following page shows water requirements in the WMA.

Water requirements for the year 2000 at 1:50 year assurance (million m³/a)

Sub-area	Irrigation	Urban (1)	Rural (1)	Mining and bulk industrial (2)	Affore-station (3)	Total local require-ments	Transfers out	Grand Total
Upper Olifants	**100**	1	1	0	1	**103**	94 (4)	**197**
Koue Bokkeveld	**65**	0	1	0	0	**66**	0	**66**
Doring	**13**	1	1	0	0	**15**	0	**15**
Knersvlakte	**3**	0	1	3	0	**7**	0	**7**
Lower Olifants	**140**	3	1	0	0	**144**	4 (5)	**148**
Sandveld	**35**	2	1	0	0	**38**	0	**38**
Total for WMA	**356**	**7**	**6**	**3**	**1**	**373**	**0**	**373**

1) Includes component of the 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) Quantities given refer to impact on yield only.
4) Transfers out of the Upper Olifants of 94 million m^3/a for downstream irrigation, mainly via the Lower Olifants River canal.
5) Transfers out of the Lower Olifants of 4 million m^3/a consists of a transfer of 2.5 million m^3/a to meet the Namakwa Sands mining requirement and 0.4 million m^3/a to the northern Sandveld for urban use. The rest is transportation losses.

Water requirements are influenced by the following:

- There is uncertainty regarding the accuracy of run-of-river yields and yields from farm dams, especially above Clanwilliam Dam;
- The extent of actual water use by irrigators, particularly those outside of WUAs;
- The extent of over-abstraction in the Olifants River sub-area, with resulting variable assurances of supply.

Future requirements

Little growth is anticipated for towns, industry and mining. In the Upper Olifants, Koue Bokkeveld and the Sandveld sub-areas there is a demand for ongoing expansion of existing irrigation. There is potential for further irrigation. Development in the Lower Olifants is constrained by water availability and in peak demand periods through existing infrastructure.

The *Olifants Doring Basin Study Phase 1 (1998)* recommended that restrictions be placed on the issuing of further licences in identified catchments, until more information becomes available regarding the feasibility of identified development options and the implications of the Reserve. Further allocations were in response restricted to allow the issuing of licenses only to the following maximums:

Koue Bokkeveld/Witzenberg	950 ha
Citrusdal/Clanwilliam	475 ha
Middle Doring	150 ha
Ceres Karoo	1 500 ha
Coastal Zone	2 000 ha

The restrictions are currently being adhered to by DWAF. The restrictions were to apply for a period of seven years (1998-2005) after which it was anticipated that there would be finality on the extent of development on the major irrigation schemes identified in the *Olifants Doring Basin Study Phase 1 (1998)*. A review of these restrictions is to take place in 2005.

The NWRS discussion of high scenario water requirements for 2025 assumes limited population growth, but more equitable distribution of wealth leading to higher average levels of water services. No adjustments were made reflecting the impacts of increased water efficiency. Tourism was considered to be the sector in the WMA undergoing the most growth between 2000 and 2025. The NWRS high scenario predicted that requirements would reduce by 1 million m^3/a in the Koue Bokkeveld sub-area, and by 4 million m^3/a each in the Olifants (combination of the two ISP sub-areas) and Knersvlakte sub-areas by 2025. The NWRS 2025 base scenario predicted that requirements would reduce in the Koue Bokkeveld, Olifants (combination of the Upper and Lower Olifants ISP sub-areas) and Knersvlakte sub-areas by 2025, by 1 million m^3/a each. The NWRS concluded that water requirements would remain stable, perhaps decreasing slightly with the trend of depopulation of the rural areas.

Yield balance

The table on the following page shows water requirements in the WMA.

The reconciliation of available water and requirements for the year 2000, indicates that there was an overall deficit of 34 million m^3/a in the WMA. A deficit of 29 million m^3/a is experienced in the Lower Olifants sub-area. This deficit reflects a shortage at a 1: 50 assurance of supply, however, in practice a lower level of assurance is accepted by irrigators. The 6 million m^3/a deficit in the Sandveld sub-area is attributable to urban and irrigation water requirements, in excess of what can sustainably be supplied from the available resources, with the resultant over-exploitation of groundwater to make up the shortfalls. The Upper Olifants, Doring, Koue Bokkeveld and Knersvlakte sub-areas are all approximately in balance. It is anticipated that implementation of the Reserve will influence the use of farm dams, mainly on small tributaries, where water will have to be released to meet the needs of the Reserve. Little change in water requirements is foreseen unless new large-scale irrigation development occurs. The raising of Clanwilliam Dam (which could provide additional yield of up to 40 million m^3/a) and development of the deep Table Mountain Group aquifer, are currently seen as the most promising possible large-scale developments in the WMA.

Reconciliation of water requirements and availability for the year 2000 at 1:50 year assurance (million m³/a)

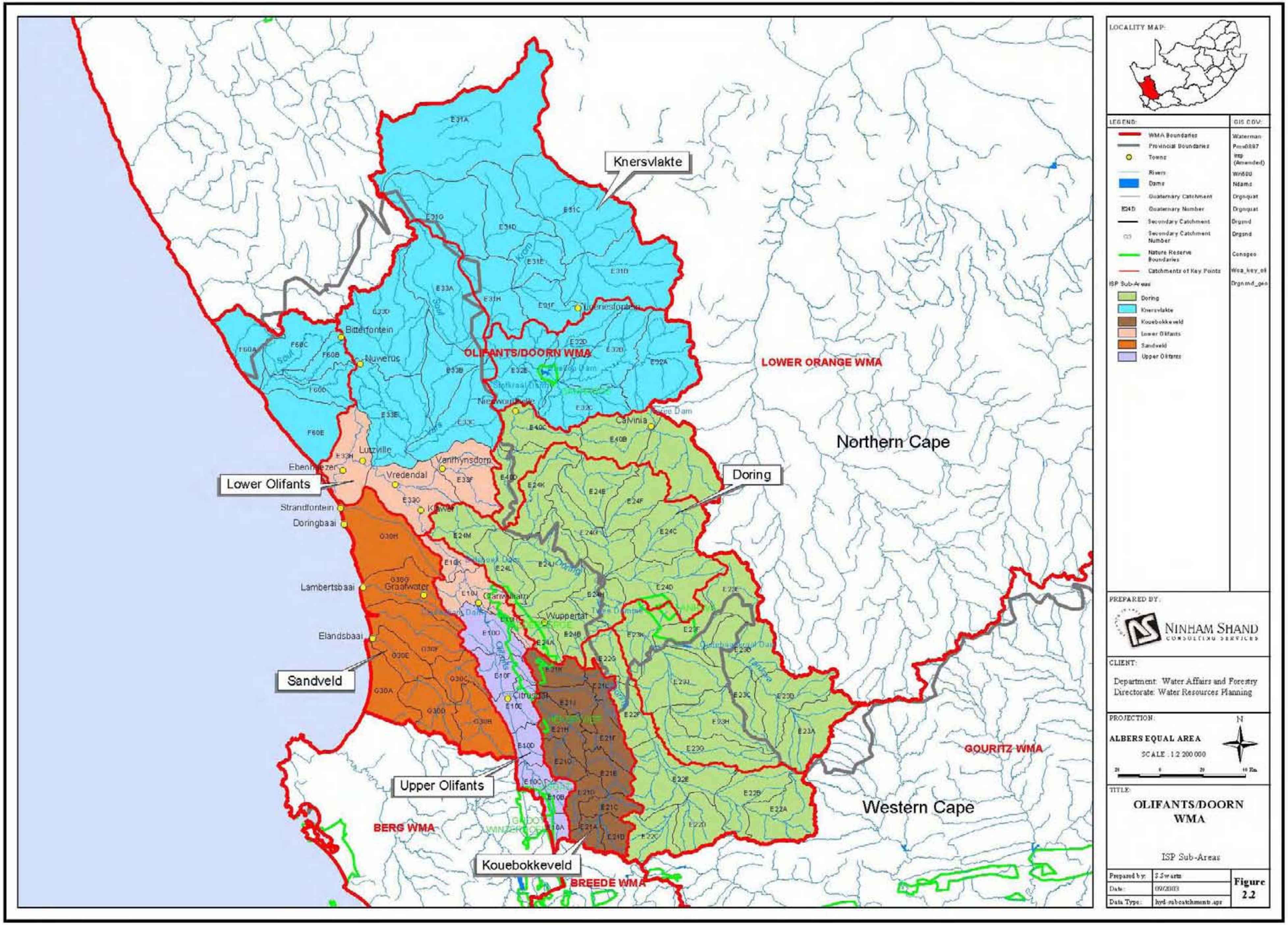
Sub-area	Available yield			Water requirements			Balance (1)
	Local yield	Transfers in (2)	Total	Local require-ments	Transfers out (2)	Total	
Upper Olifants	197	0	**197**	**103**	94 (3)	**197**	**0**
Koue Bokkeveld	67	0	**67**	**66**	0	**66**	**1**
Doring	11	3	**14**	**15**	0	**15**	**(1)**
Knersvlakte	4	4	**8**	**7**	0	**7**	**1**
Lower Olifants	25	94 (3)	**119**	**144**	4 (4)	**148**	**(29)**
Sandveld	32	0	**32**	**38**	0	**38**	**(6)**
Total for WMA	**336**	**3**	**339**	**373**	**0**	**373**	**(34)**

1) Surpluses are shown in the most upstream sub-area where they first become available.
2) Transfers into and out of sub-areas may include transfers between sub-areas as well as transfers between WMAs. Addition of the transfers per sub-area therefore does not necessarily correspond to the total transfers into and out of the WMA.
3) Transfers from the Upper to the Lower Olifants sub-area of 94 million m^3/a for downstream irrigation, mainly via the Lower Olifants.
4) Transfers out of the Lower Olifants of 4 million m^3/a consists of a transfer of 2.5 million m^3/a to meet the Namakwa Sands mining requirement (and an additional 1 million m^3/a transportation losses), and 0.4 million m^3/a to the northern Sandveld for urban use.

Water quality

The surface water quality of the Olifants/Doorn WMA is quite variable. Physical and chemical characteristics of the WMA geology have a strong influence on the water quality. Water quality in the Upper Olifants and Koue Bokkeveld is good and suitable for all uses, although seasonal differences are noted. The quality of water in the upper Doring River (E22), when flowing, is suitable for agriculture and domestic water supplies, however, at the end of summer the quality deteriorates. Highly saline flows from the Tankwa Karoo tributaries have a sporadic influence. In the upper portions of the Sandveld sub-area water quality is poor, resulting from agricultural activities on the Malmesbury shales which are high in salts. Agricultural activities influence the water quality significantly throughout the WMA, especially during the summer months.

Groundwater quality is generally controlled by aquifer lithology and geochemistry. Accordingly groundwater quality in the Olifants/Doorn WMA varies significantly between the fractured-rock aquifers that overlie generally impermeable shale- or granite-dominated pre-Cape formations. The most vulnerable aquifer is the primary coastal aquifer in the vicinity of Elands Bay and Lamberts Bay, reflecting the potential risk of seawater intrusion from exploitation of groundwater in this area. The heavy reliance on groundwater for town supplies also highlights the need for aquifer protection, monitoring and wellfield management.



ISP Sub-areas

Perspective of the sub-areas

Upper Olifants

The Olifants River (E10A-G) rises in the Cederberg Mountains at the southern edge of the WMA and provides the most significant contribution to the available water in the WMA. The Upper Olifants sub-area extends to the Clanwilliam Dam wall. The area is currently in balance. In the upper reaches of the Olifants River numerous small farm dams have been constructed for the irrigation of fruit and vegetables. A large proportion of irrigated land is under citrus, with a small proportion under deciduous fruit, which is the economic mainstay in the valley. There is also limited commercial forestry. Invasive alien plants occur mainly in the riparian zone which reduce yield by 5 million m^3/a and therefore should be systematically eradicated.

The area is dominated by the Table Mountain Group (TMG) which forms the high ridges of the Cederberg. The TMG fractured-rock aquifers provide an important base flow contribution to surface water drainage. There is evidence that groundwater in the coastal plain of the WMA is linked to the high mountain recharge water found in this sub-area. Groundwater yield estimates are considered to be higher than previously estimated at 20 million m^3/a. Groundwater is being increasingly used to supplement summer shortfalls in irrigation water supplied from the river, particularly in the river reach upstream of the Clanwilliam Dam (E10D-F). There is a transfer of 94 million m^3/a from the dam to the Lower Olifants sub-area.

There is demand for growth in agriculture in the Upper Olifants, including pressure from resource-poor farmers to be given land and water allocations. Water trading should be encouraged to accommodate this need or further resource development should be undertaken. There is insufficient storage to provide for agricultural use during the dry summer and the low flows are pressurised by ongoing peak demand. A higher percentage of existing use should be stored during winter high flows in off-channel storage. No further licences for additional use are being encouraged until the EWR have been established.

Koue Bokkeveld

The Koue Bokkeveld sub-area forms part of the southern boundary of the WMA. It lies between the Koue Bokkeveld and southern Cederberg mountain ranges on the west (E10 boundary), and the Swartruggens mountain range on the east (E22 boundary). The Koue Bokkeveld has several rivers that feed into the Doring River. The most notable of these are the **Groot River** (E21F), **Matjies River** (E21L) and the **Riet River** (E21). There is only the small town of Op-die Berg in this sub-area. The area overlies fractured rock aquifers and Karoo aquifers and there is considerable potential for expansion of groundwater use. The sub-area therefore has a small surplus of 1 million m^3/a and can be regarded as essentially in balance. It has been extensively developed for the cultivation of deciduous fruits and vegetables. Irrigation constitutes 98% of water use in the sub-area. Irrigation water is stored in a large number of farm dams. There is increasing demand for further development. An embargo was placed on development in the area (1998-2005) to ensure that *ad hoc* development did not negatively affect the viability of potential larger schemes on the Doring River. Any future development must be informed by the Reserve requirements currently being investigated in the Comprehensive Reserve Determination study.

Doring

The Doring sub-area forms part of the southern and eastern boundaries of the WMA. The Doring River rises in the E22 catchments. It meets with the Olifants River (E23F-H) below the Bulshoek Weir. This sub-area incorporates the Doring River, the Tankwa River and the Oorlogskloof River catchments. The MAP in this sub-area varies from 199 mm in the E23 catchments to 256 mm in the E40 catchments. In the E22 catchment, an inter-basin water transfer of 2.5 million m^3/a takes place from the catchment of Lakenvallei Dam in the Breede WMA, via the Inverdoorn canal, into the Upper Doring River catchment for irrigation purposes. The Doring River is the only unimpounded river in the region and it supports nine species of indigenous fish, seven of which are endemic, illustrative of the ecological diversity. Groundwater baseflow into the rivers is ecologically important to species which over-summer in pools in the river bed.

There is uncertainty regarding the groundwater usage in the area. Much of the groundwater is of very poor quality and, given the relatively low yield estimates, would be capital intensive to develop for any large-scale supply. However, for small-scale supply some parts of the sub-area are reliant on groundwater and it is believed that further exploitation potential exists. The towns of Calvinia and Nieuwoudtville are reliant on groundwater. The sub-area has a deficit of 1 million m^3/a.

There is a demand for increased agriculture aimed at poverty alleviation. Investigations of potential dams in the region (Aspoort, Melkbosrug and Melkboom) have been undertaken and it was determined that there is potential for irrigation developments on a relatively large scale. It was however indicated that considerably more work was needed to verify the assumptions used and allay environmental concerns regarding the potential dam sites and impact on the river system. A development cap was put in place to ensure that *ad hoc* development did not preclude the development of any of these schemes.

Knersvlakte

The Knersvlakte sub-area forms the northern part of the eastern boundary of the WMA. It comprises the Hantams, the Kromme and the Goerap catchments, as well as the Sout River tributary of the Lower Olifants River. The sub-area extends from the escarpment range (Lower Orange WMA boundary) to the coastline. Rainfall is low and there is limited surface water and groundwater recharge. The sub-area is dependent on groundwater mainly from primary aquifers, fractured rock aquifers, and dolerite dykes. The key uses are stock watering and domestic use. Limited irrigation is undertaken; it does however comprise 43% of the total water use. Namakwa Sands Mine is on the coast and water is transferred from the Lower Olifants to supply the mine. The towns of Bitterfontein, Nuwerus and Loeriesfontein rely on groundwater supply. The sub-area has a surplus of 1 million m^3/a. Water requirements are not anticipated to expand significantly.

Lower Olifants

The Lower Olifants is the area of the Olifants River below Clanwilliam Dam and includes the Bulshoek Weir, the confluence with the Doring River (E33F-H) and estuary. The estuary is important and freshwater requirements for the estuarine Reserve are being determined in a Comprehensive Reserve Determination Study, currently underway. At 144 mm, this catchment has the lowest average MAP in this WMA. The catchment receives a large transfer from the Upper Olifants but a deficit of 29 million m^3/a still exists. Irrigated agriculture is the largest water user with estimated requirements of about 140 million m^3/a (i.e. about 95% of the total requirements in the catchment). The groundwater usage is predominantly in the primary aquifer along the coast, with some further use from the deeper aquifers. Irrigation occurs mainly from the water conveyed from Bulshoek Weir, by means of a 186 km canal.

The water available for use is constrained by the physical limitations of the canal and water conservation and demand management initiatives, such as the upgrading of the canal to reduce losses, must be investigated. Water is transferred out of the sub-area to serve the Namakwa-Sands mine (2.4 million m^3/a). There is a requirement for a better assurance of supply for agriculture and for growth. There is pressure to allocate additional water to resource-poor farmers in this area. The Lower Olifants River WUA is engaged in facilitating water trading to ensure that provision is made for poverty alleviation. The sub-area is stressed and no further abstraction licences should be issued.

Sandveld

The Sandveld is bounded on the west by the Atlantic coastline, on the east by the Olifants Mountain Range, and on the south by the Berg WMA. It has several small rivers which flow towards the sea. The most notable of these are the Verlorevlei River (G30F) and the Langvlei River (G30G). Apart from fishing and eco-tourism around the coastal resort towns, potato farming primarily under centre-pivots, is the economic mainstay of the G30 coastal plain. The catchment is stressed, with an estimated deficit of 6 million m^3/a. Activities are predominantly dependent on groundwater. Rapid agricultural development has already lead to over-exploitation of the groundwater resource. Based on the yield balance estimates, no further growth in the agricultural sector can be supported from the currently developed resource. Individual users undertake groundwater usage and groundwater resources are threatened by declining water levels and seawater intrusion, due to poorly co-ordinated aquifer management. There are no major dams in the sub-area. Invasive alien plant control is an important catchment management activity as the impact is approximately 3 million m^3/a on the yield of this stressed catchment.

Introduction to the ISP Strategies

The many issues and concerns identified in the WMA will be addressed through the implementation of appropriate regional water management strategies (of which many are existing). DWAF staff has identified the essential management strategies to manage the Olifants/Doorn WMA. Additional required strategies may be developed in future.

Nine broad strategy groups, that cover all necessary current and required future water management activities - were identified from current DWAF Regional Office activities, and the requirements of the NWA and the NWRS. These are:

- Yield balance and reconciliation;
- Water resources protection;
- Water use management;
- Water conservation and demand management;
- Institutional development and co-operative governance;
- Social and environmental;
- Waterworks development and management;
- Monitoring and information management; and
- Implementation.

Under each of these strategy groups, specific strategies particular to the Olifants/Doorn WMA were developed.

For each strategy, the following aspects are addressed:

- ***Management objective*** in terms of the envisaged solutions for the strategy;
- ***Situation analysis;*** providing a synopsis of the current situation with a focus on the issues;
- ***Strategy;*** stating the approach or plan that DWAF will follow to reach its objectives for the strategy;
- ***Management actions;*** states the required actions to implement the strategy;
- ***Responsibility;*** the responsible offices or Directorates are named;
- ***Priority;*** very high to low priority rating assigned.

Responsibilities for strategies were assigned to responsible DWAF Directorates or Sections within the Western Cape Regional Office. DWAF head office champions were identified where appropriate.

DEPARTMENT OF WATER AFFAIRS AND FORESTRY
Directorate National Water Resource Planning

OLIFANTS/DOORN INTERNAL STRATEGIC PERSPECTIVE
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APPENDICES

ABBREVIATIONS AND ACRONYMS

AFS	Administrative Filing System
AIDS	Acquired immunity deficiency syndrome
CAGE	Citrusdal Artesian Groundwater Exploration
CAPE	Cape Action Plan for People and the Environment
CCAW	Co-ordinating Committee for Agricultural Water
CCT	City of Cape Town
CEIMP	Consolidated Environmental Implementation and Management Plan
CMA	Catchment management agency
CMS	Catchment management strategy
CSDB	Corporate Spatial Database
DEADP	Department of Environmental Affairs and Development Planning
DEAT	National Department of Environmental Affairs and Tourism
DLA	Department of Land Affairs
DOA	Department of Agriculture
DWAF	National Department of Water Affairs and Forestry
EC	Electrical conductivity
ECA	Environmental Conservation Act
EIA	Environmental impact assessment
EMF	Environmental management framework
EPP	Emergency preparedness plans
EURO CAP	European Common Agricultural Policy
EU	European Union
EWR	Ecological water requirements
GA	General authorisation
GIS	Geographical information system
GWS	Government water scheme
HDI	Historically Disadvantaged Individual
IAC	Irrigation Action Committee
IAP	Invasive alien plants
IDP	Integrated development plan
ISP	Internal strategic perspective
IRF	Irrigation return flows
IWRM	Integrated water resources management
IWRP	Integrated Water Resource Planning
MAP	Mean annual precipitation
MAR	Mean annual run-off
MIG	Municipal Infrastructure Grant
MSL	Mean sea level
PESC	Present Ecological Status Class
NEMA	National Environmental Management Act
NGO	Non-Governmental Organisation
NMC	Namaqualand Metamorphic Complex
NWA	National Water Act
NWRS	National Water Resource Strategy
ORGWS	Olifants River Government Water Scheme
POLMON	Pollution Monitoring Information System
RAMSAR	Conservation areas classified in terms in of this convention on "wetlands"
RO	Regional office (DWAF)
RDM	Resource directed measures
RPF	Resource-poor Farmers
RQO	Resource quality objectives
SAWS	South African Weather Service

SDM	Source directed measures
SFRA	Stream flow reduction activity
SKEP	Succulent Karoo Ecosystem Plan
SWDS	Solid waste disposal site
TDS	Total dissolved solids
TMG	Table Mountain Group
TSS	Total suspended solids
WARMS	Water use authorisation and registration management system
WC&DM	Water conservation and demand management
WCNCB	Western Cape Nature Conservation Board
WfW	Working-for-Water
WfWetlands	Working for Wetlands
WMA	Water Management Area
WMS	Water management system
WODRIS	Western Cape Provincial Government Olifants Doring River Irrigation Study
WQM	Water quality management
WRSA	Water resources situation assessment
WSA	Water Service Authority
WSDP	Water service development plan
WSP	Water service provider
WTW	Water treatment works
WUA	Water user association
WWTW	Wastewater treatment works

GLOSSARY OF TERMS

AQUICLUDE	An impermeable geological unit that cannot transmit water at all. Very few natural geological materials are considered to be aquicludes.
AQUIFER	A saturated permeable geological unit that can transmit significant (economically useful) quantities of water under ordinary hydraulic gradients. Specific geologic materials are not innately defined as aquifers and aquitards, but within the context of the stratigraphic sequence in the sub-surface area of interest.
AQUITARD	A saturated geological unit of relatively lower permeability within a stratigraphic sequence relative to the aquifer of interest. Its permeability is not sufficient to justify production wells being placed in it. This terminology is used much more frequently in practice than aquiclude, in recognition of the rarity of natural aquicludes.
ASSURANCE OF SUPPLY	The reliability at which a specified quantity of water can be provided, usually expressed either as a percentage or as a risk. For example "98% reliability" means that, over a long period of time, the specified quantity of water can be supplied for 98% of the time, and less for the remaining 2%. Alternatively, this situation may be described as a "1 in 50 year risk of failure" meaning that, on average, the specified quantity of water will fail to be provided in 1 year in 50 years, or 2% of the time.
BASIN	The area of land that is drained by a large river, or river system.
CONDENSED AREA	The equivalent area of alien plants with a maximum concentration/density that represents the more sparsely distributed alien plants that occur over a large area.
CATCHMENT	The area of land drained by a river. The term can be applied to a stream, a tributary of a larger river or a whole river system.
CONFINED AQUIFER	An aquifer that is physically located between two aquicludes, where the piezometric water level is above the upper boundary of the aquifer. The water level in a well tapping a confined aquifer usually rises above the level of the aquifer. If the water rises above ground level, the aquifer is called artesian.
DEFICIT	Describes the situation where the availability of water at a particular assurance of supply is less than the unrestricted water requirement.
DISCHARGE AREA	The area or zone where groundwater emerges from the aquifer. Natural outflow may be into a stream, lake, spring, wetland, etc. Artificial outflow may occur via pump wells.
ECOSYSTEM	A unit made up of all the living and non-living components of a particular area that interact and exchange materials with each other.
ENDOREIC	An area which is inwardly draining.
ENVIRONMENTALLY SENSITIVE AREA	A fragile ecosystem, which will be maintained only by conscious attempts to protect it.
GROUNDWATER	Water in the subsurface, which is beneath the water table, and thus present within the saturated zone. In contrast, to water present in the unsaturated or vadose zone which is referred to as soil moisture.

GROUNDWATER YIELD POTENTIAL	The maximum amount of groundwater that can be continuously withdrawn without creating critically low water levels exceeding recharge.
HYDROTECT	More correctly known as a *'hydraulically conductive tectonic structure/s'* are regionally significant faults, master joints or fractures along which deep artesian groundwater flow is channeled.
IRRIGATION QUOTA	The quantity of water, usually expressed as m^3/ha/a, or mm/a, allocated to land scheduled under the scheme. This is the quantity to which the owner of the land is entitled at the point at which he or she takes delivery of the water and does not include conveyance losses to that point.
MEAN ANNUAL PRECIPITATION	Frequently abbreviated to MAP, this is the long-term mean annual precipitation a specified period of time, at a particular point along a river and for a particular catchment and catchment development condition.
MEAN ANNUAL RUNOFF	Frequently abbreviated to MAR, this is the long-term mean annual flow calculated for a specified period of time, at a particular point along a river and for a particular catchment and catchment development condition.
OPPORTUNISTIC IRRIGATION	Irrigation from run-of-river flow, farm dams, or compensation flows released from major dams. As storage is not provided to compensate for reduced water availability in dry years, the areas irrigated generally have to be reduced in dry years.
POROSITY	The degree to which the total volume of soil or rock is permeated with spaces or cavities through which water or air can move.
PRIMARY AQUIFER	Aquifers in which the water moves through the spaces that were formed at the same time as when the geological formation was formed, for instance intergranular porosity in sand (for example alluvial deposits).
RECHARGE AREAS	Areas of land that allow groundwater to be replenished through infiltration or seepage from precipitation or surface runoff.
RELIABILITY OF SUPPLY	Synonymous with assurance of supply.
RESERVE	The quantity and quality of water required (a) to satisfy basic human needs by securing a basic water supply, as prescribed under the Water Services Act, 1997 (Act No. 108 of 1997) for people, who are now or who will, in the reasonably near future, be (i) relying upon; (ii) taking water from; or (iii) being supplied from, the relevant water resource; and (b) to protect aquatic ecosystems in order to secure ecologically sustainable development and use of the relevant water resource as indicated in the National Water Act (Act No. 36 of 1998).
RESOURCE DIRECTED MEASURES	Measures that focus on the quality and overall health of water resources.
RESERVOIR	The lake formed behind a dam wall. In this report the colloquial term dam is generally used for reservoir.
RESOURCE QUALITY	The quality of all the aspects of a water resource including: (a) the quantity, pattern, timing, water level and assurance of instream flow; (b) the water quality, including the physical, chemical and biological characteristics of the water; (c) the character and condition of the instream and riparian habitat; and (d) the characteristics, condition and distribution of the aquatic biota.

RESOURCE QUALITY OBJECTIVE	Quantitative and verifiable statements about water quantity, water quality, habitat integrity and biotic integrity that specify the requirements (goals) needed to ensure a particular level of resource protection.
RIVER SYSTEM	A network of rivers ranging from streams to major rivers and, in some cases, including rivers draining naturally separate basins that have been inter-connected by man-made transfer schemes.
SALINITY	The concentration of dissolved salts in water. The most desirable drinking water contains 500 parts per million or less of dissolved minerals.
SATURATED ZONE	The subsurface zone below the water table where pores within the geologic matrix are filled with water and fluid pressure is greater than atmospheric. Aquifers are located in this zone.
SECONDARY AQUIFER	Aquifers in which the water moves through spaces that were formed after the geological formation was formed, such as fractures in hard rock.
SOURCE DIRECTED CONTROL	Measures primarily designed to control water use activities at the source of impact, through tools such as standards, and conditions in water use authorisations.
SUB-AREA	The sub-divisions used as management regions for this document.
SUBPROVINCE	A geological term defining an area which has common geological characteristics
SURPLUS	Describes the situation where the availability of water at a particular assurance of supply is more than the unrestricted water requirement.
UNCONFINED AQUIFER	An aquifer, which is not restricted by any confining layer above it. Its upper boundary is the water table, which is free to rise and fall. The water level in a well tapping an unconfined aquifer is at atmospheric pressure and does not rise above the level of the water table within the aquifer. An unconfined aquifer is often near to the earth's surface and not protected by low permeable layers, causing it to be easily recharged as well as contaminated.
UNSATURATED ZONE	An area, usually between the land surface and the water table, where the openings or pores in the soil contain both air and water.
WATER TABLE	The top of an unconfined aquifer where water pressure is equal to atmospheric pressure. The water table depth fluctuates with climate conditions on the land surface above and is usually gently curved and follows a subdued version of the land surface topography.
WATER TRANSFERS	Water transferred from one drainage basin or secondary sub-catchment to another.
YIELD	The maximum quantity of water obtainable on a sustainable basis from a dam, river or aquifer in any hydrological year, in a sequence of years, and under specified conditions of catchment development and dam operation.

PREFACE

The Department of Water Affairs and Forestry (DWAF), as the custodian of the South Africa's water resources, wishes to make optimal use of these resources in promoting economic growth and wealth for all its citizens. On the other hand, armed with the National Water Act (NWA) and other legislation, it has the difficult responsibility of ensuring that such water utilisation is sustainable, and especially ensuring the sustainability of our natural environment. The following document presents DWAF's strategic perspective on how it wishes to protect, allocate use, develop, conserve, manage and control the water resources within the Olifants/Doorn Water Management Area (WMA) until the regional responsible authority (to be known as the Catchment Management Agency or CMA) has been established and is in a position to take over most or all of these functions.

In keeping with sound business practice, the Regional Office of the Department, assisted by the Directorate: National Water Resource Planning together with the other relevant DWAF Head Office Directorates, has focused on the following in preparing this document:

- Understanding what their core business is in conducting their interim water resource management functions (these must be in line with DWAF's Vision, Mission, Policy Objectives, the NWA, the recently drafted National Water Resource Strategy, and all NWA implementation processes);

- Clear management objectives and the setting of desired deliverables;

- Obtaining a thorough understanding of the natural, social, economic, political and other environments in the Berg WMA in which they have to perform their strategically important responsibilities. This is crucial to ensuring that the service they deliver optimises benefits for all water users by integrating all planning, implementation and management activities;

- A clear understanding of the water resources availability and how it is intended that this water be used. Reconciliation of water requirements and availability, as well as optimisation of river and water system operations, in the best interest of the country and the regional economy, is fundamental to the success of this management role.

- Providing a concise overview of the way in which DWAF will manage the business at hand. This includes strategies and actions regarding all aspects of water resources management in the WMA. Where no clear policy or approach exists, a strategy to obtain better decision support information is proposed.

- Business infrastructure and human resources that need to be assigned to each task or function. Prioritisation of these tasks and functions, including work scheduling.

The structure of this Internal (to DWAF) Strategic Perspective (ISP), or interim management strategy, has been prepared in such a way that the reader is provided with the necessary background along with the management approach to be adopted by the Department. This includes motivations as to how these approaches are intended to benefit all by ensuring equity of access to water, sustainability in maintaining the balance of utilisation by natural ecosystems and water users, and efficient and effective water use.

CHAPTER 1
BACKGROUND TO THE OLIFANTS/DOORN INTERNAL STRATEGIC PERSPECTIVE

1.1 LOCATION OF THE OLIFANTS/DOORN WATER MANAGEMENT AREA (WMA)

Figure 1.1 shows the location of the OLIFANTS/DOORN WMA, which falls within the Western Cape and Northern Cape Provinces.

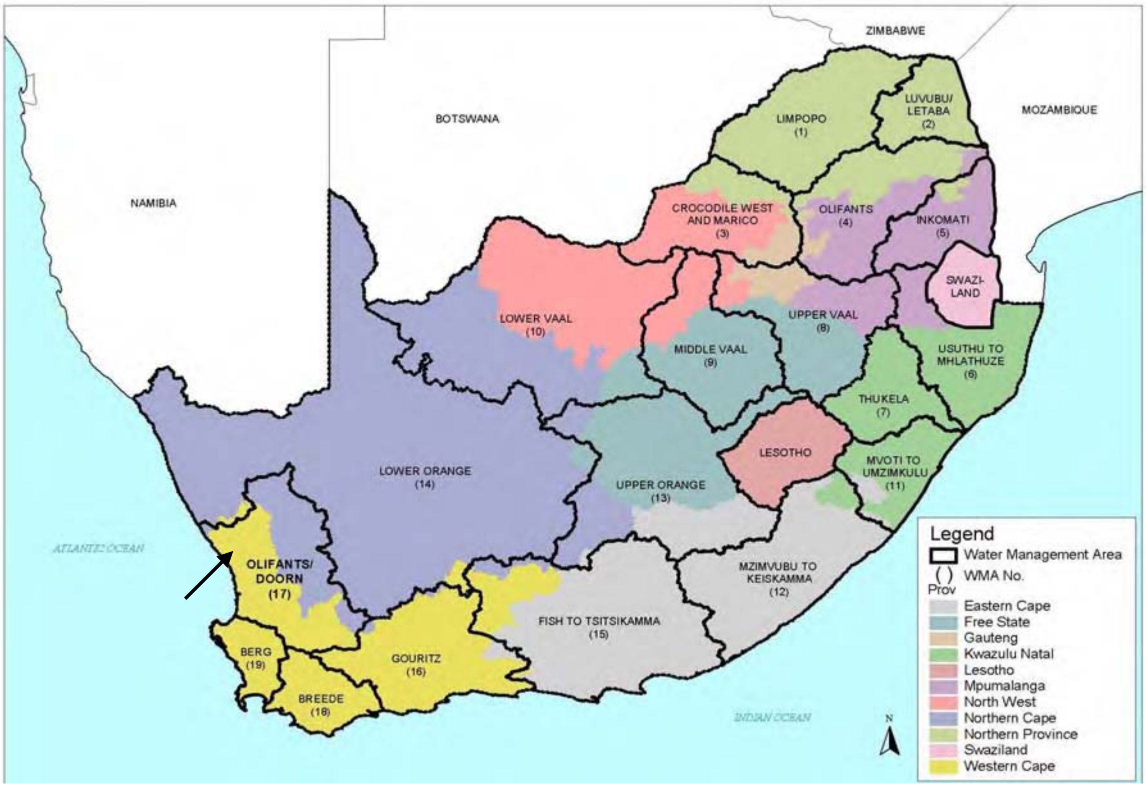


Figure 1.1: Location of the Olifants/Doorn Water Management Area

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 - geographically, seasonally, and socio-politically.

Prosperity for South Africa depends upon sound management and utilisation of our 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 and interacts with the NWA includes the Water Services Act (Act 108 of 1997) and the National Environmental Management Act (Act 107 of 1998).

1.2.2 The National Water Resource Strategy (NWRS)

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

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

1.2.3 Catchment Management Strategies (CMS)

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

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

1.3 INTERNAL STRATEGIC PERSPECTIVES (ISPs)

1.3.1 The Objectives of the ISP Process

The objective of this ISP is 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 it's management functions to an 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 need to be made aware of the bigger picture, as well as the management detail associated with each specific water resource management unit.

1.3.2 Approach Adopted in Developing the ISP

The ISP for the Olifants/Doorn 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 Olifants/Doorn WMA. This was achieved through interviews with individual members of DWAF's Regional Office in Bellville and by collating information from the NWRS, WMA reports, Water Resource Situation Assessment (WRSA) reports and other catchment study reports. The following topics were discussed with Regional Office staff, and their issues and concerns documented:
   - Water Situation;
   - Resource Protection;
   - Water Use;
   - Water Reconciliation;
   - Water Infrastructure;
   - Monitoring and Information;
   - Water Management Institutions;
   - Co-operative Governance;
   - Planning Responsibilities.

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

ii) The first workshop was held with attendees from the Regional Office, the Integrated Water Resource Planning (IWRP) Chief Directorate of the Department as well as the consulting team. The workshop focused 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. Attendees of the first workshop were again involved, as were representatives of several DWAF Head Office directorates.

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

As can be deduced from the above this 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. Adopting this procedure means that this ISP remains 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 the ISP Implementation Strategy, **Strategy No 14**).

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. Relevant and readily available details have however been included where possible. The responsible authority for the further development of each strategy is indicated. For the most part this is the Regional Office, which remains responsible for involving the relevant DWAF directorates.

References for this ISP can be found in **Appendix 1**.

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. The introduction of new strategies also 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 liaising 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

Changes to this ISP will depend on need, and will be managed by DWAF until the CMA is in place to develop its own catchment management strategy. Revisions may be required as frequently as annually, or only once in five years, with frequency based on the degree to which conditions change and knowledge advances. New information affecting this ISP, and the need for new additional strategies must be brought to the attention of the Catchment Manager responsible for this ISP. The current incumbent is **Mr Abdulla Parker** who has been delegated the task of managing version control. His forwarding address is:

Mr Abdulla Parker
Department of Water Affairs and Forestry
Private Bag X16
SANLAMHOF
7532

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 NWRS contains the best information and knowledge available at the time of its preparation. The information in **Chapter 2** and **Appendix D** of the NWRS Strategy on water requirements, availability and reconciliation was updated with comments received from the public participation process in the second half of 2002. To enable the finalisation of the NWRS, these figures were “closed” for changes in February 2003.

Underlying the figures in **Chapter 2** and **Appendix D** of the NWRS 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). These are the 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 superseded 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, in some cases, emerged. The level of study has been very detailed and intense for the ISP. This has 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 differing from that in the NWRS, these discrepancies are carefully explained, as are all other instances of divergence. 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 with the ISP reports published on the Internet and in hardcopy, and presented and discussed at WMA forums. Comments received will be considered and worked into subsequent versions of the ISP on a regular (annual) 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 resource 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 in poverty eradication and the redressing of inequities.

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

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

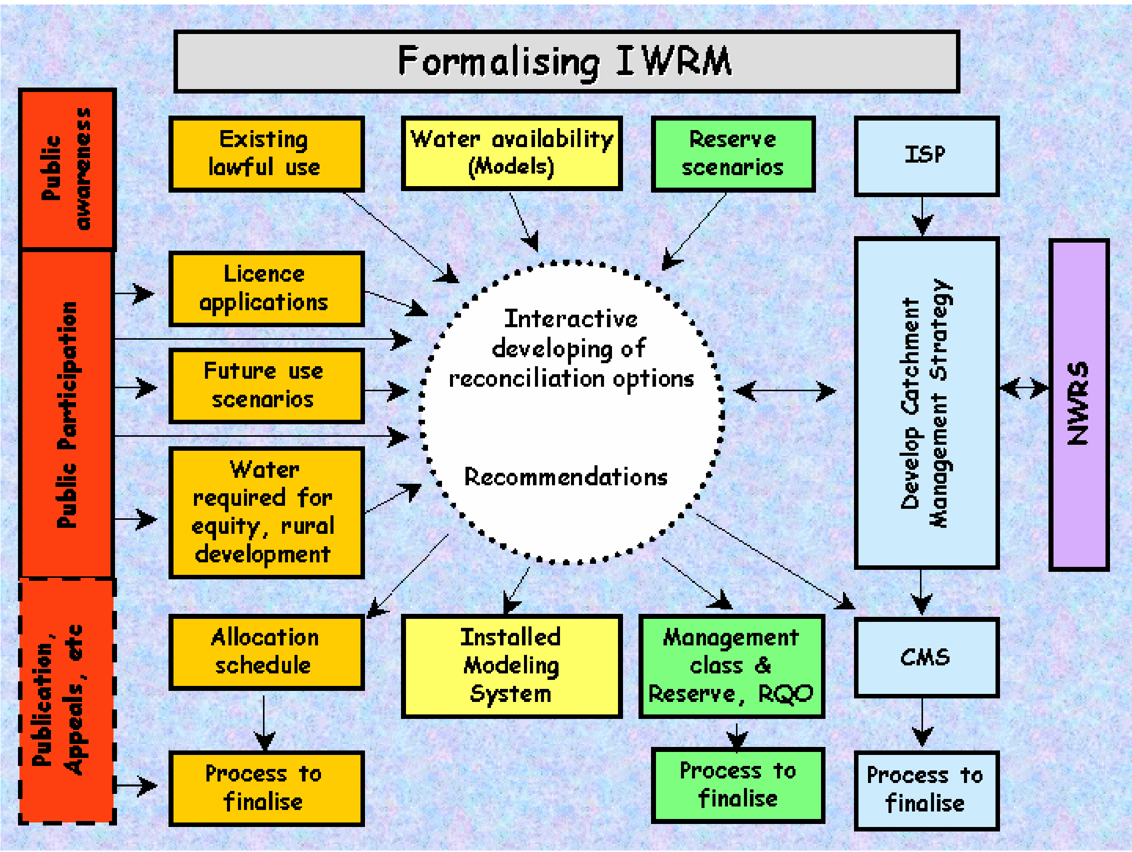


Figure 1.2: Diagram showing DWAF's Integrated Water Resources Management approach

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 respective classes that may be considered.

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

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

The active participation of stakeholders in this process will then hopefully crystallise clear recommendations on the management classes for the various reaches of the rivers, and the resultant ecological Reserve and Resource Quality Objectives and allocation schedule, as well as strategies for 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 Governing 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 management and control of water resource development 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 impede flow in water courses, and activities that affect the flow of water (environmental constraints to construction e.g. of weirs or dams);
- The implications of allocating and licencing 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 approval and control of discharges of water containing waste;
- 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 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 (IAPs);
- The management of wetlands;
- Land degradation. Erosion and sedimentation (land care);
- Land use and especially how this is impacted on 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 (WMAs) and associated ISPs, and is not repeated within the Strategy Tables. It reflects the way the Department views Integrated Water Resource Management (IWRM) 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 abovementioned 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. 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, Licencing 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 (NWA). This ISP has been prepared as DWAF’s position statement with respect to the management of water resources and, although strategies and plans have been captured without consultation with the stakeholders, it remains an open and transparent document where the understanding of the Department, its visions and its principles are made clear for all to see and to interact with. This is amplified in the Implementation Strategy (**Strategy No. 14**) 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 become 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. 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 Weir to bring water back to an acceptable quality has, *inter alia*, long been standard practice. The consequences of irrigation, the leaching of fertilisers, and 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. Should these limits be exceeded, as may happen through the cumulative impact of diffuse discharges, water may become unusable to some, or even all, users downstream. DWAF licences users to take water, and again to discharge it, in recognition that the discharge of poor quality water is a cost to the resource in terms of its further use, and in terms of this bringing about 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. This will put pressure on users and help to bring about a better quality of water in the rivers.

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, a consequence of unacceptable management practices and overloaded systems, 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 (50-100 m 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. The correct design of these sanitation systems is therefore of the utmost importance.

Water quality is a very important aspect of strategy within this ISP – considered primarily within the Water Quality Strategy and also under Groundwater. Industrial sewage discharge, diffuse agricultural discharges, sewage 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 cross-cutting 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.

1.8 GROUNDWATER

The ISP process in all of the Water Management Areas (WMAs) 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 from surface resources. This can also reduce the pressure on existing users and perhaps even circumvent the need for compulsory licensing. The Department is developing its capacity to explore and encourage the use of groundwater where appropriate.

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 the case of endoreic areas there is no interaction at all. Where interactions are weak, groundwater can very significantly add to the availability of water to users, much in the way the construction of a dam would do, but without all the negative impacts which a dam can have on the environment and on flow in rivers. Groundwater often comprises a huge pool of available water which is only of benefit if it is utilised. Care must always be taken with the issuing of licenses to ensure that both the Groundwater Reserve and other downstream users do not end up being the losers.

The realisation in this and other ISPs is that groundwater offers a huge resource of water which can be tapped, and that this can be a very significant supplement to the national water resource. See the **Groundwater Strategy No 6.2**.

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 possible release of water to allow for canoeing and other water sports downstream (the Berg, Dusi and Fish River canoe marathons being prime examples). These activities can bring very significant economic benefits to the WMAs concerned, and where water releases can be accommodated, particularly through alignment with the needs of the ecological Reserve or other downstream users, then so much the better.

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

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

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 Strategy (CMS). 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 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

OVERVIEW OF THE OLIFANTS/DOORN WMA

The Olifants/Doorn WMA derives its name from the main river draining it, namely the Olifants River. The word "Doorn", an archaic form of Doring, was added to the WMA name to distinguish it from the many other "Olifants" rivers in the country as the Olifants River's main tributary, in this catchment, is the Doring River. The WMA is bounded in the west by the Atlantic Ocean, and its eastern boundary lies along the Great Escarpment divide between the Great Karoo and the western branch of the Cape Fold Belt. The major water user of the area is irrigated agriculture, which sustains the economy of the area and provides most of the employment opportunities. Parts of the WMA have high conservation value, including some of the river reaches and the Olifants River estuary.

This chapter provides an overview of the WMA. **Chapter 3** provides more detailed information on each of the six sub-areas into which the WMA has been divided and **Chapter 4** provides an overview of its water resources.

2.1 LOCALITY AND PHYSICAL FEATURES

2.1.1 Locality and Development

The Olifants/Doorn WMA is located on the west coast of South Africa, extending from about 100 km to 450 km north of Cape Town. The south-western portion mainly falls within the Western Cape Province, and the north-eastern portion falls within the Northern Cape Province. Refer to **Figure 2.1** for the location and general layout of the WMA.

The major river in the WMA is the Olifants River, of which the Doring River (draining the Koue Bokkeveld and Doring area) and the Sout River (draining the Knersvlakte) are the main tributaries. The WMA incorporates the E primary drainage region and components of the F and G drainage regions along the coastal plain, respectively north and south of the Olifants River estuary, covering a total area of 56 446 km^2. The Olifants and Doring Rivers flow strongly during the winter months whilst flows only occur very occasionally in the Sout River. There are also a number of smaller coastal rivers and water courses which flow infrequently.

2.1.2 ISP Sub-areas

The WMA comprises 88 quaternary catchments and has been divided into six sub-areas[2] or "management units", corresponding to the current divisions used in surface water resource management by the Regional Office of the DWAF. Refer to **Figure 2.2** for the ISP sub-areas.

[2] The Olifants Doorn WMA was divided into only five sub-areas in the National Water Resource Strategy (NWRS). The Olifants River sub-area as defined in NWRS has been spilt into two for the purpose of this ISP (Upper Olifants and Lower Olifants). It was recognised that the two sections of the river have distinctly different water resource management characteristics.

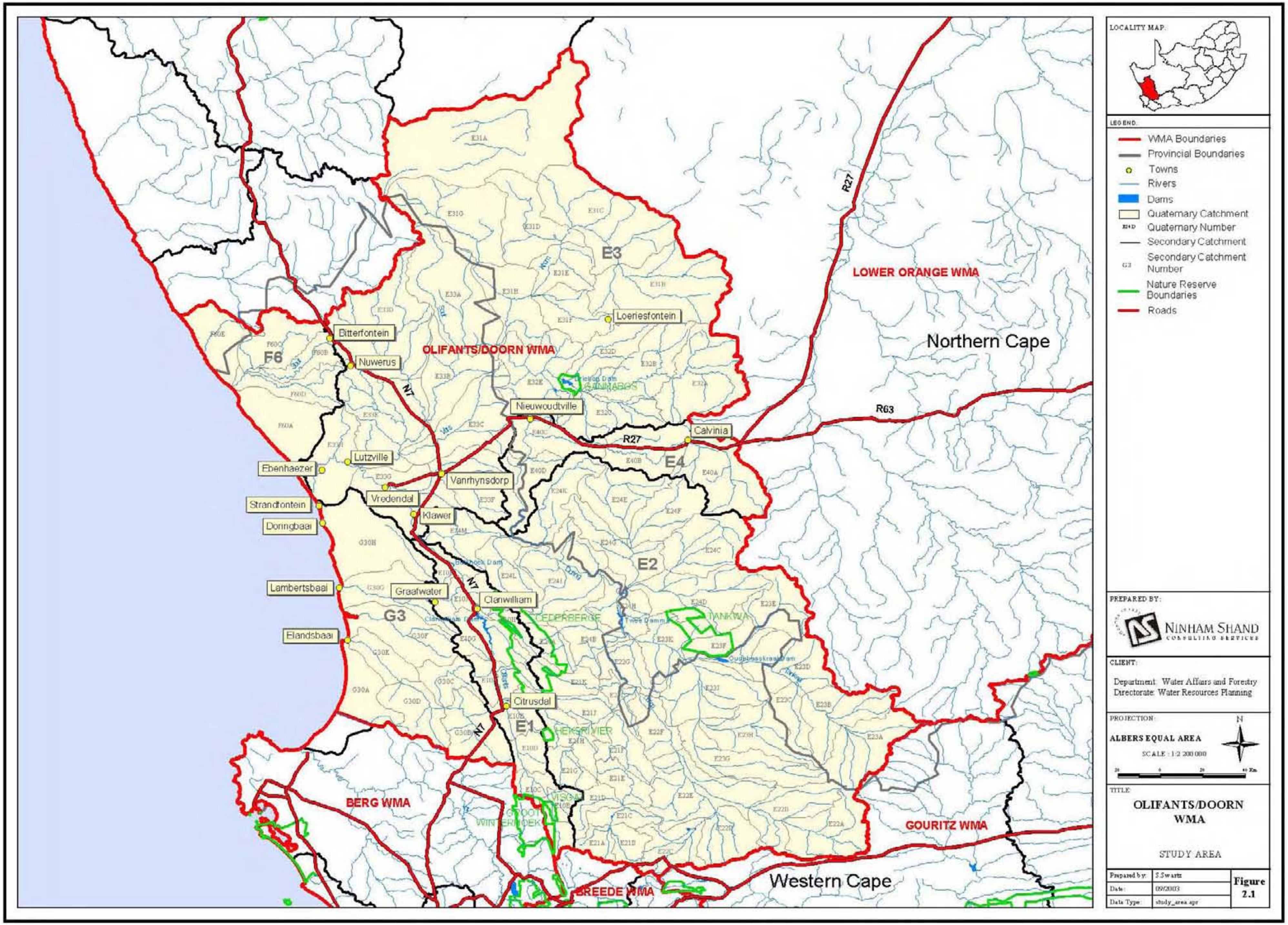


Figure 2.1: Map of the Olifants/Doorn Water Management Area

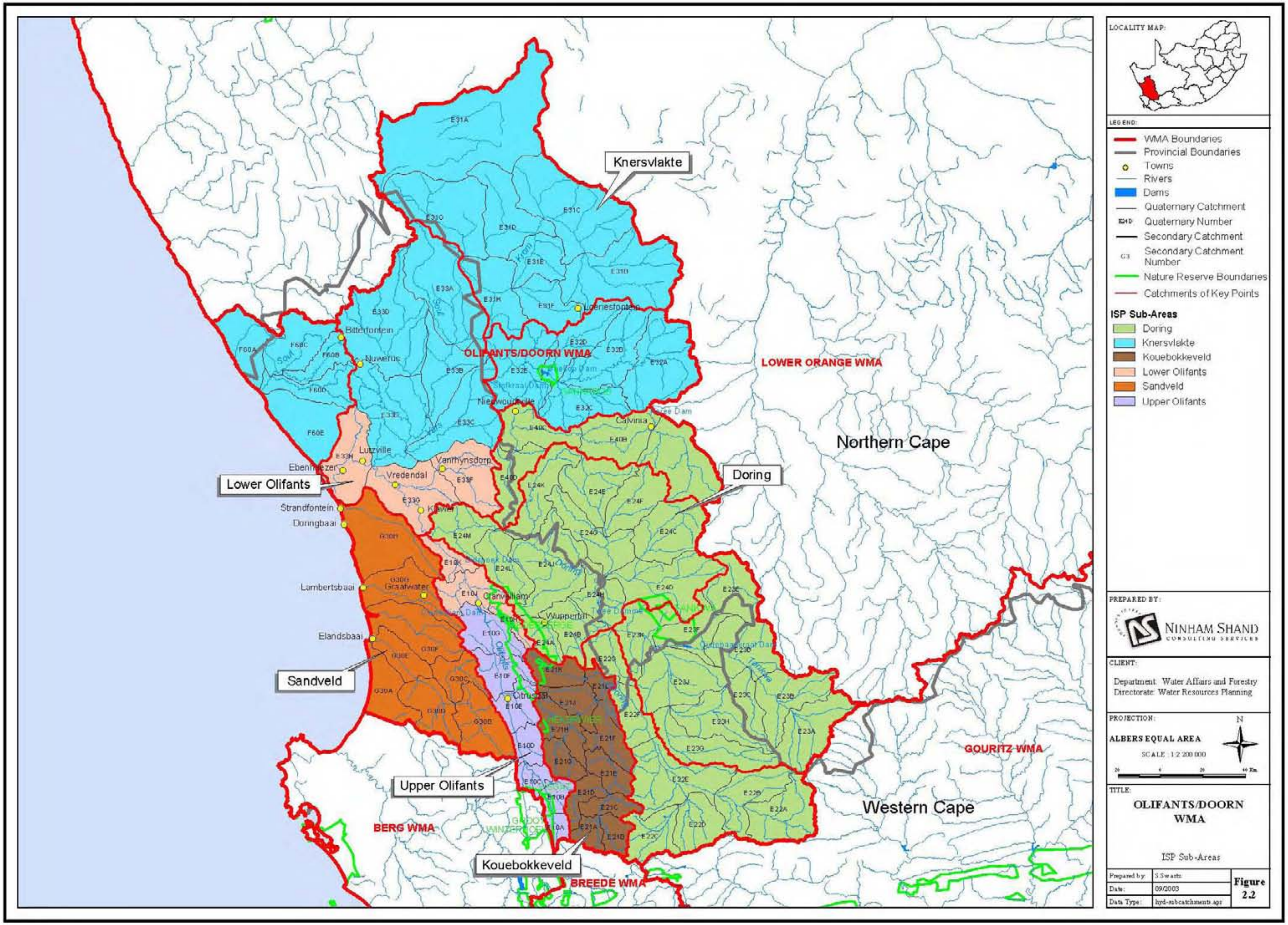


Figure 2.2: Map of the Olifants/Doorn ISP Sub-areas

These sub-areas are as follows:

- The *Upper Olifants* sub-area consisting of seven quaternary catchments (E10A-G), extending from the source of the Olifants River to the Clanwilliam Dam;
- The *Koue Bokkeveld* sub-area consisting of 11 quaternary catchments (E21A-L) draining in a northerly direction from the catchment divide between this WMA and the Breede WMA;
- The *Doring* sub-area consisting of 32 quaternary catchments (E22A-G, E23A-K, E24A-M, E40A-D) draining the south-eastern and central region of the WMA to the confluence with the Olifants River;
- The *Knersvlakte* sub-area consisting of 24 quaternary catchments (E31A-H, E32A-E, E33A-F, F60A-E) and draining the northern region of the WMA;
- The *Lower Olifants* sub-area consisting of six quaternary catchments (E10H, J, K, E33F-H,) downstream of Clanwilliam Dam;
- The *Sandveld* sub-area consisting of 8 quaternary catchments (G30A-H) within the coastal strip to the south of the Olifants River mouth.

2.1.3 Climate and rainfall

Climatic conditions vary considerably as a result of the variation in topography. Minimum temperatures in July range from –3ºC to 3ºC and maximum temperatures in January range from 39ºC to 44ºC.

The area lies within the winter rainfall region, with the majority of rain occurring between May and September each year. The mean annual precipitation is up to 1 500 mm in the Cederberg mountains in the south-west, but decreases sharply to about 200 mm to the north, east and west thereof, and to less than 100 mm in the far north of the WMA. Average gross mean annual evaporation (as measured by Symons pan), ranges from 1 500 mm in the south-west to more than 2 200 mm in the dry northern parts. Scenarios of climate-change over the next 50-100 years show this area may potentially receive up to 15% less rain in future (refer to **Figure 2.3)**.

2.1.4 Topography

The topography of the WMA is of three distinct types, namely rolling hills and sand dunes in the west along the coastal strip, rugged mountains with peaks rising to about 2 000 m above sea level in the southern area, and plains and rocky hills in the north-eastern area that are typical of the Western Karoo (**Figure 2.4**).

The Olifants River rises in the mountains in the south-east of the WMA and flows north-west. Its deep narrow valley widens and flattens downstream of Clanwilliam until the river flows through a wide floodplain downstream of Klawer. The Doring River is a fan shaped catchment. The main river rises in the south and flows in a northerly direction. It is first joined by the Groot River and then by the Tra-Tra flowing from the west and the Tankwa River from the east, before flowing in a westerly direction to its confluence with the Olifants River just upstream of Klawer.

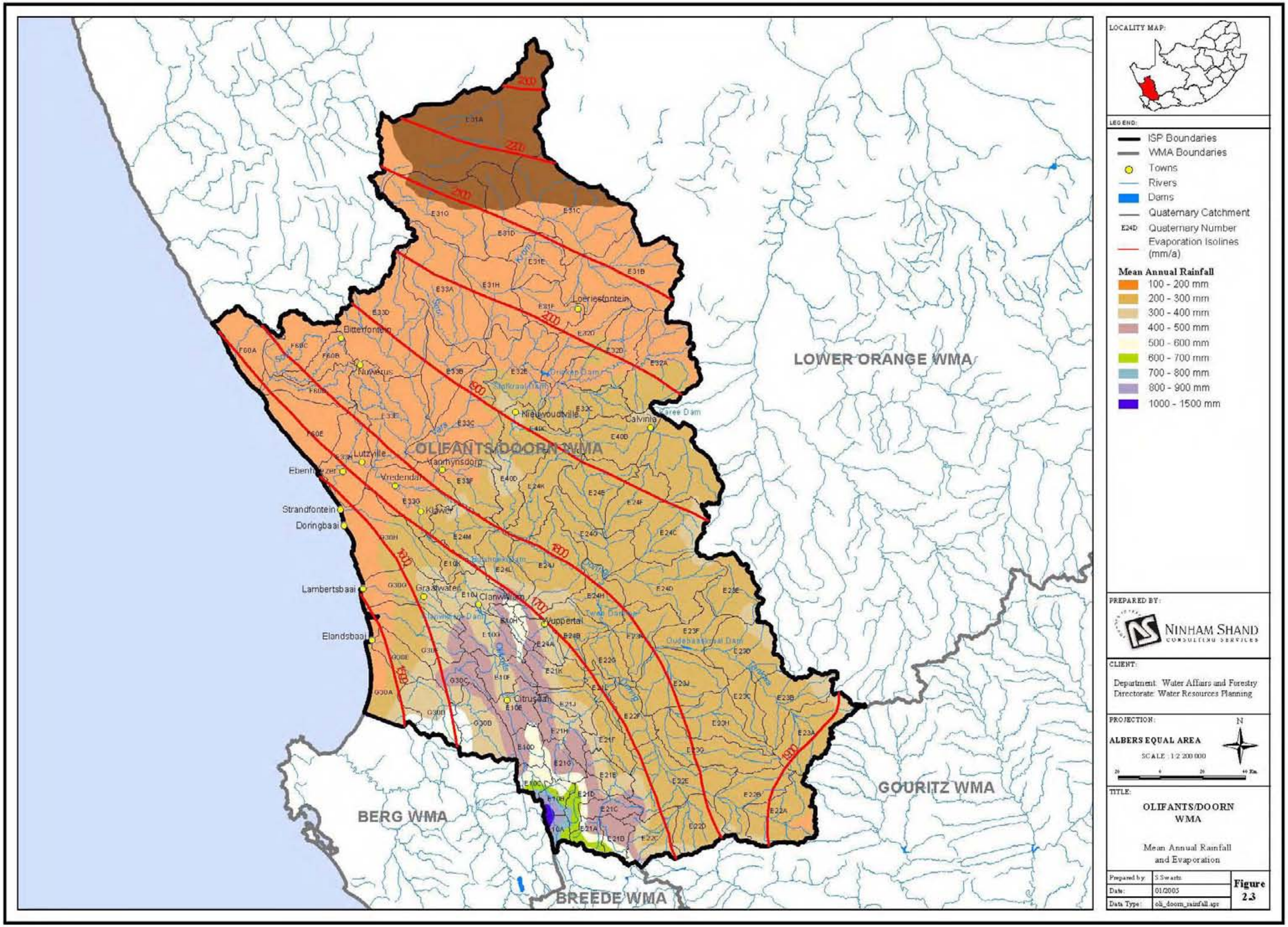


Figure 2.3: Rainfall and evaporation

The north of the WMA is flatter and much of the basin lies between 500 and 900 m above sea level. In the east there are significant mountain ranges, the Hantam near Calvinia and the Roggeveld to the south, which rise to about 1 500 m above sea level. West of Nieuwoudtville lies the Bokkeveld Mountains escarpment where the plateau elevation of about 700 m drops to about 300 m. The rolling hills and plains of the 30 to 40 km wide strip along the coast from the southern boundary of the WMA to the estuary of the Olifants River are known as the Sandveld. The deep sandy deposits overlaying the bedrock in this area are "primary" aquifers which provide a significant groundwater resource.

2.1.5 Geology

The geology of the area is dominated by sedimentary rocks of the Table Mountain Group (TMG) of the Cape Supergroup, which form the highest (almost north/south trending) mountain ranges. The rocks of the Karoo Supergroup outcrop occur largely in the eastern and northern areas of the catchment of the Doring River and comprise the valley floors of the Olifants River where it overlies the TMG. Sedimentary strata of the Vanrhynsdorp Group occur in the north, with exposures of pre-Cape metamorphic rock in the north-western and north-eastern corners of the area. The coastal plain is variably underlain by the metamorphosed shales of the Malmesbury Formation and the sandstone of the TMG. These are overlain by the more recent semi to unconsolidated sediments of alluvial, wind-blown (Sandveld Group), and marine origin as well as calcrete and ferricrete deposits.

Table 2.1: Geology and Hydrogeology of the Olifants/Doorn WMA

Hydrogeological Province (Sub-province)	ISP sub-areas	Geology/Hydrogeology	Aquifers
Adamastor			
Cederberg	Sandveld Upper Olifants W Koue Bokkeveld (E21G, H, J, K) W Lower Doring (E24A, J, L, M, lower part of E24K) Lower Oorlogskloof (E40D)	- Tertiary-Quaternary alluvials - Sandveld Group - (Bokkeveld Group) - Table Mountain Group (TMG) - Klipheuwel Group - Cape Granite Suite - Malmesbury Group	Tertiary-Quaternary alluvials Sandveld Group Skurweberg Aquifer Peninsula Aquifer
Knersvlakte	Lower Olifants/Sout Goerap	- Sandveld Group - (upper TMG) - Nama Group - Gariep Group - Namaqua Metamorphic Complex (NMC)	Sandveld Group Nama quartzites and limestones
Western Karoo			
Tankwa Karoo	Upper Doring E Koue Bokkeveld (E21A-F, L) Tankwa E Lower Doring (E24B-H, upper part of E24K)	- Tertiary-Quaternary alluvials - Lower Beaufort Group - Ecca Group - Dwyka Formation - Witteberg Group (in S) - Bokkeveld Group - (upper TMG)	Tertiary-Quaternary alluvials Witpoort Aquifer Bokkeveld sandstones
Hantam	Upper Oorlogskloof (E40A-C) Hantams Kromme	- Tertiary-Quaternary alluvials - Karoo dolerites - Ecca Group - Dwyka Formation - (upper TMG) - (Nama Group) - (NMC)	Alluvials in Calvinia Karoo dyke and sill structures, in conjunction with sandstone members in otherwise generally shaly units

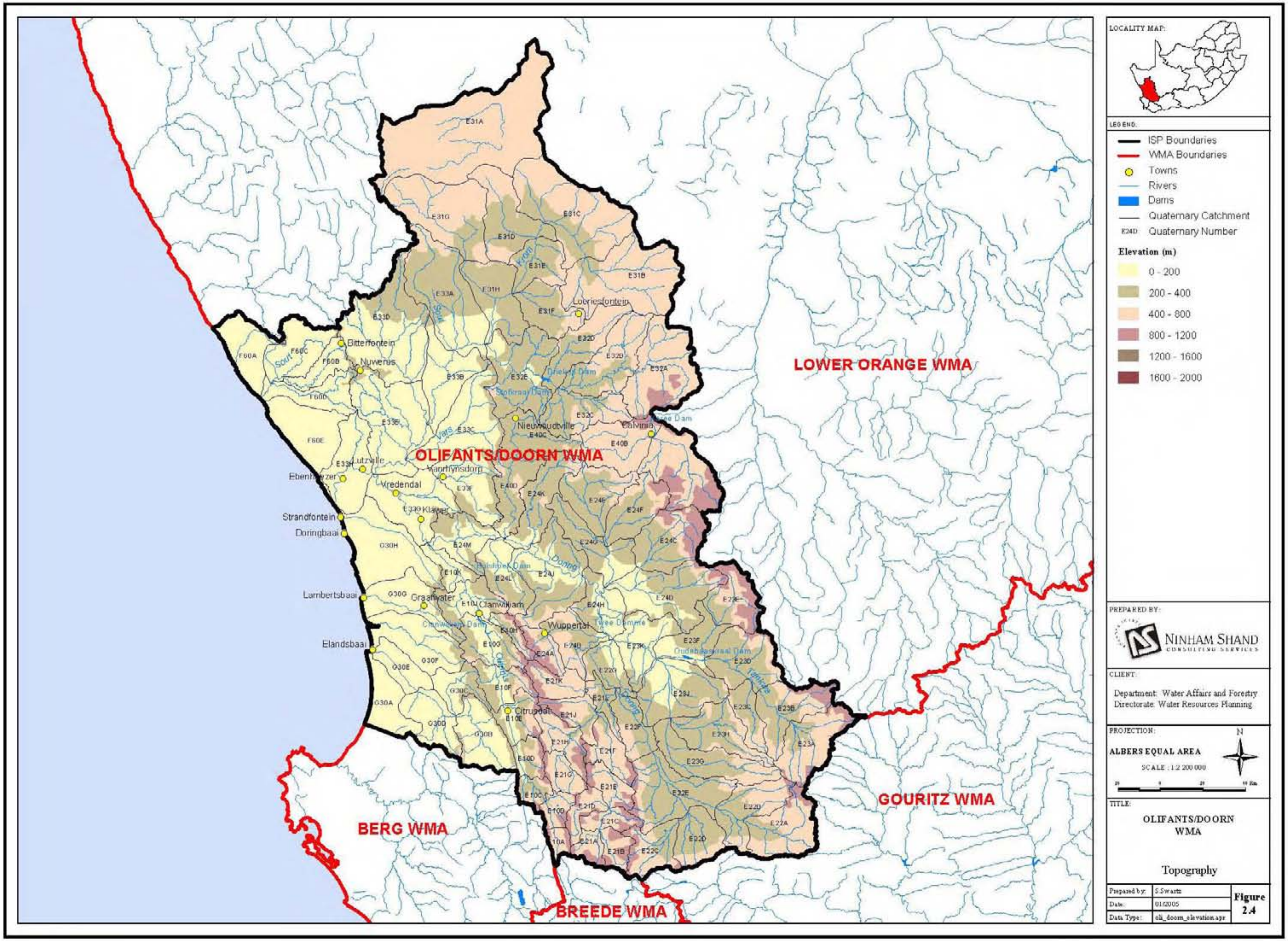


Figure 2.4: Topography

2.1.6 Vegetation

Due to the diverse soil types and variance in rainfall distribution, vegetation is varied and includes at least six veld types and several thousand plant species. Karoo and Karroid Types, False Karoo Types, Temperate and Transitional Forest Types, Scrub Types, and Sclerophyllous Bush Types dominate the Olifants/Doorn WMA and these are described in more detail below.

Karoo and Karroid types dominate the WMA, occupying some 75% of its area. The flora is characteristically low, typically less than 1 m in height, and includes scrub, bushes, dwarf trees and a few grasses. This vegetation type occurs where rainfall typically ranges between 150 mm and 500 mm, but does reach a maximum of up to 900 mm in some of the river valleys. Karoo and Karroid bushveld occurs at any altitude from sea level to 1 700 m above mean sea level (MSL).

False Karoo occurs predominantly in the north of the WMA, with small patches also occurring along the eastern and south-eastern boundaries. It is typified by low vegetation but, in contrast to Karoo type, contains more grassy elements. The areas occupied by this veld type are typically very arid and in parts may receive less than 100 mm of rainfall per annum. This veld type generally occurs below 1 200 m in elevation.

Temperate and Transitional Forest and Scrub is found in small patches towards the southern boundary of the WMA. As the name implies this veld type is typical of relatively temperate habitats. Temperate and transitional forest and scrub includes areas of forest, grasslands and fynbos and may be found from sea level up to 1 350 m. Rainfall is typically high, ranging from 650 to 1 150 mm per annum, although it may be somewhat lower within the coastal renosterveld and fynbos elements of this veld type, where it typically ranges between 300 to 500 mm per annum.

Sclerophyllous Bush is found in a broad band along the south-western portions of the WMA, just inland from the coast. This vegetation type, also referred to as Fynbos, contains a bewildering array of species which are characteristically small leafed (hence the term Sclerophyllous Bush). No single species dominates and there is a tremendous spatial turnover in species composition. The areas occupied by the Sclerophyllous Bush veld type are typically fairly mesic, receiving in excess of 500 mm, and up to 1 500 mm, of rainfall per annum.

Invasive alien plants (IAPs) cover an area of approximately 122 km^2, spread across the WMA. Much of the infested area is in the riparian zones. Acacias, Pines, Syringa, Eucalyptus and Prosopis are among the top ten genera of invading alien plants, which account for about 80% of the total water use by invasive alien plants. IAPs in the WMA are being eradicated through the DWAF Working-for-Water programme. This is further addressed under **Strategy No 8.6.**

2.1.7 Environmental protection and sensitive areas

Important conservation areas include the Tankwa-Karoo National Park, the Verlorevlei in the Sandveld (which enjoys Ramsar status), the Cederberg Wilderness Area, and the northern section of the Groot Winterhoek Wilderness Area. The Olifants River and its tributary, the Doring River, are important from a conservation perspective, because they contain a number of species of indigenous fish that occur in no other river systems, and that are endangered. In addition, reaches of some of the tributaries are virtually unspoiled by human manipulation and are of high to very high ecological importance. The Olifants River estuary is still in a relatively pristine condition and is of high ecological importance. Lists of wilderness sites are included in **Appendix 2.**

The present condition of the river at the outlet of each quaternary catchment was determined in the 2002 Water Resource Situation Assessment (WRSA) in terms of habitat integrity, and referred to as the present ecological status class (PESC). The PESC was used to estimate the quantities of water required to maintain the rivers in their present condition. The NWRS assumed the management class of the rivers at the outlets of each sub-area as follows:

Table 2.2: NWRS Management Class of Rivers in each Sub-Area

Sub-area	Management class at catchment outlet (1)
Kouebokkeveld	B
Sandveld	C, D (2)
Olifants	D
Knersvlakte	C
Doring	C

1) A = Rivers of highest ecological status, D = Rivers of low to medium ecological status.
2) Varies for different coastal rivers.

The DWAF Directorate: Resource Directed Measures (RDM) has commissioned a Comprehensive Reserve Determination Study[3] (2003-2005) for the WMA. A separate Groundwater Reserve Study was undertaken in the Sandveld (Conrad, 2003). The formal public process leading up to Ministerial decisions on Management Classes and Reserves will be undertaken at a later stage.

There are several sites given protection as Natural Heritage Sites in the Olifants/Doorn WMA. The main rivers and their tributaries are rich in sites of archaeological/cultural interest. The nature of these sites is diverse, but consists mainly of Late Stone Age artefacts, including rock paintings, cave deposits and open scatters of debris related to occupation. Earlier material, in the form of Middle and Early Stone Age artefact scatters, is also present but less numerous. Colonial material in the form of building remains and graves also occurs. Lists of heritage sites are included in **Appendix 2.**

[3] This study is being undertaken by Southern Waters Ecological Research and Consulting cc. The groundwater Reserve and wetlands Reserve determinations will not be undertaken in this study.

2.1.8 Olifants River Estuary

The mouth of the Olifants River is permanently open. Tidal influence has been noted up to 36 km upstream during spring tides. Increased salinities caused by seawater intrusion can occur up to 15 km upstream, at the end of summer, when the freshwater input is low (Olifants/Doring River Basin Study Phase 1, 1998). The Olifants River estuary has the highest botanical importance rating of all South African estuaries investigated (Coetzee, 1997). Its botanical importance derives from the good condition and large areas of intertidal and supratidal salt marsh in the lower reaches. The estuary is particularly sensitive to decreases in river flow, flood frequency and the quality of river water.

The Olifants estuary is one of only three permanently open estuaries on the west coast of South Africa, the others being the Berg and the Orange. It therefore represents a critical habitat to many estuarine-associated fish species. Seasonal extremes in salinity mean that the benthic invertebrate species diversity is relatively low, with only 45 species recorded. Thirty fish species from 21 families have been recorded in the Olifants River estuary. The percentage of fish species in the estuary which are partially or entirely estuarine-dependent is higher than elsewhere in South Africa. This means that degradation of the estuary may have a significant impact on west coast fish (Olifants/Doring River Basin Study Phase 1, 1998).

The estuary supports at least 86 species of estuarine waterbirds and has a wide range of habitats. It plays an important role in bird migration and is considered to be in the top ten South African locations of importance for conservation of waterbirds (Olifants/Doring River Basin Study Phase 1, 1998).

2.1.9 Wetlands

There are wetlands and seeps throughout the WMA that play a critical role in ecosystem health. Many of these are not mapped or categorised. The most renowned wetlands in the WMA are those along the coast.

The coastal wetlands of Verlorevlei, Die Vlei (Wamakervlei), Wadriftsoutpan and Lambert’s Bay in the Sandveld are vulnerable due to the pressure placed on the groundwater resource by over-utilisation and pollution. The wetland area at Verlorevlei has been designated Ramsar status as a wetland of international importance. Verlorevlei is situated approximately 25 km south of Lambert's Bay, between the villages of Elandsbaai and Redelinghuys and is one of the largest natural wetlands along the west coast of South Africa. Several rare species are found at the site including the white pelican and eight other threatened bird species. A survey in the 1980s reported a total of 6 829 individual birds from 60 different species in the environs of Verlorevlei. Over multiple surveys more than 75 different species have been recorded. The site is one of the ten most important wetlands for wading birds in the south-western Cape Province, providing feeding, nesting and resting facilities to a large variety of birds.

2.1.10 Surface water-groundwater interaction

There is very little quantitative knowledge of surface-groundwater interaction in this WMA. Concerns have been raised about the impact of groundwater abstraction on the ecosystems.

Baseflow is low to zero in the regolith-dominated sub-areas of the Doring and Knersvlakte, indicating a very low, negligible groundwater contribution to surface water bodies. In the TMG-dominated areas of the WMA, elevation and depth of boreholes are more critical factors to consider than distance from a river in regulating groundwater abstraction with regards to impact on base flow. Most of the base flow in rivers originates from perennial springs and seep zones. Interaction between surface and groundwater from the TMG within the river course is limited to a few areas, where the Bokkeveld Formation is eroded.

Most of the streams and rivers in the upper regions and the relatively dry areas of the WMA are considered to be either (definitions by Vegter and Pitman, 1996):

- Detached (piezometric level always below streambed, no groundwater discharge);
- Intermittent (piezometric level slopes towards stream, recharge occurs occasionally) or
- Famished (piezometric level slopes towards the stream, but groundwater does not reach it due to evapo-transpiration.

Relevant surface-groundwater interaction is therefore limited to perennial springs and rivers embedded in alluvial aquifers.

2.2 DEMOGRAPHY, LAND USE AND DEVELOPMENT

2.2.1 Population

The Olifants/Doorn WMA is the least populated WMA in the country with approximately 0.25% of the national population residing in the area. In 1995, approximately 113 000 people lived in the WMA. **Table 2.3** details the population in each sub-area. More than half of the population live in urban or peri-urban areas, and the rest in rural areas. About 65% of the population is concentrated in the south-western portion of the WMA in the Koue Bokkeveld, Upper and Lower Olifants and Sandveld sub-areas. Population density over the Doring and Knersvlakte sub-areas is low (NWRS, 2004).

Table 2.3: Population in 1995

Sub-areas	Population
Upper and Lower Olifants	52 600
Koue Bokkeveld	9 700
Sandveld	26 400
Doring	15 800
Knersvlakte	8 500
TOTAL	**113 000**

(Source: NWRS WMA Report Figure 6)

A national study (Schlemmer *et al*, 2001) was undertaken by DWAF to develop water-use scenarios to the year 2025 for the NWRS. The average growth rate of the population in the area between 1980 and 1990 was about 0.5% per year. In most parts of the WMA the urban populations increased at about 0.5% per year and the rural population decreased at between 1% and 2% per year. The exception was the magisterial district of Vredendal where the population of the town of Vredendal grew at 7% per year, to increase from 5 000 to 10 000 people between 1980 and 1990. The rural population in this magisterial district also grew at about 2% per year during the same period.

The general trend of an increasing urban population and associated decreasing rural population is expected to continue and can be attributed to the lack of strong economic stimulants, migration of young people and the impacts of HIV/AIDS (NWRS, 2004). Despite the general trend towards urbanisation, the 2025 base scenario suggests that little change can be expected in future urban growth in this WMA. It is anticipated that migration out of the WMA and HIV/AIDS will result in little overall growth.

There is strong in-migration of seasonal workers during the harvest and planting seasons. The number of migrants is believed to be tens of thousands (pers. comm. N Wullschelger, IWRM Project, 2003). This influx occurs particularly in the Koue Bokkeveld and Upper Olifants.

2.2.2 Land use and ownership

The mean annual precipitation over much of the area is less than 200 mm, with the result that, except in the wetter south-west, the climate is not suitable for dryland farming on a large scale. Consequently, more than 90% of the land in the Olifants/Doorn WMA is used as grazing for livestock, predominantly for sheep and goats. An estimated 2 190 km^2, or some 4% of the land area is cultivated for dryland farming.

Approximately 497 km^2 is under irrigation, of which almost 50% lies within the Upper and Lower Olifants sub-areas. Irrigated citrus, deciduous fruits, grapes and potatoes are grown on a large scale in the WMA and provide the mainstay of this WMA’s economy (NWRS, 2004). In addition to the intensive irrigation practised along the Olifants River, significant irrigation also takes place in the Koue Bokkeveld (18%) and along the rivers and from groundwater in the Sandveld sub-area (10%).

Urban areas are small, covering a total land area estimated at only 31 km^2. There are a few small rural settlements, but they occupy an insignificant area of land. Mining activities include mining of heavy minerals, granite quarrying and offshore diamond dredging.

The ownership of land is dominated by the white farmer sector. Resource-poor farmers have limited access to good quality agricultural land and have been historically sidelined in terms of access to water. This WMA is water stressed and there is limited surplus available from existing sources. Additional water resource developments will be required for any further irrigation development. Although the local authorities and the provincial departments of land and agriculture have programmes in place to actively transform this ownership pattern, progress has been slow.

2.2.3 Socio-economic overview

The WMA is marked by inequality in income distribution along racial and urban/rural divides. The agriculture-dominated economy of the WMA shows a pattern of depopulation. A skewed age and skills profile exists with decreasing numbers of young educated people remaining in the area. Land ownership remains dominated by its former apartheid structure and previously disadvantaged communities struggle with a lack of skills and capital to alter their *status quo*. In a needs assessment carried out in the 1990s, security of tenure, adequate housing and access to productive land were identified as the key development needs amongst the disadvantaged majority (Olifants/Doring River Basin Study Phase 1, 1998).

The northern and eastern parts of the WMA are characterised by high unemployment, are sparsely populated, have poor infrastructure and high poverty levels.

Despite significant contributions to the labour economy, gender-based discrimination limits economic growth of women in the WMA. Low levels of education and training, poor health and nutritional status and limited access to resources contribute to this barrier (Olifants/Doring River Basin Study Phase 1, 1998). Women are under-represented in decision-making structures. Traditional and social barriers limit women's participation and widen power gaps.

Entrepreneurial skills as well as general training are required together with infrastructural and financial support, in order to reverse the trend towards increasing poverty in the area (Olifants/Doring River Basin Study Phase 1, 1998).

2.2.4 Economic development

Nationally the agriculture sector contributes 4.6% to the Gross Domestic Product (GDP). In this WMA the agricultural sector contributes far more to the local economy (43.3%) than any other sector (see **Figure 2.5**). In 1997, the contribution to the Gross Geographic Product (GGP) of the WMA totalled R1.9 billion. Whilst emphasising the importance of agriculture in the regional economy of the WMA, it also highlights the relatively low level of activity in other sectors. The contribution from the Olifants/Doorn WMA to the national GDP is the lowest of any WMA in the country.

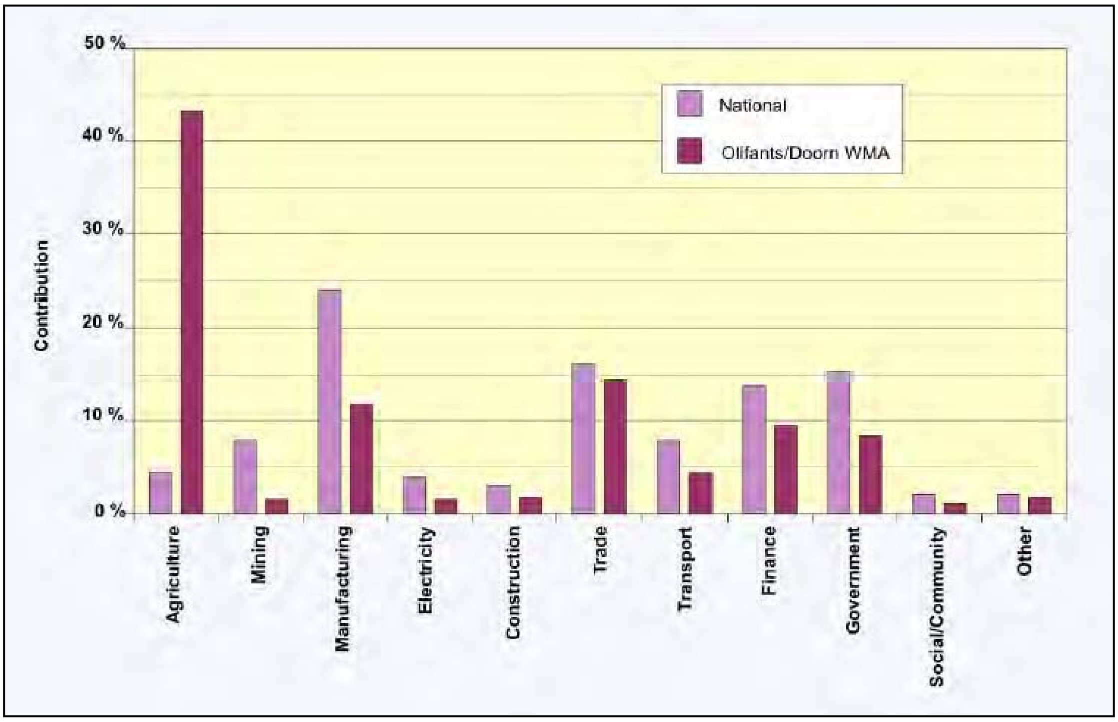


Figure 2.5: Sectoral contribution to the economy (source: Schlemmer, 2001)

Of the total labour force of 58 600 people, 8% were unemployed in 1994, which was much better than the national average of 29%. Approximately 75% of the labour force was active in the formal economy. 50% of the formally employed labour force worked in the agricultural sector, 20% in the government sector and only 9% in trade (all values are referenced to Schlemmer, 2001).

2.2.5 Agriculture and irrigation

Agricultural activities in this sector include a wide variety of crop types, many of which are high value produce. The cultivation of wine and table grapes, rooibos tea, citrus, deciduous fruit, wheat, potatoes, flower cultivation and wildflower harvesting, livestock and fisheries contribute to the sector. Wine and dried fruit are important value-added products.

Although it is estimated that a total area of about 497 km^2 of land is under irrigation, some of this is irrigated only in years when sufficient water is available. It is estimated that an average area of about 400 km^2 of crops grown under irrigation is harvested annually.

2.2.6 Strategic water use

The only power station in the area is a small privately owned hydro-electric installation (non-consumptive water user) at Clanwilliam Dam which once supplied additional electricity to the town of Clanwilliam. This facility has not been functional for the past few years due to the high operational costs.

2.2.7 Mining and industry

The only major mine in the area is the Namakwa Sands heavy minerals mine which is situated on the coast in the north-west of the WMA and is supplied with water via an allocation out of the Olifants River canal. There are also several granite quarrying operations in the vicinities of Vredendal and Vanrhynsdorp. Dredging for marine diamonds occurs offshore.

Industries in the WMA are small and the majority of them are concerned with the processing and packaging of agricultural products. Approximately only 3 million m^3/a of water is currently required by the mining and industrial sectors.

2.2.8 Forestry

Small commercial timber plantations, totalling 10 km^2, are established in the mountainous high rainfall areas in the south-west of the WMA, with very little impact on the water resource (total use one million m^3/a but negligible impact on available yield).

2.2.9 Tourism

Tourism is an important and growing component of the WMA economy. Clanwilliam Dam and the Cederberg Wilderness Area support numerous tourism-based businesses. The major towns of the area have experienced a growth in tourism over the past 10 years. The coastal towns suffer from water shortages over the summer tourist season due to peak demand.

2.2.10 Institutional arrangements

There are no water boards in the Olifants/Doorn WMA and the municipalities are the responsible water services authorities. The water services authorities are:

- West Coast District Council;
- Namakwa District Council;
- Boland District Council *(very small area included in WMA 17)*;
- Central Karoo District Council *(very small area included in WMA 17)*;
- Cederberg Municipality;
- Matzikama Municipality;
- Witzenberg Municipality;
- Hantam Municipality;
- Kamiesberg Municipality;
- Karoo Hoogland Municipality;
- Franswil Municipality.

The following water user associations have been established in the WMA:

- Lower Olifants River;
- Citrusdal;
- Clanwilliam;
- Vanrhynsdorp.

Eleven catchment forums have been established to build capacity in water resource management and to inform the development process of the Olifants/Doorn Catchment Management Agency (CMA) and these cover the entire WMA. The DANIDA IWRM project played a key role in these developments.

The WMA falls within both the Western Cape and Northern Cape provinces. The DWAF has a catchment manager based in the Bellville Regional Office who manages the entire WMA, until management functions can be progressively transferred to the CMA to be established. Where appropriate, provincial inputs to DWAF managerial decisions can be provided through both the Western Cape and Northern Cape Provincial Liaison Committees (PLCs), and their Co-ordinating Committee for Agricultural Water (CCAW) sub-committees. The main members of the CCAW are the DWAF Regional Office and the Provincial Department of Agriculture, but other provincial departments, the DWAF Head Office Planning Directorates and some national departments such as Land Affairs and DEAT also provide input. The CCAWs, previously known as the Irrigation Action Committees, are specifically responsible for liaising on the issue of irrigation water and irrigation development, including provision of water for resource-poor farmers.

2.2.11 International links and links with other WMAs

The WMA borders on the Lower Orange WMA to the north and east, the Gouritz, Breede and Berg WMAs in the south, and the Atlantic Ocean in the west. The Olifants/Doorn WMA area does not border on any neighbouring country and is not linked to any other country through the transfer of water.

The only inter-water management area transfer is a transfer of 2.5 million m^3 per year from the Breede WMA (H20C) to the Olifants/Doorn WMA via the Inverdoorn canal for irrigation purposes. No water transfer from this WMA to other WMAs is taking place nor is any planned.

2.3 WATERWORKS

2.3.1 Olifants River (Vanrhynsdorp) Government Water Scheme

The Bulshoek Weir and a canal system to irrigate land extending along the Olifants River to close to its mouth were completed in 1923. In 1935 construction of the original Clanwilliam Dam was completed, to make more water available for the scheme. Since then, improvements and extensions to the scheme have been made at intervals. A substantial raising of the Clanwilliam Dam was carried out in the late 1960s. Clanwilliam Dam and Bulshoek Weir are state-owned. The Lower Olifants River Water User Association (LORWUA) operates Bulshoek Weir. These dams are the storage components of the Olifants River (Vanrhynsdorp) Government Water Scheme which is operated and maintained by LORWUA. The last Dam Safety Report stated that the Clanwilliam Dam wall requires strengthening to meet the national safety requirements. According to the Departmental priority list the strengthening would be implemented by 2010.

Water is released from Clanwilliam Dam (live storage 122 million m^3) into the river to flow to Bulshoek Weir (live storage 5.7 million m^3), some 30 km downstream. Downstream of the weir water is distributed by a canal system consisting of main and distribution canals totalling 186 km in length. It is estimated that canal conveyance losses are of the order of 28%. **Strategy No. 9.1** deals with responses to this conveyance loss. The canal system is used for irrigation, domestic and industrial supplies for towns and for supply to the Namakwa Sands Mine, and a number of small mining activities.

Farmers with land between the dam and the weir abstract 18 million m^3/a from the releases by pumping directly from the river and the Clanwilliam canal scheme, supplying approximately 1 673 ha. The canal from the Clanwilliam Dam also supplies 1 million m^3/a for domestic use in Clanwilliam. If the abstraction from tributary rivers is also taken into account, a total of approximately 27 million m^3/a is used for irrigation in the catchment area between the Clanwilliam Dam and Bulshoek Weir.

Other than Clanwilliam Dam and the Bulshoek Weir there are no other large state-owned dams in the WMA. There are numerous farm dams throughout the Upper Olifants and Doring catchments.

2.3.2 Other Irrigation Schemes

There are also a large number of privately owned irrigation schemes, namely:

- In the Koue Bokkeveld and in the Agter Witzenberg area (upper reaches of the Olifants River) a large number of farm dams have been constructed for the irrigation of deciduous fruit and vegetables. The total irrigated area is approximately 8 600 ha.
- At the confluence of the Tankwa and Doring Rivers water is abstracted from the Doring River for the irrigation of 350 ha of land from the water works of the Elandskaroo Irrigation Board.
- Oudebaaskraal Dam on the Tankwa River (quaternary E23F) is the largest privately owned dam in South Africa, with live storage of 34 million m^3. It seldom fills completely and supplies water irregularly to approximately 320 ha of land.
- Along the Olifants River upstream of Clanwilliam Dam there are numerous small individual private schemes with various abstraction systems, including pump stations, small diversion weirs, canals and off-channel dams mainly to irrigate citrus. The total irrigated area is approximately 10 700 ha.

2.3.3 Groundwater

a. Geohydrology

The major portion of the WMA is underlain by a shallow “regolith” (intergranular/-weathered-and-fractured) aquifer (refer to **Figure 2.6**). The fractured-rock aquifer systems in this WMA include the TMG Aquifers in the *Cederberg sub-province*, and parts of the Witteberg Group in the *Tankwa Karoo sub-province*. Another fractured-rock system is represented by Karoo dolerites in the *Hantam sub-province* on the eastern side of the WMA. Primary intergranular (porous sandy) aquifers occur most extensively in the western coastal (*Knersvlakte sub-province* and western Cederberg) and northern parts of the WMA. In the northern parts of the WMA (Knersvlakte and Hantam), these primary aquifers are related to alluvial deposits found on the older Tertiary land surfaces (e.g., Knersvlakte north of Vanrhynsdorp) around the drainage basin of a major river system that formerly connected the upper Orange (Senqu) and Vaal systems to the palaeo-Olifants River mouth.

b. Spring and borehole distribution

The mapped distribution of springs in this WMA (**Figure 2.6**) is based on the systematic hydrocensus survey of the Citrusdal Artesian Groundwater Exploration (CAGE) Project. Spring location is closely correlated with the TMG aquifers and “hydrotect” structures. It is assumed that there are many other springs in this WMA that are not shown in the available database. In the southern part of the Cederberg sub-province, particularly the E10 tertiary sub-catchment, hot springs emerge within the Peninsula Aquifer.

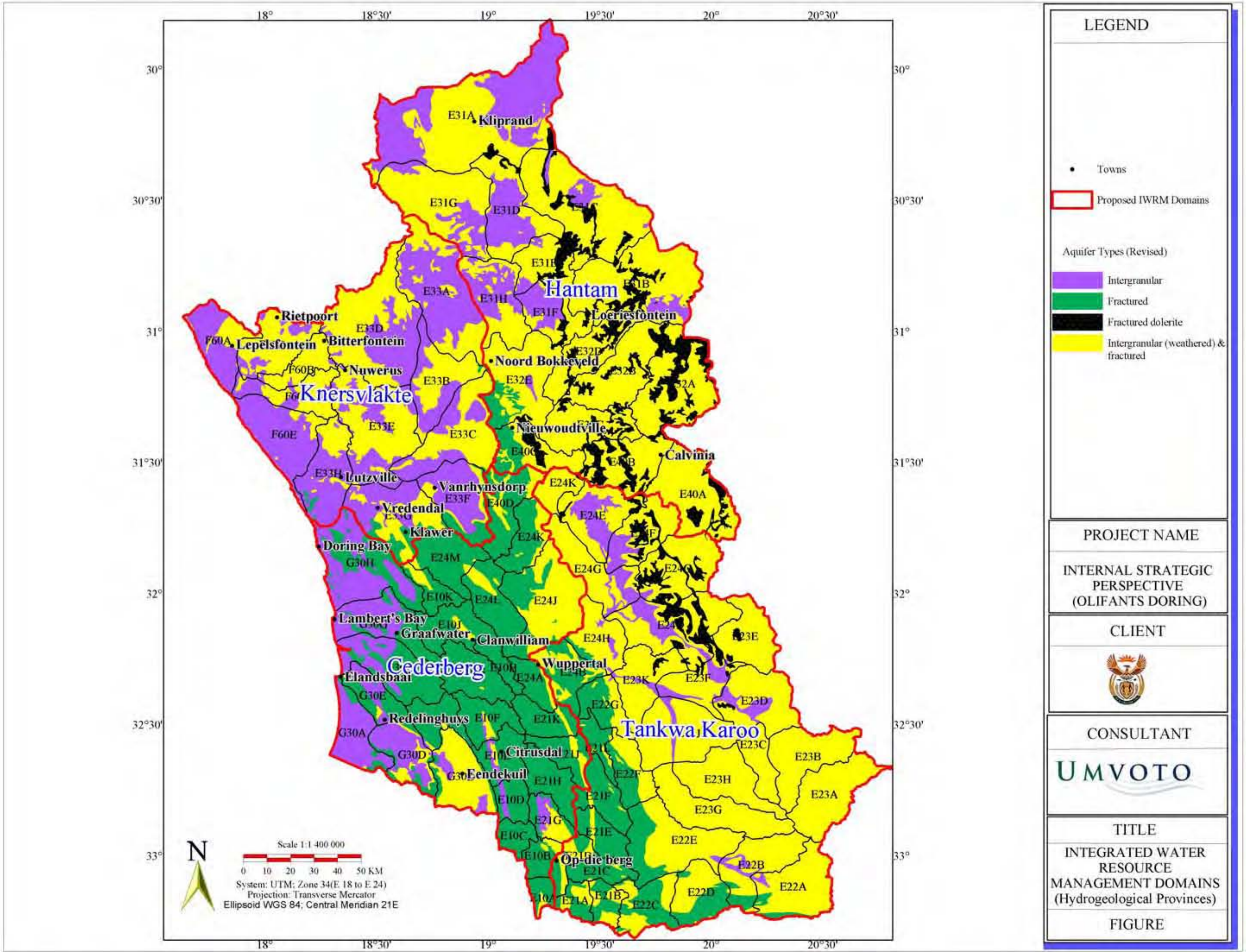


Figure 2.6: Hydrogeological sub-provinces showing naturally occurring springs

The borehole distribution on the National Groundwater Database (NGDB) reflects the actual pattern of use as well as an area-specific focus in data collection in the past (see **Appendix 4** for more detail).

There is a high density of boreholes in the Calvinia-Nieuwoudtville area (from shallow regolith, Karoo dyke and alluvial aquifers), and in TMG aquifers along the arid coastal plain between Elands Bay and Doring Bay. This reflects groundwater dependence.

There is an uneven spread of boreholes throughout the rest of the ISP area, with localised concentrations in the Koue Bokkeveld, in the Vanrhynsdorp area, and around Bitterfontein in southern Namaqualand. In all except in the alluvial and TMG instances mentioned above, the number of boreholes reflects good groundwater sources in spite of rather arid to semi-arid climatic conditions. The abstraction pattern shows a relatively high level of summer-season groundwater dependence, from whatever aquifer sources are locally available. The groundwater resource has not been systematically explored and developed, and its monitoring is uneven.

c. Aquifer recharge and yield

The recharge to the TMG aquifers is highest in the high mountains along the southern catchment boundary divide, around the Koue Bokkeveld and southern Cederberg ranges, which generally favours the exposed Peninsula Aquifer as the most sustainable source. In contrast to this, the estimated recharge in the northern part of the WMA, and over a wide area of the Tankwa Karoo in the rain shadow east of the Cederberg ranges, is less than 10 mm/a. The yields obtained to date (**Figure 2.7**) and the recharge distribution together indicate that the TMG fractured-rock aquifers should be the main groundwater exploration targets in this region.

The good correlation between the recharge and median yield map favours the use of groundwater for bulk water supply in the Upper Olifants (conjunctive use) and Sandveld (primary use) sub-areas.

The area of highest median yield (>5 ℓ/s) is shown on current DWAF maps to occur in parts of the TMG in the Agter Witzenberg and Koue Bokkeveld areas in the extreme south of the WMA, near Vanrhynsdorp in carbonate aquifers of the Nama Group, in primary aquifers in drainage channels leading to the Wadrif primary aquifer near Lamberts Bay, and along the Tra-Tra River northeast of Wuppertal. The southern and western portions of the TMG aquifers are shown to be associated with median yields in the range 2-5 ℓ/s, but this data appears to not account for recent high-yielding (>20 ℓ/s) boreholes in the Peninsula Aquifer around the Citrusdal area. The northern parts of the TMG and the Bokkeveld-Witteberg aquifers south of Wuppertal are associated with median yields between 0.5 and 2 ℓ/s. Higher areas of the western Karoo are shown to have similar (0.5-2 ℓ/s) median yields. Lower yields (0.1-0.5 ℓ/s) are obtained from areas underlain by Namaqua basement (regolith) aquifers, and along the lower Ecca Group strata in the Tankwa Karoo. Lowest yields (<0.1 ℓ/s) are reported from the Dwyka Formation in the Tankwa Karoo and from the Namaqua basement near the coast, north of the Olifants River mouth.

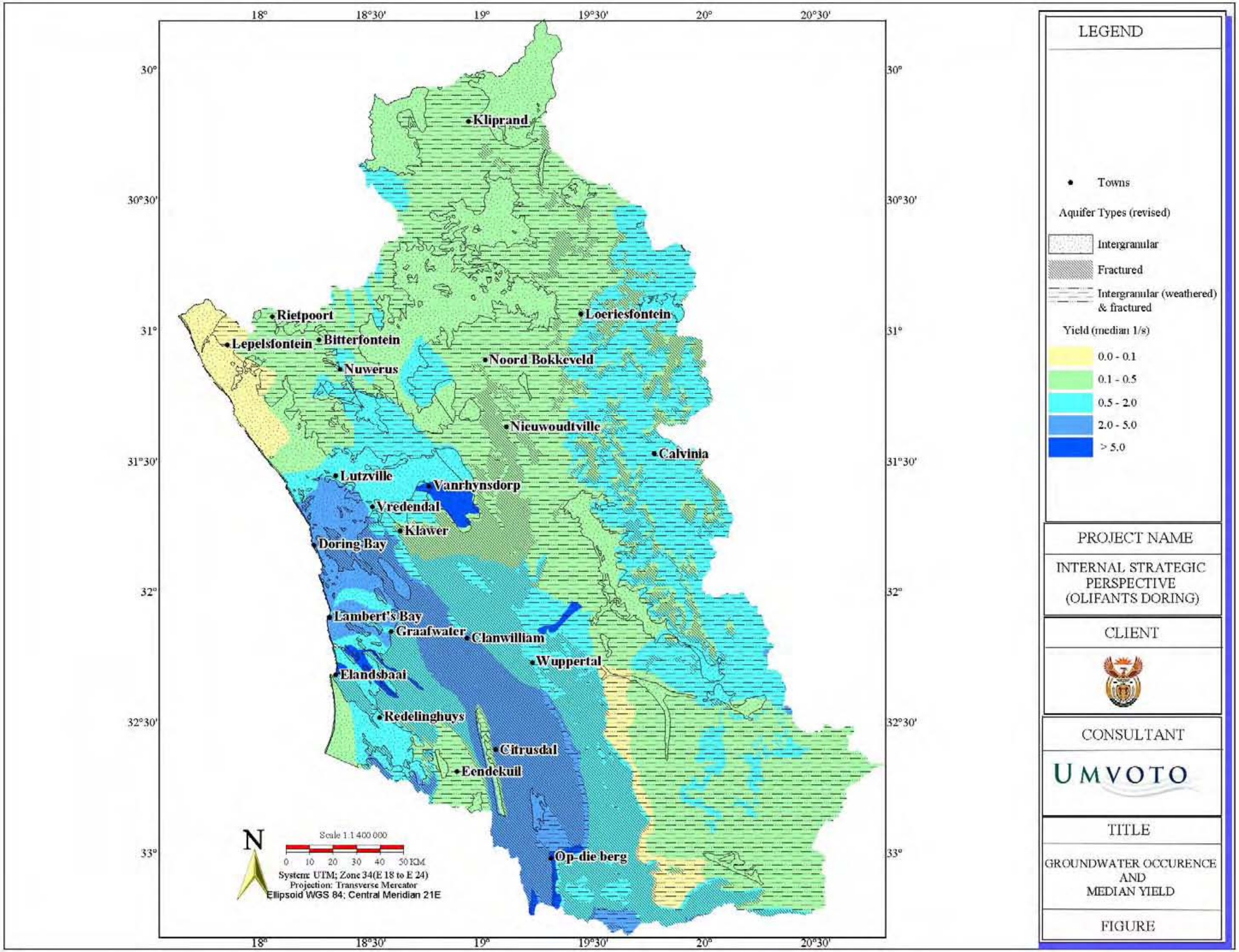


Figure 2.7: Groundwater Yields

2.3.4 Local water supply schemes

The water supply to towns in the WMA is detailed in **Appendix 9.**

Surface Water Supplies

The towns in the Olifants/Doorn WMA are all relatively small and most are supplied from local sources via infrastructure owned and operated by local authorities. There are a few exceptions, such as Klawer, Vredendal, Vanrhynsdorp, Lutzville, Ebenhaezer, Strandfontein and Doringbaai which are supplied via the Lower Olifants Government Scheme. The towns of Citrusdal and Clanwilliam obtain water directly from the Olifants River. Clanwilliam also abstracts from the Jan Dissels River upstream of its confluence with the Olifants River. The towns that are not supplied from the state-owned schemes have their own municipal supplies from local surface or groundwater sources.

Groundwater Urban and Rural supplies

Towns that are dependent or partially dependent on groundwater supplies are Loeriesfontein, Calvinia, Nieuwoudtville, Vanrhynsdorp, Bitterfontein-Nuwerus, Doringbaai, Lamberts Bay, Graafwater, Leipoldtville and Elandsbaai. Citrusdal supplements its summer water supplies with groundwater.

Southern Namakwaland Government Water Scheme

The Southern Namakwaland Government Water Scheme supplies desalinated groundwater from boreholes to the small towns of Bitterfontein and Nuwerus. This was implemented because of the severe shortage of suitable sources of surface water in those areas and groundwater of unfit quality. This scheme has recently been extended to supply the Rietpoort and Molsvlei communities.

2.3.5 Future requirements and identified infrastructural development options

Chapter 4 discusses the yield balance of the WMA in detail. This section provides a generalised picture of the future water requirements. There is not much growth anticipated in the urban areas within the WMA. There is however demand in the Koue Bokkeveld, Sandveld and Upper Olifants for agricultural expansion. The agricultural expansion in the Lower Olifants is currently limited by the infrastructural constraints of the canal and the fact that the yield of Clanwilliam Dam is over-allocated at a 1:50 year assurance of use. The historical agricultural growth and the demand for new allocations for resource-poor farmer initiatives, provides impetus to consider future development options. It should be noted that the ecological water requirements (EWR) are currently being determined in a Comprehensive Reserve Determination Study and provision for meeting the EWR must be a consideration when deliberating development options.

Reconciliation options are thoroughly discussed in **Chapter 6.** The development options shown in **Table 2.4** and **Figure 2.8** are possibilities that have been investigated for the WMA. It should be noted that the development of many of these options would be mutually exclusive. Currently the raising of Clanwilliam Dam is considered to be the most favourable surface water development option and is the subject of a feasibility study (see **Section 2.3.1**).

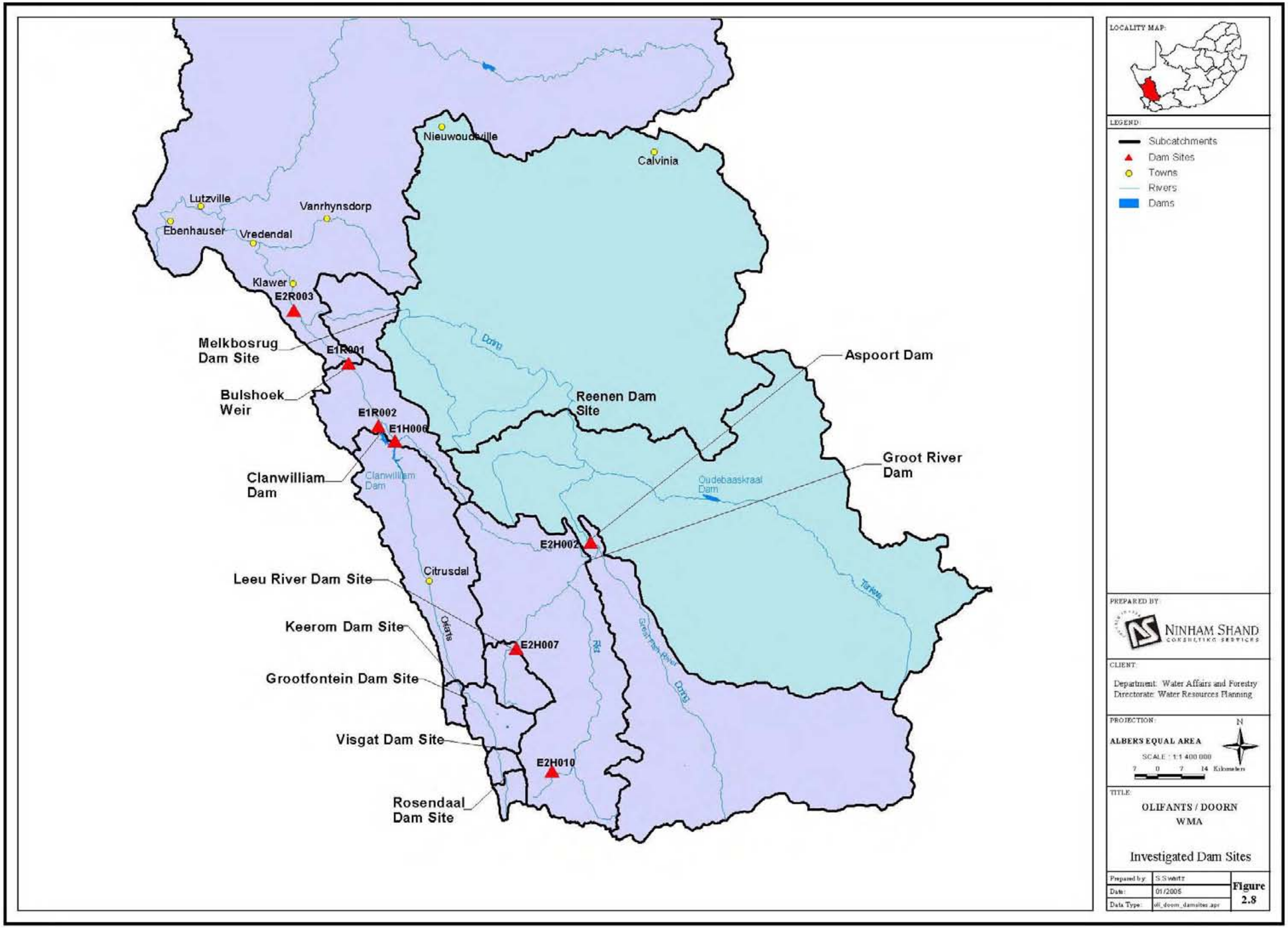


Figure 2.8: Basin Study indication of investigated dam sites

Table 2.4: Investigated Infrastructure Development Options

Name	Details	Location	Related Studies
OLIFANTS RIVER			
Additional off-channel farm dams	Cumulative capacity of 14 Mm^3 with a yield of 10 Mm^3/a	Upper Olifants	o Olifants Doring River Basin Study Phase 1 (1998) o Situation Assessment (2002)
Clanwilliam Dam Raising	Maximum additional capacity of 240 Mm^3 increase the yield by 40 Mm^3/a	Clanwilliam	o Olifants Doring River Basin Study Phase 1 (1998) o Situation Assessment (2002) o Olifants Doring River Basin Study Phase 2 (2003) o Raising of Clanwilliam Dam (starting 2004)
Grootfontein Dam	138 million m^3 capacity dam with a yield of 90 million m^3/a	Upper reaches of the Olifants River (downstream of the Visgat Gorge and at the head of the Citrusdal Valley)	o Olifants Doring River Basin Study Phase 1 (1998)
Keerom Dam	153 million m^3 capacity dam with a yield of 100 million m^3/a.	Upper reaches of the Olifants River (immediately upstream of the confluence with the Ratel River). Investigated as an alternative to Grootfontein Dam.	o Olifants Doring River Basin Study Phase 1 (1998)
Rosendaal Dam	26 million m^3/a capacity with a yield of 14 million m^3/a	Upper Olifants (Agter Witzenberg) 27 km directly north of Ceres	o Olifants Doring River Basin Study Phase 1 (1998) o Situation Assessment (2002) o Citrusdal Irrigation Board Study
Leeu River Dam	Unknown	Koue Bokkeveld on the Leeu River	Unknown
Visgat	Unknown	Upper Olifants (Agter Witzenberg)	Unknown
DORING RIVER			
Additional off-channel farm dams	Estimated capacity of 8 Mm^3 with a cumulative yield of 5 Mm^3/a	Lower Doring	o Olifants Doring River Basin Study Phase 1 (1998)
Aspoort Dam	395 Mm^3 capacity dam with a yield of 76 Mm^3/a	Aspoort on the main stem of the Doring River (Elandsdrift)	o Prov Government North Cape Study (1996) o Olifants Doring River Basin Study Phase 1 (1998) o Situation Assessment (2002)
Groot River Dam	159 million m^3/a capacity with a yield of 64 Mm^3/a	300 m downstream of the confluence with Matjies River on the farm Elandsdrift	o Olifants Doring River Basin Study Phase 1 (1998)
Melkboom Dam	388 Mm^3 capacity dam with a yield of 50 Mm^3/a	3 km upstream of the measuring and diversion weir, which is 1km upstream of the old Clanwilliam-Klawer Road	o Olifants Doring River Basin Study Phase 1 (1998) o Situation Assessment (2002) o WODRIS (2004)
Melkbosrug Dam	Capacity of 397 Mm^3 and a yield of 116 Mm^3 if no further abstraction upstream for irrigation	Lower Doring River, 37 km upstream of the confluence with Olifants River	o Olifants Doring River Basin Study Phase 1 (1998) o WODRIS (2004)
Brandewyn Dam	Input required from WODRIS	Off channel- close to confluence of Olifants and Doring	o WODRIS (2004)
Reenen Dam	Unknown	On the Doring River	Unknown
GROUNDWATER SCHEMES			
Wellfield T1	Capacity estimated between 5 and 20 Mm^3/a each	At the confluence of the Doring River with the Olifants River two wellfields on each side of Doring River to abstract groundwater from Peninsula Aquifer	WODRIS (2004)
Wellfield T2	Estimated Capacity between 3 and 10 Mm^3/a	On the right bank of the Olifants River, above the Bulshoek Weir. Wellfield abstract groundwater from Peninsula Aquifer	WODRIS (2004)
Wellfield T3	Estimated Capacity between 3 and 10 Mm^3/a	At the left bank of the Sandlaagte valley. Wellfield at Skurfkop Syncline to abstract groundwater from Peninsula Aquifer	WODRIS (2004)
Wellfield T4	Capacity was not assessed.	Brandewyn River valley above confluence with Doring River Wellfield in Brandewyn River Valley to abstract groundwater from both Skurweberg and Peninsula Aquifers	WODRIS (2004)
Wellfield T6	Capacity was not assessed	Katmakoep area between Vredendal and Strandfontein Wellfield in Katmakoep area to abstract groundwater from the Peninsula Aquifer	WODRIS (2004)
Aquifer Storage Recovery Scheme T5	Pump in and store water from the Olifants River	Sandlaagte Valley Aquifer -Storage Recovery Scheme in unutilised Sandlaagte Aquifer	WODRIS (2004)
Aquifer Storage Recovery Scheme T7	Pump in and store water from the Olifants River	Aquifer Storage Recovery Scheme in under-utilised Vanrhynsdorp dolomitic aquifer	WODRIS (2004)
Boschkloof Wellfield	Wellfield to supplement municipal bulk water supply for Citrusdal. Potential sustainable yield 15 – 20 Mm^3/a	Citrusdal	Citrusdal Municipality (1998)
CAGE	Estimated capacity of 45 Mm^3/a	Peninsula Aquifer in E10 catchment	CAGE (2000)

CHAPTER 3

SUB-AREA PERSPECTIVES

This chapter contains detailed information on each of the six sub-areas within the Olifants/Doorn WMA. It outlines the defining physical characteristics, discusses the water balance and future requirements, and highlights the main perspectives that drive the strategies relating to each sub-area, and to smaller sub-management areas (e.g. rivers) within it.

3.1 UPPER OLIFANTS SUB-AREA (E10A-G)

3.1.1 Location

The Olifants River (E10A-G) rises in the Cederberg Mountains at the southern edge of the WMA and provides the most significant contribution to available water in the WMA. The Upper Olifants has a catchment of 2 888 km^2 which drains to the Clanwilliam Dam. The sub-area falls within the Cederberg Municipality (see **Figure 3.1**).

3.1.2 Groundwater

The area is dominated by the Table Mountain Group which forms the high ridges of the Cederberg. The TMG fractured-rock aquifers provide an important base flow contribution to surface water drainage. There is evidence that groundwater in the coastal plain of the WMA is linked to the high mountain-recharge water found in this sub-area. This relationship should be considered when contemplating groundwater utilisation in the Upper Olifants sub-area. Groundwater quality varies significantly depending on the aquifer it is being drawn from and hot springs in the area indicate deep groundwater flow.

The groundwater yield (groundwater in use) was estimated in the NWRS to be 4 million m^3/a. In reviewing the groundwater literature it appears that the NWRS figures account for the resource in alluvial and fractured rock aquifers only and do not include the resource available from the deep aquifers in the Table Mountain Group Sandstones. Based on the studies and best understanding and knowledge within the Department, it was agreed that 20 million m^3/a should be used (see **Section 4.1** and **Appendix 4**).

UPPER OLIFANTS SUB-AREA MAIN FEATURES:

Main Rivers:
- Olifants River (E10);
- Rondegat River (E10G)
- Boontjies River (E10D)

Towns: Citrusdal, Clanwilliam.

Main dams:
- Clanwilliam Dam (122 million m^3) in E10G;

Some identified schemes:
- Groundwater schemes
- Raising of Clanwilliam Dam
- Rosendaal Dam
- Grootfontein Dam

Transfers:
- Transfer to the Lower Olifants

Major conservation areas:
- Cederberg Conservancy
- Cederberg Wilderness Area
- Groot Winterhoek Nature Reserve
- Cederberg (Hexberg) Nature Reserve

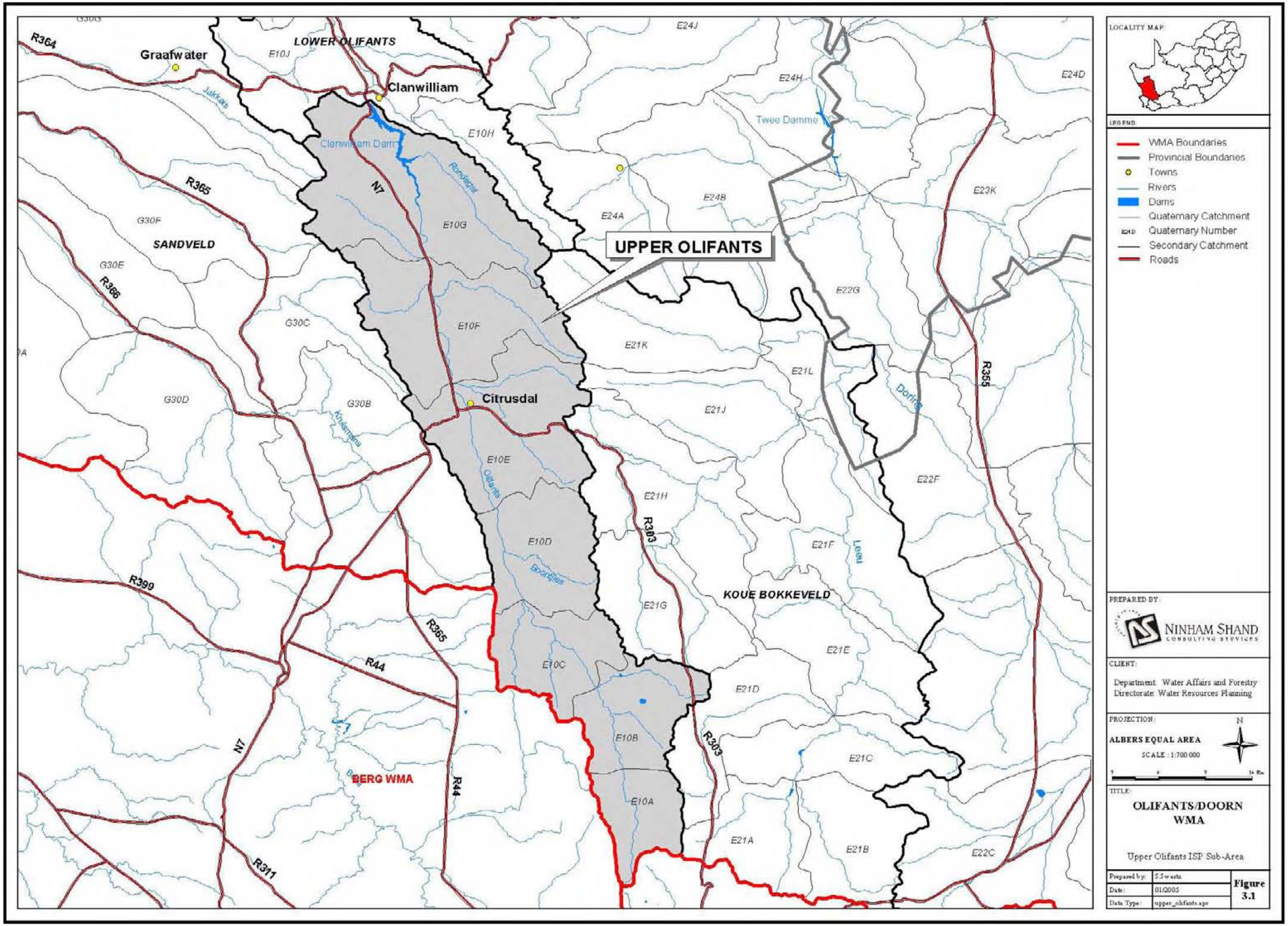


Figure 3.1: Upper Olifants Sub-area

Appendix 4 summarises findings of recent studies and details the arguments for groundwater availability to be significantly higher than given in the NWRS. The estimates of unused groundwater potential in this sub-area and the rural nature of the population suggest that groundwater could contribute to widespread provision of water for the basic human needs, as well as an allocation for irrigation via a conjunctive-use scheme with or without the raising of the Clanwilliam Dam.

3.1.3 Water Resources Availability

A summary of the water resources is given in **Table 3.1.** The cumulative MAR for the Upper Olifants sub-area is 437 million m^3/a. The average mean annual precipitation (MAP) for the key area is about 460 mm. The current estimates of the average annual volume of flows required satisfying the ecological water requirements of the preliminary Reserve are as shown in **Table 4.2** and **Appendix 3**.

Table 3.1: Upper Olifants Yield Balance

Resource	*Million m^3/a at 1:50 yr assurance*
Water Availability	
Gross surface water yield	**188**
Subtract - **Ecological Reserve** - **Invasive alien plants**	 **14** **5**
Net surface water yield	**169**
Groundwater	**20**
Return flows	**8**
Total local yield	**197**
Transfer in	**0**
Total Available Water	**197**
Requirements	
Irrigation	**100**
Urban	**1**
Rural	**1**
Industrial / mining	**0**
Afforestation	**1**
Total local requirements	**103**
Transfer out	**94**
Total Water Requirements	**197**
Reconciliation	
Yield Balance	**0**

Updates since the NWRS: Reserve

The 2003, *Olifants Doring River Basin Study Phase 2* provided a rapid Reserve. This figure was adopted rather than the desktop estimate used by the NWRS as it is more accurately calculated for the conditions in this WMA. Refer to the discussion in **Chapter 4**.

Invasive Alien Plant Control: Invasive alien plants occur mainly in the riparian zone. The impact of invasive alien plants on the yield in this sub-area is 5 million m^3/a. Although infestation is not heavy in most parts of the sub-area, the mountainous nature of the area makes it costly to clear invasive alien plants. As part of good catchment management invasive alien plant infestations should be systematically removed to limit future impact. Eradication would provide the benefit of increasing the base flows of the rivers. The cost of eradication should be borne by direct beneficiaries or, if none can be identified, by catchment management charges.

Figure 3.2: Irrigation release from Clanwilliam Dam

3.1.4 Current Water Requirements and Use

Irrigation: In the upper reaches of the Olifants River numerous small farm dams have been constructed for the irrigation of fruit and vegetables. A large proportion of irrigated land is under citrus, with a small proportion under deciduous fruit, which is the economic mainstay in the Olifants River Valley. The area under irrigation is approximately 11 100 ha at a scheduled quota of 11 100 m^3/ha/a. There are limited measurements to determine abstracted water volumes used by irrigated agriculture. Ongoing efforts to enhance the efficiency of irrigation should be encouraged to maximise the available resource.

Groundwater is being increasingly used to supplement summer shortfalls in irrigation water supplied from the river, particularly in the river reach upstream of the Clanwilliam Dam (E10D-F). The 94 million m^3/a let out from the dam to the Lower Olifants sub-area is considered a transfer from this sub-area.

Supply to towns: The main towns in the catchment are Clanwilliam and Citrusdal. Clanwilliam is supplied from Clanwilliam Dam and the Jan Dissels River, whereas Citrusdal is supplied from the Olifants River. Citrusdal has experienced periods of failure in surface water supply from the Olifants River in summer, and now augments supply from high-yielding boreholes (>20 ℓ/s) in the Boschkloof wellfield. Urban use accounts for 1 million m^3/a.

Commercial forestry: Approximately 766 ha of commercial forestry occurs in this sub-area. No further forestry is envisaged. Further forestry licences should not be recommended.

3.1.5 Yield Balance

The yield balances in the sub-area are shown in **Table 3.1**. The total available yield in this sub-area is 197 million m^3/a. The requirements are 197 million m^3/a. The sub-area is therefore in balance.

3.1.6 Future Water Requirements

Irrigation
There is demand for growth in agriculture in the Upper Olifants. There is pressure from resource-poor farmers to be given land and water allocations. Water trading should be encouraged to accommodate this need or further resource development should be undertaken. There is insufficient storage to provide for agricultural use during the dry summer and the low flows are pressurised by ongoing peak demand. A higher percentage of existing lawful use should be stored during winter high flows in off-channel storage dams instead of using scarce summer flows. No further licences for additional use are being encouraged until the EWRs have been established.

Urban use
The towns of Citrusdal and Clanwilliam are in this sub-area. There is moderate pressure for growth. The investigations into the raising of Clanwilliam Dam and groundwater sources will provide options for augmenting town supplies.

3.2 KOUE BOKKEVELD SUB-AREA [E21]

3.2.1 Location

The sub-area forms part of the southern boundary of the WMA. It lies between the Koue Bokkeveld and southern Cederberg mountain ranges on the west (E10 boundary), and the Swartruggens Mountain Range on the east (E22 boundary). There is only the small town of Op-die-Berg in this sub-area. There is intensive agricultural development, mainly deciduous fruit and vegetables.

The Koue Bokkeveld has several rivers which feed into the Doring River. The most notable of these are the **Groot River** (E21F), **Matjies River** (E21L) and the **Riet River** (E21). The Koue Bokkeveld has a catchment of 3072 km^2.

3.2.2 Groundwater

The sub-area is underlain by formations of the Table Mountain Group (TMG), Bokkeveld Group and Witteberg Group. Younger alluvial deposits occur in restricted areas around the river flood plains. The most important aquifers are the Peninsula, the Nardouw and the Witteberg quartzites. These aquifers range between 100 – 200 meters thick thus having significant storage potential. High rates of recharge occur in the fractured rock aquifers from rainfall and snow melt.

The groundwater quality varies, depending on the aquifer being utilised, but is of fairly good quality if not being drawn from the Karoo rocks. Numerous boreholes have been drilled around the TMG-Bokkeveld contact here. There is potential to increase the utilisation of the deeper Peninsula and Witteberg Aquifers. Groundwater for the sub-area is discussed in detail in **Appendix 4.**

KOUE BOKKEVELD SUB-AREA MAIN FEATURES:

Main Rivers:
- Groot River (E21F)
- Matjies River (E21L)
- Riet River (E21)

Towns: Op-die -Berg

Main dams:
- Jakkals Dam in E21C
- Lochlynne Dam in E21A

Some identified schemes:
- None

Transfers:
- None

Major conservation areas:
- Cederberg Wilderness Area & Conservancy
- Matjiesrivier Nature Reserve
- Hottentotskloof
- Swartruggens Conservancy

3.2.3 Water Resources Availability

The average MAP for this sub-area is 413 mm and the cumulative natural MAR is 279 million m^3/a. The resource availability is summarised in **Table 3.2.**

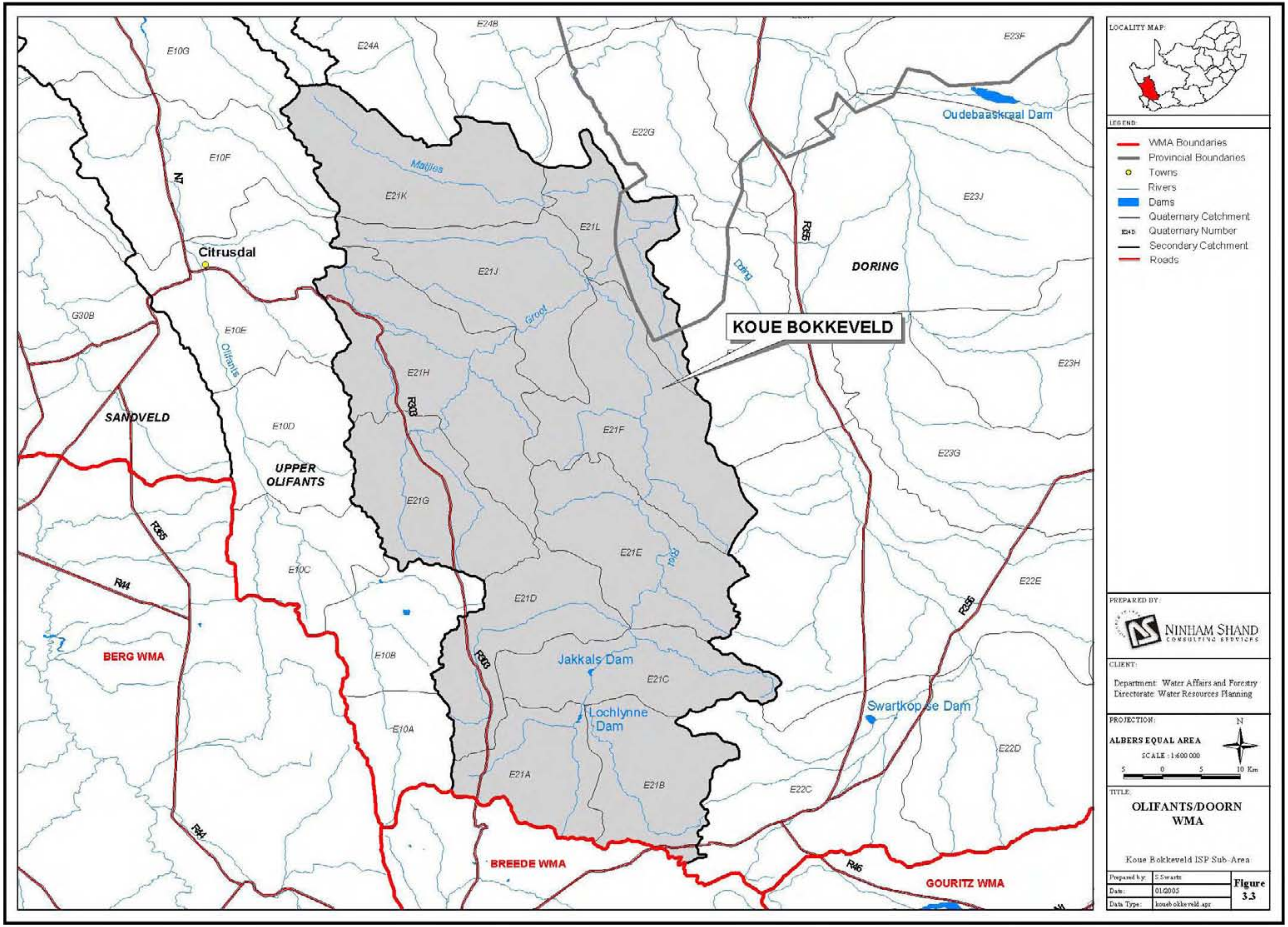


Figure 3.3: Kouebokkeveld Sub-area

Invasive Alien Plant Control: Invasive alien plant infestations account for 1 million m^3/a impact on the yield. Black wattle infestations in the Middleberg Pass and Pine infestations in the Groot River are significant. As part of good catchment management IAPs should be controlled, as this area is prone to rapid invasion of the mountainous terrain which would lead to costly removal.

Table 3.2: Koue Bokkeveld Yield Balance

Resource	*Million m^3/a at 1:50 yr assurance*
Water Availability	
Gross surface water yield	**60**
Subtract	
- **Ecological Reserve**	**0**
- **Invasive alien plants**	**1**
Net surface water yield	**59**
Groundwater	**5**
Return flows	**3**
Total local yield	**67**
Transfer in	**0**
Total Available Water	**67**
Requirements	
Irrigation	**65**
Urban	**0**
Rural	**1**
Industrial / mining	**0**
Afforestation	**0**
Total local requirements	**66**
Transfer out	**0**
Total Water Requirements	**66**
Reconciliation	
Yield Balance	**1**

3.2.4 Current Water Requirements and Use

Irrigation: The Koue Bokkeveld catchment has been extensively developed for the cultivation of deciduous fruits and vegetables. Irrigation constitutes 98% of water use in the sub-area. Irrigation water is stored in a large number of farm dams and accounts for the total gross surface water resource as shown in **Table 3.2**.

Supply to towns: There is only the small town of Op-die-Berg in the Koue Bokkeveld.

3.2.5 Water Balance

The water availability and water requirements are approximately in balance. The agricultural sector is the largest water use sector in the catchment using 98% of the water. The total yield available in the sub-area is calculated as 67 million m^3/a and the total current requirements are estimated at 66 million m^3/a. The sub-area therefore has a small surplus of 1 million m^3/a and can be regarded as essentially in balance.

Figure 3.4: Many of the mountain streams of the Koue Bokkeveld are pristine.

Figure 3.5: The Cederberg and Swartruggens are rich in San rock art.

3.2.6 Future Water Requirements

Irrigation

There is increasing demand in the area for agricultural expansion. In the Olifants Doring River Basin Study Phase 1 (1998) the cost benefit ratio for the Koue Bokkeveld farm developments was substantially higher than that calculated for other proposed schemes.

However, in the Basin Study report it was recommended that a total limit of 950 ha should be placed on the approval of further irrigation licences. A period of seven years (1998-2005) was allowed for setting the Reserve for the re-assessment of the major developments along the Doring River, after which the situation would be reviewed.

Once the EWR has been determined the potential for increased storage of winter water can be assessed. The groundwater-surface water interactions need to be considered prior to contemplating increased groundwater use. However, there is potential in the deeper TMG aquifers. The limiting of new irrigation licences (to a total of 950 ha) should be reconsidered before the end of 2005.

3.3 DORING SUB-AREA [E22, E23, E24, E40A – D]

3.3.1 Location

The sub-area forms part of the southern and eastern boundaries of the WMA. The Doring River rises in the E22 catchments. It meets with the Olifants River (E23F-H) below the Bulshoek Weir. This sub-area incorporates the Doring River, the Tankwa River and the Oorlogskloof River catchments. The sub-area has a catchment area of 20 970 km^2 (see **Figure 3.6**).

3.3.2 Groundwater

This area is on the boundary between Cape Fold Mountain rocks and those of the Karoo. It is underlain by formations of the Witteberg Group, Dwyka Formation, Ecca Group, and lower Beaufort Group. The Dwyka and the Ecca Formations form fractured rock aquifers. Rainfall patterns in this region are such that infrequent flood events recharge the aquifers. Baseflow into the rivers is ecologically important to species which over-summer in pools in the riverbed. There is uncertainty regarding the groundwater usage in the area. Much of the groundwater is of very poor quality and given the relatively low yield estimates would be capital intensive to develop for any large-scale supply. However, for small-scale supply some parts of the sub-area are reliant on groundwater and it is believed that further exploitation potential exists. Groundwater for the sub-area is discussed in detail in **Appendix 4.**

3.3.3 Water Resources Availability

The MAP in this sub-area varies from 199 mm in the E23 catchments to 256 mm in the E40 catchments. The incremental MAR is about 229 million m^3/a.

In the E22 catchment, an inter-basin water transfer of 2.5 million m^3/a is undertaken from the catchment of Lakenvallei Dam in the Breede WMA via the Inverdoorn canal into the Upper Doring River catchment for irrigation. The privately owned Oudebaaskraal Dam on the Tankwa River supplies water for irrigation of a maximum of 320 ha.

DORING SUB-AREA MAIN FEATURES:

Main Rivers:
- Doring River (E24)
- Tankwa River (E23)
- Tra-Tra River (E23K)
- Groot River (E22)
- Biedou River (E24J)
- Koebee River (E24M)
- Brandewyn River (E24M)
- Oorlogskloof (E40A)

Towns: Calvinia, Niewoudtville, Wuppertal.

Main dams:
- Oudebaaskraal (34 million m^3) in E23F

Some identified schemes:
- Aspoort Dam
- Melkboom Dam/ Melkbosrug Dam
- Brandewyn Dam

Transfers:
- Inter-basin transfer via the Inverdoorn Canal

Major conservation areas:
- Tankwa Karoo National Park
- Akkerendam Nature Reserve
- Swartruggens Conservancy

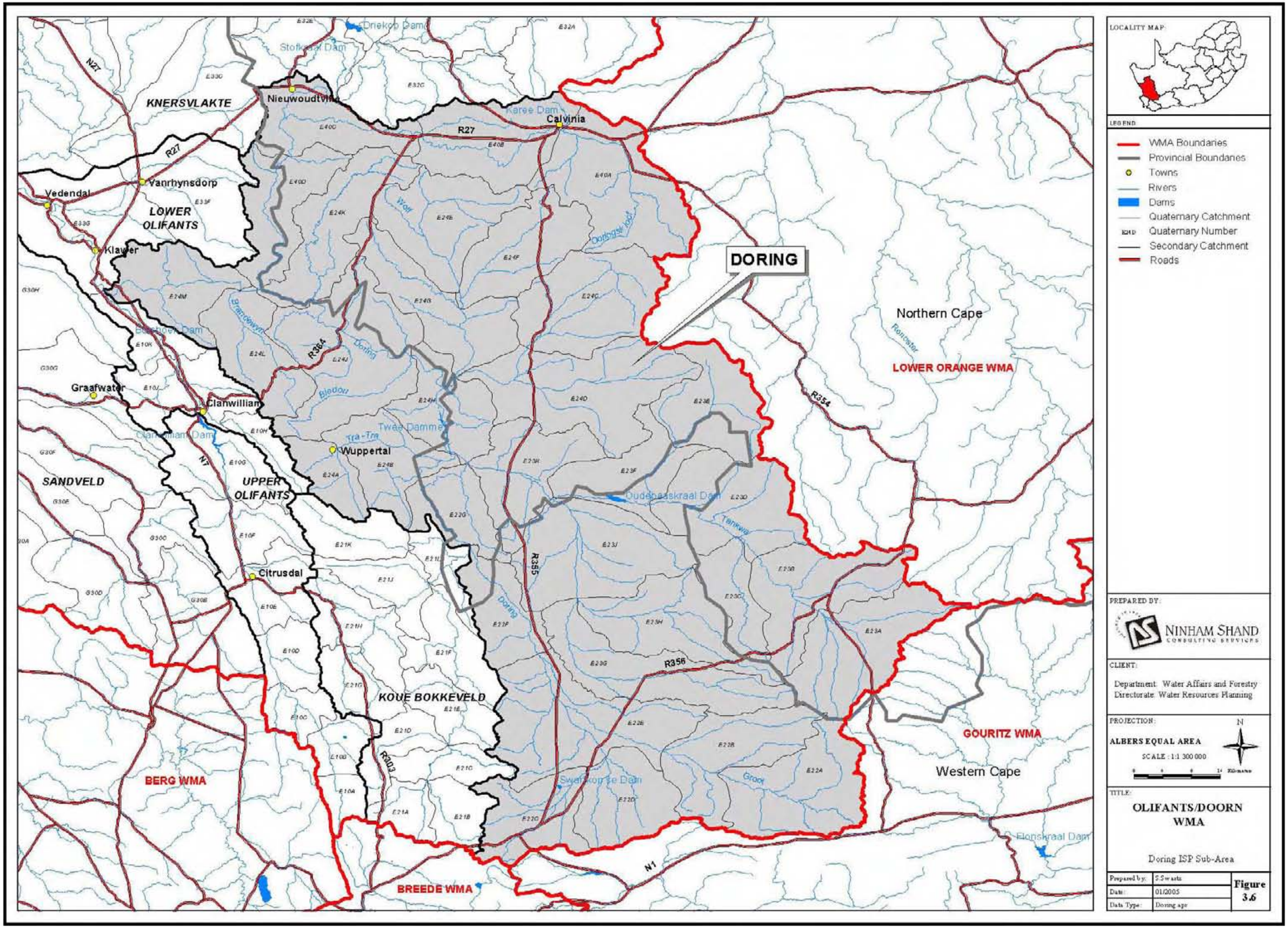


Figure 3.6: Doring Sub-area

Invasive Alien Plant Control: Invasive alien plant infestations are not yet significant in terms of water consumption but occurrences should be controlled in accordance with good catchment management, as the riparian areas are prone to rapid invasion. Prevention of infestation would provide the benefits of maintaining the base flows of the rivers.

3.3.4 Current Water Requirements and Use

Table 3.3 provides a summary of the water resources.

Table 3.3: Doring Yield Balance

Resource	*Million m^3/a at 1:50 yr assurance*
Water Availability	
Gross surface water yield	**10**
Subtract - **Ecological Reserve** - **Invasive alien plants**	 **2** **0**
Net surface water yield	**8**
Groundwater	**3**
Return flows	**0**
Total local yield	**11**
Transfer in	**3**
Total Available Water	**14**
Requirements	
Irrigation	**13**
Urban	**1**
Rural	**1**
Industrial / mining	**0**
Afforestation	**0**
Total local requirements	**15**
Transfer out	**0**
Total Water Requirements	**15**
Reconciliation	
Yield Balance	**(1)**

Irrigation: The E23 catchment is located in a dry climate. Lucerne and pastures are grown under irrigation. At the confluence of the Tankwa and Doring rivers, water is abstracted from the Doring River for the irrigation of 350 ha of land from the water works of the Elandskaroo Irrigation Board.

Supply to towns: The two main towns of the sub-area are small. Calvinia (small dam and 3 boreholes) and Nieuwoudtville (1 borehole) are reliant on groundwater.

3.3.5 Water Balance

The total yield available in the sub-area is calculated as 14 million m^3/a and the total current requirements are estimated at 15 million m^3/a. The sub-area therefore has a small deficit of only 1 million m^3/a and can be regarded as essentially in balance.

3.3.6 Future Water Requirements

Irrigation: There is a demand for increased agriculture aimed at poverty alleviation. An investigation of the potential of a dam at Aspoort was undertaken by the Northern Cape Province in the 1990s. Various initiatives were investigated further in the Olifants Doring River Basin Study (1998) such as dams further down the Doring River at Melkbosrug and Melkboom.

Figure 3.7: The Draaikraal River, like many of the Doring's tributaries, is dry in summer.

The study indicated that the Aspoort and Melkboom dams would have potential for irrigation developments on a relatively large scale. It was however indicated that considerably more work was needed to verify the assumptions used.

The Northern Cape Department of Agriculture originally proposed to undertake a pilot scheme to verify some of the assumptions used for the Aspoort Scheme. However, the pilot scheme has not yet been undertaken. The Western Cape Department of Agriculture initiated the Western Cape Provincial Government Olifants Doring River Irrigation Study (WODRIS) which has investigated the Melkboom and Melkbosrug dams in more detail. A development cap was put in place for a period of seven years, up to the end of 2005, to ensure that *ad hoc* development did not preclude the development of any of these schemes by the Northern Cape. At the end of 2005 DWAF should reconsider the situation in the light of new information available at that stage.

Recently private farmers proposed a project entitled the Tankwa-Karoo Empowerment Project. The project proposes to develop 600 ha of dates, taking winter surplus from the Doring River via a 33 km pipeline to the Oudebaaskraal Dam. There are however significant environmental concerns surrounding the construction of any dams on the Doring River which has resulted in the evaluation of an off-channel storage dam on the Brandewyn River. The EWRs, which would have to be released if any dam was constructed, has also been of concern. The Department commenced a Comprehensive Reserve Determination Study of the Olifants and Doring Rivers, which is expected to be complete by the end of 2005 (refer to **Section 2.1.8** and **Strategy 7.1**).

Urban use: There is limited storage and the supplies to towns require augmentation. Future supply will need to be secured and additional storage is required.

3.4 KNERSVLAKTE SUB-AREA [E31A-H, E32, E33A-E, F60B-E]

3.4.1 Location

The sub-area forms the northern part of the eastern boundary of the WMA. It comprises the Hantams, the Kromme and the Goerap catchments, as well as the Sout River tributary of the Lower Olifants River. The sub-area extends from the escarpment range (Lower Orange WMA boundary) to the coastline. The Kromme portions of the sub-area has an endoreic drainage pattern (E31A sub-catchment), which is thought to have been connected many of millions of years ago to an extensive palaeo-drainage system in the southern part of the Lower Orange WMA. The Knersvlakte has a catchment of 16 710 km^2 (see **Figure 3.8**).

3.4.2 Groundwater

The sub-area is dependent on groundwater, the key uses being for stock watering and domestic use. Groundwater is drawn from primary aquifers, fractured rock aquifers, and dolerite dykes. The groundwater quality is generally poor and volumes are limited. Rainfall is low and there is little recharge other than during flood events.

Recharge processes and patterns and their relationship to historical weather patterns limit the groundwater potential. This relationship and the aquifer storage potential are currently not well understood, therefore predictions must be conservative. There is limited further groundwater development potential in this sub-area. Reports of declining water levels in the supplies to small towns support this. Groundwater for the sub-area is discussed in detail in **Appendix 4**.

KNERSVLAKTE SUB-AREA MAIN FEATURES:

Main Rivers:
- Hantams River (E32E);
- Krom River (E31C)
- Sout River (E33C)
- Geelbeks River (E33D)
- Groot Goerap (F60D)

Towns: Loeriesfontein, Nuwerus, Bitterfontein

Main dams:
- Driekop Dam in E32D
- Stofkraal Dam in E32E

Future identified schemes:
- None

Transfers:
- Transfers to Namakwa-Sands and towns

Major conservation areas:
- None

Figure 3.8: Knersvlakte Sub-area

3.4.3 Water Resources Availability

The MAP in this key area varies between 118 mm in the E31 catchments and 198 mm in the E32 catchments. The cumulative MAR for the area is about 27 million m^3/a. The climate is very dry and opportunities for surface water resource development are limited. The total available water resource and the corresponding preliminary ecological water requirements are summarised in **Table 3.4.**

Table 3.4: Knersvlakte Yield Balance

Resource	*Million m^3/a at 1:50 yr assurance*
Water Availability	
Gross surface water yield	**1**
Subtract - **Ecological Reserve** - **Invasive alien plants**	 **0** **0**
Net surface water yield	**1**
Groundwater	**3**
Return flows	**0**
Total local yield	**4**
Transfer in	**4**
Total Available Water	**8**
Requirements	
Irrigation	**3**
Urban	**0**
Rural	**1**
Industrial / mining	**3**
Afforestation	**0**
Total local requirements	**7**
Transfer out	**0**
Total Water Requirements	**7**
Reconciliation	
Yield Balance	**1**

There are no major dams in the sub-area. There is a transfer of 2.4 million m^3/a into the sub-area from the Olifants River Canal near Lutzville (E33H) to the Namakwa Sands Mine (F60D). The distribution loss of 1 million m^3/a, due to this transfer, forms part of the total transfer shown in the table.

Invasive Alien Plant Control: Invasive alien plants are mainly situated in riparian areas. However, due to dry climate they are not a regional priority for eradication, as the impact on yield is negligible. IAP infestations do influence the yield potential of primary aquifers and eradication should be encouraged as a good catchment management practice.

3.4.4 Current Water Requirements and Use

In the F60 catchments, water is required mainly for urban, rural and mining uses.

Figure 3.9: Looking west across the Knersvlakte from Van Rhyn's Pass

Figure 3.10: The Sout River

Irrigation: Limited irrigation is undertaken in this sub-area. It does however comprise 43% of the total water use. Agricultural activities are predominantly grazing, due to low rainfall.

Mining: The estimated requirement for mining use is 2.5 million m^3/a. This requirement is primarily for the Namakwa Sands Mine.

Urban Use: The towns in this catchment include Bitterfontein, Nuwerus and Loeriesfontein which rely on groundwater.

3.4.5 Water Balance

The total yield from the sub-area is estimated to be 8 million m^3/a and the total requirements 7 million m^3/a. Therefore with a surplus of 1 million m^3/a the sub-area is approximately in balance.

3.4.6 Future Water Requirements

Irrigation: The irrigation requirements in the sub-area are not anticipated to expand.

Mining: The mining activities in the sub-area are not anticipated to expand significantly.

Urban use: All rural and urban supplies in this area are based on groundwater. The towns in this sub-area are stressed and are looking for other sources or increased groundwater resources.

3.5 LOWER OLIFANTS SUB-AREA (E10H – K, E33G, E33F, E33H)

3.5.1 Location

The Olifants River flows from Clanwilliam Dam for 35 km to the Bulshoek Weir, below which the Doring River (E33F-H) joins it and together they flow to the sea at the Olifants Estuary. The Lower Olifants has a catchment area of 8 216 km^2.

3.5.2 Groundwater

The E33F-H catchments are underlain mainly by low-grade metamorphic schists, limestone and marbles of the Nama and Gariep Groups, locally overlain by aeolian, shallow-marine and alluvial terrace deposits. The E10J-K catchments are underlain by gently folded and faulted TMG units, with localized outcrops of lower Bokkeveld Group around Clanwilliam (E10J).

The groundwater usage is predominantly in the primary aquifer along the coast, with some further use from the deeper aquifers. There is great uncertainty regarding the actual groundwater use. It is necessary to establish potential groundwater usage and baseflow estimates in this water stressed area.

Appendix 4 details the models estimating groundwater recharge and availability.

LOWER OLIFANTS SUB-AREA MAIN FEATURES:

Main Rivers:
- Olifants River (E10);
- Doring River (E24)
- Jan Dissels River (E10H)
- Sout River (E33C)

Towns: Vredendal, Vanrhynsdorp, Papendorp, Lutzville, Ebenhaezer, Koekenaap, Klawer

Main dams:
- Bulshoek Weir (18 million m³) in E10J;

Some identified schemes:
- None

Transfers:
- Transfer to Namakwa-Sands
- Transfer to Sandveld sub-area.

Major conservation areas:
- Olifants River Estuary
- Lutzville Conservation Area
- Moedverloren Nature Reserve

3.5.3 Water Resources Availability

At 144 mm, this catchment has the lowest average MAP in this WMA. The incremental natural MAR is 41 million m^3/a. The catchment receives a large transfer of 94 million m^3/a from the Upper Olifants but a deficit of 29 million m^3/a still exists. Irrigated agriculture is the largest water user with estimated requirements of about 140 million m^3/a (i.e. about 95% of the total requirements in the catchment).

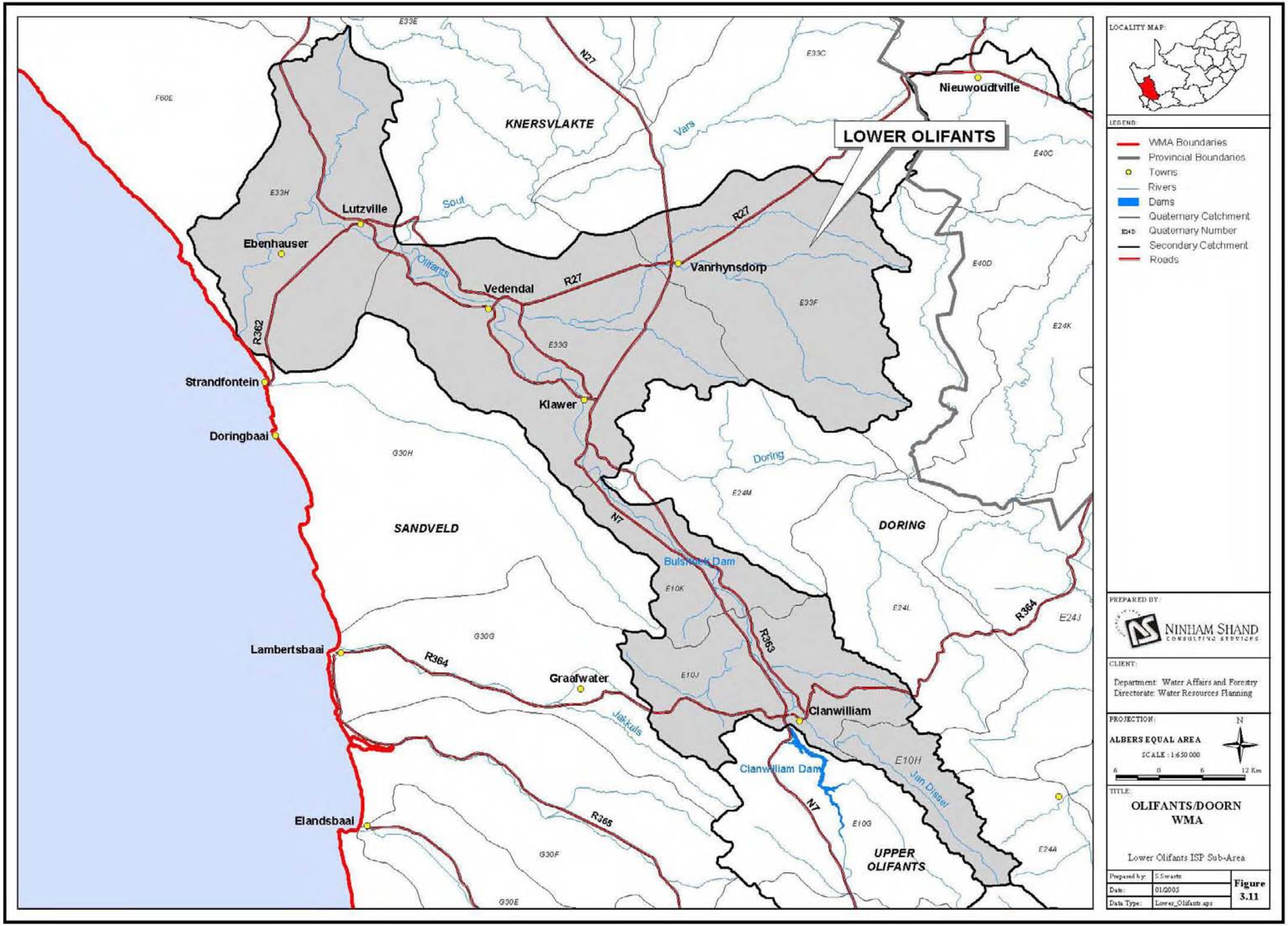


Figure 3.11: Lower Olifants Sub-area

The estuary is considered to be important and freshwater requirements for the estuarine Reserve are being determined in the Reserve Determination Study (refer to **Section 2.1.9**).

Figure 3.12: The extensive salt marsh at the Olifants River Estuary provides habitat for many rare species.

Invasive Alien Plant Control: Invasive alien plants occur mainly in the riparian zone. The impact on yield is very small.

Table 3.5: Lower Olifants Yield Balance

Resource	*Million m^3/a at 1:50 yr assurance*
Water Availability	
Gross surface water yield	**26**
Subtract	
- **Ecological Reserve**	**8**
- **Invasive alien plants**	**0**
Net surface water yield	**18**
Groundwater	**1**
Return flows	**6**
Total local yield	**25**
Transfer in	**94**
Total Available Water	**119**
Requirements	
Irrigation	**140**
Urban	**3**
Rural	**1**
Industrial & mining	**0**
Afforestation	**0**
Total local requirements	**144**
Transfer out	**4**
Total Water Requirements	**148**
Reconciliation	
Yield Balance	**(29)**

3.5.4 Current Water Requirements and Use

A summary of the water resources is given in **Table 3.5.**

Irrigation: Agriculture is the major user in this sub-area with a requirement of 140 million m^3/a. The scheduled area under irrigation is approximately 11 920 ha, at a scheduled quota of 12 200 $m^3/ha/a$, although the average quota used is only about 11 000 $m^3/ha/a$. Approximately 11 000 ha is irrigated from the GWS canals supply, although only 9 211 ha is scheduled. The crops grown in the catchment are grapes (wine, table and raisins), deciduous fruits and vegetables.

Figure 3.13: Cultivation of table grapes and wine grapes is wide spread in the Lower Olifants.

Figure 3.14: The irrigation canal snakes down the Olifants River Valley.

Grapes are the dominant crop. These crops are mainly irrigated from water conveyed from Bulshoek Weir by means of a 186 km canal.

Urban Use: The main towns in this catchment are Vredendal, Vanrhynsdorp, Lutzville, Ebenhaezer and Klawer. These abstract and treat water from the canal for urban use. The water available for use is constrained by the physical limitations of the canal and water conservation and demand management initiatives such as the upgrading of the canal to reduce losses, must be investigated. Urban use accounts for 3 million m^3/a. Water is also transferred out of the sub-area for urban use in the northern Sandveld (0.4 million m^3/a).

Mining Use: Water (2.4 million m^3/a) is transferred out of the sub-area to serve the Namakwa-Sands mine.

3.5.5 Water Balance

The total yield from the sub-area, including the transfer, was calculated as 119 million m^3/a, consisting of 25 million m^3/a local yield and a "transfer" from the Upper Olifants sub-area of 94 million m^3/a. The total requirements are 148 million m^3/a. The sub-area therefore has a deficit of 29 million m^3/a (assuming that the Upper Olifants sub-area is in balance) taking into account the impact of the Reserve. If the impact of the Reserve on the yield is not taken into account, which is the current actual situation, the deficit is only 5 million m^3/a.

3.5.6 Future Water Requirements

Irrigation: There is a requirement for a better assurance of supply for agriculture and for growth. There is pressure to allocate additional water to resource-poor farmers in this area. The Lower Olifants River WUA is engaged in facilitating water trading to ensure that provision is made for poverty alleviation. The sub-area is stressed and no further abstraction licences should be issued.

Urban use: There are several towns in the Lower Olifants area. Limited growth of these towns is anticipated.

3.6 SANDVELD SUB-AREA [G30]

3.6.1 Location

The sub-area forms part of the western coastal boundary of the WMA. The Sandveld has several small rivers which flow towards the sea. The most notable of these are the **Verlorevlei River** (G30F) and the **Langvlei River** (G30G). It is bounded on the west by the Atlantic coastline, on the east by the Olifants mountain range, and on the south by the Berg WMA. The Sandveld has a catchment of 4 590 km^2 (see **Figure 3.15**).

The Sandveld sub-area is divided between the Cederberg Municipality, incorporating the towns of Elandsbaai (G30E), Lambertsbaai and Graafwater (G30G), and the Matzikama Municipality, incorporating the coastal settlements of Strandfontein and Doringbaai (G30H). Apart from fishing and eco-tourism around the coastal resort towns, potato farming primarily under centre-pivots, is the economic mainstay of the G30 coastal plain. Activities are predominantly dependent on groundwater, except in a restricted northern part of the G30H, where a pipeline from the Olifants River Government Scheme supplies Strandfontein and Doringbaai. The Verlorevlei catchment (G30B-E) is fed by perennial stream flows from the Olifants Mountains and northern Piketberg.

3.6.2 Groundwater

The area is underlain by Malmesbury Group Shales with overlying Piekenierskloof, Graafwater and Peninsula Formations of the Table Mountain Group. Numerous other major faults and fracture zones crosscut the sub-area. Along the coastal plain, young wind-deposited sands cover older marine and fluvial deposits. The groundwater in the Sandveld is from the shallow primary aquifer and from the deeper TMG Aquifer. There is evidence that water flow in the TMG in the Upper Olifants sub-area is linked to the water in the Sandveld[4]. Recharge occurs from local rainfall as well as the postulated linkages with the fractured-rock aquifers to the east. Water for agricultural purposes is obtained almost entirely from groundwater.

The DANIDA study reported that the G30F catchment is stressed. The groundwater resources are utilised by individual users without co-ordinated wellfield management. Outside of G30F the contamination of groundwater by seawater could be attributed to poor aquifer management rather than a lack of available groundwater.

SANDVELD SUB-AREA MAIN FEATURES:

Main Rivers:
- Jakkals River (G30G);
- Langvlei River (G30F)
- Verlorevlei River (G30E)
- Hol River (G30D)

Towns: Graafwater, Lambertsbaai, Elandsbaai, Doringbaai, Leipoldtville and Strandfontein

Main dams:
- None

Future identified schemes:
- None

Transfers:
- Transfer from Lower Olifants

Major conservation areas:
- Verlorevlei Ramsar Site
- Rocherpan Nature Reserve
- Elandsbaai Nature Reserve

4 This relationship is still under investigation.

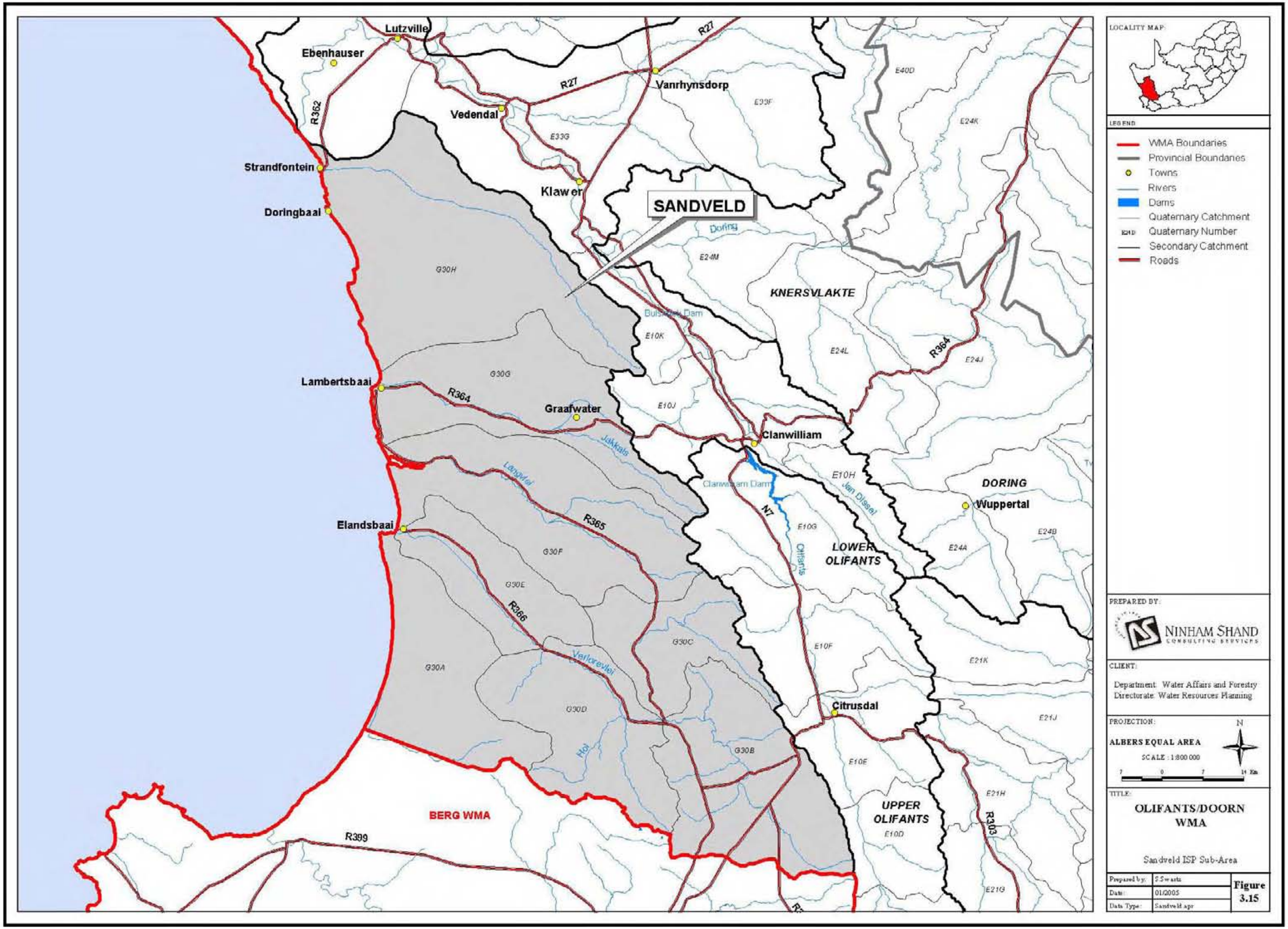


Figure 3.15: Sandveld Sub-area

3.6.3 Water resources availability

The MAP across the Sandveld area is about 295 mm and the cumulative natural MAR is approximately 55 million m^3/a. The primary source of water in this catchment is groundwater. Rapid agricultural development has already lead to over-exploitation of the groundwater resource. A summary of the water resources for this sub-area is given in **Table 3.6**.

Table 3.6: Sandveld Yield Balance

Resource	*Million m^3/a at 1:50 yr assurance*
Water Availability	
Gross surface water yield	**5**
Subtract - **Ecological Reserve** - **Invasive alien plants**	 **0** **3**
Net surface water yield	**2**
Groundwater	**30**
Return flows	**0**
Total local yield	**32**
Transfer in	**0.4**
Total Available Water	**32**
Requirements	
Irrigation	**35**
Urban	**2**
Rural	**1**
Industrial & mining	**0**
Afforestation	**0**
Total local requirements	**38**
Transfer out	**0**
Total Water Requirements	**38**
Reconciliation	
Yield Balance	**(6)**

There are no major dams in the sub-area. There is a transfer of 0.4 million m^3/a of water from the Olifants River Canal near Ebenhaezer (E33H) to Strandfontein and Doringbaai (G30H) and rural domestic consumers in the vicinity.

Invasive Alien Plant Control: Invasive alien plants are mainly situated in riparian areas and areas throughout the catchment. Eradication is an important element of catchment management. The current impact of invasive alien plants on the 1:50 yield is approximately 3 million m^3/a. There is concern that the impact of IAPs on primary aquifers in the Sandveld has been underestimated.

3.6.4 Current water requirements and use

Agriculture: Agriculture is by far the largest water use sector with estimated requirements of approximately 35 million m^3/a (i.e. about 92% of the total requirements). The primary crop in the catchment is potatoes. The fastest growing irrigation development in the catchment occurs in quaternary catchment G30F.

Figure 3.16: Looking east across the Sandveld towards Clanwilliam. Dust from newly prepared fields fills the air.

Supply to towns: The main towns in the catchment are Graafwater, Lambertsbaai, Elandsbaai, Doringbaai, Leipoldtville and Strandfontein. Strandfontein and Doringbaai are supplied, in addition to groundwater, with 0.4 million m^3/a piped from the Olifants River Scheme that is fed from the Clanwilliam Dam. The other three towns rely on groundwater.

3.6.5 Water Balance

The total yield from the sub-area is estimated at 32 million m^3/a and the total requirements as 38 million m^3/a. The catchment is stressed with an estimated deficit of 6 million m^3/a.

3.6.6 Future water requirements

Irrigation: Although there is increasing demand for agricultural development the surface and groundwater resources in this area are already stressed, especially in the G30F catchment area. Based on the yield balance estimates no further growth in the agricultural sector can be supported from the currently developed resource.

Urban use: The urban use is currently supplied by coastal aquifers and a small transfer from the Lower Olifants sub-area. The coastal groundwater sources in most cases are in danger of being over-abstracted with a risk of causing seawater intrusion. There are seasonal peaks relating to tourism influx which will need to be provided for.

CHAPTER 4
WATER RESOURCES AND WATER REQUIREMENTS

This chapter presents a perspective of the water availability in the catchment, an overview of the water requirements attributed to the various use sectors and an overview of the yield balance and reconciliation options. For the most part, the values as provided in the NWRS (availability, requirements, balance) are taken to be a summation of the best available knowledge. Where changes to these are proposed, they are identified and substantiated. Overall, the WMA is in deficit, a consequence of deficits in the Olifants River and the Sandveld, with other catchments generally in balance.

As discussed in **Chapter 2**, the WMA was divided into six sub-areas as shown in **Table 4.1** below and on **Figure 2.2**.

Table 4.1: ISP sub-areas

ISP Sub-area	Catchments
Upper Olifants	E10A to E10G
Koue Bokkeveld	E21A to E21L
Doring	E22, E23, E24A-M, E40A-D
Knersvlakte	E31A-H, E32, E33A-F, F60
Lower Olifants	E10H-K, E33F-E33H
Sandveld	G30A (part) to G30H

4.1 WATER RESOURCES AVAILABILITY

A summary of the natural mean annual runoff (MAR) by sub-area, together with the estimated average annual flow requirement for the ecological component of the provisional Reserve is given in **Table 4.2**.

The Olifants estuary is of high ecological importance (see **Section 2.1.9**) and although the estuarine freshwater requirement has not yet been determined, the Olifants Doring Basin Study Phase 1 (1998) stated that moderate further development in the WMA could be considered. There are no significant natural lakes in the WMA.

The water resources are not evenly distributed over the WMA. The highest runoff is from the relatively small southern central mountainous area of the WMA, notably the Upper Olifants, Doring and Koue Bokkeveld sub-areas, with limited runoff emanating from the arid remainder. The total natural mean annual runoff (MAR) of 1 068 million m^3/a has been significantly reduced by abstractions, mainly for irrigation. These net MAR values are shown according to the WRSM90 database, which exclude endoreic areas. The NWRS values appear to have included the endoreic areas, and were therefore higher.

Table 4.2: Natural MAR and provisional ecological Reserve requirements (million m³/a)

Sub-area	Natural MAR	Incremental natural MAR (1)	Ecological Reserve	Incremental Ecological Reserve (1)
Upper Olifants	437	437	93	93
Koue Bokkeveld	279	279	29	29
Doring	508 (2)	229	68 (2)	39
Knersvlakte	27	27	3	3
Lower Olifants	1 013 (2)	41	181(2)	17
Sandveld	55	55	8	8
Total for WMA	**1 068**	**1 068**	**189**	**189**

1) Quantities given are incremental, and refer to the sub-area under consideration only. This is the total volume, based on preliminary estimates. Impact on yield will be a portion of this.
2) Main stem cumulative.

In the 2003, *Olifants Doring River Basin Study Phase 2* Study, the Reserve was determined by using the Rapid methodology. These Reserve values were adopted for the Upper and Lower Olifants sub-areas, rather than the desktop estimate used by the NWRS, as these were more accurately calculated for the conditions in the Olifants River. Refer to the more detailed discussion in **Appendix 3**. The principle being followed is that all rivers should proportionally contribute to the Reserve. The concept of a "distributed" Reserve upstream of Clanwilliam Dam means that, to meet the Reserve, there would be a proportional impact on rivers upstream of the dam, instead of the full impact being on the dam only.

The available yield in the WMA is a combination of the yields from existing infrastructure supplying surface water, actual groundwater use and, to a small degree, usable return flows. There is also a small transfer of 3 million m³/a into the WMA from the Breede WMA. **Table 4.3** shows the availability of surface water for the sub-areas (see **Table 4.4** for Total Availability).

Table 4.3: Surface water yield for the year 2000 at 1:50 year assurance (million m³/a)

Sub-area	Yields from major dams (a)	Yields from minor dams & run of river (b)	Surface water yield before reductions (c = a+b)	Reduction in yield: Reserve (d)	Reduction in yield: Alien plants (e)	Surface water yield (c-d-e)
Upper Olifants	159 (1)	29 (2)	**188**	14	5	169
Koue Bokkeveld	0	60	**60**	0	1	59
Doring	5	5	**10**	2	0	8
Knersvlakte	0	1	**1**	0	0	1
Lower Olifants	21 (3)	5	**26**	8	0	18
Sandveld	0	5	**5**	0	3	2
Total for WMA	**185**	**105**	**290**	**24**	**9**	**257**

1) Clanwilliam Dam yield of 133 million m³/a, increased by 26 million m³/a to 159 million m³/a when the distributed Reserve is implemented.
2) The yield from *minor dams and run of river* of 55 million m³/a when no EWRs are applied, reduced by 26 million m³/a to 29 million m³/a. when the distributed Reserve is implemented.
3) Bulshoek Weir incremental yield.

Variations from the NWRS figures:

The impact of the updated Rapid Reserve on the yields of the Upper and Lower Olifants sub-areas are 14 million m^3/a and 8 million m^3/a respectively. The total impact of the Reserve on the combined Upper and Lower Olifants sub-areas is thus 22 million m^3/a, compared to the 12 million m^3/a of the NWRS.

Table 4.4 shows the yields per sub-area including groundwater, useable return flows and water transfers into the WMA or sub-areas.

Table 4.4: Available yield for the year 2000 at 1:50 year assurance (million m^3/a)

Sub-area	Natural resource		Usable return flow			Total local yield (1)	Transfers in (2)	Grand Total
	Surface water	Ground-water	Irrigation	Urban	Mining and bulk			
Upper Olifants	169	20	8	0	0	197	0	**197**
Koue Bokkeveld	59	5	3	0	0	67	0	**67**
Doring	8	3	0	0	0	11	3	**14**
Knersvlakte	1	3	0	0	0	4	4	**8**
Lower Olifants	18	1	4	2	0	25	94 (3)	**119**
Sandveld	2	30	0	0	0	32	0	**32**
Total for WMA	**257**	**62**	**15**	**2**	**0**	**336**	**3**	**339**

1) After allowance for the impacts on yield of the ecological component of the preliminary Reserve, river losses, alien invasive plants, dry land agriculture and urban runoff.
2) Transfers into sub-areas may include transfers between sub-areas as well as transfers between WMAs. Addition of the transfers therefore does not necessarily correspond to the total transfers into the WMA.
3) Transfers into the Lower Olifants of 94 million m^3/a for irrigation, mainly via the Lower Olifants River canals.

Variations from the NWRS values

a.) The combined irrigation return flow for the Upper and Lower Olifants sub-area was shown as 19.2 million m^3/a in the NWRS. This has been modified to a total of 12 million m^3/a made **up** of 8 million m^3/a in the Upper Olifants sub-area and to 4 million m^3/a in the Lower Olifants sub-area, as return flow below Bulshoek Weir up to the confluence with the Doring River is generally regarded as usable (varying seasonally), but quality then deteriorates quickly due to saline inflows from the Tankwa Karoo. The return flow is generally regarded as very saline and is mostly not considered to be suitable for direct re-use, although not enough is known about this.

b. Groundwater use along the Olifants River was documented as 4 million m^3/a in the NWRS. This use in the **Upper** Olifants sub-area has been increased to 20 million m^3/a, based on additional information that has since become available. Supporting information in this regard is documented in the *Olifants/Doorn Groundwater Overview* in **Appendix 4.**

c. The transfer to the Knersvlakte from the Upper Olifants sub-area via the Lower Olifants sub-area has been increased from 3 to 4 million m^3/a to account for operational losses in the Lower Olifants sub-area.

4.1.1 Water Availability Uncertainties

The following uncertainties exist:

- The Comprehensive Reserve requirement has yet to be determined and the yield balance is currently based on Rapid Reserve estimates only;
- The preliminary Reserve estimates do not include the estuarine or wetlands Reserve requirements, as these have yet to be determined;
- The possible effect of climate change has not been allowed for in the ISP. There have been predictions that the effects of global warming could cause a possible 10-15% reduction in streamflow in the Western Cape by 2015.

4.2 WATER REQUIREMENTS AND USE

4.2.1 Existing Requirements

The water requirements and use estimates, as shown in **Table 4.5**, are based on a 1:50 year (98%) level of assurance of supply.

The agricultural sector is by far the largest water use sector with estimated requirements of about 95% (356 million m^3/a) of the total requirements. The scheduled area under the Olifants River GWS canal system is 11 500 ha with an irrigation quota of 12 400 $m^3/ha/a$. The canal system is used for irrigation, domestic and industrial supplies for towns (refer to **Section 2.3.2**), and to the Namakwa Sands Mine, and a number of small mining activities. The strategies in **Chapter 6** describe and respond to the uncertainty associated with estimates of actual irrigation water use.

The primary source of water for towns in the Sandveld (G30), Kromme (E31), Goerap (F60), and Oorlogskloof (E40) is groundwater. The main towns in the Lower Olifants (E33) and Upper Olifants (E10) rely on water from the Olifants River Government Water Scheme, which draws water from Clanwilliam Dam or the canal system. The Namakwa Sands Mine located in the Knersvlakte (Goerap catchment - F60), obtains water from the Olifants River Government Water Scheme.

Table 4.5: Water requirements (in million m³/a, for the year 2000) at 1:50 year assurance

Sub-area	Irrigation	Urban (1)	Rural (1)	Mining and bulk industrial (2)	Afforestation (3)	Total local requirements	Transfers out	Grand Total
Upper Olifants	100	1	1	0	1	**103**	94 (4)	**197**
Koue Bokkeveld	65	0	1	0	0	**66**	0	**66**
Doring	13	1	1	0	0	**15**	0	**15**
Knersvlakte	3	0	1	3	0	**7**	0	**7**
Lower Olifants	140	3	1	0	0	**144**	4 (5)	**148**
Sandveld	35	2	1	0	0	**38**	0	**38**
Total for WMA	**356**	**7**	**6**	**3**	**1**	**373**	**0**	**373**

1) Includes component of the 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) Quantities given refer to impact on yield only.
4) Transfers out of the Upper Olifants of 94 million m^3/a for downstream irrigation, mainly via the Lower Olifants River canal.
5) Transfers out of the lower Olifants of 4 million m^3/a consist of a transfer of 2.5 million m^3/a to meet the Namakwa Sands mining requirement, and 0.4 million m^3/a to northern Sandveld urban use. The rest is provision for losses.

4.2.2 Uncertainties regarding existing requirements

Uncertainties exist regarding the following water uses:

- The accuracy of run-of-river yields and yields from farm dams, especially above Clanwilliam Dam. There is also uncertainty about the volume impounded by these farm dams;
- The extent of actual water use by irrigators, particularly those outside of WUAs;
- The extent of over-abstraction in the Olifants River sub-area, with resulting variable assurances of supply.

4.2.3 Future Requirements

Little growth is anticipated for towns, industry and mining. There is demand for further agricultural development throughout the WMA. In the Upper Olifants, Koue Bokkeveld and the Sandveld sub-areas, the demand is for ongoing expansion of existing irrigation. There is potential for further irrigation. Development in the rest of the WMA is constrained by water availability and in peak demand periods through existing infrastructure.

The *Olifants Doring Basin Study Phase 1 (1998)* recommended interim restrictions on further licensing, until more information was available on development options and the Reserve. Total new irrigation licences were restricted to the following maximums:

Koue Bokkeveld/Witzenberg:	950 ha
Citrusdal/Clanwilliam:	475 ha
Middle Doring:	150 ha
Ceres Karoo:	1 500 ha
Coastal Zone:	2 000 ha

The restrictions are currently being adhered to by DWAF. The restrictions were to apply for a period of seven years (1998-2005) when it was anticipated that there would be finality on the extent of development on the major irrigation schemes identified in the *Olifants Doring Basin Study Phase 1 (1998)*. A review of these restrictions is to take place in 2005. In most cases the irrigation development would have to be supported by resource developments such as farm dams.

The NWRS discussion of water requirements for 2025 assumes limited population growth, but more equitable distribution of wealth leading to higher average levels of water services. No adjustments were made reflecting the impacts of increased water efficiency. Tourism was considered to be the sector in the WMA undergoing the most growth between 2000 and 2025. The NWRS concluded that water requirements would remain stable perhaps decreasing slightly with the trend of depopulation of the rural areas.

The NWRS base scenario predicted that requirements would reduce in the Koue Bokkeveld, Olifants (combination of the two ISP sub-areas) and Knersvlakte sub-areas by 2025, by 1 million m^3/a each.

The NWRS high scenario predicted that requirements would reduce by one million m^3/a in the Koue Bokkeveld sub-area, and by four million m^3/a each in the Olifants (combination of the two ISP sub-areas) and Knersvlakte sub-areas by 2025. The future reconciliation scenarios are provided in **Tables 4.7 and 4.8**.

4.3 YIELD BALANCE

The reconciliation of available water and requirements for the year 2000, given in **Table 4.6**, indicates that there was an overall deficit of 34 million m^3/a in the WMA. A deficit of 29 million m^3/a is experienced in the Lower Olifants sub-area. This deficit reflects a shortage, but in practice irrigators accept a lower level of assurance.

A zero balance is shown for the Upper Olifants sub-area, because it has been assumed that users upstream of Clanwilliam Dam are not impacted on by the storage in the dam, but that the risk of shortages (deficit of 29 million m^3/a) are carried by users situated in the catchment below the dam. The catchment above Clanwilliam Dam (Upper Olifants) has therefore been assumed to be in balance. Ideally, the risk of shortages should be spread among all users. A significant portion of this deficit (22 million m^3/a) can be ascribed to the impact of the Reserve on the Olifants River, which has been taken into account in these calculations, although no releases are currently made for the Reserve.

Table 4.6: Reconciliation of water requirements and availability for the year 2000 at 1:50 year assurance (million m³/a)

Sub-area	Available yield			Water requirements			Balance
	Local yield	Transfers in (2)	Total	Local require-ments	Transfers out (2)	Total	(1)
Upper Olifants	197	0	**197**	**103**	94 [3]	**197**	**0**
Koue Bokkeveld	67	0	**67**	**66**	0	**66**	**1**
Doring	11	3	**14**	**15**	0	**15**	**(1)**
Knersvlakte	4	4	**8**	**7**	0	**7**	**1**
Lower Olifants	25	94 [3]	**119**	**144**	4 [4]	**148**	**(29)**
Sandveld	32	0	**32**	**38**	0	**38**	**(6)**
Total for WMA	**336**	**3**	**339**	**373**	**0**	**373**	**(34)**

1) Surpluses are shown in the most upstream sub-area where they first become available.
2) Transfers into and out of sub-areas may include transfers between sub-areas as well as transfers between WMAs. Addition of the transfers per sub-area therefore does not necessarily correspond to the total transfers into and out of the WMA.
3) Transfers from the Upper to the Lower Olifants sub-area of 94 million m^3/a for downstream irrigation, mainly via the Lower Olifants.
4) Transfers out of the Lower Olifants sub-area of 4 million m^3/a consists of a transfer of 2.5 million m^3/a to meet the Namakwa Sands mining requirement and 0.4 million m^3/a for northern Sandveld urban use. The balance is to provide for losses.

The 6 million m^3/a deficit in the Sandveld sub-area is attributable to urban and irrigation water requirements, in excess of what can sustainably be supplied from the available resources, with the resultant over-exploitation of groundwater to make up the shortfalls. The Upper Olifants, Doring, Koue Bokkeveld and Knersvlakte sub-areas are all approximately in balance.

It is anticipated that implementation of the Reserve could influence the use of farm dams, mainly on small tributaries, where water may have to be released to meet the needs of the Reserve. In the Doring sub-area, the Reserve will mainly impact on the resource potential which may still be developed. Due to the limited occurrence and development of surface water in the Knersvlakte and Sandveld sub-areas, implementation of the Reserve will not have any significant impact in these sub-areas.

A perspective on the possible future situation is given in **Table 4.7** for the base scenario and **Table 4.8** as representative of a possible high water use scenario, in line with the changes in water requirements as foreseen in the NWRS. Little change in water requirements is foreseen unless new large-scale irrigation development occurs.

The raising of Clanwilliam Dam, which could provide additional yield of up to 40 million m^3/a, or development of the deep Table Mountain Group aquifer, are currently seen as the most promising possible large-scale developments in the WMA.

Table 4.7: Reconciliation of water requirements and availability for the year 2025 base scenario at 1:50 year assurance (million m³/a)

Sub-area	Available yield			Water requirements			Balance (1)
	Local yield	Transfers in (2)	Total	Local requirements	Transfers out (2)	Total	
Upper Olifants	197	0	**197**	**103**	94 [3]	**197**	**0**
Koue Bokkeveld	67	0	**67**	**65**	0	**65**	**2**
Doring	11	3	**14**	**15**	0	**15**	**(1)**
Knersvlakte	4	4	**8**	**6**	0	**6**	**2**
Lower Olifants	25	94 [3]	**119**	**143**	4 [4]	**147**	**(28)**
Sandveld	32	0	**32**	**38**	0	**38**	**(6)**
Total for WMA	**336**	**3**	**339**	**370**	**0** [5]	**370**	**(31)**

1) Based on existing infrastructure and infrastructure under construction in the year 2000. Also includes return flows from growth in requirements.
2) Based on changes in water requirements as a result of population growth and general economic development. Assumed no general increase in irrigation.
3) Brackets around numbers indicate a negative balance.

Table 4.8: Reconciliation of water requirements and availability for the year 2025 high scenario (million m³/a)

Sub-area	Available yield			Water requirements			Balance (1)
	Local yield	Transfers in (2)	Total	Local requirements	Transfers out (2)	Total	
Upper Olifants	198	0	**198**	**105**	94 [3]	**199**	**(1)**
Koue Bokkeveld	67	0	**67**	**65**	0	**65**	**2**
Doring	11	3	**14**	**15**	0	**15**	**(1)**
Knersvlakte	4	4	**8**	**7**	0	**7**	**1**
Lower Olifants	26	94 [3]	**120**	**146**	4 [4]	**150**	**(30)**
Sandveld	32	0	**32**	**42**	0	**38**	**(10)**
Total for WMA	**338**	**3**	**341**	**380**	**0** [5]	**380**	**(39)**

1) Based on existing infrastructure and infrastructure under construction in the year 2000. Also includes return flows from growth in requirements.
2) Based in changes in water requirements as a result of population growth and general economic development. Assumed no general increase in irrigation.
3) Brackets around numbers indicate negative balance.

The base scenario assumes little change in economic empowerment, no significant increase in agriculture and a slightly negative population growth in the WMA (refer to **Section 2.2.1**). This results in a slight decrease of the requirements.

The high scenario assumes a more equitable distribution of economic wealth leading to a higher average standard of living and level of water services. Due to the strong irrigation based economy in the WMA and given the high level of utilisation of currently available resources, the requirements are expected to remain close to current levels (NWRS, 2004).

4.4 RECONCILIATION INTERVENTIONS

The Olifants-Doring WMA is stressed and the following reconciliation interventions[5] must be considered in order to reduce the deficit (refer to the **Reconciliation Strategy 6.3):**

- On-farm losses in the agricultural sector, which is by far the largest water use sector should be quantified and measures implemented to reduce this;
- Infrastructural losses: The feasibility of upgrading the canal system from Bulshoek Weir and improving the canal system operational procedures have been investigated by LORWUA and the recommended actions should be considered for implementation;
- Although invasive alien plants currently only have a limited impact on the WMA yield, removal should be prioritised to prevent expansion which could have a significant impact in the future;
- Development of groundwater, including the TMG aquifers;
- The investigation of the raising of Clanwilliam Dam should proceed;
- Investigations of other potential development schemes should be considered together with the Clanwilliam Dam Raising before any final development decisions are made;
- Implementation of water conservation and demand management measures by local authorities.

4.5 WATER QUALITY

4.5.1 Surface water

The surface water quality of the Olifants-Doorn WMA is quite variable. Water quality in the Clanwilliam Dam area is suitable for all uses. There is a slight increase in concentration of total dissolved solids (TDS) in a downstream direction. Previous studies (*Olifants Doring Basin Study Phase 1, 1998*) found that there was a difference between unimpacted catchments and the main stem of the Olifants River that was impacted by agricultural activities. Unimpacted catchments, like the Jan Dissels River, showed evidence of a seasonal trend in the data. The seasonal trend indicated elevated TDS concentrations at the end of summer (March/April) and decreased concentrations at the end of winter (July – October). It was found that TDS concentrations in the main stem Olifants River were higher but still suitable for agricultural and domestic purposes (*DWAF Basin Study, 1998*). No trend was evident but

[5] It should be noted that these interventions are not ranked in terms of which would produce the highest volumes.

there were strong seasonal variations with higher concentrations early in winter probably originated from the wash-off of salts from the catchment, and reduced concentrations at the end of winter. In the Olifants River downstream of Clanwilliam Dam and upstream of the Doring River confluence the water quality remained suitable for agriculture and domestic water supplies.

Water quality in the Koue Bokkeveld is ideally suited for all uses. A trend of increasing TDS over time was observed in the Leeu River even though the quality is still acceptable. Marked seasonal differences were also found, with higher concentrations in summer than in winter (*Olifants Doring Basin Study Phase 1, 1998*).

The quality of water in the upper Doring River (E22), when flowing, is suitable for agriculture and domestic water supplies. However, TDS concentrations in the Kruis River are very high and variable and the water quality has been classified as marginal to poor (*Olifants Doring Basin Study Phase 1, 1998*). Water quality in the Doring River (E24) is marginal and TDS concentrations increase in a downstream direction. In the lower reaches, the water quality varies between good at the end of winter and marginal at the end of summer, probably as a result of the predominantly winter rainfall in the catchment. The water quality is still suitable for all uses but it does indicate deterioration. It has been reported (Dr Cate Brown, Southern Waters pers. comm. 2004) that farmers stop irrigating when the water begins tasting salty. Highly saline flows from the Tankwa Karoo tributaries have a sporadic influence.

The water quality status in the Oudekraal (E23), Oorlogskloof (E40), Kromme (E31), Hantams (E32), Lower Olifants (E33) and Namaqualand (F60) areas is not adequately known. It should be noted that water availability in these rivers is limited.

In the Sandveld sub-area water quality is poor to completely unacceptable in the Kruis River catchment (upper reaches of the Verlorevlei River). It improves slightly in a downstream direction but the lack of data precludes any concrete conclusions about water quality in the Verlorevlei River and in Verlorevlei itself. The cause of the poor water quality is the result of agricultural activities on the Malmesbury shales, which are high in salts and cover a large part of the Kruis River catchment (Sinclair *et al*., 1986).

Other water quality variables were also examined in the Olifants Doring River Basin Study Phase I (1998) and it was concluded for the Olifants River that:

- The source water of the Olifants River had elevated TDS and nitrogen concentrations, probably as a result of agricultural activities in the upper catchment which have an impact on the river, especially during the summer months;
- Physical and chemical characteristics of the Olifants River gorge and the mountain river reaches largely resemble natural conditions in unimpacted streams of the Western Cape. Water quality is very good until the valley widens at Citrusdal;
- The middle reaches of the river (Citrusdal to Bulshoek Weir) are impacted by agricultural activities which lead to elevated levels of dissolved and suspended solids, and nutrients, in particular nitrates. The effect of poorer water quality is exacerbated during the summer months;

- Downstream of the confluence of the Doring and Hol (in quaternary E33E) Rivers, the concentrations of TDS, total suspended solids (TSS), anions, cat-ions and alkalinity increased dramatically. This was ascribed to the introduction of more saline Doring River water coupled with additional saline irrigation return flows. A marginal decrease in nutrient concentrations was observed suggesting that nutrient enrichment in this reach was marginal.

For the Doring River it was concluded that:

- The Doring River is influenced by two distinct water chemistry systems, the one originating in the Karoo, and the other in the Cederberg Mountains. The differences in these two systems are largely the result of geological characteristics of their catchments although land use affects it to some degree.
- Rivers flowing into the Doring River from the Karoo region tend to have higher salinities, higher pH and elevated levels of nutrients and TSS (mostly clay particles).
- Rivers flowing off the southern Cederberg have low nutrient levels and lower TDS concentrations. These rivers are similar to "fynbos" rivers of the Western Cape.
- The combined effect of the two systems results in elevated salinities during periods of high flow from the Karoo rivers. When the Karoo rivers stop flowing, continued discharge from the Cederberg tributaries continue to dilute Doring River water, resulting in lower salinity levels. Towards the end of summer, salinities tend to increase again when there is no longer flow in the Doring River.

4.5.2 Groundwater Quality

Groundwater quality is generally controlled by aquifer lithology and geochemistry. Accordingly groundwater quality in the Olifants/Doorn WMA varies significantly between the fractured-rock (quartzitic) aquifers and the “intergranular (weathered) and fractured” aquifers that overlie generally impermeable shale- or granite-dominated pre-Cape formations.

- The waters in fractured-rock aquifers such as the TMG and the Witteberg Quartzites generally have an electrical conductivity (EC) of less than 70 mS/m and are moderately acidic (pH 5.5 – 6). The fractured rock aquifers yield neutral to alkaline groundwater with an EC greater than 300 mS/m, locally > 1 000 mS/m.

- Malmesbury fractured rock aquifers have acceptable water quality only where there is potential for groundwater leakage from higher-quality TMG aquifers.

- Bokkeveld groundwater is of acceptable to marginal quality. In the E10 catchments it has a mean pH of 7.7, relatively high salinity and low alkalinity. The TDS is more than 3 000 mg/l (~600 mS/m). Compared with the Bokkeveld and Karoo fractured rock aquifers adjacent to it, the quality of groundwater from the Dwyka Formation seems very poor (300-1 000 mS/m).

- Groundwater of the lowest quality (>1 000 mS/m) is found in primary aquifers overlying Dwyka tillite and lower Ecca shale in the Kliprand area, and from

Namaqua basement aquifers of low yield and low recharge potential in the northwest. The average EC for 186 groundwater-sampling points in the Nuwerus-Stofkraal-Bitterfontein area is 709 mS/m, ranging between 463-530 mS/m near Nuwerus and 566-720 mS/m near Bitterfontein.

- The groundwater in the south-western part of the WMA is generally of ideal or very good quality (EC < 70 mS/m). It is suitable for use in small towns and rural settlements where surface water scheme supplies are not in place.

The existing aquifer vulnerability map (**Figure 4.1**) appears to underestimate the aquifer vulnerability to contamination throughout the WMA. "Most vulnerable" areas (shown in red) appear in the primary coastal aquifer south of and around Elands Bay, and also north of Lamberts Bay, reflecting the potential risk of seawater intrusion from exploitation of groundwater in this area. Some areas of "moderate" aquifer vulnerability cover fractured-rock aquifers of the TMG south of Citrusdal, and Witteberg-Bokkeveld aquifers south of Wuppertal (shown in yellow). In the urban centres throughout the ISP-area it is imperative that the local authorities appreciate that the aquifers are vulnerable to contamination from urban discharge (for example, leachate from solid waste disposal sites, spills from wastewater treatment works (WWTWs) and/or quality of treated effluent used for irrigation). The importance of spring protection and well-head protection should be appreciated and understood, also in the rural areas (refer to **Appendix 4** for a more detailed description).

4.5.3 Water quality monitoring

Water quality is poorly monitored in the Olifants/Doorn WMA, although the Upper and Lower Olifants have a fair distribution of its seven monitoring points. The best-monitored surface water sampling point is the Jan Dissels River at Clanwilliam. In the Doring River catchment there are eight routine surface water quality-monitoring stations. The E3 (Hantam) catchments are poorly sampled, with the F6 (Goerap) catchment having no routine DWAF river/stream monitoring points. The G3 (Sandveld) catchment has six routine monitoring points (refer to **Strategy 13.1**).

The distribution of boreholes, which can be used for water quality monitoring, is discussed in **Section 2.3.3b.** The distribution is controlled by climatic and not geological criteria and therefore provides very poor coverage of the various aquifers (refer to **Strategies 6.2, 13.1 and 13.2**).

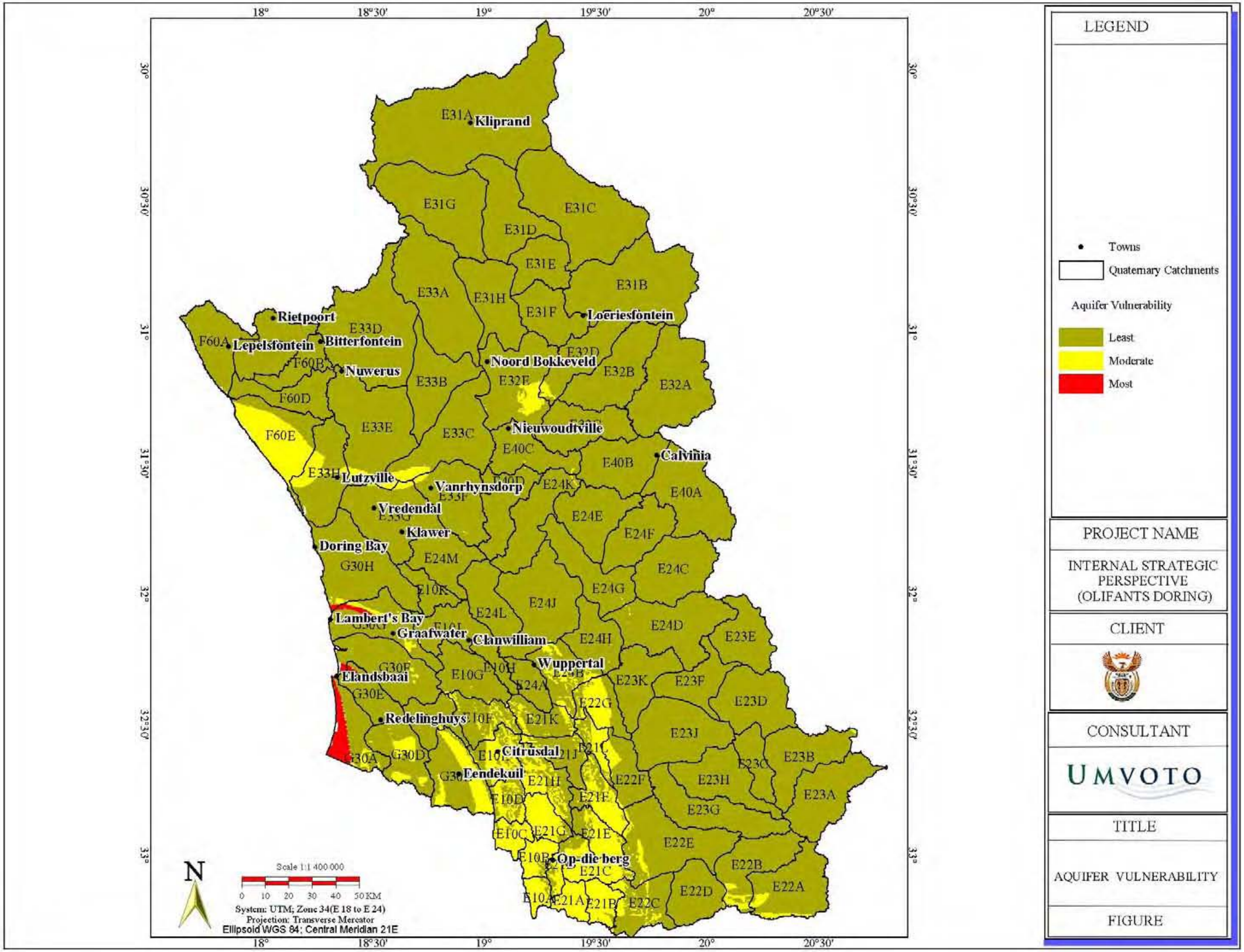


Figure 4.1: Aquifer Vulnerability

CHAPTER 5
INTRODUCTION TO THE ISP STRATEGIES

The many issues and concerns identified in the WMA will be addressed through the implementation of appropriate regional water management strategies. DWAF staff has identified the essential management strategies to manage the Olifants/Doorn WMA. Additional required strategies may be developed in future.

As stated in **Chapter 1**, the objective of this ISP is to provide a framework for DWAF's management of the Olifants/Doorn WMA both now and when the management functions are handed over to an established CMA. This ensures 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.

Ten broad strategy groups, called main strategies, that cover all necessary current and required future water management activities, were identified from current DWAF Regional Office activities, and the requirements of the NWA and the NWRS. These main strategies are:

- Yield balance and reconciliation;
- Water resources protection;
- Water use management;
- Water conservation and demand management;
- Institutional development and support;
- Social and environmental considerations;
- Integration and co-operative governance;
- Waterworks development and management;
- Monitoring and information management; and
- Implementation.

Under each of these main strategy groups, specific strategies particular to the Olifants/Doorn WMA were developed.

For each strategy, the following aspects are addressed:

- ***Management objectives*** in terms of the envisaged solutions for the strategy;
- ***Situation assessment*** providing a synopsis of the current situation with a focus on the issues;
- ***Strategic approach*** stating the approach or plan that DWAF will follow to reach its objectives for the strategy;
- ***Management actions*** states the required actions to implement the strategy;
- ***Responsibility*** names the responsible offices or Directorates;
- ***Priority*** in terms of the ISP rating system (low, medium, high and very high).

Responsibilities for main strategies and for individual strategies were assigned to responsible DWAF Directorates or Sections within the Western Cape Regional Office. DWAF head office champions were identified where appropriate. A total of 25 strategies were developed for implementation under the ten main strategy groups, in the six sub-areas.

Additional strategies that may be required in future could become apparent and should be developed as they become necessary. Some strategies combine aspects that may need to be expanded into separate strategies. The effectiveness, issues or problems encountered with water supply and sanitation programs in rural areas were not addressed in this ISP.

CHAPTER 6
YIELD BALANCE AND RECONCILIATION STRATEGIES

The current and future management perspectives and the yield balance situation were discussed in ***Chapters 3*** and ***4***.

Yield balance and reconciliation strategies address the need to:

- Clarify uncertainties and information needs regarding the availability of surface water and groundwater;
- Undertake detailed water use and requirement investigations;
- Determine and implement water reconciliation strategies for specific systems, geographical areas or water sectors.

The following specific strategies have been developed further:

- Reliability of water availability and use;
- Groundwater;
- Reconciliation.

6.1 RELIABILITY OF WATER AVAILABILITY AND USE

Management Objective:
To improve the reliability of the information on existing and potential water availability and use in the Olifants/Doorn WMA.

Situation Analysis:
There are seven main areas of uncertainty regarding the yield balance in the WMA, namely:
Farm Dams **-** There is concern that the yields of farm dams in the Koue Bokkeveld and Upper Olifants sub-areas have been underestimated; verification and validation of existing lawful use in these areas will resolve this. The particular sources of water (groundwater or surface water) being used at different times of the year also need to be established. An understanding of "on farm" water balances is needed.

Water Usage **-** Irrigation water usage in the Upper Olifants is not adequately quantified. Some users in the Lower Olifants sub-area abstract directly from the river and this needs to be quantified. Validation of registration is required throughout the WMA (refer to the **Verification Strategy**).

Groundwater **-** Current and potential groundwater use has been under-estimated in parts of the WMA**.** Resource assessments on regional and local scales are available from studies such as CAGE and the IWRM project. The discrepancies in the available numbers, and the gaps in formation, highlight the need for scientifically defendable estimates of the resource potential acceptable to most groundwater practitioners. Reconciliation of these figures is required (refer to the **Verification Strategy**).

Monitoring **-** Basic knowledge of flow, rainfall and snowfall are not well monitored. A more integrated strategic monitoring network needs to be established. This WMA is in a transitional climatic area and predictions for climate change indicate a possible reduction of rainfall by up to 15% with an increase in variability. The WMA water resources are already under stress and weather variations of this nature will only exacerbate such stress (refer to the **Monitoring Strategy**).

Reserve **-** (Refer to the **Reserve and Resource Quality Objectives Strategy**)
The effect of the Reserve on the yield of Clanwilliam Dam is given as a reduction of 12 million m^3/a in the NWRS. The *Olifants Doring River Basin Study Phase 2 (2003)* calculates the reduction in yield to be 40 million m^3/a if the EWR is supplied by Clanwilliam Dam alone and 14 million m^3/a if it is "*distributed Reserve*" (refer to **Section 4. 1** and **Appendix 3** for the discussion of this aspect).

The principle being followed is that all rivers should proportionally contribute to the Reserve. The concept of a "*distributed Reserve*" upstream of Clanwilliam Dam means that, to meet the Reserve, there would be a proportional impact on rivers upstream of the dam, instead of the full impact being on the dam only. For implementation of the *distributed Reserve*, all in-channel storage facilities will have to make appropriate releases, while a single point Reserve would release the entire Olifants River contribution from the Clanwilliam Dam alone.

***Water losses and return flows* -** There are high losses from the Olifants Government Water Scheme canal system. These losses are significant with estimates range from 20% to 38% during peak demand. These losses need to be quantified and action taken to reduce losses in conveyance. In this sub-area the water in summer is of such poor quality that it does not dilute return flows sufficiently for them to be allocated as re-usable. Due to this the NWRS values were reduced for the ISP.

***Invasive Alien Plants (IAPs)* –** There is concern that the impact of IAPs on primary aquifers in the Sandveld has been under-estimated.

Future Potential

The future potential for the development of the water resources in the WMA relies on five options:

- Increased storage of high flows in the Upper Olifants by constructing off-channel storage dams, to be filled by pumping during the winter;
- Decrease in assurance of supply where appropriate;
- Water conservation and demand management measures – particularly related to upgrading and improving operation of the Olifants Government Water Scheme canal;
- Various options which have been investigated for additional storage in the WMA, which are detailed in **Table 2.4**. The raising of Clanwilliam Dam is the option which is currently favoured due to the advantage afforded by the need to strengthen the dam;
- Groundwater as local reconciliation and conjunctive use option.

Strategy:

The registration and validation process of existing lawful use will be prioritised and continued. The surface and groundwater modelling for areas or aquifers under stress must be improved in conjunction with increased monitoring. The Department will continue to increase efforts to confirm the WMA groundwater use and availability and collection of aquifer-specific information will be encouraged.

Management Actions:

- Validation of registration.
- Undertake more detailed assessments of the availability of groundwater data within the TMG Aquifer regions and verify groundwater use data, once registered, to amend groundwater yields if necessary. This will be in terms of priorities identified in the **Groundwater Strategy** (for detail of studies underway refer to the **Reserve and resource quality objective (RQO) Strategy**).
- Determine run-of-river and farm dam yields in the Upper Olifants and Koue Bokkeveld sub-areas as outlined in the **Verification Strategy**.
- Update the yields when the current Comprehensive Reserve Study has been completed.
- Undertake further investigation on the water use of invasive alien plants in the Sandveld sub-area.

Responsibility: Regional Office with input from the Directorate National Water Resource Planning.

Priority: Very high

6.2 GROUNDWATER

Management Objective:

To ensure:

- Proper management of currently utilized aquifers;
- Reasonable evaluation of existing groundwater resource use and potential use from different aquifers; and
- Scientifically robust recommendations in management and licencing guidelines for exploration and aquifer development programmes (in specific areas) to support management decisions.

Situation Analysis:

Aquifer specific, spatially weighted or spatially averaged resource assessments on regional and local scales are available from studies such as CAGE (DWAF 2001), the Olifants/Doring WMA Water Resources Situation Assessment (DWAF 2002), the WODRIS Study (PAWC 2004), the IWRM project (DANIDA 2003) and DWAF funded projects on the Sandveld (1990 and 2003). Groundwater information is provided in **Section 2.3.3** and within each sub-area in **Chapter 3** of this document.

The discrepancies in the available numbers as well as the data and information gaps highlight the need for agreement on an appropriate scientific methodology and scale at which to quantify the resource, RQOs and licencing conditions.

Regionally there are five strategic aquifer systems in this ISP area. These are:

- The Peninsula Aquifer (fractured rock aquifer);
- The Nardouw Aquifer (fractured rock aquifer);
- The Sandveld Aquifers (primary aquifers of marine and fluvial origin);
- The Witteberg Quartzites (fractured rock aquifer); and
- The Dolerite dyke system (fractured rock aquifer).

In the northern part of the WMA, use of groundwater is of low volume but of high dependency. In the southern parts there is a higher volume available for seasonal use for agricultural production. Economic and social costs can be high in the event of failure in respect of either quantity or quality of supply.

RQO and Monitoring

At present it is unknown exactly how many boreholes are in operation throughout the WMA, particularly in the Upper Olifants, Sandveld and Lower Olifants sub-areas. A comprehensive audit of groundwater usage and current exploration is required. Current groundwater monitoring sites are opportunistic rather than designed (refer to the **Monitoring Strategy**). Determination of the groundwater Reserve has been done at an Intermediate Level in the G30E, G30F, and G30G catchments and at the Preliminary/Rapid level in the following catchments: E10E, E10F, E10G, E10J, E10K, G30H, E33G (refer to the **Reserve Strategy**).

Current protection, monitoring and management of springs are inadequate (refer to the **Resource Protection Strategy**). A number of groundwater Reserve studies have recently been completed or are currently underway or planned (refer to **Section 2.1.8**).

Water Quality

Appreciation of the movement of contaminants in fractured rock aquifers and thus protection of the groundwater resource in this WMA is poor (refer to the **Water Quality Strategy**). Poor or limited spring protection and wellfield management, and poor land-use practices pose a significant threat to RQOs (refer to the **Reserve and RQO Strategy**). The aquifer vulnerability mapping needs to be re-assessed, as it hasn't taken fractured rock aquifers into account.

Licencing and Registration

As of July 2004 there were nine groundwater use licence applications awaiting decisions in quaternaries E33F, E31E, E10C, E, F and G30A and H. Licence applications are taking up to two years or more to be processed, which perhaps reflects a lack of capacity or guidance to deal with these applications.

This is a resource management issue and requires a high degree of co-operation amongst users. For this reason consideration needs to be given to the licencing of an aquifer to a single or a group of Water Service providers, WUAs or other purposeful institutions, such that the cumulative impact of individual or small-scale groundwater developments is limited. Apportionment of individual borehole allocations within a defined aquifer zone/province then becomes the role of the local institution, and not of DWAF.

Strategic Approach:

The groundwater resource must be utilised sustainably through appropriate wellfield management and maintenance at an appropriate scale as well as at an aquifer specific scale where appropriate. Conflicting information regarding groundwater yield potential must be resolved and groundwater usage as registered on the water use authorization and registration management system (WARMS) database must be validated. Groundwater plays a critical role in this WMA and the resource management challenge of the potentially linked Upper Olifants and the Sandveld must be met. A pilot institution should be established to undertake large area aquifer management in the Upper Olifants to ensure integrated control of abstraction.

Management Actions:

- Undertake a groundwater use and exploration audit along the lines of the GRIP projects underway in the Limpopo and Eastern Cape Province;
- Establish a pilot institution to undertake large area aquifer management in the Upper Olifants to ensure integrated control of abstraction;
- Consider the option that a licence be awarded to a Water User Association rather than to individual users, where such bodies exist. DWAF would still maintain the responsibility to develop and/or authorize the aquifer specific management plans for a catchment and a wellfield scale (refer to the **Licencing Strategy**);

• Review and if necessary revise General Authorisations to limit over-abstraction (refer to the **General Authorisation Strategy**); • Initiate a co-ordination programme to improve communication between the past, current and proposed regional studies in this WMA to support the integration of groundwater understanding, insight of regional groundwater flow patterns contributing to rivers and wetlands into regulatory decisions and the design of monitoring networks; • Develop an acceptable and sound approach to water resource evaluation such that confidence in the groundwater resource quantification increases; • Develop scientific recommendations for exploration and aquifer development programmes, sustainable technology, quantitative management tools, interfaces with environmental and earth science education initiatives and vulnerability to/protection from pollution and soil erosion; • Develop and implement a strategy for integrating the results of the current DANIDA and WRC funded studies into the practice and knowledge base of the RO, and any other groundwater development.
Responsibility: Regional Office Geohydrology in conjunction with WRPS: IHP.
Priority: Very High

6.3 RECONCILIATION OF WATER AVAILABILITY AND REQUIREMENTS

Management Objective:

- To achieve an improved understanding of the balance between the available resources and requirements.
- To identify possible interventions to reconcile existing and future supplies and demand.

Situation Analysis:

Available yield

Table 6.1: Available yield for the year 2000 at 1:50 year assurance (million m^3/a)

Sub-area	Natural resource		Usable return flow			Total local yield (1)	Transfers in (2)	Grand Total
	Surface water	Ground-water	Irrigation	Urban	Mining and bulk			
Upper Olifants	169	20	8	0	0	197	0	**197**
Koue Bokkeveld	59	5	3	0	0	67	0	**67**
Doring	8	3	0	0	0	11	3	**14**
Knersvlakte	1	3	0	0	0	4	4	**8**
Lower Olifants	18	1	4	2	0	25	94 (3)	**119**
Sandveld	2	30	0	0	0	32	0	**32**
Total for WMA	**257**	**62**	**15**	**2**	**0**	**336**	**3**	**339**

1. After allowance for the impacts on yield of the ecological component of the preliminary Reserve, river losses, alien invasive plants, dry land agriculture and urban runoff.
2. Transfers into sub-areas may include transfers between sub-areas as well as transfers between WMAs. Addition of the transfers therefore does not necessarily correspond to the total transfers into the WMA.
3. Transfers into the Lower Olifants of 94 million m^3/a for irrigation, mainly via the Lower Olifants River canal.

The available yield is 339 million m^3/a. The available yield is *inter alia* determined by the infrastructure in the WMA. The Clanwilliam Dam and Bulshoek Weir feed water into the irrigation canal system and it has limited capacity and high conveyance losses. There are also numerous small farm dams in the Koue Bokkeveld and Upper Olifants used to store the high flows in winter. Additional off-channel storage is required in the Upper Olifants to increase the yield and to reduce abstractions during summer low flows. The groundwater potential needs to be resolved but the indication is that there is capacity for groundwater use to be increased in the southern portion of the WMA. Ensuring appropriate releases for the EWR is a key issue.

Current Water Requirements

The current water requirements are 373 million m^3/a. Irrigation is the largest user in the WMA. There are opportunities for water conservation and demand management in the agricultural sector as well as in urban supplies. A key issue is the leakage from the Bulshoek Weir and high conveyance losses from the canal system. This aging canal infrastructure is noted for its conveyance losses, which are estimated to be nearly 30% and does not have sufficient capacity to meet the summer peak demands.

Table 6.2: Water requirements for the year 2000 at 1:50 year assurance (million m³/a)

Sub-area	Irrigation	Urban (1)	Rural (1)	Mining and bulk industrial (2)	Affore-station (3)	Total local require-ments	Transfers out	Grand Total
Upper Olifants	100	1	1	0	1	**103**	94 (4)	**197**
Koue Bokkeveld	65	0	1	0	0	**66**	0	**66**
Doring	13	1	1	0	0	**15**	0	**15**
Knersvlakte	3	0	1	3	0	**7**	0	**7**
Lower Olifants	140	3	1	0	0	**144**	4 (5)	**148**
Sandveld	35	2	1	0	0	**38**	0	**38**
Total for WMA	**356**	**7**	**6**	**3**	**1**	**373**	**0**	**373**

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) Quantities given refer to impact on yield only.
4) Transfers out of the Upper Olifants of 94 million m^3/a for downstream irrigation, mainly via the Lower Olifants River canal.
5) Transfers out of the lower Olifants of 4 million m^3/a consists of a transfer of 2.5 million m^3/a to meet the Namakwa Sands mining requirement, and 0.4 million m^3/a to northern Sandveld urban use. The rest is due to losses.

Current Water Balance

Table 6.3: Reconciliation of water requirements and availability for the year 2000 at 1:50 year assurance (million m³/a)

Sub-area	Available yield			Water requirements			Balance (1)
	Local yield	Transfers in (2)	Total	Local require-ments	Transfers out (2)	Total	
Upper Olifants	197	0	**197**	**103**	94 (3)	**197**	**0**
Koue Bokkeveld	67	0	**67**	**66**	0	**66**	**1**
Doring	11	3	**14**	**15**	0	**15**	**(1)**
Knersvlakte	4	4	**8**	**7**	0	**7**	**1**
Lower Olifants	25	94(3)	**119**	**144**	4 (4)	**148**	**(29)**
Sandveld	32	0	**32**	**38**	0	**38**	**(6)**
Total for WMA	**336**	**3**	**339**	**373**	**0**	**373**	**(34)**

1) Surpluses are shown in the most upstream sub-area where they first become available.
2) Transfers into and out of sub-areas may include transfers between sub-areas as well as transfers between WMAs.
3) Addition of the transfers per sub-area therefore does not necessarily correspond to the total transfers into and out of the WMA.
4) Transfers from the Upper to the Lower Olifants sub-area of 94 million m^3/a for downstream irrigation, mainly via the Lower Olifants.
5) Transfers out of the Lower Olifants sub-area of 4 million m^3/a consists of a transfer of 2.5 million m^3/a to meet the Namakwa Sands mining requirement and 0.4 million m^3/a for northern Sandveld urban use, losses making up the balance.

The current water balance shows a theoretical deficit of 34 million m^3/a. Of this 24 million m^3/a is the present estimate of the Reserve which is currently not implemented. There is therefore an over-allocation of resources. Farmers have adjusted their irrigation practices to allow for this apparent deficit of 10 million m^3/a, and with that approach an uneasy balance exists. Due to the low storage capacity the WMA is vulnerable to shifts in rainfall patterns and calculations of yield and dam operating rules must adapt to reflect this. A comprehensive Reserve study is currently being undertaken and the deficit may be shown to be even higher. Decisions will have to be made on the implementation of the Reserve, and how the resultant impacts are to be addressed.

Current and Future Demands

The domestic/urban use is very small in relation to the overall use. The scenarios for future use vary from a small decrease to a small increase and hence should not be difficult to meet. The base 2025 scenario for urban use indicated that 7 million m^3/a would be required whereas the high 2025 scenario estimated that 17 million m^3/a would be required. The NWRS discussion of water requirements for 2025 assumes limited population growth but more equitable distribution of wealth leading to higher average levels of water services. Tourism was considered to be the sector in the WMA undergoing the most growth between 2000 and 2025. The NWRS concluded that water requirements would remain stable, perhaps decreasing slightly with the trend of depopulation in the rural areas.

Agriculture is the main economic activity in the WMA. The NWRS assumes no increase in irrigation requirements from the current use to 2025. There is however some demand for further irrigated agriculture throughout the WMA and this is particularly notable in the Upper Olifants and Koue Bokkeveld. There is land available for expansion in the Koue Bokkeveld, as well as in the Doring around the proposed Melkbos, Melkboom and Aspoort dams. For new development to occur water resource development will be necessary.

The cost of resource development will determine the expansion. It is likely that small additions could be undertaken through private schemes and that large development would only occur if government subsidies were in place.

The theoretical shortage of water for irrigation will however have to be addressed first, especially the EWR supply.

Potential Resource Developments:

- Raising of Clanwilliam Dam;
- Increased off-channel storage (farm dams) of high flows in the Upper Olifants sub-area;
- Water conservation and demand management – specifically related to upgrade, maintenance and efficient operation of the Olifants Government Water Scheme canal;
- Groundwater scheme development for local reconciliation;
- Surface water development options recommended by the WODRIS study.

Funding of Infrastructure

It should be noted that Government policy under normal circumstances is that the users will be required to pay for any additional resource development that may be required to provide for the ecological water requirements of the Reserve, or water for additional use. The exception is RPFs, for whom limited State subsidies may be available for bulk water infrastructure.

Strategy:

Water Conservation and Demand Management (WC&DM) in the conveyance and distribution of agricultural water, as well as improved operational efficiency of the canal system are priorities in this WMA. Urban WC&DM will also result in small water savings. Ongoing eradication of IAPs throughout the WMA will have a beneficial effect, albeit small as far as the added volume of water is concerned. Implement sustainable management of stressed aquifers. Water trading should be encouraged.

To provide a holistic picture of the WMA and options for development, the feasibility of the various large-scale storage schemes investigated over the past few decades should be discussed with the users and water forums. DWAF should make a statement regarding its position on these schemes once the Comprehensive Reserve Determination study and the Raising of Clanwilliam study have been completed in 2006. The development of off-channel farm dams should be encouraged, to store high winter flow in order to reduce the abstraction of summer low flows. Groundwater scheme options must be investigated and appropriate development options initiated.

Management Actions:

- Undertake a study to confirm run of river and farm dam capacities in the Koue Bokkeveld and Upper Olifants;
- Undertake verification of water use as per the **Verification Strategy;**
- Undertake more detailed assessments of the availability of groundwater data;
- Verify groundwater use data, as registered, to amend groundwater yields if necessary. This will be in terms of priorities identified in the **Groundwater Strategy** and **Verification Strategy;**
- A groundwater reconciliation study is required. It must address the assumptions and definitions, which provide a standard DWAF approach to the groundwater yield in conjunction with surface yield;
- All affected yields should be updated, following completion of the Comprehensive Reserve Determination which is currently under way;
- Ensure that the Clanwilliam Dam Raising Study proposes appropriate guidelines for Reserve implementation in the Upper Olifants sub-area;
- Provide a statement regarding DWAF's position on the various investigated large-scale storage schemes, once the Clanwilliam Dam Raising Study and Comprehensive Reserve Determination have been completed in 2006;
- Set up a detailed model for comparison of availability and requirements.

Responsibility: Regional Office with input from the Directorate National Water Resource Planning.

Priority: Very High

CHAPTER 7
WATER RESOURCES PROTECTION STRATEGIES

The *Water Resources Protection Strategies* address the need to achieve the protection of water resources to ensure their continuing availability for human use by providing enough water of appropriate quality while maintaining acceptable ecological and system functioning. This will be achieved by:

- Classification of freshwater bodies and determination of their human and environmental Reserves;
- Setting resource quality objectives for freshwater bodies;
- Addressing water quality management, pollution control and sanitation; and
- Addressing solid waste management.

Therefore, water required for socio-economic growth must be balanced with the availability of water that is fit for use by all users, including the protection of aquatic ecosystems. The NWRS defines two complementary approaches for the protection of water resources. **Resource Directed Measures** focus on the character and condition of the in-stream and riparian habitat, whilst **Source Directed Controls** focus on the control of water use at the point of potential impact, through conditions attached to water use authorisations.

These strategies aim to achieve adequate protection for surface and groundwater resources, in terms of the desired states of these resources, in order to reach a balance between protection and sustainable use.

The following specific strategies have been developed:

- Reserve and resource quality objectives;
- Water Quality Management; and
- Wastewater Treatment and Solid Waste Management.

7.1 RESERVE AND RESOURCE QUALITY OBJECTIVES

Management Objective:

The strategy in the Olifants/Doorn WMA seeks to ensure that:

- All the river systems in the Olifants/Doorn WMA are classified and RQOs are determined within the constraints of the national RDM priorities;
- Reserve (i.e. surface, groundwater, estuarine and wetland) determinations are carried out timeously and at appropriate levels, depending on the ecological and yield balance requirements on the system;
- Implementation Strategies for the Reserve and the RQOs are developed, once they have been determined.

Situation Analysis:

The Olifants/Doorn system comprises of two very ecologically different river systems. Flow in the Olifants River is perennial and is of good quality, because of the southern Cederberg mountains with their high winter rainfall. Much of the remainder of the WMA is located in the Karoo, resulting in low runoff of high variability and of poor quality. There are eight endemic fish species in the Olifants River, which is indicative of the significant bio-diversity. The major tributaries of the Doring River are the Groot, Tankwa, Tra-tra, Bos, Biedou and Brandewyn. The Groot River is a perennial river formed by a number of tributaries flowing from the Cedarberg mountains.

The remainder of the tributaries stem from lower rainfall areas, bordering on the Karoo and therefore many are ephemeral. Nine indigenous fish species (seven of which are endemic) and the unimpounded nature of the Doring River makes this a conservation worthy river. The Doring River is particularly sensitive to in-stream water storage structures which would change the flow dynamics and impact on the opportunity for fish to move up and down the river (refer to **Section 2.1.7**).

The Reserve

The NWRS recommends the following management classes at catchment outlets:

Table 7.1: Management classes at catchment outlets

Item	Management class at catchment outlet
Kouebokkeveld	B
Sandveld	(2) C, D
Olifants	D
Knersvlakte	C
Doring	C

1. A = Rivers of highest ecological status, D = Rivers of low to medium ecological status
2. Varies for different coastal rivers

The mouth of the Olifants River is permanently open. The tidal influence extends 36 km upstream during spring tides. The Olifants River Estuary has high conservation status. It has large areas of intertidal and supratidal salt marsh and a large number of fish and bird species which depend on the estuary. The estuary is sensitive to decreases in river flow and flood frequency. The river water quality entering the estuary is influenced by high agricultural runoff in the Lower Olifants.

The Sandveld rivers are ephemeral and feed the coastal wetlands of Verlorevlei, Langvlei, Wadriftsoutpan and Jakkalsvlei near Lambert's Bay. These systems are vulnerable due to the pressure placed on the groundwater resource and the poor quality of irrigation return flow.

The ongoing Reserve determination studies are discussed in **Section 2.1.8.** The *Olifants Doring River Basin Study Phase 2 (2003)* undertook some EWR determinations and these are integrated into the water balance in **Chapter 4**.

The Koue Bokkeveld is a highly utilised, complex system which has a unique natural environment. Hence, there is a lack of understanding regarding the Reserve requirements to ensure the functioning of the tributaries and the impact of farm dams.

The Doring sub-area is also an area of concern as many of the tributaries are ephemeral and the ecological functioning of these systems is not well understood. During summer these tributaries dry up into a series of pools in which the fish and other aquatic species survive the summer. It was recently discovered that indigenous fish species only survive in pools which have groundwater inflow during the summer. The link between groundwater baseflow and the ephemeral streams may therefore be even more critical than previously thought. Groundwater use in these drier areas must be carefully considered. It should be noted that a constraint in the Reserve Determination process is a lack of flow and water quality data throughout the WMA (refer to the **Monitoring and Data Management Strategy**).

Olifants River

Implementing the Reserve requirement at Clanwilliam Dam will result in a reduction in the yield of the dam. This reduction in yield based on the Desktop Reserve is given as 12 million m^3/a in the NWRS. The model used in the *Olifants Doring River Basin Study Phase 2 (2003)* calculates the reduction in yield to be 40 million m^3/a if the Reserve is met from the dam alone, and 14 million m^3/a for a *distributed Reserve* (refer to **Appendix 3**). The outlet structure of the Clanwilliam Dam will be affected by the EWR and the possibility of a multi-level outlet structure and concomitant water quality issues will be considered in the *Raising of Clanwilliam Dam Study*.

Groundwater and Springs

Current protection, monitoring and management of springs are inadequate. There is limited quantitative understanding of variations in spring discharge and current understanding of the relationship of different aquifers to spring flow and baseflow is uncertain. The fractured rock aquifers are especially vulnerable to contamination. The groundwater supply to small coastal resorts and the towns is also vulnerable (refer to the **Water Quality Strategy**).

Strategy:

The Olifants/Doorn WMA was identified and prioritised for Comprehensive Reserve Determination studies to be undertaken. These studies should be encouraged and supported to ensure that the work is undertaken as efficiently as possible. New licences should be discouraged in the stressed areas (Koue Bokkeveld, Upper and Lower Olifants and Sandveld) until the EWR and RQO have been finalised by the Comprehensive Reserve Determination Study.

The interim licencing practices must not jeopardise the Reserve. A precautionary approach should be adopted to licence applications, which need to be resolved in the interim. These decisions will continue to rely on *ad hoc* Rapid Reserve determinations. Only empowerment initiatives should be dealt with in this manner on account of their priority. Where possible, licences can be issued for shorter periods where there is still uncertainty about the EWR. The Regional Office must encourage and educate users regarding the importance of the EWR so as to encourage a willingness to implement the Reserve (refer to the **Capacity Building and Communication Strategy**).

EWR determinations for wetlands and groundwater will continue to be done on an *ad hoc* basis according to the latest, existing RDM methodologies. Following the development of methodologies for wetlands and groundwater, timeous identification and initiation of such Reserve studies can take place to ensure a better understanding of groundwater dependent ecosystems in the WMA. All large-scale groundwater applications will require quantification of surface -groundwater interaction.

The infrastructure development investigations such as the possible raising of Clanwilliam Dam must include designing appropriate outlet structures for appropriate flood releases. Operating rules must be updated to achieve the aims of the EWR once the Dam is raised. Once identified the operator of the dam must be trained to understand the EWR.

Management Actions:

- Utilise the River Health Programme annual surveys and other specified monitoring programmes to monitor Reserve implementation;
- Utilise technical information provided by the 2003-2005 Comprehensive Reserve Determination Study and the Sandveld Preliminary Reserve study once complete to inform Reserve implementation;
- Implement operating rules for Clanwilliam Dam after raising which meet EWR. Monitor and audit the results of these releases;
- Undertake a study to develop methods for Groundwater- Surface water interactions. Focus on contributions to river and wetland systems;
- Implement an education programme to explain the implications of the RQO and the Reserve, as informed by the comprehensive study, to local authorities, WUAs and water forums (see the **Capacity Building and Communication Strategy**);
- The results of the Reserve Determination must be integrated into an Integrated Resource Management Plan for the Koue Bokkeveld;
- Implement a baseline-monitoring programme to collect required information for wetland EWR study (refer to the **Monitoring Strategy**).

Responsibility: The implementation of this strategy is the responsibility of the Southern Cluster with contributions by the Directorate Resource Directed Measures.

Priority: Very High

7.2 WATER QUALITY MANAGEMENT

Management Objective:

This strategy seeks to achieve improved understanding of the condition and quality of water resources in the WMA and to meet the RQOs by implementing a receiving water quality management approach.

Situation Analysis:

Surface water

The high winter rainfall and the natural geology in the upper reaches of the Olifants River ensure that the water quality is good. There is an increase in salinity downstream of the confluence of the Olifants and Doring Rivers. This is attributed to the geological formations in the Doring and saline return flows from agricultural areas in the Olifants River. Many of the Doring's tributaries are ephemeral and subject to erosion which means high levels of turbidity when they are flowing during the wet season. Surface water in the northern sub-areas tends to be of lower quality on account of its higher salinity. It is generally not of potable standard (TDS of 1 000 mg/ℓ at best).

Water quality standards must be reviewed in light of the European Common Agricultural Policy standards (EURO CAP) to ensure that the export market is not jeopardised. Encourage EURO CAP and ISO14000 standards to be implemented.

Groundwater

The groundwater in the Upper Olifants sub-area is of a high quality as it is drawn from the Table Mountain Group (TMG) Sandstones. Some of the groundwater in the Sandveld is believed to be utilising Peninsula Formation hydrotechts and therefore draws on the same aquifer in the TMG Sandstones. The remaining Sandveld groundwater is contained in sandy primary aquifers which are vulnerable to infiltration by irrigation runoff. There is also some saline intrusion from the sea along the Sandveld coast due to over-abstraction.

Appreciation of the movement of contaminants in fractured rock aquifers and thus protection of the groundwater resource in this WMA is poor. Systematic monitoring of a background, diffuse and a point source nature is required to monitor and protect groundwater resources from contamination by Irrigation Return Flow (IRF) and or seawater intrusion. Groundwater in the primary aquifers of the Doring sub-area is of low quality as it is influenced by the chemistry of the Karoo Basin rocks which increase the salinity and iron content of the water. Water in the Knersvlakte is variable, from reasonable quality in the Vanrhynsdorp Karstic aquifers (E33F) near the coast to poor quality groundwater in the inland region.

Water Quality Issues and concerns in the WMA are:

- Lack of RQOs;
- Pollution (nutrient enrichment) of surface water, groundwater, estuaries and wetlands by agricultural return flow;
- Micro-organism pollution;
- Intrusion of seawater- coastal aquifers;
- Sedimentation and turbidity.

Specific water quality issues raised for sub-areas are:

Upper Olifants - The Citrusdal valley experiences eutrophication which is largely attributed to agricultural return-flows, especially in the summer months when the flow is relatively low in the river. Further to this municipal effluent, municipal solid waste management and informal settlements cause poor water quality. Effluent from fruit and wine industries needs to be monitored in Citrusdal. The fish kills, which have previously been attributed to temperature inversions in Clanwilliam Dam, need to be monitored in conjunction with water quality.

Lower Olifants - Effluents from fruit and wine industries cause seasonal water quality problems. Wine industry effluents from Klawer, Vredendal and Lutzville require on-going monitoring and management. The process of irrigation normally results in saline return flows. Poor agricultural and land management practices could result in even more undesirable agricultural return flow (refer to the **Co-operative Governance Strategy**). Due to the poor water quality, micro-organism pollution can be a problem in the Lower Olifants.

Sandveld – Pollution of wetlands and shallow aquifers by agricultural return flow is a concern and requires monitoring. Seawater intrusion into the coastal aquifers due to over-abstraction has been recognised as a threat to the sustainability of coastal water supplies.

Koue Bokkeveld – The lack of adequate sanitation for farm workers creates water quality concerns in the Koue Bokkeveld. This is exacerbated by the influx of seasonal workers during harvesting. Siltation is also a problem on account of the intensive agricultural practices.

Doring –The eastern tributaries of the Doring River have high salinity in this area as a consequence of the geology and the fact that many of the tributaries are ephemeral. This is completely natural but has consequences for utilisation.

Knersvlakte – The Knersvlakte is a naturally saline system. The brine effluent from the desalination plant at Bitterfontein which is released into evaporation ponds and the mining effluent from the Namakwa Sands operations requires on-going monitoring to prevent possible detrimental impacts.

Strategy:

A key element of the water quality strategy is to focus on improving the quality of agricultural runoff through co-operative governance with the Department of Agriculture Western Cape (see the **Co-operative Governance Strategy**).

The water quality concerns need to be better understood and therefore monitoring must be improved (refer to the **Monitoring and Data Management Strategy**). Borehole design and abstraction should be managed to avoid seawater intrusion (refer to the **Groundwater Strategy**).

Water Quality Management Strategy

Management Actions:
• Establish RQOs; • Utilise existing guidelines for borehole design in sensitive areas and where necessary update them to be area specific. Prioritise aquifers most stressed with respect to over-abstraction, poor management and threat of contamination for purposeful intervention to improve groundwater management and resource protection; • Identify and implement groundwater recharge protection zones for the resource; • Engage with the Department of Agriculture regarding programmes to limit poor agricultural practices that impact on water quality; • Encourage the CCAW to consider all new irrigation applications in terms of their impacts on water quality; • Develop and implement Pollution Incidence Plans where appropriate; • Focus surface water quality monitoring efforts on agricultural return flow and bacteriological pollution. Focus groundwater monitoring on seawater intrusion in coastal abstraction schemes (refer to the **Monitoring Strategy**); • Ensure water quality standards meet European export industry standards so that the economic base of the WMA is not threatened; • Monitor water quality in the Clanwilliam Dam in relation to the occasional fish kills; • Develop a better understanding of the short-term (day to day) water quality variability in the Doring River and its relationship with the ecology.
Responsibility: The implementation of this strategy is the responsibility of the Regional Office.
Priority: Medium

7.3 WASTEWATER TREATMENT AND SOLID WASTE MANAGEMENT

Management Objective:

To improve the negative impact that waste management practices in the WMA has on water quality.

Situation Analysis:

Issues and concerns in the WMA are:

- It is unknown which WWTWs have adequate contingency plans to deal with power outages and spills;
- Each town has its own Solid Waste Disposal Site (SWDS), some of which do not meet the full legislated standards;
- Control of solid waste on farms can be problematic, as it is perceived that farmers often dump solid waste near river courses resulting in pollution;
- The European standards for water quality need to be met in order for export produce to be accepted in the European Union (EU).

Specific Water Quality issues raised for sub-areas are:

Upper Olifants - The WWTWs at Citrusdal and Clanwilliam require urgent attention, as they do not meet the legislated standards. The SWDS of Citrusdal requires urgent attention, as it is currently not meeting required standards.

Lower Olifants - The SWDSs of Clanwilliam and Vredendal require urgent attention, as they are currently not meeting required standards.

Sandveld - Graafwater's WWTW is not meeting legislated effluent standards.

Strategy:

Sections 19 and 20 of the National Water Act state that a land owner, a person in control of land or a person who occupies land on which activities are undertaken which cause or might cause pollution is responsible for preventing and remedying the effects of such pollution. Despite this, there appears to be confusion within the WMA regarding which tier of government is responsible for pollution control. Intervention is required to establish whether provincial or local authorities are responsible for this issue. DWAF should provide standards for farm dump sites and provide limited solid waste technical assistance to local authorities through Water Service Development Plans (WSDPs).

Water quality standards must be reviewed in light of the European Common Agricultural Policy standards (EURO CAP) to ensure that the export market is not jeopardised. Encourage EURO CAP and ISO14000 standards to be implemented.

Management Actions:

- Update the list of all WWTWs (**Appendix 7**) in the WMA and identify those which have problems meeting prescribed discharge standards;
- Monitor the effectiveness of maturation ponds at the various municipalities at regular intervals;
- Assess the needs required to ensure improved management of SWDSs and WWTWs and develop a priority list;
- Through co-operative governance with local authorities, build capacity to ensure that operators of WWTWs develop responsibilities and procedures for emergency control of spillages, power failures and mechanical breakdowns;
- Highlight to the Municipal Infrastructure Grant (MIG) the concerns that the DWAF have regarding the SWDSs and the WWTWs which require infrastructure upgrades. Encourage appropriate funds to be made available for necessary upgrades;
- Liaise with the Department of Health to provide guidance regarding WWTWs and SDWSs that do not meet requirements;
- Through co-operative governance with local authorities, implement the Department's Sanitation Policy and monitor it;
- Ensure strict pollution control measures are given in new water use authorisations issued (refer to the **Licencing Strategy**).

Responsibility: The implementation of this strategy is the responsibility of the Regional Office in consultation with the national Waste Discharge and Disposal Directorate.

Priority: High

CHAPTER 8
WATER USE MANAGEMENT STRATEGIES

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

Verification of existing lawful use in terms of the water use authorisations is essential and in water stressed areas Compulsory Licensing may be required. General Authorisations provide a means of reducing the number of authorisations that require processing but should not compromise the protection of the water resource.

The *Water Use Management Strategy is required to address*:
- Usage of general authorisations to manage water use
- Verification of the extent and legality of existing water use
- Processing and issuing of new water use authorisations
- Control of invasive alien plants and weeds, and
- Implementation of pricing for water use.

The following specific strategies have been developed further:
- Water allocation and licensing;
- Verification of existing lawful use;
- Management of non-compliant use;
- Compulsory licensing;
- General authorisations;
- Invasive alien plant control; and
- Support to local authorities.

8.1 WATER ALLOCATION AND LICENCING

Management Objective:

This strategy deals with abstraction and storage licences, dam safety licences, effluent disposal licences, stream-flow reduction activity licences and licences to abstract groundwater. These are guidelines for the response to water-se applications. This strategy is to ensure that:

- licences are not issued in stressed catchments;
- optimal use of available resources;
- surplus water in the WMA is allocated as a priority to resource-poor farmers.

Situation Analysis:

The *Olifants Doring Basin Study Phase 1 (1998)* recommended restrictions on further licensing until more information was available on development options and the Reserve. Further allocations were restricted to the following limit on total licence quantity:

Koue Bokkeveld/Witzenberg	950 ha
Citrusdal/Clanwilliam	475 ha
Middle Doring	150 ha
Ceres Karoo	1500 ha
Coastal Zone	2000 ha

The restrictions are currently being adhered to by DWAF. The restrictions were to apply for a period of seven years, up to the end of 2005, to ensure that *ad-hoc* development did not preclude the development of any of these schemes by the Northern Cape. At the end of 2005, DWAF should reconsider the situation in the light of new information available at that stage. It is preferred that the High Confidence Reserve Determination and Raising of Clanwilliam Dam Feasibility studies should be completed, prior to a review of the restrictions to ensure that the relevant information is available. This could mean that the review may have to be postponed to 2006.

Licensing Farm Dams

This WMA is in a transitional climatic zone but much of its water comes from winter rainfall. This leads to the condition that the greatest demand is during summer when river flow for abstraction is limited. Farm dams play a very important role in two of the sub-areas in the WMA, namely, the Upper Olifants and the Koue Bokkeveld. There are opportunities for additional farm dam storage in the upper and the lower tributaries of the Doring River, depending on the requirements for the ecological reserve.

Stream Flow Reduction Activity Licensing

There is very little commercial forestry in this catchment. Approximately 10 km^2 is registered in the Upper Olifants sub-area. Further applications are not expected but would be evaluated in the same way as any other water use licence application.

Groundwater Licensing

It should be considered whether a groundwater abstraction licence from the fractured rock aquifers should be awarded to a Water User Association rather than to individual users so as to ensure integrated regional management of the resource. DWAF would require that aquifer-specific management plans are developed and the Water User Association would be required to implement the operating rules. RQOs and capacity building are needed to ensure compliance and adaptation of the operating rules as the monitoring information becomes available.

Issues raised for the sub-areas are detailed below:

Doring - The water resource in the vicinity of Calvinia and Niewoudtville is stressed. Trading of water use authorisations is to be encouraged to benefit resource-poor farmers. In-channel dams should be discouraged on the Doring River on account of the ecological flow requirements of the river. Limited off-channel storage can be considered where the impact on the EWR would be acceptable. Large portions of this sub-area rely on groundwater. The Western Cape Provincial Government *Olifants Doring River Irrigation Study (WODRIS study 2002-2004)* is investigating opportunities in this area.

Koue Bokkeveld - There is a lot of pressure on the water resource in the southern region of this sub-area. Numerous farm dams have been developed and there is pressure for new allocations where possible trading rather than new allocations should be encouraged. The area may need to be considered for compulsory licensing should the Reserve not be met.

Upper Olifants - There are numerous farm dams in the headwaters of the Upper Olifants sub-area and in the vicinity of Citrusdal. There are a number of applications to construct more off-channel dams to store winter water abstracted from the Olifants River in accordance with the water allocations. The Upper Olifants is stressed in summer and there is insufficient storage in farm dams. Registration of farmers' boreholes is important to determine the level of conjunctive use. The implementation of the Reserve upstream of the Clanwilliam Dam could be problematic and may result in a need for Compulsory Licensing.

Sandveld - A Reserve study is being undertaken in the Sandveld where the groundwater resources are stressed and the cumulative impact of individual or small-scale groundwater developments are not sufficiently accounted for.

Lower Olifants – The Lower Olifants is stressed, as there is over-allocation of the yield from Clanwilliam Dam which serves the Olifants River Government Water Scheme. There is pressure for development in the Vredendal area but there are limited unused allocations which can alleviate the pressure. Downstream of Bulshoek Weir, abstraction from the river is allowed under conditional authorisations (only when water is available) and below the confluence with the Doring River there may be opportunities for winter abstraction and off-channel storage, based on winter surplus flow.

Knersvlakte - Bitterfontein-Nuwerus, Rietpoort and Molsvlei urban supply areas are stressed. Further groundwater development and continued desalination seems to be the only source of future supply. Increased domestic use of groundwater had led to an urgent need for ongoing monitoring and reporting back to the water users.

Strategy:

The licensing approach will be to evaluate and process water use and storage licences only in those catchments or aquifers that clearly have allocable volumes of water. The processing will be subject to the constraints posed by the availability of resources and information. New licences for additional surface water abstraction should be discouraged until the Comprehensive Reserve Determination Study has been completed (2006).

Off-channel storage is to be encouraged in areas where surplus winter water can be stored to supplement summer low flows. The cumulative impacts of developing additional storage must take the Reserve and ecological functioning of the river system into account and ideally should benefit these. Licences should be issued for a shorter period increasing water-resource management flexibility.

The unused allocations should be quantified and trading encouraged to present opportunities to provide water to resource-poor farmers. Additional groundwater abstraction licences should be considered where abstraction will not negatively impact on surface water sources.

Area specific strategies

Koue Bokkeveld - The high winter rainfall regime with concomitant low summer flows occurs but the development of additional farm dams is not supported due to the uncertain impact that these dams may have on the small Doring River tributaries. New licences for farm dams in the Koue Bokkeveld should be discouraged until the Comprehensive Reserve Determination Study has been completed (2006).

Upper Olifants - Farmers should be encouraged and licensed to develop their off-channel storage capacity to store winter water to replace summer low-flows abstraction and thereby limit the impact on the Olifants River during the dry season. A licence to raise Clanwilliam Dam should also be considered. Pending the determination of the Reserve, storage capacities of existing or new off-channel storage dams should be in accordance with the DWAF's current licencing policy, i.e. storage is limited to a maximum of 60% of the annual allocated volume of abstraction. Additional groundwater licences can be considered.

Lower Olifants - Licences for additional surface water abstraction should be discouraged in this area. Additional groundwater licences can be considered.

Sandveld - The total groundwater abstraction needs to be capped and trading encouraged within this volume.

Management Actions: • Initiate an education programme to improve registration and compliance to licence conditions • Implement the recommendations of the National Licencing Strategy; • A Water Allocation Plan should be developed for the Sandveld; • Licence conditions must be refined with assistance of the WUAs. Licences for regional discharge conditions should be reviewed i.t.o. effluent (refer to the **Water Quality Strategy**); • Ensure that more information about boreholes is provided with groundwater licence applications including borehole logs.
Responsibility: Regional Office
Priority: Very High

8.2 VERIFICATION OF EXISTING LAWFUL USE

Management Objective:

Verification is required as a preliminary step towards compulsory licensing to improve the knowledge about water use and enable water pricing to be implemented.

Situation Analysis:

As the first step towards verification, there needs to be a validation process of water use registration information contained on the WARMS database for the Olifants/Doorn WMA. A particular concern is the lack of reliable measurements of irrigation water being used in areas which do not have WUAs. Quantities registered are accepted without being measured. There are insufficient Water Control Officers in the field to undertake such validation and control activities.

Issues identified in specific sub-areas

Upper Olifants - There is limited information on groundwater abstraction on farms and surface water abstraction from the Olifants River tributaries. It is necessary to understand the different water sources upon which users rely during different months of the year.

Sandveld - The area is highly stressed and verification of registered groundwater abstraction is critical, as is the use of surface water. Seawater intrusion and dewatering of wetlands add significance to understanding the utilisation in the area. Unlawful use is a concern in this sub-area (refer to the **Management of Non-compliant Use Strategy**).

Doring - The groundwater abstraction in the Doring needs to be better defined.

Koue Bokkeveld - A more accurate determination of the number and capacities of the farm dams in this area needs to be undertaken. The amount of groundwater abstraction is also subject to poor information.

Lower Olifants - The quantity of water being abstracted between Clanwilliam Dam and Bulshoek must be determined. Some of the farmers appear to have expanded illegally. The abstraction from the Lower Olifants' tributaries such as the Jan Dissels must also be quantified as this is uncertain and the area is stressed during peak demand.

Once there is a better understanding of the legal water use in the WMA the legal process of verification can be initiated.

Strategy:

Validation of the water-use registration should be undertaken as a matter of urgency in the five sub-areas identified. The validation of surface water and groundwater-use registration for the two highest priority sub-areas should be undertaken within 1-2 years. Validation of the water use registration for the remaining sub-areas should be undertaken within 2-4 years. Once completed, the verification process can be initiated to enable compulsory licensing in those sub-areas which are confirmed to require intervention. Verification should be in line with the National Verification Guidelines.

Management Actions: Implement the regional verification of registered water use, verification of the status of illegal dams (regarding impoundment), abstraction and afforestation, as well as the procedure for dealing with unauthorised water use according to the policy being developed by the Directorate Water Abstraction and In-stream Use as follows: • Outsource implementation of the validation and verification processes; • Encourage further registration of use and complete the population of the WARMS database with water user registration information (information management); • Improve knowledge of the assurance of supply of registered water use; • Use the Departmental *pro forma* letters to deal with under-, over- or no- registration, based on the administrative process in Section 35; • Audit the WARMS data and use appropriate remote-sensing data, maps, aerial photography or any other relevant information in the audit and do random or targeted field-check verifications according to available resources; • Improve knowledge of impoundments, farm dams, diversion works, groundwater use and irrigation, SFRAs and domestic and industrial use through the registration process, after such uses have been registered.
Responsibility: Regional Office assisted by the Directorate Water Abstraction and In-stream Use, where necessary.
Priority: Very High for the Sandveld and Koue Bokkeveld, and medium for other areas.

8.3 MANAGEMENT OF NON-COMPLIANT USE

Management Objective:

To manage non-compliance with lawful water use and provide appropriate approaches suited to the Olifants/Doorn WMA.

Situation Analysis:

There is a perception that non-compliant use is occurring in certain areas in the WMA. Many of these require validation before it can be determined whether non-compliance is occurring. Some officials have expressed concern that some users appear to develop infrastructure, i.e. farm dams, prior to obtaining licences due to the protracted nature of the licensing process after which the applicants expect the dams to be approved *ex-post facto*. In other cases there is concern that users are over-abstracting during periods of low flow.

There are also reported incidences of exploitation of the General Authorisations in the WMA. Generally authorised water use for both surface and groundwater abstraction requires regular review, to ensure that there is compliance and that the resource is protected (refer to the **General Authorisations Strategy**).

Upper Olifants - In the Citrusdal area there are several dams which do not have licences. This is currently being rectified, by applications having been submitted for licensing or structures being removed.

Lower Olifants - Below Bulshoek Weir, the historical ten morgen developments are not necessarily authorised. Use downstream of Bulshoek Weir should be validated as soon as possible, and compliance monitoring is implemented.

Sandveld - In the Sandveld, wetlands are being modified and in-filled illegally (refer to the **IEM Strategy**). Further to this, some irrigators (potato farmers) in the Sandveld are abstracting groundwater without the proper licencing arrangements. Groundwater usage in the Sandveld requires urgent verification (refer to the **Verification Strategy**).

Strategy:

This strategy follows verification unless there are known contraventions. Unlawful use will not be tolerated. Decisive action will be taken against clear cases of illegal use. Compliance monitoring must be improved to ensure operational compliance. Self-regulating measures by WUAs are to be encouraged and DWAF should then audit results regularly.

Management Actions:

(Refer to the **Verification Strategy, Capacity Building and Communication Strategy** and **Co-operative Governance Strategy**).

- Follow steps in national guidelines;
- Establish procedures and information for compliance monitoring;
- Regional Office to ensure legal support to prosecute illegal activities;
- Put monitoring system for compliance monitoring in place (procedures and infrastructure).

Responsibility: Regional Office

Priority: Very High

Management of Non-Compliant Use Strategy

8.4 COMPULSORY LICENSING

Management Objective:

To plan for compulsory licensing in the identified catchments.

Situation Analysis:

Compulsory licensing is driven by the need to curtail resource use so as to comply with the Reserve, redress inequities and resolve over-allocation where necessary.

Compulsory licensing is seen as a medium priority within this WMA. Although compulsory licensing is seen as a last resort for resolving the negative yield balances, there are areas in the Olifants/Doorn WMA which may require compulsory licensing if verification and water-rights trading do not resolve over-allocation and inequity in the area and if the requirements of the Reserve cannot be met.

In this WMA the problems of over-use, over-allocation and the need to provide for the Reserve are key drivers for compulsory licensing. Inequities in allocation are important but play a secondary role due to there being relatively limited demand and alternative strategies to provide water to RPFs. There are subsidies available which can be utilised to buy water-use rights for RPFs.

The priority for compulsory licensing within the WMA is:

1. Sandveld;
2. Upper Olifants;
3. Koue Bokkeveld;
4. Lower Olifants.

Sandveld - The water resources of the Sandveld sub-area are seriously over-allocated, groundwater resources are being depleted and wetlands and rivers seriously damaged. Within the Sandveld sub-area, Elandsbaai and Verlorevlei require critical attention and Langvlei may also require intervention, as local sources are over-utilised. A Sandveld Management Plan is expected to be an outcome of the current RDM Sandveld Study. This plan will detail the appropriate response to the stress, over-allocation and inequity currently being experienced.

Upper Olifants - The Upper Olifants sub-area is the second priority in the WMA as there is over-allocation and there is a need to provide for the Reserve. The verification process must be completed to determine the level of stress in this sub-area prior to considering compulsory licensing. Conjunctive use between groundwater and surface water to fully use allocations should be considered.

If the planned raising of Clanwilliam Dam is not realised, and additional off-channel storage not created by upstream users, the urgency of compulsory licensing along the Olifants River will increase.

Koue Bokkeveld - There is increasing demand for agricultural expansion in the Koue Bokkeveld. The rivers in this sub-area are expected to have high Reserve requirements due to the nature of the riverine ecosystem and the water quality concerns during summer. The results of the High Confidence Reserve Determination will inform the need for compulsory licensing.

Lower Olifants - Water trading is occurring in the Lower Olifants sub-area through the Lower Olifants River Water User Association (LORWUA). It is planned that some of the water-use rights available for trade will be bought by LORWUA and held in trust for resource-poor farmer initiatives. Although the Lower Olifants is over-allocated, the process of verification and water trading must be allowed as an opportunity to resolve as much of the stress as possible, prior to considering compulsory licensing. The need for compulsory licensing is linked to the similar need in the Upper Olifants sub-area and will also depend on whether the possible Clanwilliam Dam raising occurs or not**.**

Strategy:
Compulsory licensing should be undertaken for the Sandveld because of the existing stressed situation. The need for compulsory licensing in the other sub-areas needs to be re-assessed after verification. The evaluation of the equity needs in the WMA needs to be undertaken and re-allocation could, if necessary, be done along with compulsory licensing to provide water for the Reserve and to balance requirements with water yields.

Management Actions:
Implement the compulsory licensing process in the identified catchments, if the water requirements are not resolved in another way, in a phased, integrated manner as a step-wise process in the Sandveld and other required sub-areas according to the National guidelines.

Responsibility: Regional Office

Priority: Medium

8.5 GENERAL AUTHORISATIONS

Management Objective:
To use GAs as a management tool to alleviate the administrative processes of licensing.

Situation Analysis:
Current General Authorisations (GAs) are listed in **Appendix 8.** These GAs can and will change and the ISP should be updated to reflect any changes. General authorisations as published on 26 March 2004, in terms of Section 39 of the NWA have stipulated the following:

- Areas excluded from GAs for the taking of water from a water resource and storage of water, currently only apply to:
  - E10A-K Olifants River (above the confluence with the Doring);
  - The Groot River E21 (tributary of the Doring River) Koue Bokkeveld sub-area; and
  - The Verlorevlei River G30 in the Sandveld sub-area.

- The Sandveld sub-area (G primary drainage region) includes Subterranean Government Water Control Area which is excluded from the GA for groundwater abstraction:
  - Strandfontein;
  - Wadrif;
  - Graafwater.

- Portions of the WMA are limited "Groundwater Taking Zones". These are listed in **Appendix 8;**
- It is also classified for irrigation with waste and for the disposal of waste;
- GAs apply for limited discharges to water resources for the whole WMA;
- The Olifants River is the only water resource to which a special limit effluent standard applies;
- There is one RAMSAR listed wetland in the WMA, namely Verlorevlei;
- Control and management of river channel modification is regulated through the March 2004 General Authorisations (see **Appendix 8)**.

Strategy:
GAs are generally in place but the need for some changes or refinements has been identified. The more urgent identified changes to the GAs must be evaluated and motivated to enable changes to be made. GAs should be reviewed regularly and should attend to WMA-specific needs. GAs should be made more specific for tributaries, and for groundwater. Groundwater GAs need to reflect the aquifer being used, and need to consider the cumulative impact of small users.

Management Actions:
- Introduce area-specific GAs, where water-use limits are determined by availability of water;
- Regular Review;
- Revise GAs to be more specific.

Responsibility: Regional Office

Priority: High

8.6 INVASIVE ALIEN PLANTS

Management Objective:

To prioritise invasive alien plant clearing operations from a water-resource perspective.

Situation Analysis:

In 1999-2001 aerial photography was undertaken for the WMA and converted into IAP infestation-density information. There is no waterweed problem in the WMA, although algae in the waterways is a concern. The Working-for-Water (WfW) programme has implementation projects in the following areas:

- Citrusdal;
- Clanwilliam;
- Loeriesfontein;
- Calvinia;
- Nieuwoudtville;
- Witzenberg.

The effect of clearing IAPs in this WMA on discharge to the river and recharge to groundwater should be assessed. WfW are currently undertaking a reprioritisation due to limited funds.

DWAF sees the WMA needs and priorities as follows:

Upper Olifants - Tributaries along the Upper Olifants sub-area need to receive attention before the infestation becomes too widespread. The effect of IAPs on the low flow in the Upper Olifants sub-area needs to be determined.

Lower Olifants - The Clanwilliam Dam to Bulshoek Weir clearing is scheduled to terminate in 2004. This area is only partially cleared and the work should preferably continue until the main infestation is cleared and only maintenance is required.

Sandveld - The Sandveld sub-area is also largely groundwater dependent but it doesn't have any IAP clearing programmes and this should be a priority. There is a need to initiate programmes in the Sandveld sub-area as preservation of the coastal wetlands require IAP clearing, monitoring and education to ensure retention of critical wetland functions (refer to the **Integrated Ecological Management Strategy**). Vaardrift and Jakkals River are the highest priority catchments within the Sandveld sub-area.

Koue Bokkeveld - The Koue Bokkeveld sub-area is at risk of becoming heavily invaded and pre-emptive work is required in this area. The clearing is in difficult mountainous terrain and the cost will be lower if preventative measures are taken soon rather than waiting for infestation to become dense and necessitating a higher priority.

The WfW programme is currently receiving a much higher payment from users (through the Catchment Management charges) in this WMA and across the Western Cape than elsewhere in the country. This should entitle the water users to higher levels of service in terms of IAP clearing. Since the Olifants/Doorn is one of the poorest WMAs in the country there are significant poverty relief benefits to any clearing initiatives in the WMA.

Strategy: Since the WMA stress on water resources is particularly high during summer, the low flows are important both to users and the Reserve. This should result in a WfW focus on riparian IAPs to release as much low flow as possible. Recommended water resource priorities for IAP clearing programmes in the WMA are: 1. Upstream of Clanwilliam Dam (Citrusdal); 2. Sandveld; 3. Clanwilliam Dam to Bulshoek Weir; 4. Koue Bokkeveld; 5. Downstream of Bulshoek Weir; Any water released due to IAP clearing should be allocated to alleviate water restrictions and/or to the Reserve and/or to resource-poor farmer initiatives where opportunities exist. The concept of “Water Enhancement and Allocation”[6] should be considered in this WMA. It is critical to consider ongoing maintenance. Where WfW has provided the initial clearing service, a follow-up maintenance programme must be negotiated with the landowner.
Management Actions: The following actions are required to manage the removal of invasive alien plants: • Review priority of IAP clearing activities in the WMA with the WfW Area Manager; • Initiate a “Working for Wetlands” project in the Sandveld; • Compile a regional WfW “follow-up” strategy for handover of maintenance responsibility to landowner after WfW has completed primary clearing; • Design a regional strategy for co-operation with the Department of Agriculture in the Western Cape and the Department of Environmental Affairs and Development Planning (DEA&DP) to educate farmers on the importance of wetlands and the eradication of IAPs; • Resolve WfW funding in the WMA; • Initiate a programme to monitor and respond to excessive algae in the canals.
Responsibility: Regional Office in consultation with WfW.
Priority: Medium

Invasive Alien Plants Strategy

[6] Users who are willing to take on the responsibility for IAP clearing and ongoing maintenance are given a portion of the water which is released by their IAP clearing.

8.7 SUPPORT TO LOCAL AUTHORITIES

Management Objective:

Co-operatively ensure adequate water supplies to local towns and municipalities, including appropriate provision for future supply. Establish local authority requirements for logistical, financial and information support.

Situation Analysis:

Free basic water is implemented throughout the WMA. Available water should be sufficient to meet the requirements of the various water supply schemes in the short term. DWAF is currently phasing out its involvement in supply services and is handing over the responsibility to local authorities who are then supported by DWAF.

Section 2.3.4 and **Appendix 9** details the towns and their sources of supply. There is currently a review being undertaken of all licences and use in towns. This should be completed during 2004. All towns appear to be using more than their 1998 use and this additional use needs to be authorised (Pers Comm Willie Enright DWAF Regional Office, February 2004). Towns in the Upper Olifants sub-area get their water mostly from the Olifants River with some additional supply from groundwater. Towns in the Lower Olifants sub-area and the southern portion of the Knersvlakte sub-area get their water from the canal and supplement this with groundwater. Those not near the canal or the Olifants River mostly use groundwater (Sandveld sub-area, northern parts of the Knersvlakte sub-area and the Doring sub-area). The Koue Bokkeveld sub-area does not have any significant towns but the water supplies are from the river and groundwater to small communities.

An accurate and up-to-date DWAF database of all Local Authority use called Muniwater, is maintained by the Water Services Directorate. Information provided in the WSDPs is generally insufficient and local authorities require assistance to improve the WSDPs (refer to the **Capacity Building Strategy**).

Groundwater

Conjunctive use of surface and groundwater to satisfy allocations should be considered for future supply, particularly in the Citrusdal area (refer to the **Groundwater Strategy**).

Local authorities who use groundwater need to develop operational plans to ensure sustainable use as the mismanagement of groundwater resources can have a dire effect on the supply to towns. Supplies to towns which are dependent on groundwater, namely the coastal towns and those in the northern reaches of the WMA have no back-up supply if the resource fails. These operational plans should be included in the WSDPs. There is such an initiative under the Masibambane project. The artificial storage of groundwater has been investigated in some areas such as Calvinia.

Eco-tourism and other forms of Tourism

The WMA has tourism potential and this must be provided for. Tourism peaks during summer and storage must be provided to accommodate this.

Seasonal workers   Large numbers of seasonal workers create peaks in demand during the harvesting period and adequate storage must be provided to accommodate this.
Strategy: DWAF is no longer responsible for management of direct water provision, however, it is committed to providing support to local authorities who are responsible for water provision. Future needs, although anticipated to be reasonably small, need to be quantified and future sources of supply secured. Education, advice and practical support for water conservation and demand management initiatives and support for the WSDPs are required.
Management Actions: • Assist local authorities in implementing successful water conservation and demand management;   • Assist local authorities with groundwater operational plans and drought-management plans;   • Encourage conjunctive use of groundwater and surface water to satisfy allocations (see the **Groundwater Strategy**);   • Ensure that all local authority water use data is updated and provide assistance if necessary;   • Assist local authorities in identifying and securing local supplies for future augmentation;   • Provide assistance to local authorities in the drafting of WSDPs, relevant sections of integrated development plans (IDPs) and relevant disaster management initiatives (refer to the **Capacity Building Strategy**).
Responsibility: Regional Office
Priority: High

Support to Local Authorities Strategy

CHAPTER 9
WATER CONSERVATION AND WATER-DEMAND MANAGEMENT STRATEGIES

The options for further augmentation of water supply by developing physical infrastructure are limited. Attention needs to be devoted to managing the demand for water, encouraging the efficient and effective use thereof and minimisation of loss or waste of water. The foundation of effective water conservation and demand management is the creation of a water conservation and demand management culture within all water management and water services institutions and among water users.

The National Water Conservation and Demand Management Strategy is currently being developed. This strategy is based on the reasonable premise that many water users can maintain their quality of life whilst using less water. Furthermore significant reductions in water use can be achieved by changes in behaviour and the adoption of water-saving technologies. DWAF will continue to encourage all water users to voluntarily comply with the water conservation and demand management principles and strategies.

The **Urban/industrial/agricultural water-use efficiency Strategy** is required to address urban, agricultural and industrial conservation measures and water-demand management.

9.1 URBAN/INDUSTRIAL/AGRICULTURAL WATER-USE EFFICIENCY

Management Objective:

To improve the efficiency of water use by providing and encouraging effective WC&DM measures by local authorities, industries, mines and agriculture, as an alternative to, or as a means of postponing, new water supply schemes.

Situation Analysis:

Agricultural WC&DM

Irrigation in the WMA is by far the largest water-use sector with estimated water requirements of 95% of the total water requirements. Many of the farms are already using high tech efficient water systems and savings from these farms will be limited.

Conveyance: Olifants River Irrigation Scheme Canal

There are significant losses from the long, open canals which convey water throughout the Lower Olifants. According to the DANIDA IWRM WC&DM Situation Assessment (2002) study, the canal water losses are up to 28%. Several repairs have been made to the canal over the past five years but the high losses can be reduced further. The losses are due to the age and type of open canal, evaporation, leakage, spills and occasional mismatch of timing of releases and water abstraction. There is a short period during which maintenance can be undertaken annually as downstream users are dependent on the canal system. The operational losses in the canal in the north-west have been reduced by the introduction of a balancing dam at Ebenhaezer. The DANIDA IWRM study estimated that losses along the canal could be reduced to approximately 15% through proper maintenance and refurbishment. Such an improvement will reduce the current deficit in the Lower Olifants. This additional water would reduce the probability of compulsory licensing being undertaken in the near future and any excess water could be provided to RPFs. The repair and maintenance of the canal is therefore a priority.

Crop type

The Provincial Department of Agriculture started tests on crops in the 1990s in order to establish the optimum water needs for these crops. The project will be extended to potato farming in the Sandveld and the cultivation of wine grapes in the Lower Olifants. Lessons learnt in these pilot projects will be shared with agricultural water users and institutions. A WC&DM strategy is being developed for the Lower Olifants through the Western Cape Provincial Government *Olifants Doring River Irrigation Study* (WODRIS Study 2002-2004).

Urban and Industrial WC&DM

Although urban requirements are comparatively small in this WMA, improved efficiency through WC&DM would potentially save 1 million m^3/a. Currently, only losses from the purification works are monitored. There are notable losses in Vredendal, Elandsbaai and Clanwilliam purification works. This could be attributed to the age and inefficient management of the existing infrastructure by local authorities. The cost savings for municipalities could be significant and will support their WC&DM efforts.

An IWRM WC&DM project funded by DANIDA was undertaken in 2002 and the pilot projects are now being run in the Cederberg Municipality. This work should be extended throughout the WMA. There are few large industries in the WMA. Re-use of effluent from wineries, distilleries and the fruit processing/packing industries should be encouraged wherever possible.

Strategy:

The reduction of the Lower Olifants deficit through the upgrading and maintenance of the Olifants River Government Water Scheme canal is the WC&DM priority for the WMA. This requires better measurement of losses by measuring allocations at point of release to monitor improvements.

Improving urban use inefficiencies and clearing of IAPs will provide a small but significant increase in availability. Agricultural rationalisation (crop changes) in the long-term will enhance agricultural sustainability.

The National Directorate of Water Use Efficiency has developed sectoral strategies (e.g. urban and agricultural WC&DM Strategies). The local authorities and WUAs must implement these broad-based strategies.

Management Actions:

The following management actions are required:

- Assist LORWUA to quantify losses in irrigation and canal systems and assess the rehabilitation and management options;
- Assist LORWUA to develop an appropriate long-term management and maintenance plan for the Olifants River Government Water Scheme;
- Encourage WUAs, and the local authorities (through their WSDPs) to implement the broad-based sectoral strategies developed by the DWAF Water Use Efficiency Directorate;
- Assist local authorities to quantify losses (unaccounted for water) in the reticulation system of the main towns and distribution systems between dams and users. A pilot project in one town could be used to determine the scale of the problem;
- Conduct water conservation and demand-management awareness campaigns.

Responsibility:

Regional Office in conjunction with the National Directorate of Water Use Efficiency.

Priority: High

CHAPTER 10
INSTITUTIONAL DEVELOPMENT AND CO-OPERATIVE GOVERNANCE STRATEGIES

The NWA provides for a fundamental transformation of water resources management and governance, to appropriate and representative regional and local institutions. Such institutions include any organisation or person who fulfils the functions of a water management institution. Water-user associations and Catchment Management Agencies are such organisations. Water-resource management requires co-operative data collection, information sharing, sharing of visions and plans, and co-operative making of joint decisions. Consequently, there is an inherent need for establishing co-operative relationships with such organisations. This is required to ensure that management and control of the water resources in the ISP-area are integrated with the relevant strategies of other organisations, whilst meeting the requirements of particular legislation with which it must comply.

The *Institutional Development and Support Strategy* is required to address:

- Formation of Catchment Management Agencies;
- Catchment Forums and Advisory Committees related issues;
- Formation of Water user associations;
- Education and capacity building in the water sector;
- Community awareness;
- Communications relating to water;
- Public consultation and participation;
- Co-operation regarding water management.

The following specific strategies have been developed further:

- Institutional development (CMA, WUA and Forums);
- Co-operative Governance;
- Capacity Building and Communication.

With no international rivers no internationally-related strategy is required.

10.1 INSTITUTIONAL DEVELOPMENT (CMA, WUA AND FORUMS)

Management Objective:

The institutional development strategy in the Olifants/Doorn seeks to ensure that:

- Transformation of existing irrigation boards into representative, viable WUAs that includes all water users is achieved;
- Transformation of the institutional structures to be fully representative of the water users in the WMA;
- The development and operation of catchment forums is supported;
- The establishment process of the CMA for the Olifants/Doorn is supported and monitored;
- The performance of the WUAs is monitored and audited;
- The performance of the CMA is monitored and audited.

Situation Analysis:

The Olifants/Doorn WMA is one of three pilot WMAs where the DANIDA-funded Integrated Water Resource Management (IWRM) project, 2001 – 2004, was implemented. One of the project's tasks was aimed at developing the capacity within the WMA to support the necessary water forums and the establishment of the CMA.

Catchment Forums

In 2001, eleven catchment forums were established throughout the WMA. These forums will continue to promote IWRM even after the CMA is established. Problems challenging the forums consist of the reference group's ability to hold regular meetings (travel distances are significant) and the "buy-in" by previously disadvantaged sectors.

It is interesting to note that forums based in areas where groundwater is utilised as the major source of supply, such as the Knersvlakte, Sandveld and the Elandskaroo, have less coherence and experience more problems than those formed in more controlled irrigation areas. This may be due to the fact that users in these areas have less of a culture of co-operation regarding their resource utilisation. Users still frequently regard groundwater as a private resource and they are reluctant to co-operate to the same degree as surface water users.

CMA Establishment

CMA reference group meetings were held during 2002-2004 and the proposal for the establishment of the Olifants Doorn Catchment Management Agency was finalised in 2004 with assistance from the DANIDA project. The proposal for the establishment of the CMA was evaluated and accepted. It is envisaged that the CMA will be established in 2005.

Several issues relating to the viability of the CMA are raised namely:

- The CMA can be financially viable, however:
  - concern was expressed that water charges may become too expensive for the agricultural community, which is the key in this WMA economy;
  - the high cost of WfW programmes in the Western Cape must be addressed;
- The CMA must make provision for the socio-economic divide in the WMA. Capacity building, communication and equal representation will be critical to the functioning of the CMA;

- Catchment forums will need ongoing support in the medium to longterm;
- The land-reform process must be informed by water resource constraints and water supply to resource-poor farmers should be assured;
- There are limited resources and only a small staff can be supported. The CMA will therefore only be able to undertake mainly managerial and liaison functions. This is appropriate if strongly supported by the WUAs and government bodies;
- Revenue collection is the key functions and will dictate the success of the CMA.

WUAs

Doring – The Elandskaroo Irrigation Board is in the process of being disestablished. The Ceres Karoo and Cederdoorn forums represent the Doring sub-area.

Koue Bokkeveld - Four WUAs will be established in the Koue Bokkeveld area. Each major river will have its own WUA associated with it. Currently the Koue Bokkeveld and Witzenberg Forums represent this area.

Lower Olifants - The Lower Olifants River WUA, Clanwilliam WUA and Vanrhynsdorp WUA were established with the Minister's approval. The Lower Olifants and Middle Olifants forums represent this area.

Sandveld - The Sandveld Forum has been experiencing poor support and cohesion. This may be due to the fact that as a groundwater dependent area, there is no history of user co-operation as practised elsewhere with irrigation boards. The Langvlei and Graafwater WUAs are in the process of being established.

Upper Olifants - The Citrusdal WUA was established with the Minister's approval. The Upper Olifants Forum represents this area.

Knersvlakte - The South Namakwaland, Hantam and Nama-Karoo forums represent this area.

Co-ordinating Committee for Agricultural Water

The Co-ordinating Committee for Agricultural Water (CCAW) for the Western Cape, carries the responsibility for issues relating to the use of irrigation water. This committee is also responsible for reviewing and approving subsidies for irrigation development for RPFs. The CCAW comprises representatives from the DWAF Southern Cluster, Department of Agriculture, Department of Land Affairs and the Department of Environmental Affairs and Development Planning.

Strategy:

Continue with support for the capacity-building and support work initiated by the DANIDA IWRM project in terms of the establishment and operation of the catchment forums, WUAs, CMA, and other structures. The transformation of Irrigation Boards into WUAs and especially the establishment of new WUAs and other supporting structures should be expedited. Facilitate the establishment of the CMA.

Management Actions: • Provide continued financial support for administrative costs incurred by the catchment forums; • The Southern Cluster will continue to support and facilitate full transformation of irrigation boards to WUAs and establishment of new WUAs; • Catchment forums and WUAs will be suitably capacitated by DWAF to undertake appropriate local water resource management tasks; • Implement the CMA proposal once it has been approved by the Minister; • Use institutions for bulk licences – e.g. groundwater wellfields (refer to the **Licensing Strategy**).
Responsibility: Regional Office
Priority: High

10.2 CO-OPERATIVE GOVERNANCE

Management Objective:

To improve co-operation between DWAF and other authorities regarding shared decision-making and so achieve effective IWRM in the Olifants/Doorn WMA.

Situation Analysis:

The WMA falls into two provinces, namely the Northern Cape and Western Cape. Authorities of both provinces therefore play a role in the management of the water resource. Despite this division, DWAF Western Cape is responsible for management of the entire WMA. The key co-operative governance partners for this WMA are Department of Environmental Affairs and Tourism, Department of Agriculture, provincial departments of environmental affairs and agriculture as well as the local authorities (refer to **Section 2.2.11**). Further to this, co-operation by the CCAW and the WUAs are all critical to successful water resource governance.

Key areas for co-operation:

- RPF initiatives;
- Land management and environmental considerations (including environmental processes for dam approvals);
- Water quality;
- Monitoring and maintenance of WWTWs and SWDSs;
- Support to local authorities;
- Education initiatives;
- Water conservation and demand management.

Strategy:

Promote the effective management of water resources in the WMA through co-operation between DWAF, other government departments and local authorities. Continue involvement in the various co-operative management bodies already established, and ensure active involvement in new bodies that are being or will be established, where they can contribute towards improved water-resource management.

Management Actions:

- Obtain the Northern Cape and the Western Cape Provincial Development Strategies. Study them focusing on areas where water is a constraint or opportunity and provide feedback;
- Liaise with both Provincial Governments and get involved with the compilation of the Provincial strategies;
- Facilitate improved co-operation between DWAF and DEA&DP regarding the management of wetlands, estuaries and invasive alien plant control programmes;
- Facilitate improved co-operation between DWAF and DEAT, DEA&DP and DOA regarding provincial procedures for dam approvals and solid waste disposal facilities;

Co-operative Governance Strategy

• Facilitate the development of a Memorandum of Understanding with the Department of Agriculture to co-ordinate approvals for land clearing with water allocations and licencing; • Identify information-sharing needs with other departments, local authorities and institutions to avoid duplication of effort; • Optimise the effectiveness of the CCAW and other liaison structures (e.g. water forums); • Facilitate co-operation with the Department of Agriculture's Land Care Programme to reduce poor farming practices; • Liaise with local authorities regarding their integrated development plans and WSDPs and inform them of possible impacts and DWAF requirements.
Responsibility: Regional Office
Priority: High

10.3 CAPACITY BUILDING AND COMMUNICATION

Management Objective:

To support and develop capacity building and training within water management bodies operating in the WMA.

Situation Analysis:

Capacity within DWAF

There is concern regarding the existing capacity of the Southern Cluster to undertake required tasks within the WMA, particularly with regard to tasks requiring scientific knowledge (i.e. monitoring and interpretation of monitoring data). There is ongoing loss of staff with experience and knowledge.

Capacity within local authorities

In the past, the West Coast District Municipality performed most of the water service-related duties. Now that the local municipalities have the responsibility as water service authorities, they require applicable training and capacity building to prepare, for example, water service development plans (WSDPs). Capacity building within local authorities is also needed to facilitate management of their water supply schemes. The IWRM DANIDA project supported local authority WC&DM efforts.

Water user capacity

There are different levels of capacity building needed in the WMA. Broad training and awareness programmes are required for some to raise water user's awareness of water issues and educate them regarding the Reserve, resource health, over-abstraction, WC&DM and monitoring techniques. Further to this many users require capacity building to enable them to actively participate in water management bodies such as catchment forums, WUAs and ultimately the CMA.

The DANIDA IWRM project has provided practical capacity building through public participation during the formation of the water forums, followed by the administrative support of the forums. Local previously disadvantaged individuals have been provided with training courses to provide the necessary skills to run the forums. In addition, a "water-champion" programme is in operation which develops skills to generate proposals, apply for funding and implement and manage small scale IWRM projects.

WMA Communication priorities

Monitoring results - Communication of water quality and quantity monitoring results is needed to sensitise water users and authorities to problems such as over-abstraction and requirements for maintenance of infrastructure.

Non-payment and reluctance to pay - DWAF can assist in marketing the concept and educate people regarding payment and water conservation. All users need to understand that water is not owned but is a shared resource and that they must pay for the use thereof.

Groundwater - Users and water resource professionals need to be informed regarding the time and space scale of processes and the geology that govern groundwater, its quantification and the risk and adaptive management approach most suited to its management. User education material and methodologies should be encouraged to facilitate and ensure compliance with the law and co-operation as regards monitoring and exploration practice.

Strategy:

Promotion of the education, training and awareness raising regarding the WMA water resources is required to achieve effective management and efficient use. Utilise all reasonable opportunities to build capacity and train staff and water users at all levels.

Management Actions:

- Provide technical support and information transfer workshops to local authorities and other water institutions that have insufficient capacity to manage their water resources;
- Initiate education programmes together with the DOA, covering good irrigation and land management practices;
- Initiate education programmes together with the DEAT and DEA&DP regarding the importance of wetlands and ecological water requirements;
- Initiate and support an Internet self-monitoring programme allowing farmers and municipalities to submit monitoring information on-line;
- Create a library of all WMA reports for the CMA;
- Deepen and strengthen the water-champion programme as well as forum secretary programmes;
- Develop and implement a strategy for interfacing with existing education initiatives in order to support sustainable groundwater supply;
- Develop a concept document for groundwater education at various levels of government, community and schools.

Responsibility: Regional Office in conjunction with the Communication Directorate

Priority: High

CHAPTER 11
SOCIAL AND ENVIRONMENTAL STRATEGIES

Water for development or "water for equity" is a major focus that will be pursued under this strategy. In addressing inequities of the past, the provision of an equitable share of available water to previously disadvantaged communities is addressed as one way of improving the livelihoods of the poor and to get a more equitable distribution of water use. The establishment of resource-poor farmers and the adequate provision of water to areas in which land restitution is in progress must be prioritised as one of the ways to eradicate poverty. The water reconciliation for the WMA has shown that little water is available for allocation to resource-poor farmers. Procedures must therefore be introduced to make this water available.

The *Social and Environmental strategies are required to address:*

- Compliance with environmental legislation;
- Mitigation of environmental and social impacts;
- The environmental development approval process;
- Strategic environmental assessment;
- Poverty eradication issues pertaining to resource-poor farmers and other measures;
- Water-related land-reform issues.

The following specific strategies have been developed:
- Integrated Environmental Management;
- Poverty Eradication (Resource-poor Farmers).

11.1 INTEGRATED ENVIRONMENTAL MANAGEMENT

Management Objective:

The Environmental Management strategy in the Olifants/Doorn WMA seeks to ensure that the resource is managed in a manner which recognises and sustains the environmental health of the system.

Situation Analysis:

Terrestrial environment

There are a number of important pristine environmental areas in the southern catchments. The vegetation is sensitive to impact – there is seldom rehabilitation after agricultural land-use. Soil which has elevated salinity from irrigation practices, will not easily support natural growth. A lack of post-farming rehabilitation allows increased erosion. Removal of riparian vegetation has a significant impact on sedimentation and water quality. IAP infestation is dealt with in **Strategy 8.6**.

Aquatic environment

The Olifants River estuary is ecologically significant. All the tributaries should be managed properly to protect the indigenous species as well as the undeveloped nature of the WMA. Wetlands in the Sandveld sub-area are vulnerable to degradation due to over-abstraction of groundwater as well as physical modification and infilling. The Western Cape Wetlands Forum was recently formed to assist with the cataloguing, assessment and monitoring of wetlands in the province. It consists of a number of government and NGO bodies. The Reserve requirements are detailed in **Strategy 7.1** and water quality issues are dealt with in **Strategy 7.2**.

Social environment

An overview of the WMA socio-economic situation is given in **Section 2.2.3.** Many locals and visitors use Clanwilliam Dam as a recreation area. The dam is used predominantly for fishing and water sports.

Situation per sub- area

Doring - Nine indigenous fish species (seven of which are endemic) and the unimpounded nature of the Doring River makes this an important river. There is a great deal of resistance from conservationists to developing storage (dams) on the Doring River. The vegetation of the area is unique and has been evaluated in the Succulent Karoo Ecosystem Plan (SKEP). The area has tourism potential which is being developed. The Cape Action Plan developed a proposal for the Greater Cederberg Biodiversity Corridor for People and the Environment (CAPE) to protect the biodiversity of the area.

Knersvlakte – The Knersvlakte is trying to develop tourism.

Koue Bokkeveld – The sub-area includes the Swartruggens Conservancy, the Cederberg National Park Wilderness Area and the Cederberg Conservancy which have high conservation value and are largely pristine terrestrial environments.

Upper Olifants - The Cederberg mountain landscape and vegetation are world-renowned. The associated wilderness areas, private nature reserves and the Cederberg Conservancy play an important conservation and tourism role in this key area. There are eight endemic fish species in the Olifants River. **Lower Olifants -** The estuary is sensitive and is likely to have a significant effect on the Reserve requirement (refer to the **Reserve and RQOs Strategy**). Subsistence fishers utilise the lower estuary. Fish counts have been undertaken for a number of years. A process has been initiated to encourage aquaculture in the Lower Olifants. Western Cape Nature Conservation Board (WCNCB) has been involved in developing this initiative. The wetland near Clanwilliam is threatened by the activities of the town's adjacent SWDS. **Sandveld -** Erosion due to rapid expansion activities and poor erosion protection is a problem in the Sandveld. Fertiliser and pesticide run-off is problematic for the coastal wetlands such as Verlorevlei.
Strategy: Ensure that all water-related activities comply with the requirements of the National Environmental Management Act (NEMA), Environmental Conservation Act (ECA) and other related environmental legislation for water use activities and make sure WUAs and CMA (once constituted) comply. Support the Western Cape Wetlands Forum. The Department has developed a National Integrated Environmental Strategy. The local authorities and WUAs must implement these broad-based strategies.
Management Actions: • Contribute towards the work of the Working-for-Wetlands and Western Cape Wetlands Forum; • Initiate Working-for-Wetlands programmes in the Sandveld sub-area. • If storage is required on the Doring River, off-channel storage would be the most likely choice; • Undertake a study with respect to the impacts of aquaculture on the system; • Ensure that DWAF construction and maintenance activities are guided by Environmental Management Plans.
Responsibility: The implementation of this strategy is the responsibility of the Regional Office in consultation with the National Directorate WA&IU.
Priority: Low

11.2 POVERTY ERADICATION (RESOURCE-POOR FARMERS)

Management Objective:

The Poverty Eradication strategy in the Olifants/Doorn WMA seeks to ensure that:

- Inequities in water allocations are rectified;
- Viable resource-poor farmer initiatives are supported and provided with water;
- Ways of best providing water to the poor are researched and implemented.

Situation Assessment:

Resource-poor Farmers

The *Olifants Doring River Basin Study Phase 1 (1998)* and *Olifant Doring Water Resources Situation Assessment (2002)* and the NWRS (2004) provide an outline of the demographics, economics and socio-economic aspects of the WMA (also see **Section 2.2**) These documents together with the public participation undertaken for the River Basin Study Phase 1 and the CMA establishment process established a need for poverty eradication, land reform and establishment of resource-poor farmer initiatives in this WMA. The Western Cape's Department of Agriculture's WODRIS study has focussed on this issue in the Lower Doring, Lower Olifants and northern Sandveld sub-areas.

Many of the current initiatives are sponsored by local municipalities or the Western Cape Department of Agriculture. Municipalities in the WMA fund resource-poor farmers (RPFs) through**:**

- Providing the use of municipal land for RPF farming activities;
- Providing water to RPF farming activities;
- Providing loans which will be repaid once the RPFs start making profit.

The Department of Agriculture has also been providing technical support to the establishment of RPFs in the WMA. Assisting RPFs requires more than the provision of land and water. Ongoing support (through partnerships with commercial farmers for example) is key to their success. The DANIDA IWRM project (2002-2004) has developed a process of mentoring and building the capacity of "water champions" in each of the forums through small development and water conservation projects. An emerging farmer project database was developed in 2003 by the IWRM project. The database is linked to GIS farm cadastral data to aid decision-making. A list of RPF initiatives per sub-area is included as **Appendix 12**.

Some commercial farmers have provided portions of their land to their workers as joint venture schemes in order to start RPF initiatives with benefits and water allocations accruing to both the original farmer and the worker. There is no monitoring to check these operations and their benefit to the previously disadvantaged individuals is yet to be verified.

Poverty Eradication Strategy

A challenge to the transformation process in the WMA was identified during the IWRM water forum establishment process. RPFs feel that they are allocated land with little or no water use rights, while commercial farmers receive “large water quotas”. There is a perception amongst RPFs that previously advantaged water users dominate the water forums and WUAs, and that despite having representation on these forums, their ability to give meaningful input is constrained. Three emerging-farmer forums have been established to develop capacity in the Lower Olifants (Matzikama) and in the Upper Olifants (Cederberg and Witzenberg) areas.

Food Security Use (Schedule 1)

The use of water for food gardens is covered under Schedule 1 use. The water balance is unlikely to be effected by Schedule 1 use due to the limited application in this WMA. There is no need to constrain Schedule 1 use provided it is used for its intended purpose, to improve the livelihoods of the poor and previously disadvantaged through subsistence farming.

Other Empowerment Initiatives

A further poverty eradication initiative in this WMA is the Working-for-Water projects being undertaken. The Olifants/Doorn is the one of the poorest WMAs in the country and the provision of employment opportunities through these IAP eradication programmes provide significant poverty relief (refer to the **IAP Strategy 8.6** for more detail on these initiatives).

Sub-area overview

(Refer to **Appendix 12** for details of empowerment initiatives in each sub-area)

Upper Olifants - The Cederberg Municipality has been investigating the availability of land upstream of Clanwilliam Dam but to date no tangible solutions have been achieved. There are individual farmers in this part of the catchment who are selling ownership of their farms to employees as part of black empowerment initiatives. The Cederberg Emerging Farmer Forum and the Witzenberg Emerging Farmer Forum have been established to encourage and capacitate RPFs.

Knersvlakte - In the Hantam region (i.e. Calvinia and Niewoudtville), establishment of RPFs is led by the Provincial Department of Agriculture.

Doring - The focus of the WODRIS study was on poverty-reduction opportunities. WfW has a clearing programme which brings poverty relief in the Oorlogskloof sub-catchment.

Koue Bokkeveld - There has been a few proposals for land reform in this sub-area, but these have achieved limited success.

Lower Olifants - The Matzikama Municipality has initiated the establishment of the Lower Olifants RPFs in collaboration with LORWUA. The Matzikama Emerging Farmer Forum has been established to encourage and capacitate RPFs. LORWUA is currently using water trading to provide for RPF initiatives. The WODRIS study recommended that groundwater be used for supplying RPFs in the vicinity of the coast.

Access to Funding There is existing, ongoing liaison regarding access to funding. However, there is a need to formalise the process as it is currently confusing and time consuming. The IWRM undertook "emerging farmer" roadshows during late 2003. These aimed to educate people about the assistance available to them. DWAF can however only subsidise farmers for bulk water infrastructure where they are included in WUAs or other water management institutions.
Strategy: Pro-actively support poverty eradication and land reform principles, by initiating or supporting initiatives through co-operative governance, via the various implementation vehicles provided by legislation. Review the position of farm workers and water allocations for them. Co-operate with the Western Cape Department of Agriculture to understand the water implications of the RPF opportunities and land reforms.
Management Actions: • Continue to support RPFs through co-operative governance and co-ordination with Department of Land Affairs (DLA), DOA and DEA&DP. This should continue to be focussed through the CCAW; • Encourage WUAs to identify and initiate RPF projects; • Through the licensing process, mechanisms to be sought to benefit empowerment initiatives; • Implement pertinent recommendations of the WODRIS study; • Streamline the funding application procedures.
Responsibility: The implementation of this strategy is the responsibility of the Regional Office in consultation with CCAW.
Priority: High

CHAPTER 12
WATERWORKS DEVELOPMENT AND MANAGEMENT STRATEGIES

Alternative options for the future management and ownership of major water resource infrastructure currently owned and operated by DWAF, is being investigated at national level. In the interim, there is an ongoing need to economically and safely manage the existing water resource infrastructure at both national and regional level.

The Waterworks development and management strategy is required to address:
- Strategies for major infrastructure systems or components;
- Strategies for specific geographical areas or rivers;
- Recreation relating to water resources;
- Disaster management planning.

The following specific strategies have been developed:
- Waterworks Management, Operation and Ownership;
- Waterworks Development Strategy;
- Public Health and Safety/ Disaster Management;
- Recreation.

12.1 WATERWORKS MANAGEMENT, OPERATION AND OWNERSHIP

Management Objective:

- Ensuring that existing infrastructure is repaired, operated and maintained in an efficient and safe manner;
- Ensuring that users receive water at agreed assurances of supply and safety;
- Implementing transfer of ownership and delegation of operating and maintenance functions and infrastructure to appropriate water management institutions.

Situation Assessment:

The water supply should be sufficient to meet the requirement of the various water supply schemes in the immediate future. DWAF is currently trying to phase out their involvement with Water Supply Services, and instead focus their efforts on supporting the initiatives of the local authorities.

Section 2.3 describes the water supply system in the Olifants/Doorn WMA and **Section 2.2.11** provides information on the WMA water service providers. The water sources and other system infrastructural details are shown in **Appendix 9. Appendix 10** shows existing irrigation scheme information. The existing major dams are listed in **Appendix 11.**

The various components of the system are as follows:

- Olifants River (Vanrhynsdorp) Government Water Scheme;
  - Clanwilliam Dam;
  - Clanwilliam Canal;
  - Bulshoek Weir;
- Main Irrigation Canal and Distribution Canals;
- Southern Namaqualand Government Water Scheme (Bitterfontein);
- Sandveld Government Supply Scheme (Graafwater);
- Inverdoorn Canal.

Olifants River (Vanrhynsdorp) Government Water Scheme

The Olifants River Government Water Scheme (ORGWS) supplies raw water from the Clanwilliam Dam to farmers, municipalities, mines and industries in the Olifants River valley between the dam and the river estuary via the Bulshoek Weir and canal. The 1:50 year yield of Clanwilliam Dam and Bulshoek Weir combined is 154 million m^3/a. The Bulshoek Weir and canal system has reported conveyance losses of up to 28% due to poor maintenance and the age of the system. The ORGWS is operated in an integrated, shared manner, in which the major components of infrastructure are owned by DWAF and parts of it is operated and maintained by LORWUA. The Clanwilliam canal is operated and maintained by the Clanwilliam WUA. It is important to note that support of the ORGWS is critical since much of the WMA economy relies on this scheme.

Clanwilliam Dam

Clanwilliam Dam is the largest water storage facility in the WMA and forms a key element in the utilisation and management of water resources. A study has been commissioned by DWAF to investigate the raising of Clanwilliam Dam (2004 –2005) after a dam safety report recommended that the existing dam wall be strengthened. Sedimentation in Clanwilliam Dam was reported at 17% as surveyed in the *DWAF, Clanwilliam Dam, Capacity Determination, 1994*.

A privately owned hydro-electric power station is situated directly below Clanwilliam Dam. It is currently not in operation due to the high operating expenses. DWAF would like it to be closed permanently as the timing of its water requirements hamper management of flow through the canal system.

Clanwilliam Dam is currently being operated by DWAF but the Department aims to transfer responsibility for operation and maintenance jointly to the two WUAs (LORWUA and Clanwilliam WUA). A small canal supplying irrigation water to farmers directly from Clanwilliam Dam is operated and maintained by the Clanwilliam WUA.

Bulshoek Weir

Extensive work is necessary for the repair of electrical and mechanical components. Water leaks also need to be sealed. The maintenance budget is R8 million for the year 2003-2004 and R13 million overall. Sluice gates, which are currently hand-operated, are to be automated as part of the second phase of refurbishment. Operation and maintenance of the Bulshoek Weir has been transferred to LORWUA. The refurbishment of the sluices and sealing of leakages are DWAF responsibilities.

Canal

There are considerable challenges related to maintenance and repair of both the Clanwilliam WUA and LORWUA canals. In addition to the high cost of maintenance, the canal can only be closed for a relatively short period each year for maintenance. Canal capacity constraints and conveyance losses must be addressed. A balancing dam has been built (2003-2004) on the canal near Ebenhaezer in order to regulate the flow in the canal at this point. Operation and maintenance of the canal has been transferred to LORWUA. During 2003, LORWUA appointed consultants to investigate the condition of the canal systems downstream of Bulshoek Weir.

Southern Namaqualand Government Water Supply Scheme (Bitterfontein)

This scheme supplies water from boreholes to the towns of Bitterfontein and Nuwerus. The scheme has recently been extended to also supply the communities of Rietpoort and Molsvlei. The operators of the scheme have managed to reduce the running costs of the desalination plant considerably over time but it is still incurring financial losses. The West Coast District Municipality currently operates this scheme on behalf of DWAF, but ownership will be transferred to the West Coast District Municipality as the water service authority.

Sandveld Government Water Supply Scheme (Graafwater)

This scheme supplies water from boreholes to the town of Graafwater. The scheme is currently operated by DWAF but ownership will be transferred to the Cederberg Municipality as the water service authority.

Inverdoorn Canal

The Inverdoorn Canal is the only inter-WMA transfer in the Olifants/Doorn WMA. 2.5 million m^3 per year is transferred from the catchment area of the Lakenvallei Dam in the Breede WMA through the Inverdoorn Canal for irrigation purposes in the upper Doring catchment. The scheme is privately owned.

Privately owned irrigation schemes

- In the Koue Bokkeveld in the upper reaches of the Doring River and in the upper reaches of the Olifants River a number of conjunctive schemes with small farm dams and boreholes have been constructed for the irrigation of fruit and vegetables;
- At the confluence of the Tankwa and Doring Rivers water is abstracted from the Doring River for the irrigation of 350 ha of land through the water works of the Elandskaroo Irrigation Board;
- The Oudebaaskraal Dam on the Tankwa River, with a capacity of 34 million m^3, supplies water to irrigate approximately 320 ha of land.

Ongoing operation and routine maintenance

The following issues and concerns regarding operation and maintenance were identified:

- The economy of the area is heavily dependent on regional water schemes and it is essential that these function well;
- Losses at Bulshoek Weir and along the canal conveyance system are unacceptably high. Refurbishment of Bulshoek Weir/Clanwilliam Dam needs urgent attention. Some of these refurbishment works are being carried out (refer to the **Urban/industrial/ agricultural water-use efficiency Strategy 9.1**);
- Management of the canal capacity constraints and conveyance losses must be dealt with.
- The refurbishment and ongoing maintenance of the canal, now the responsibility of the Lower Olifants River Water Users Association (LORWUA) is extremely costly;
- The canal is being used to capacity most of the time and it is therefore difficult to maintain;
- Clanwilliam Dam wall needs to be strengthened for dam safety reasons.

Strategy:

The ownership and management responsibilities are separated and the need for co-operative and integrated management will continue to grow as operation and maintenance of schemes are transferred to WUAs. Proper management of the system is required to meet the needs of users in an efficient manner.

Management Actions: • DWAF to assist LORWUA to implement the findings of their canal investigation so as to address canal capacity constraints and conveyance losses; • DWAF to assist LORWUA to develop operation and maintenance plans for the canal • Refurbishment of Bulshoek Weir must be completed as soon as possible; • Implement appropriate findings of the Raising of Clanwilliam Dam study (2004-2005); • Consult with the owner of the hydro-electric plant to determine whether it can be permanently closed.
Responsibility: Regional Office
***Priority*:** Medium

12.2 WATERWORKS DEVELOPMENT

Management Objective:
To outline likely future waterworks developments in the WMA.

Situation Analysis:

In response to the WMA deficit **(**refer to **Chapter 4** and the **Reconciliation Strategy 6.3)** and the water restrictions which have been implemented annually for the past few years, there is consideration of development of new waterworks. It should be noted that the High Confidence Reserve Determination study is still underway, however, the current yield balance implies a lack of ability to meet the EWR. Despite limited population-growth predictions there is demand in the Koue Bokkeveld, Sandveld and Upper Olifants for agricultural expansion. The expansion of irrigated agriculture in the Lower Olifants is currently limited by the infrastructural conveyancing capacity constraints of the canal.

A table of the various water resource infrastructure options historically considered throughout the Olifants/Doorn WMA is provided in **Section 2.3.4.** It should be noted that the development of many of these options would be mutually exclusive. Due to high comparative financial and ecological costs of many of the options, the raising of Clanwilliam Dam is currently considered the most favourable surface water development because dam safety requirements stipulate that the wall be strengthened irrespective of whether or not the wall height is raised. A feasibility study has been commissioned to investigate the possible raising (see **Section 2.3.1**). Associated complementary options such as increased system effectiveness and WC&DM options will also be addressed.

Groundwater scheme options could be developed complementary to surface water development options such as the raising of Clanwilliam Dam. These have been outlined in the CAGE and WODRIS studies. Pre-feasibility studies would need to be undertaken to determine the most beneficial options or combination of options, reliant on identified demands.

Strategy:
Investigate the raising of Clanwilliam Dam and appropriate complementary groundwater schemes to a suitable feasibility level and implement findings appropriately.

Management Actions:
- Implement appropriate findings of the *Raising of Clanwilliam Dam* study;
- Initiate pre-feasibility studies and borehole drilling to confirm the suitability of the various groundwater opportunities for large-scale development;
- Implement appropriate findings of the WODRIS study.

Responsibility: Regional Office with input from the Integrated Water Resource Planning Directorate

Priority: Medium

Waterworks Development Strategy

12.3 PUBLIC HEALTH AND SAFETY/ DISASTER MANAGEMENT

Management Objective:

Effective disaster management planning and implementation relating to flood management, operation during droughts, dam safety and emergency spills.

Situation Analysis:

Disaster Management planning

The West Coast District Municipality and local municipalities are in the process of transforming their disaster management body into the disaster management forums required by the Disaster Management Act (Act No 57 of 2002). A Western Cape Disaster Management Forum will be established.

Emergency response is documented in the Emergency Preparedness Plans (EPP) for Clanwilliam Dam and Bulshoek Weir. The response teams provided for in the document primarily come from the DWAF Regional Office and Western Cape Provincial Administration. The emergency supply arrangements need to be developed for various durations of possible non-supply from the system or its components, for the various user groups.

Flood management

DWAF heads the Flood Disaster Response Committee for the WMA. Further to provisions for full dam failure made in the EPP, in 2003, DWAF produced a flood management operating rule for Clanwilliam Dam. The Cederberg Municipality has a dam-break plan and included a disaster management chapter in their IDP.

Drought management

There is a current drought operating rule for Clanwilliam Dam that is revised from year to year. The rule assumes that the dam empties under 1:50 year drought conditions. If the dam does not spill at the beginning of November, restrictions are applied. The Clanwilliam Dam is only a 30% MAR dam hence provision for a long-term drought is not feasible. DWAF intends undertaking system analyses to update these drought operating rules.

Dam Safety

Bulshoek Weir underwent work to secure the weir through the construction of a concrete curtain at the base of the wall preventing excess water leaks below the foundations. Clanwilliam Dam wall requires strengthening due to poor geology founding conditions and possible concrete failure. To meet the national safety requirements this will need to be undertaken by 2010 (pers. Comm.. Dr Chris Oosthuizen, DWAF Civil Design-Dam Safety, June 2004).

Strategy:

DWAF must assist in the WMA to ensure compliance with the Disaster Management Act and Dam Safety legislation requirements. This will require assistance in the development of disaster management forums required in the WMA. It will also require support, where appropriate, of the Public Safety Unit. DWAF should assist provincial and local government in capacitating and training these disaster management forums, committees and units. The EPPs must be kept up-to-date and contact people in the EPPs must be regularly reminded of its requirements. Despite the fact that dam storage capacity in the WMA is limited an effort should be made to control droughts or floods.

Management Actions:

- Review EPPs after floods and other emergency events; update procedures where appropriate;
- Regularly update the contact list and undertake the occasional drill to ensure preparedness
- Compile disaster management plans in accordance with the Disaster Management Act;
- Encourage the establishment of disaster management forums in all district and local municipalities according to the Disaster Management Act;
- Review and improve operating rules regularly;
- Document the existing drought management rule and review it regularly. Address both surface and groundwater resources;
- Implement the requirements of the NWA regarding dam safety.

Responsibility: Regional Office

Priority: Low for Disaster Management and High for Dam Safety.

12.4 RECREATION

Management Objective:

Ensuring the sustainable and equitable management and regulation of the use of water resources, especially state-owned dams, for recreation.

Situation Analysis:

The NWA defines recreation on rivers and dams as a water use. There is an existing policy in place for zoning of dams, concessions, and stakeholder involvement as far as recreational use is concerned.

Within the Olifants/Doorn WMA, the Clanwilliam Dam and the Bulshoek Weir are currently extensively used for recreational purposes. Motorised water sport is permitted on both Clanwilliam Dam and Bulshoek Weir. The potential raising of Clanwilliam Dam will increase the inundation area and future planning will need to take this into account.

Strategy:

DWAF sees its role as being to maximize recreational benefit from the use of state assets. At the same time this should not be at unreasonable cost to other water users. The future management of these assets, and the likely negative impacts that current use might have, need to be evaluated. At the same time the very real social benefits of the recreational opportunities provided by dams and rivers need to be taken into account. No asset should be further restricted or closed to use without very close consideration of the social cost that this might carry, and such a decision should not be taken lightly. It is important that facilities should not be exclusive and bound to traditional users. DWAF must ensure that equity is achieved in making its resources available to all users.

Management Actions:

- Review and implement the existing recreational use policy in the Olifants/Doorn WMA
- Utilisation of the dams for recreational purposes should be promoted;
- Strategies developed by the Department on how these dams could best be utilised, should be implemented.

Responsibility: Regional Office

Priority: Low

CHAPTER 13
MONITORING, DATA AND INFORMATION MANAGEMENT STRATEGIES

The Act requires the Minister to establish national monitoring systems for water resources to collect appropriate data and information. The Department is addressing the shortcomings of the current arrangements by amalgamating all existing and planned monitoring and assessment systems into a structured and coherent monitoring, assessment and information system.

Monitoring is required to introduce billing, to ensure compliance with water authorisation conditions, and to control all water use.

The Monitoring, Data and Information Management Strategies are required to address:

- Water-use control from freshwater bodies and bulk water infrastructure;
- Monitoring networks and data capturing for physical, chemical and biological aspects of surface and groundwater;
- Issues relating to information systems;
- Information access and requirements;
- Ensure that the ecological water requirements are fulfilled;
- Ensure that aquifers are not over-abstracted.

The following specific strategies have been developed:

- Monitoring and Data Management;
- Information Management.

13.1 MONITORING AND DATA MANAGEMENT

Management Objective:

Effective regional monitoring networks, support linkages and databases to ensure adequate management information for sustainable water use and protection of surface and sub-surface water bodies.

Situation Assessment:

The design of an integrated regional monitoring network (surface and groundwater) is critical to obtaining data for water resource management. This will increase confidence in resource evaluation, inter- and intradepartmental system understanding and regulatory decisions. Given the scarcity of water in the WMA (current deficit estimated to be 34 million m^3/a), appropriate monitoring is a priority. The monitoring network must have a medium to long-term scientific context that is regularly re-evaluated. The existing flow-gauging infrastructure is documented in **Appendix 13.**

A *Strategic Framework for National Water Resource Quality Monitoring Programmes and Guidelines for Designing Such Programmes*, as well as a national Departmental Five-year Monitoring Plan has recently been completed, which addresses the following monitoring programmes:

- National Microbial, Chemical, Eutrophicaion, Radioactivity and Toxicity Monitoring Programmes;
- River Health Programme, Ecological Reserve Determination and Monitoring, Hydrographic Surveys for sedimentation, Dam walls for dam safety, Hydrological Monitoring Programme and Geohydrological Monitoring Programme;

The inter-departmental, integrated monitoring strategy must ensure that the following specific issues are addressed:

Meteorological

The South African Weather Services (SAWS) is responsible for undertaking weather monitoring and forecasts. It is of concern that the Olifants/Doorn WMA is vulnerable to climate change as its economy is based on agriculture. Weather stations and concomitant data are decreasing as budget cuts require SAWS to prioritise their data collection.

Reserve Monitoring

The High Confidence Reserve Determination Study (2003-2005) will resolve Reserve requirements and provide guidance for Reserve monitoring. River Health Monitoring is being undertaken and will be used to assist in monitoring the EWR to ensure that the goals are being achieved.

Groundwater Monitoring

Groundwater monitoring sites are not considered adequate. The frequency of monitoring requires attention and the distribution of sites is inadequate for aquifer specific monitoring. In general, municipal supplies are not being routinely monitored. The Lower Olifants sub-area was specifically highlighted as having insufficient groundwater monitoring. REGIS and HYDRAS III are the groundwater databases in operation.

Surface Water
In general, the quality and quantity of surface water is inadequately monitored in the WMA (refer to the **Water Quality Management Strategy 7.2** and **Capacity Building and Communication Strategy 10.3**).

Monitoring issues by key area include:

Upper Olifants - The only reliable flow monitoring points are at Clanwilliam Dam and at the Citrusdal Bridge. It is important to determine water abstraction above Clanwilliam Dam, therefore the highest priority sites for additional gauging stations are situated along the Upper Olifants River. A priority site is in the upper reaches at Rosendaal.

There is a need to monitor in-stream flows and water quality in the Clanwilliam Dam to accurately determine the nature of recent fish kills. These kills have previously been blamed on temperature stratification which exacerbates water quality and oxygen content issues within the dam.

Lower Olifants - Flow gauging points are located downstream of Lutzville. Groundwater is insufficiently monitored in this area.

Knersvlakte – Flow-gauging stations are required in the northern part of the WMA as it is currently inadequately gauged. The groundwater resource in the Kromme River catchment needs to be studied. Some rainfall stations need to be established.

Sandveld - The ground and surface water interaction needs to be further researched. The coastal areas including the extensive wetlands of the Sandveld need to be monitored.

Doring - There are flow gauging points at the Aspoort and Melkboom sites. Water quality and flow-gauging sites are required on the Tra-Tra, Biedou and Tankwa Rivers. A further gauging station between the Matjies River and Doring River stations is required on the Groot River. Other, lower priority, sites for gauging stations include the Koebee River and Kransgat River.

The following specific monitoring-related issues and concerns were identified:
- Data collected by consultants is not being routinely integrated into the DWAF databases;
- Water quality information is not integrated into the groundwater database in a routine manner which undermines groundwater protection;
- Transcription/capturing of data and regular interpretation of results is limited by staff capacity constraints;
- The sites designated for River Health Monitoring should be utilised for both water quality as well as flow monitoring. Water quality monitoring should be undertaken monthly;
- Water user "self-monitoring" programmes utilising the Internet as an interface should be investigated to counteract DWAF's limited monitoring resources (refer to the **Capacity Building and Communication Strategy 10.3**);

- The time intervals between groundwater monitoring readings are too long. This could result in the non-capture of seasonal events;
- The groundwater monitoring needs must be established for the north of the WMA.
- The focus of regular groundwater monitoring should be on water levels and conductivity (an indicator of salinity);
- Surface-Groundwater interactions and vertical and lateral recharge patterns need to be better understood to ensure efficient monitoring programmes. There is insufficient co-ordination between groundwater, surface water and environmental monitoring and monitoring of spring flows is inadequate;
- The monitoring network should include groundwater interactions with solid waste.

Strategy:

DWAF must co-ordinate its monitoring efforts with all role-players in the WMA to ensure efficient and effective data collection, capturing and analysis to provide sufficient information for management of the water resource. The WMA strategy must be in line with Regional Office and national strategies which are still being developed.

Management Actions:

- Develop a Monitoring and Data Management Plan (see text box below);
- Update the priority list of monitoring requirements based on research and the needs assessment;
- Evaluate and interpret groundwater monitoring data and information and integrate the outcome into groundwater management actions;
- Capacity building and development of appropriate monitoring of municipal groundwater and surface water supplies. The WSDPs of local authorities must define their current water requirements and estimates of future water requirements;
- Co-ordinate the groundwater and water quality monitoring and regular information exchange, particularly with respect to the management and monitoring of effluent from WWTWs;
- Initiate a pilot study using advanced technology to measure regional changes in groundwater level rather than borehole-by-borehole measurements based on the principle of appropriate technology in the logistic and social circumstances;
- Select preliminary sites for prioritised groundwater monitoring based on best available information. Integrate the insights and results gained through all relevant studies;
- Implement improved weather monitoring;
- Establish snow gauges in the high mountains to develop an understanding of the contribution of snowmelt to surface water runoff and groundwater recharge in the Olifants River catchment;
- The National Eutrophication Monitoring Programme should be implemented at Clanwilliam Dam and Bulshoek Weir;
- Clanwilliam Dam water quality information must be communicated to the public during incidents of fish kills.

Responsibility: Regional Office

Priority: Very High

Guidelines for compiling a WMA Monitoring and Data Management Plan:

- Review or identify all aspects that need to be monitored. Group all monitoring needs into logical systems with common goals according to functional areas, which are then divided further into sub-systems;
- Develop a detailed information requirement and monitoring needs assessment for the various systems, which were grouped by functional areas;
- Identification and motivation of required or additional monitoring points or functions required for the WMA;
- Amalgamation of the identified existing and planned monitoring and assessment systems needs into a coherent and structured monitoring, assessment and information system;
- Review resources required for adequate monitoring of surface and groundwater (and other water-related aspects e.g. rainfall);
- Motivation for the regional share of the national monitoring budget;
- Regularly review and update the WMA monitoring strategy; and feed this back into the regional strategy;
- Initiate and encourage co-operative, collaborative relationships between the Department and other organisations or individuals that have relevant data or operate water-related monitoring, assessment and information systems.
- Development of monitoring programmes in the WMA should take cognisance of existing and developing National Monitoring Programmes e.g. National Eutrophication Monitoring Programme, National Microbiological Monitoring Programme etc.

13.2 INFORMATION MANAGEMENT

Management Objective:

To establish and maintain acceptable procedures and standards for storage, manipulation, backup, archiving, dissemination, access to and sharing of accurate water management-related information, within DWAF and other institutions involved in water resource management within the WMA.

Situation Assessment:

Spatial data

DWAF is the custodian of an extensive GIS (UNIX based) corporate spatial database (CSDB) based in Pretoria and managed by Directorate: Geomatics. The region keeps a copy of the CSDB which is updated regularly. It includes data obtained from other companies, state departments, consultants and academics. A list of available data with metadata is available on the DWAF website (www.dwaf.gov.za).

Aerial Photography

The Department owns 1: 30 000 aerial photography covering the most of the Western Cape which was undertaken by the regional Working-for-Water programme in 1999/2000.

Invasive Alien Plants Mapping

Invasive alien plants density mapping has been undertaken for the WMA in 1999-2001. Working-for-Water is using this mapping for planning purposes.

Surface Water Hydrology and Water Quality

The Hydrological Information System and related systems were replaced with an Australian hydrological database system called HYDSTRA in 2002. It is functioning effectively and is providing support for management decisions utilising water quality and quantity data.

WARMS

The Water Use Authorisation and Registration Management System (WARMS) is not currently supporting management sufficiently in the Olifants/Doorn WMA. The system is unable to provide basic information (for example, it does not produce a list of all farmers scheduled in a particular quaternary). It also has no way of graphically displaying all registered users on a map. The registration data must be verified before it can be used for decision-making purposes. If, once verified, this information was publicly available it would allow for refinement and self-policing by other registered users, forcing more unregistered users to come into the fold. Maximum allowable water use is not captured, but only average use. It should be noted that assurance of supply is the same in all cases.

POLMON, WMS and AFS

The Pollution Monitoring Information System (POLMON) is still active. This is currently used in conjunction with the Water Management System (WMS) and Administrative Filing System (AFS), developed locally, for the water quality resource management.

Strategy:

Appropriate resources must be allocated to implement an approved Information Management Plan.

To reduce the resource requirements the approach may best be to develop water user "self-monitoring" capacity. The internet could be used as a data capture tool if users were able to regularly enter their own standardised readings into a database. This may need to be included as a condition on new licences in order to enforce submission of information. Quality of the data is essential and DWAF resources would have to be made available to check and verify data on a regular basis before accepting it. User-friendly guidelines would also have to be developed to support self-monitoring.

Feedback of all monitoring data to landowners and local government in an accessible and useful format is required in order to encourage co-operation, capacity building and good water resource management.

Management Actions:

Compile a WMA Information Management Plan as follows:

- Identify what information the Departmental information managers require;
- Implement an appropriate knowledge management system within the Regional Office;
- Determine IT and GIS-specific requirements such as hardware and software for storage;
- Develop an information sharing policy which should detail the following:
  - What information should be shared?
  - Who should have access to it?
  - What is the integrity of the information to be shared?
  - With whom is sharing of information beneficial?
- Upgrade Head Office and Regional Office software to enhance interaction between monitoring hardware, databases and PCs, e.g. data from automatic data loggers and the National Groundwater Database (NGDB). Identify information requirements from other departments, provincial and local government and other organisations;
- Ensure implementation of the information sharing policy;
- Implement the information-sharing policy through co-operative governance with other departments, local authorities and institutions through various formal and informal committees or other forms of effective co-operation;
- Install adequate storage, backup and archiving facilities and library systems in all the Western Cape regional offices;
- Engage with the WARMS managers to facilitate the development of a management-friendly interface and outputs for the Olifants/Doorn WMA;
- Formulate an approach to deal with available information that is not being systematically captured;
- Source all work which has been done in the area including minor studies (e.g. MSc and PhD theses).

The Regional Office should: • Address custodianship of the databases and requirements for auditing of information or databases for shared databases; • Establish scientific posts that are responsible for the interpretation of data, dissemination of information and development of the GIS-based Data, Information and Knowledge Management; • Initiate the planning of a GIS-based data and information base useful to local government, Department of Land Affairs and Education, other DWAF Directorates, Aid organisations, NGO's and the private sector at WMA or larger scale level. Any GIS-based system must provide data as well as information and best-practice and/or planning guidelines relevant in any particular area and be regularly updated; • Promote the integration of surface, groundwater and ecological monitoring/data collection, centralisation of results and access at ROs and regular interpretation and use of the results as input into an accessible GIS- based information system.
Responsibility: The Regional Office is responsible for implementing this strategy within the WMA in conjunction with the Directorate: Information Management.
Priority: Very High

CHAPTER 14
IMPLEMENTATION STRATEGIES

The Implementation Strategy is required to address:

- Implementation programme for the ISP;
- Resources to implement the ISP;
- Delegation of responsibility;
- Budgeting priorities.

14.1 IMPLEMENTING THE ISP

Management Objective:

To ensure that the approaches put forward by the Department through this ISP are adopted and implemented in the Olifants/Doorn WMA. This will require commitment, funding and capacity.

Situation Assessment:

The ISP is an internal document developed by the Department of Water Affairs and Forestry. The ISP sets out the approaches which the Department is taking towards water management in the Olifants/Doorn WMA and lists suggested actions towards achieving good management of the water resources.

The wider public has had no direct input into the writing of this ISP - yet it is recognised that the approaches suggested have a significant impact on the people of the Olifants/Doorn WMA. Whilst the approach to date in developing this ISP may seem non-participatory, it must be remembered that this is not a Catchment Management Strategy - but DWAF setting out how it sees the situation, and the steps which it views as most appropriate in dealing with that situation. Interactions with the public have been an important influence in developing the approaches adopted.

This ISP is not a closed document but is to be made available to the wider public for comment and input. This makes the ISP an inherently transparent document – opening out the thinking and planning of the Department. Although DWAF makes no commitment to adopt every comment made, these will be taken seriously and the ISP will be updated and improved as newer and better perspectives are formed. Once the CMA has been established it will be required to develop a CMS, and this will require full public participation. It is to be hoped that the ISP will be taken as useful baseline information and, indeed, that the approaches adopted here are found to be acceptable to, and adaptable by, the new dispensation.

Delegation of overall responsibility for the implementation of the ISP to a responsible official with the required level of authority is a critical factor to successfully implement the ISP. Organisational restructuring was undertaken during 2002-2004 and the new structure is due to be implemented in April 2005 in the Southern Cluster (previously the Western and Eastern Cape Regional Offices). The need to implement the ISP according to strategies must be reflected in the revised structure.

An important factor in this WMA is the fact that approximately 95% of the water use is by the agricultural sector. Agriculture is the highest single contributor to the economy of the area. The WMA presents a growing tourism industry particularly in its coastal resorts and the natural conservation areas in the Cederberg. These aspects are strengths of the area. The “weaknesses” of the area are in the knowledge of the EWR, the use of water resources and poverty in the area. The “threats” to developing water resources in the WMA are IAPs and high EWR. The “opportunities” for water resource development can be found in the WODRIS study with a possible off-channel dam on the Doring River and further development of the TMG Deep Aquifers.

Some issues and concerns that have been identified are:

- Internal DWAF liaison must be strengthened, as Head Office and Regional Office Cluster co-ordination is currently inefficient;
- There is a shortage of trained, experienced personnel at DWAF, specifically staff with scientific and local knowledge. Specific departments suffering severe shortages are "Water Quality" and "Water Services";
- The budget for Water Resource Management is generally inadequate;
- Personnel language and gender challenges. Afrikaans speakers are able to collect field information better in this WMA due to the community profile;
- It is estimated that 16 people will be required to undertake all the CMA tasks. This estimated required staff complement might however prove insufficient, considering the extent of the WMA responsibilities. Funding additional staff may prove to be a challenge.
- The future CMA may be unable to perform the hydrology services adequately with the staff they are able to afford. Hydrology services should stay with DWAF as a service/utility;
- In the past, the West Coast District Municipality performed all the water services duties in some towns in the area. Now that the local municipalities are taking over they require more relevant and applicable training in this regard, e.g. water services development plans (WSDP) (refer to the **Capacity Building Strategy**);
- Capacity within Municipality – needs support and capacity building, e.g. good reporting, IDPs, water service development plans (refer to the **Capacity Building Strategy**).

Strategic Approach:

ISPs for each WMA are guided by the NWRS and decisions affecting national resource distribution and use, as presented in the NWRS, are binding on each ISP. This ISP does, however, make a number of corrections and improvements which serve as knowledge updates to the NWRS, particularly as regards catchment water balances and the availability of water for purposes of allocation. The ISP is signed off by the Director responsible for the NWRS and approved by the Department's Water Resources Functional Management Committee. It is also published on the Departmental website. It therefore has the status of an official document containing current best available knowledge with regard to water resource use and availability.

The ISP should be updated as and when new information becomes available and will serve as the primary source document for decision-making, within the framework provided by the NWRS. The implementation of the ISP is an enormous task and will have to be tackled in a stepwise fashion. Much of what is in this document describes the day-to-day functions of the Department – but there are many new tasks, functions, and actions set out in response to DWAF's visions for the future.

It is recognised that it is quite impossible to immediately launch into, and achieve, all that is required by this ISP. Funds and capacity are real constraints. The approach is to take the ISP and to use it as instruction, guidance, and motivation in the development of yet clearer management and action plans. These must be built into Departmental Business Plans, and budgeted for as part of Departmental operating costs.

This will necessarily be in a phased manner as dictated by available resources, but it is important that the ISP be used to leverage maximum funds, maximum capacity, and to bring optimum management to the WMA. The position with regard to the 'Authority of Information Contained in the ISP' is further set out in **Section 1.3.4** of **Chapter 1** of this ISP document.

The major focus in the short-term will be the focus on making water available for RPFs. This must be achieved through the implementation of many strategies, which must complement each other and avoid serious water shortages.

Management Actions:

The following actions are required:

- Publish the ISP to be accessible for public input and comment (consider hard-copy and web-based options). Copies will be presented to key stakeholders on request. It is not the intention to have a major drive for public input, but merely to create the opportunity for input;
- Develop materials which help to take the ISP to Provincial, District and Local Government Authorities. Also to support the Water Services Development Plans, organised agriculture, emerging farmers, and others. Materials should be useful in preparation of the Provincial Growth and Development Strategy and other regional and provincial planning activities;
- There are many actions in the ISP which do require public involvement – and it is important that the thinking with regard to, for example, the use of groundwater, and the importance of WC&DM, is delivered forcefully to local authorities, other direct water users such as agriculture, and the wider public;
- Collate and consider all comments in revising and improving the ISP;
- The ISP should be open to continuous improvement, with updating on a regular basis;
- All Regional Office water resource management staff, Working-for-Water, and other major stakeholders should have access to, or copies of, the ISP;
- Approaches set out in the ISP need to be accepted and adopted by both national and regional staff. Where there is resistance to ideas then this needs to be resolved in an open climate of debate and understanding. Modification of the ISP is not ruled out;
- The practicalities of implementation demands must always be considered;
- Most actions in this ISP have been assigned to the Regional Office. It is critically important that the tasks outlined are prioritised, budgeted for, and built into regional and national business plans and budgets;
- Assign a senior official in the Regional Office to the implementation of the ISP;
- Identify and delegate responsibility for the successful implementation of individual ISP strategies to specific officials in the responsible regional and head office functional groups/Directorates;
- Identify champions or contact persons in the Regional Office for more specialised functions (refer to **Table 14.1**).

Responsibility: The Regional Office is responsible for implementing this strategy.

Priority: This strategy has very high priority. The implementation is to be ongoing until the Olifants/Doorn CMA is established and the ISP is superseded by a CMS.

Implementing the ISP Strategy

Table 14.1: Responsibilities/champions for the strategies

Strategies	Regional Office Responsibility	Head Office Champions [1]
YIELD BALANCE AND RECONCILIATION	**Gerrit van Zyl**	**NWRP / OA/WRPS**
Reliability of Water Availability and Use	Gerrit van Zyl	NWRP: F. Stoffberg/ OA: A. Brown
Groundwater	Mike Smart/ Paul Seaward	WRPS: Fanie Botha
Reconciliation	Gerrit van Zyl	NWRP: F. Stoffberg
WATER RESOURCES PROTECTION	**Gareth McConkey**	**RDM / WDD**
Reserve and Resource Quality Objectives	Toni Belcher	RDM / WDD: Barbara Weston
Water Quality Management	Gareth McConkey	WDD
Wastewater Treatment and Solid Waste Management	Abdulla Parker/ Francois van Harden	WDD
WATER USE MANAGEMENT	**Willie Enright**	**WA&IU / WUE**
Water Allocation and Licensing	Abdulla Parker	WA&IU: Francois van der Merwe
Verification of Existing Lawful Use	Abdulla Parker/ Francois van Harden	WA&IU: Francois van der Merwe
Management of Non-compliant Use	Abdulla Parker/ Francois van Harden	WA&IU: Francois van der Merwe
Compulsory Licensing	Willie Enright/ Abdulla Parker	WA: Ashwin Seetal
General Authorisations	Abdulla Parker	WA&IU: Francois van der Merwe / WDD
Invasive Alien Plants	Lies Bezuidenhout	WfW
Support to local authorities	Zolile Basholo	NWRP: F Stoffberg / OA: A Brown
WATER CONSERVATION AND WATER DEMAND MANAGEMENT	**Zolile Basholo / Mary Rahube**	**WA&IU / WUE**
Urban/Industrial/Agricultural WC&DM/ Water Use efficiency	Mary Rahube	WUE: Nigel Adams
INSTITUTIONAL DEVELOPMENT AND CO-OPERATIVE GOVERNANCE	**Willie Enright**	**WMIG**
Institutional development (CMA, WUA and Forums)	Abdulla Parker/ Francois van Heerden	WMIG: Eustathia Bofilatos
Co-operative Governance	Abdulla Parker/ Francois van Heerden	WMIG
Capacity Building and Communication	Abdulla Parker/ Francois van Heerden	WMIG: Eustathia Bofilatos / WA&IU : Jean Msiza

Strategies	Regional Office Responsibility	Head Office Champions [1]
SOCIAL AND ENVIRONMENTAL	**Willie Enright**	**WMIG / WA&IU**
Integrated Environmental Management	Toni Belcher	WA&IU: Valerie du Plessis
Poverty Eradication (Resource-poor Farmers)	Abdulla Parker	WA&IU
WATERWORKS DEVELOPMENT AND MANAGEMENT	**Southern Cluster: Dewald Coetzee/ Tyl Willems**	**None**
Waterworks Management, Operation and Ownership	Erwin Weidemann/ De Wet Oosthuizen	Southern Cluster: Dewald Coetzee
Waterworks Development	Abdulla Parker/ Francois van Heerden	Southern Cluster: Dewald Coetzee
Public Health and Safety /Disaster Management	Abdulla Parker/ Francois van Heerden	WRPS: Chris Swiegers
Recreation	Abdulla Parker/ Francois van Heerden	Environment and Recreation: Lorraine Fick
MONITORING AND INFORMATION MANAGEMENT	**Gerrit van Zyl**	**M: IM**
Monitoring and Data Management	Gerrit van Zyl	D: IP : Elias Nel
Information Management	Gerrit van Zyl	CD: IM: A. Muller
IMPLEMENTATION	**M: Southern Cluster**	**None**
Implementation	M: Southern Cluster	None

1. The abbreviations for the various DWAF Directorates, related organisations and designations are:

Chief Director	:	CD
National Water Resource Planning	:	NWRP
National Working-for-Water	:	NWfW
Options Analysis	:	OA
Scientific Services	:	SS
Social and Ecological Studies	:	WA&IU
Waste Discharge and Disposal	:	WDD
Water abstraction and Instream Use	:	WA&IU
Water Use Efficiency	:	WUE
Water Resource Planning Systems	:	WRPS
Water Allocation		WA
WMI Governance	:	WMIG
Working for Wetlands	:	WfWetlands
Working-for-Water		WfW

APPENDICES

Appendix 1

References

REFERENCES

Acocks, J P H. (1988). *Veld types of South Africa*. Botanical Survey of South Africa, Memoirs, 57. Pretoria, RSA: Botanical Research Institute. p 146.

Anon (2000). *Olifants/Doring River: Follow-up study to investigate the proposed irrigation schemes* - Contract No. 259 - 2000/2001. Study proposal. A. G. P. Ltd.

Aartsma, H. and A. Malan (2003). *Western Cape Olifants/Doring River Irrigation Study. Bulk water conveyance options for irrigation.* Volumes I and II: Draft 1. Contract Number: 259-2000/2001. Arcus Gibb.

Baron and Seward P (2000). *Evaluation of groundwater use in South Africa*. Unpublished DWAF information.

Board, W., D. J. Hagen, et al. (2003). *Western Cape Olifants/Doring River Irrigation Study. Surface water resources development options.* Volumes I and II Contract Number: 259-2000/2001. Arcus Gibb.

Boucher, C. (2002). *Western Cape Olifants/Doring River Irrigation Study. Botanical report*. Draft 2. Contract No. 259 - 2000/2001. A. G. P. Ltd.

Brown, C. A. and E. G. Day (1997). *Olifants/Doring River Basin Study Phase 1: Impacts of water resource developments on the riverine ecosystem*. Volume 3: Doring River situation assessment. Southern Waters cc.

Brown, C., K. Riemann, et al. (2003). *Western Cape Olifants/ Doring River Irrigation Study (WODRIS): Potential impacts to surface ecosystems as a result of groundwater abstraction*.

Coetzee J.C , Adams J.B and Bate G.C. (1997). *A Botanical Importance Rating of Selected Cape Estuaries.* Water SA 23:81-93.

CSIR (1990). *Preliminary assessment of the potential for fresh water extraction from the Olifants Estuary.*

CSIR. 1995. *Handy Reference Manual on the Impacts of Timber Plantations on Runoff in South Africa.* Forestek, Stellenbosch

Dallas, H. F. (1997). *Olifants/Doring River Basin Study Phase 1: Impacts of water resource developments on the riverine ecosystem*. Volume 2: Olifants River situation assessment.

Department of Agriculture, Pretoria, 1994. *National Livestock Census*

Department of Water Affairs and Forestry, South Africa (1990a). *Olifants River System Analysis: Yield Analysis of the Area Upstream of Bulshoek Dam*. Final Draft. BKS Consulting Engineers.

Department of Water Affairs and Forestry, South Africa (1990b). *Proposed Sandveld Regional Water Supply Scheme by* C J Littlewort. Report P G300/00/0290

Department of Water Affairs and Forestry, South Africa (1992). *Olifants River System Analysis : Operating rule determination by use of stochastic hydrology - present and future development.* Ninham Shand in association with BKS Incorporated. Report P E100/00/0192

Department of Water Affairs and Forestry, 1998: *Olifants/Doring River Basin Study Phase 1*, BKS in association with Ninham Shand, Report No. PE000/00/0198.

Department of Water Affairs and Forestry, South Africa (1998). *Quality of domestic water supplies, Volume 1 : Assessment Guide*.

Department of Water Affairs and Forestry, South Africa (2000a). *Water Balance Model: A decision support system for reconnaissance level planning*.

Department of Water Affairs and Forestry, South Africa(2000b). *National Demographic Study.*

Department of Water Affairs and Forestry, South Africa (2000c). *Reconnaissance Investigation into the Development and Utilisation of Table Mountain Group Artesian Groundwater, using the E10 catchment as a Pilot Study Area.* Prepared by Umvoto Africa / SRK Consulting Joint Venture.

Department of Water Affairs and Forestry, South Africa (2000d). *Water Situation Assessment Model User Manual.*

Department of Water Affairs and Forestry (2001). *The Distribution of South Africa's Population, Economy and Water Usage into the Long Term Future: A Study of Demographic, Economic and Socio-Economic Change Relating to Water Usage, Report on Phase 2.* Lawrence Schlemmer, Markdata and Eric Hall and Associates, Report No. P RSA /00/2200.

Department of Water Affairs and Forestry (2002): *Olifants/Doring Water Management Area: Water Resources Situation Assessment.* Ninham Shand in association with Jakoet and Associates, Volume 1 and 2, Report No. P17000/00/0101.

Department of Water Affairs and Forestry (2003): *Olifants-Doorn Water Management Area: Proposal for the Establishment of the Olifants-Doorn Catchment Management Agency*. Prepared by the stakeholders of the Olifants-Doorn WMA and facilitated by Ubufazi Consulting.

Department of Water Affairs and Forestry, South Africa (2003). *Olifants/Doring River Basin Study Phase 2.* BKS.

Development Bank of Southern Africa, *A Regional Profile of the Southern African Population and its Urban and non-urban Distribution.* 1970-1990

Du P. le Grange, A. (2001). *Olifants/Doring River: Follow-up study to investigate the proposed irrigation schemes.* Contract No. 259 - 2000/2001. Draft Inception Report. Draft 1. A. G. P. Ltd.

Esterhuizen, D., M. van Veelen, et al. (2000). *Olifants/Doring River Rapid Reserve Assessment for three predetermined sites.* Draft Copy.

Feuchtwanger, T. (1979). *Thermal infrared survey of the south west coastal area, between Melkbosstrand and of the Olifantsriver*. DWAF.

Gaffney Group. (1998). *Official South African Local Government Yearbook 1997 – 1998.*

GEOSS and SRK (2003). *Olifants-Doorn groundwater guidelines. Trial implementation and testing*. Draft final version 1: minus monitoring.

Görgens, A. (1998). *Methodology for incorporation of alien vegetation impacts in the national water balance model*. Memorandum to Department of Water Affairs and Forestry.

Hagen, D. J., McStay J., et al. (2001). *Western Cape Olifants/Doring River Irrigation Study: Physical characteristics and present land use*. Draft 1.

Hartnady, C.J.H., and E.R. Hay (2002). *Western Cape Olifants Doring Study (WODRIS).* Phase A. Hydrogeological inception report.

Hartnady, C. J. H. and E. R. Hay (2002). *The use of structural geology and remote sensing in hydrogeological exploration of the Olifants and Doring River Catchments. A synthesis of the hydrogeology of the Table Mountain Group. Formation of a research strategy*. K. Pietersen and R. Parsons.

Hartnady, C. J. H. and E. R. Hay (2002). *Experimental deep drilling at Blikhuis, Olifants River valley, Western Cape: motivation, setting and current progress. A synthesis of the hydrogeology of the Table Mountain Group. Formation of a research strategy.* K. Pietersen and R. Parsons.

Hay, E. R. and C. J. H. Hartnady (1997). *Hydrogeology and groundwater resource potential of the Olifants/Doring River Basin, Western and Northern Cape Provinces*.

Hay, E. R. and C. J. H. Hartnady (2002). *Western Cape Olifants Doring Study (WODRIS). Phase B. Hydrogeological reconnaissance report.*

Hay, E. R. and C. J. H. Hartnady (2003). *Western Cape Olifants/ Doring River Irrigation Study (WODRIS). Task 3 - Phases A and B. Subsurface water: hydrogeological reconnaissance report.*

Hester, A. and N. Carter (2003). *Western Cape Olifants/Doring River Irrigation Study. Environmental synthesis report.* Draft 1. Contract Number: 259-2000/2001. Arcus Gibb.

Howard, G. (1998). *Olifants/Doring River Basin Study Phase 1: Water resources evaluation: Hydrology*.

Hughes, DA and Münster, F. 1999. *A decision support system for an initial "low-confidence" estimate of the quantity component of the Reserve for rivers*. Unpublished discussion document available at http://www.ru.ac.za.departments/iwr.

King, J. M. and C. A. Brown (1997). *Olifants/Doring River Basin Study Phase 1: Impacts of water resource developments on the riverine ecosystem. Volume 1: assessment of impacts*. Southern Waters cc.

King, J and Louw, D. (1998). *Instream flow assessments for regulated rivers in South Africa using the Building Block Methodology.* Aquatic Ecosystem Health and Management, 1, 109-124.

Lambrechts, J. J. N. and B. H. A. Schloms (1998). *Olifants/Doring River Basin Study Phase 1: Soils and irrigation potential investigation.* Final report. BKS and Ninham Shand.

Langhout, C. (1998). *Olifants/Doring River Basin Study Phase 1: Physical characteristics and land use.*

Laubscher, J. (1998). *Olifants/Doring River Basin Study Phase 1: Financial viability of irrigation schemes.*

Le Maitre, D C, Versfeld, D B, and Chapman, R A. (1998). *The impact of Invading Alien Plants on Surface Water Resources in South Africa: A Preliminary Assessment*.

Luger, M. (1998). *Olifants/Doring River Basin Study Phase 1: Synthesis of Environmental Studies*. BKS and Ninham Shand.

McKenzie, R. S., N. W. Schäfer, et al. (1990). *Olifants River System Analysis. Yield analysis of the area upstream of Bulshoek Dam.* BKS Inc., DWAF.

Midgley, D C, Pitman, W V and Middleton, B J. (1994). *The Surface Water Resources of South Africa, 1990*. Volumes 1 to 6. Report to the Water Research Commission, Pretoria.

Murray, S. L. and A. H. M. Görgens (1994). *Olifants River System Analysis. Hydrology of the Doring River.* Ninham Shand, DWAF.

Nel, Van Wilgen and Gelderblom. (1999). *The Contribution of Plantation Forestry to the Problem of Invading Alien Trees in South Africa: A Preliminary Assessment*. P 62.

Ninham Shand (1996). *Financial Viability of Agricultural Development in the Doring River Valley, Calvinia District.* Provincial Government of the Northern Cape

Ninham Shand (1999). *Interim Adjustment of WR90 Quaternary Naturalised Flows to Reflect CSIR Afforestation-Related Streamflow Reduction Activities.*

Ninham Shand (2002). *Olifants/Doring Water Management Area. Water Resources Situation Assessment.* Main Report: Volumes 1 and 2.

Riemann, K. and L. Groenewald (2003). *Western Cape Olifants/ Doring River Irrigation Study (WODRIS). Task 3 - Phase D. Subsurface water: hydrocensus report.*

Rooseboom *et al* 1992. *The Development of the New Sediment Yield Map of Southern Africa*. Water Research Commission Publication No. 297/2/92

Rooseboom, A. (1998). *Olifants/Doring River Basin Study Phase 1: Reservoir sedimentation report.* BKS and Ninham Shand.

Rosewarne, P., C. J. H. Hartnady, et al. *Exploration for deep artesian groundwater resources in the Table Mountain Group fractured-rock aquifer: meeting Citrusdal community water supply needs from "hydrotect" structures in the Olifants River syncline.* Research project proposal to the Water Research Commission.

Schlemmer, L, MarkData (Pty) (Ltd), and Eric Hall & Associates (2001). *The Distribution of South Africa's Population, Economy and Water Usage into the Long-term Future: Report on Phase 2.* Report No. PRSA/00/2200, to the Department of Water Affairs and Forestry, Directorate: Water Resources Planning, Pretoria.

Schreuder, D. N. (1978). *'n Oorsig van die grondwaterpotensiaal van die area tussen die Berg- tot Olifantsrivier. Weskus Projek: Berg- tot Olifantsrivier.* DWAF.

Schulze, R E, Jaharaj, M Lynch, S D, Howe, B J, Melvil-Thomson, B. (1997). *South African Atlas of Agrohydrology and Climatology*. Report to the Water Research Commission, Pretoria. Report No. TT82/96.

Seward, P and Seymour, A. (1996). *Groundwater harvest potential of the Republic of South Africa.*

Simonic, M. (2000). *Assessment of the ambient groundwater quality on a national scale in the Republic of South Africa*. WRC Project K5/841.

Sinclair, S.A., Lane, S.B and Grindley, J.R. (1986). *Estuaries of the Cape: Part II: Synopsis of available information on individual systems*. Report No. 32 – Verlorevlei (CW13). Heydorn, A.E.F. and Morant, P.D. (Eds). Stellenbosch, CSIR Research Report. 431

Tharme, R. E. (1993). *Proposed Rosendaal Dam: Instream Flow Requirements of the Olifants River (Western Cape), upstream of Clanwilliam Dam.* Freshwater Research Unit and U. o. C. Town, Citrusdal Irrigation Board.

Theron, T. P. (1998). *Olifants/Doring River Basin Study. Water resources development options.*

Titus, R., S. Adams, et al. (2002). *Groundwater Situation Assessment in Olifants/Doorn Water Management Area (Version 1.0).* Groundwater Group, DWAF.

Van Veelen, M., T. Baker, et al. (1998). *Olifants/Doring River Basin Study Phase 1:. Water quality assessment.* BKS and Ninham Shand.

Vegter, J R. 1995. *Groundwater resources of the Republic of South Africa*. WRC Project 483.

Versfeld, D B, Le Maitre, D C and Chapman, R A. 1997. *Alien Invading Plants and Water Resources in South Africa*. Report to the Water Research Commission, Pretoria.

Visser, J. (2000). List of projects/initiatives/studies in the Olifants/Doring Catchment Area. DWAF.

White Paper H-'87. Republic of South Africa 1987 – 88. *Second Report on the Proposed Southern Namaqualand Government Regional Water Supply Scheme*.

Yates, R. (2002). *Western Cape Olifants/Doring River Irrigation Study. Archaeological heritage impact assessment.* Draft 2. Contract No. 259 - 2000/2001. A. G. P. Ltd.

Appendix 2

Heritage and Wilderness Sites in the WMA

APPENDIX 2: PROTECTED NATURAL AREAS AND NATURAL HERITAGE SITES WITHIN THE OLIFANTS/DOORN WMA

Source: DANIDA IWRM Institutional Roles and Linkages Situational Assessment- WMA17 Olifants/Doorn

Existing Conservancies
- Benede Bergrivier Conservancy
- Biedou Conservancy
- Cederberg Conservancy
- Lambertsbaai/Strandveld Conservancy
- Wupperthal Conservancy

Proposed Conservancies
- Groot-Winterhoek
- Keerom
- Koue Bokkeveld
- Olifants Mountain
- Renosterveld
- Saron
- Witzenberg

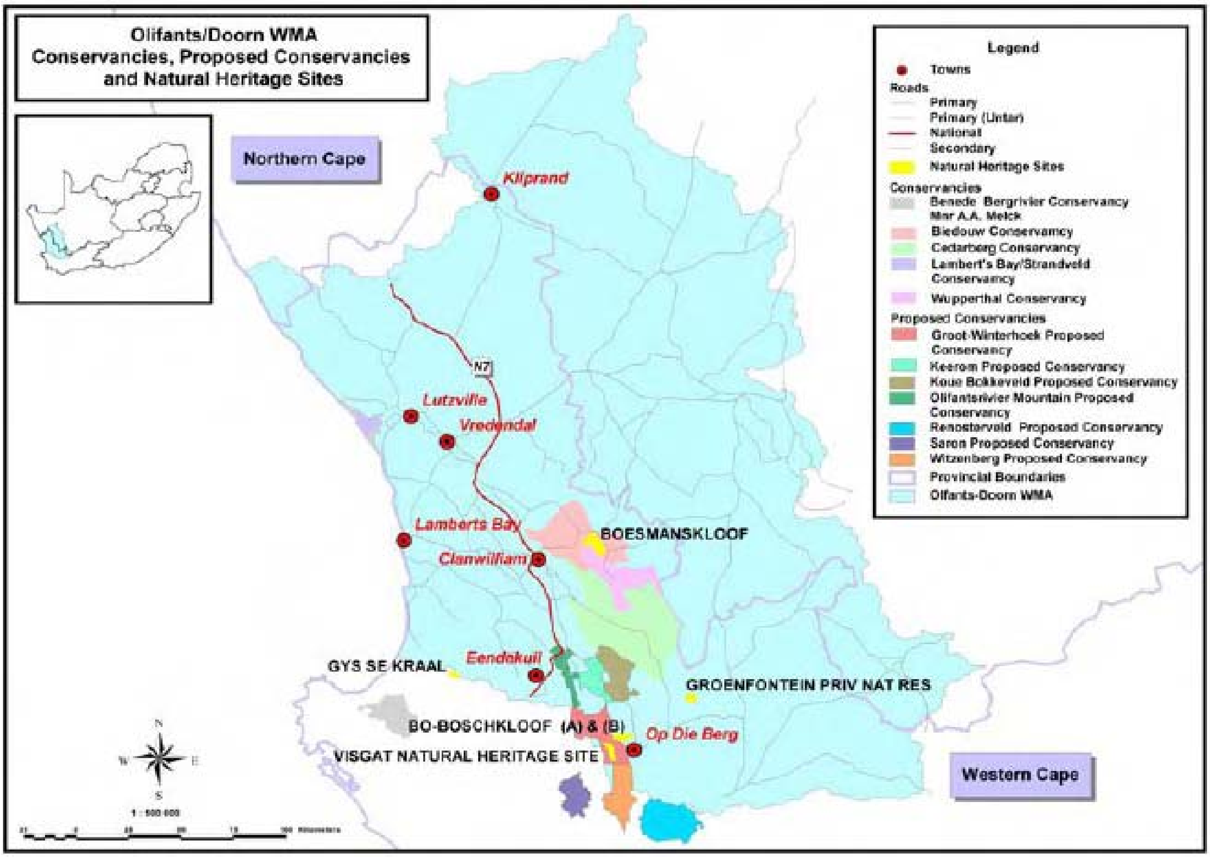
Natural Heritage sites
- Boesmandskloof
- Visgat
- Gys se Kraal
- Bo-Boskloof
- Groenfontein

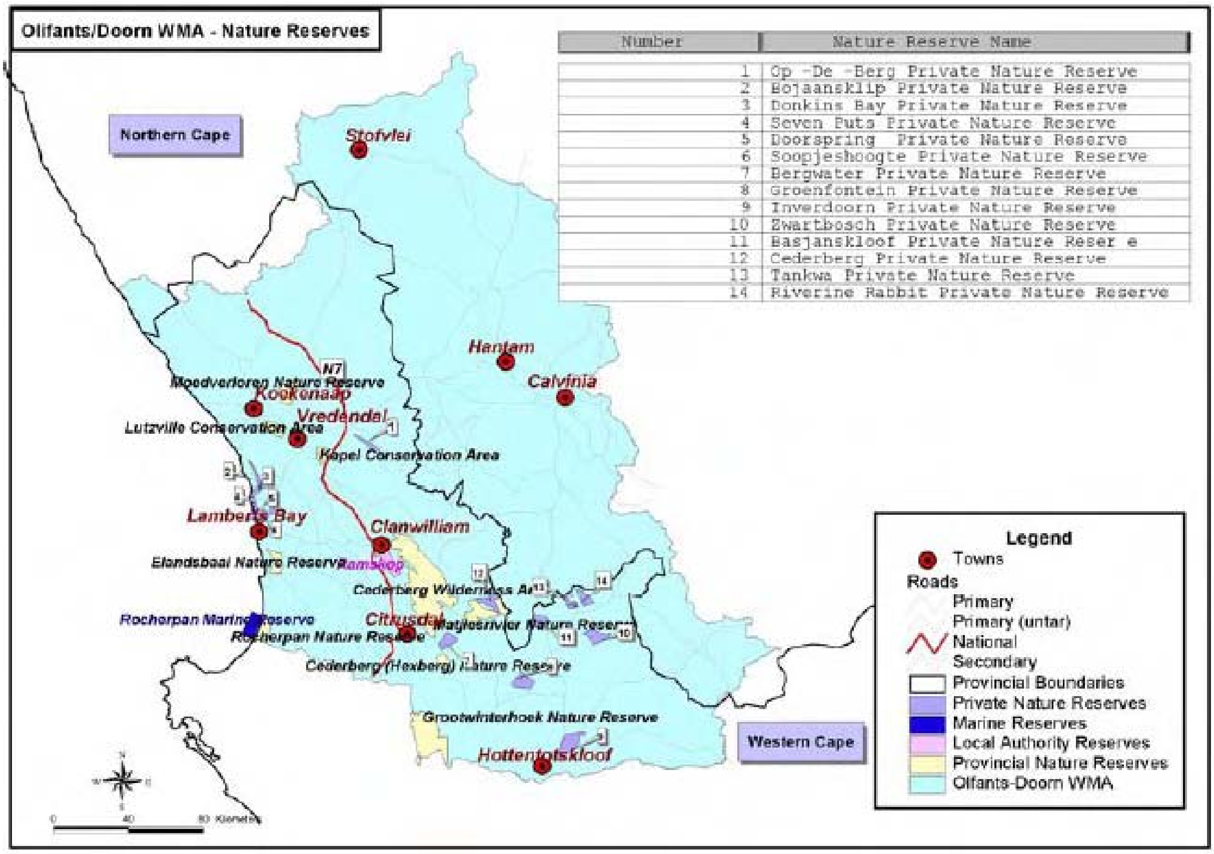
Marine Nature Reserves
- Rocherpan Marine Nature Reserve

Provincial Nature Reserves
- Elandsbaai
- Lutzville Conservation Area
- Meerdeverloren
- Rocherpan
- Cederberg
- Grootwinterhoek
- Matjiesrivier
- Cederberg Wilderness Area
- Trawal Conservation Area

Municipal Nature Reserve
- Hangskop Nature Reserve (Clanwilliam)

Appendix 2


Olifants/Doorn WMA
Conservancies, Proposed Conservancies
and Natural Heritage Sites
Northern Cape
Western Cape
Kliprand
Lutzville
Vredendal
N7
Lamberts Bay
Clanwilliam
Eendekuil
Op Die Berg
BOESMANSKLOOF
GYS SE KRAAL
GROENFONTEIN PRIV NAT RES
BO-BOSCHKLOOF (A) & (B)
VISGAT NATURAL HERITAGE SITE
1 : 500 000
Legend
Towns
Roads
Primary
Primary (Untar)
National
Secondary
Natural Heritage Sites
Conservancies
Benede Bergrivier Conservancy
Mnr A.A. Melck
Biedouw Conservancy
Cedarberg Conservancy
Lambert's Bay/Strandveld Conservancy
Wupperthal Conservancy
Proposed Conservancies
Groot-Winterhoek Proposed Conservancy
Keerom Proposed Conservancy
Koue Bokkeveld Proposed Conservancy
Olifantsrivier Mountain Proposed Conservancy
Renosterveld Proposed Conservancy
Saron Proposed Conservancy
Witzenberg Proposed Conservancy
Provincial Boundaries
Olifants-Doorn WMA


Olifants/Doorn WMA - Nature Reserves
Number
Nature Reserve Name
1 Op -De -Berg Private Nature Reserve
2 Bojaansklip Private Nature Reserve
3 Donkins Bay Private Nature Reserve
4 Seven Puts Private Nature Reserve
5 Doorspring Private Nature Reserve
6 Soopjeshoogte Private Nature Reserve
7 Bergwater Private Nature Reserve
8 Groenfontein Private Nature Reserve
9 Inverdoorn Private Nature Reserve
10 Zwartbosch Private Nature Reserve
11 Basjanskloof Private Nature Reser e
12 Cederberg Private Nature Reserve
13 Tankwa Private Nature Reserve
14 Riverine Rabbit Private Nature Reserve
Northern Cape
Western Cape
Stofvlei
Hantam
Calvinia
N7
Moedverloren Nature Reserve
Koekenaap
Vredendal
Lutzville Conservation Area
Kapel Conservation Area
Lamberts Bay
Clanwilliam
Elandsbaai Nature Reserve
Ramskop
Cederberg Wilderness Area
Rocherpan Marine Reserve
Rocherpan Nature Reserve
Citrusdal
Matjiesrivier Nature Reserve
Cederberg (Hexberg) Nature Reserve
Grootwinterhoek Nature Reserve
Hottentotskloof
Legend
Towns
Roads
Primary
Primary (untar)
National
Secondary
Provincial Boundaries
Private Nature Reserves
Marine Reserves
Local Authority Reserves
Provincial Nature Reserves
Olifants-Doorn WMA

AREA NAME	CATEGORY	GRID REFERENCE
Bo-Boschkloof	Natural Heritage Site	32º 58'S 19º 12'E
Bushmans Kloof	Natural Heritage Site	32º 07'S 19º 08'E
Cederberg Wilderness Area	Wilderness Area	32º 15'S 19º 15'E
Cederberg State Forest	Habitat and Wildlife	32º 35'S 19º 15'E
Elandsbaai Nature Reserve	Habitat and Wildlife	32º 20'S 18º 35'E
Elephant Rock	Habitat and Wildlife	31º 38'S 18º 07'E
Gannabos	Natural Heritage Site	31º 08'S 19º 12'E
Groot Groenfontein Private	Natural Heritage Site	32º 50'S 19º 34'E
Grootfontein	Natural Heritage Site	32º 55'S 19º 06'E
Gys se Kraal	Natural Heritage Site	32º 42'S 18º 32'E
Matroosberg State Forest	Habitat and Wildlife	33º 25'S 19º 50'E
Oorlogskloof Nature Reserve	Habitat and Wildlife	31º 27'S 19º 00'E
Penguin Island (Lamberts Bay)	Habitat and Wildlife	32º 05'S 18º 18'E
Perdefontein	Natural Heritage Site	33º 20'S 19º 20'E
Rocherpan Nature Reserve	Habitat and Wildlife	32º 35'S 18º 17'E
St Helena Bay Rock Lobster	Habitat and Wildlife	32º 45'S 18º 03'E
Tankwa Karoo National Park	National Parks and	32º 14'S 19º 50'E
Verlorevlei	RAMSAR Site	32º 22'S 18º 27'E
Visgat	Natural Heritage Site	32º 57'S 19º 12'E

(Source: WRSA, 2002)

Appendix 3

Yield and Ecological Water Requirements

YIELD AND ECOLOGICAL WATER REQUIREMENTS

3.1 Yield

A detailed description of values utilised in the yield balance provided in Chapter 3 follows.

The ecological water requirements (EWRs) shown in Table 4.2 for the Doring, Koue Bokkeveld, Knersvlakte and Sandveld sub-areas are given as per the NWRS. The hydrology for the NWRS Olifants sub-area needed to be evaluated in greater detail than in the NWRS, because the sub-area was divided into the Upper Olifants and Lower Olifants sub-areas for the ISP evaluation, with the split being below Clanwilliam Dam.

More updated hydrology than was available for the NWRS, which was undertaken for the *Olifants/Doring River Basin Study Phase 2*, *Possible Raising of Clanwilliam Dam* (2003) investigation, became available for the Clanwilliam Dam/Bulshoek Weir system in 2003. Where possible, these updated hydrological values have been used in the hydrological calculations for the Upper and Lower Olifants sub-areas, as it contains the latest information with regards to hydrology, land use and demand distribution (including the EWR).

Unfortunately, not all required information could be extracted from the abovementioned study results, such as e.g. the incremental yield of the Bulshoek Weir and the impact of the Reserve on this incremental yield. It was therefore necessary to undertake additional modelling for the Upper and Lower Olifants sub-areas respectively, using the latest WRYM model setup from the 2003 study, to provide the required values. This involved running the model with and without the ecological Reserve and comparing the difference in yield.

In the *Olifants/Doring River Basin Study Phase 2 (2003)* investigation, the concept of a "*distributed*" Reserve for the Upper Olifants River was introduced, in order to try and obtain a more pragmatic approach towards meeting the Reserve requirement at an EWR site just downstream of Clanwilliam Dam, which was determined during Phase 1 of the Basin Study. The ecological Reserve was therefore calculated for a number of points on the river upstream of the dam. Users will be required to ensure that there is adequate runoff to meet the Reserve. This is viewed as a more equitable result, with all users contributing to the Reserve by means of reduced abstractions. This would be difficult to control in practice but is in line with the intention of the National Water Act. The requirements for the "*distributed*" Reserve for the Upper Olifants as shown in **Table 4.2**, in practice requires that water use from upstream farm dams or direct abstraction from the river be limited.

Incremental ecological Reserve requirements for the Upper and Lower Olifants sub-areas were thus derived from the additional modelling undertaken for this study, according to the latest available model set-up, hydrology, land use and demands.

The NWRS values for surface water resources, which used a combined 1:50 year yield of 154 million m^3/a for the Clanwilliam Dam/Bulshoek Weir system, refer to yields under "*undeveloped*" conditions (i.e. a dam placed in a natural environment). The 1:50 year yield of

Clanwilliam Dam, according to the *Olifants/Doring River Basin Study Phase 2 (2003)* hydrology, as discussed in detail in **Appendix 3.2**, is 115 million m^3/a, and the developed 1:50 year incremental yield of Bulshoek Weir was modelled as 18 million m^3/a. These values can however not summarily be used in the ISP as they are yields modelled under "*developed*" conditions. An attempt could be made to derive the undeveloped dam yield from the developed yield by adding impact values, but this would be of low confidence. It was therefore decided to retain the combined dam yield of 154 million m^3/a from the NWRS and to proportionally increase the "*developed*" yields to sum to the NWRS combined value. The 1:50 year yield used for Clanwilliam Dam is thus 133 million m^3/a and for Bulshoek Weir is 21 million m^3/a.

It has been assumed that the reduction in yield of the Upper Olifants farm dams due to the requirements of a "distributed" Reserve would be offset by an increased yield from Clanwilliam Dam. The Clanwilliam Dam yield of 159 million m^3/a shown in the following **Table 4.3** is therefore a combination of the 1:50 year yield of 133 million m^3/a (when no EWRs are applied) and an increase of 26 million m^3/a to 159 million m^3/a, due to the effect of limiting use from upstream farm dams (to meet the Reserve). The 1:50 year yield from *minor dams and run of river* of 55 million m^3/a when no EWRs are applied will in turn reduce by 26 million m^3/a to 29 million m^3/a, due to the effect of limiting use from upstream farm dams to meet the Reserve. The adjustment of both these components of the surface water yield by 26 million m^3/a in **Table 4.3** does not change the overall surface water yield of the Upper Olifants sub-area.

It should be noted in **Table 4.4** that the yields of Clanwilliam Dam and Bulshoek Weir are based on the "developed" yield modelling using the system configuration as set up during the *Olifants/Doring River Basin Study Phase 2 (2003)* as discussed in detail above and in **Appendix 3.2**, and which have been proportionally increased to the combined dam yield of the NWRS. The Clanwilliam Dam yield dropped from 141 million m^3/a to 133 million m^3/a, whilst the Bulshoek Weir yield increased from 13 million m^3/a to 21 million m^3/a. There is however some uncertainty about the accuracy of these changes. There is also some uncertainty about the Bulshoek Weir yield because the effect of sedimentation[7] (which has significantly reduced the storage volume) has not been incorporated in the yield analyses.

Table 4.3: The 1:50 year yield from *minor dams and run of river* was estimated at 60 million m^3/a in the NWRS for the Olifants catchment. This was split into 55 million m^3/a in the Upper Olifants and 5 million m^3/a in the Lower Olifants for the ISP sub-areas. These figures were then reduced to 29 million m^3/a for the Upper Olifants sub-area to reflect the impact of the Reserve (55 -26), while the value for the Lower Olifants sub-area remained 5 million m^3/a, thus a comparative total of 34 million m^3/a.

Although it is currently considered to be unlikely that additional releases, to those made from Clanwilliam Dam for the ecology, will be made from Bulshoek Weir, the reduction in yield of 8 million m^3/a, to meet the Reserve for the Lower Olifants sub-area, has been retained in these

[7] In the 1994 survey, sedimentation was noted as 17% however it is believed that this is underestimated (Pers Comm 2003 F van Heerden-DWAF Clanwilliam)

calculations for consistency. A total impact of the Reserve on the combined Upper and Lower Olifants is thus 22 million m^3/a, compared to the 12 million m^3/a of the NWRS.

3.2 Determination of the impact of the preliminary ecological Reserve for the Clanwilliam Dam

The Olifants Doring River Basin Study Phase 2 included a report called the *Clanwilliam Dam Raising Reconnaissance Study* (Van Veelen and Jonck, 2003) which determined the historical firm yield of Clanwilliam Dam as 148,9 million m^3/a (Table 4.1 of that report). This is when the ecological water requirement (EWR) is not taken into account. The firm yield was determined as 97,2 million m^3/a if the preliminary Reserve is released from the dam only, and 130,9 if the preliminary Reserve requirement is applied both upstream and downstream of the dam (so-called distributed EWR). Historical impacts of the EWRs above Clanwilliam Dam are therefore calculated as follows:

EWR applied at Clanwilliam Dam only: 51,7 million m^3/a (= 148.9 – 97.2).
Distributed EWR: 18,0 million m^3/a (= 148.9 – 130.9).

Stochastic analysis in the study was however done only for the distributed EWR scenario during the study, and not for the other options. The impact of the EWR on the 1:50 year yield is therefore not known in all cases. The 1:50 year yield at Clanwilliam Dam for the distributed EWR scenario was determined as 101 million m^3/a. The ratio of the 1:50 year to historical yield is therefore 0.772 (101/130,9) and is used to estimate the yields for the other two scenarios as follows:

Scenario	Historical yields	1:50 year	Factor
No EWR	148.9	115 (2)	0.772
Distributed EWR	130.9	101 (1)	0.772
EWR supplied from Clanwilliam Dam only	97.2	75 (2)	0.772

(1) From the *Clanwilliam Dam Raising Reconnaissance Study*.
(2) Estimated by application of the ratio.

From the above, the 1:50 year impact of the EWR is as follows:

Scenario	Impact of EWR
Distributed EWR	14
EWR supplied from Clanwilliam Dam only	40

The incremental yield of the Bulshoek Weir and the impact of the Reserve on this incremental yield could however not be derived from previous reports. Another set of historical yield analyses, using the WRYM setup and supporting data from the *Clanwilliam Dam Raising*

Reconnaissance Study, were therefore done as part of this ISP, to determine the incremental yield of the Bulshoek Weir. The historical incremental yield was found to be 23 million m^3/a and the impact of the EWR on this was estimated to be 11 million m^3/a. The calculated 1:50 year yields and impacts are thus, applying the factor of 0,772:

Incremental 1:50 year yield: 18 million m^3/a.
Incremental impact of the IFR: 8 million m^3/a.

Appendix 4

Groundwater Overview

APPENDIX 4: GROUNDWATER OVERVIEW

1. INTRODUCTION

The Olifants-Doorn Water Management Area (WMA) incorporates the E primary drainage region and marginal parts of the F and G drainage regions along the coastal plain, respectively north and south of the Olifants River estuary, covering a total area of 56 446 km^2. Its western boundary is the Atlantic Ocean, and its eastern boundary lies along the Great Escarpment divide between the Great Karoo and the Western branch of the Cape Fold Belt.

The main catchments forming the Olifants/Doorn WMA are:

- The Upper Olifants River (E10) secondary drainage region covering an area of 2 888 km^2;
- The Doring and Tankwa (E20) secondary drainage region covering an area of 21 320 km^2;
- The Lower Olifants-Hantams-Kromme (E30) secondary drainage region covering an area of 22 136 km^2;
- The Oorlogskloof (E40) secondary drainage region covering an area of 2 722 km^2;
- The Goerap (F60) tertiary drainage region covering an area of 2 790 km^2;
- The Sandveld (G30) tertiary drainage region covering an area of 4 590 km^2.

Figure 1 shows the study area and topography. **Figure 2** and **Figure 3** show the ISP sub-areas and a cross-section of the geology.

2. WATER MANAGEMENT AREA ISSUES

Groundwater resources are unevenly distributed through the Olifants/Doorn WMA, from relative abundance in the mountainous southeast to extreme scarcity in the north-western coastal desert. In that respect the Olifants/Doorn represents a microcosm of Southern Africa as a whole. In the arid western portions streams are ephemeral and flow only during episodic flood events, so that for the most part there is no alternative to groundwater, other than seawater desalination. Often the groundwater quality is brackish in these areas and requires reverse osmosis to improve water quality to potable standards.

In those parts of the WMA with better endowment of surface water, planners and engineers often overlook groundwater as a potential water source. The causative factors are feelings of unreliability and lack of trust by users, previous experience of failure in groundwater-based supply due to mismanagement (e.g., over-pumping, absence of monitoring of abstraction, spring flow and regional to local water levels, neglect of essential subsurface pump or screen maintenance), poor perception and limited understanding of groundwater (data) from a quantity, quality and/or environmental-impact perspective.

A lack of sound scientific under-standing of the mechanism of groundwater occurrence and flow, compounded by a lack of good quality information (Section 2.2 below), exacerbates this situation.

2.1 GUIDING PRINCIPLES

The New Water Act (NWA), 1998 does not distinguish between surface and groundwater. The four guiding principles of an Integrated Water Resources Management (IWRM) strategy are:

- The National Water Act gives equal weight to groundwater and surface water;
- Groundwater resources are integral to water-resource development planning, to the extent that only if groundwater is proven to be inadequate should surface water be considered as a source;
- Water demands must be optimally reconciled with all available resources;
- The optimal use of available resources is promoted through conjunctive use of surface and groundwater supply as well as storage opportunities, where feasible; and
- All water use must follow the principles of sustainability, equity and efficiency.

2.2 AVAILABILITY OF INFORMATION

Information about the volume of the available groundwater resource, the distance between a suitable source and its intended use, and its reliability (assuming proactive, appropriate aquifer management) needs to be conveniently available to planners and engineers in a readily understandable format. General background information is published in map form at 1: 2 500 000 scale on the poster sheet "Groundwater Resources of the Republic of South Africa" (Vegter, 1995), and regional information appears on the 1: 500 000 scale on the hydrogeological map of Cape Town 3218, and also Calvinia 3018. However, these graphic information sources are too generalized at too small a scale to be practically useful for aquifer exploration, development and management.

There is now a growing opinion arising from debate in the ISP workshops that hydrogeological map (graphic) information at a minimum scale of 1: 50 000 is needed, and that a geographic information systems (GIS)-based or "geoinformatics" approach to hydrogeological data management and information dissemination on the web is also required. Such an approach was pioneered within the E10 tertiary subcatchment of the Olifants/Doorn WMA during the 1998-2000 Citrusdal Artesian Groundwater Exploration (CAGE) Project.

2.3 GROUNDWATER RESOURCES

Resource assessments on regional and local scales for the southern and western parts of the Olifants/Doorn WMA are available from studies such as CAGE, the recent Olifants/Doring (sic) Water Management Area: Water Resources Situation Assessment (DWAF, 2002, Chapter 6.2, **Table 6.2.1**) undertaken to contribute to the National Water Resource Strategy (NWRS), and the current Danish International Development Agency (DANIDA) IWRM Project (2000-2004). The results of the groundwater resource evaluation are not consistent in these reports. Detailed cross-referencing and critical review of different approaches used is required, but is beyond the scope of this study.

As in other WMAs around South Africa, groundwater use can be distinguished in five general categories:

Rural Domestic: ranges from individual boreholes for primary water supply to rural landowners, villages, schools clinics, hospitals, through small scale reticulation over short distances (2 - 5 km), to larger schemes based on several boreholes that would either fall under schedule 1, general authorisation or license agreement;

Livestock/ agricultural: individual boreholes for stock watering, vegetable gardening, etc. largely falling under schedule 1 or general authorisations (GAs);

Irrigation: larger schemes requiring well developed and managed groundwater resources/wellfields requiring to be licensed or GA if the allocation (based on property size) is adequate.

Bulk water supply: wellfields in large or extensive aquifer systems consisting of several high yielding boreholes requiring to be licensed;

Industrial (incl. mining): medium to large-sized reticulation schemes based on several boreholes or a wellfield. None exists in the WMA at present as the Namakwa Sands heavy mineral mine in the F60 catchment is supplied from the Olifants River and small quarrying operations around Vredendal and Vanrhysndorp are tallied.

Table 1, extracted from the DWAF (2002) Situation Assessment, summarises the usage of groundwater in the above categories as estimated for 1995. These numbers do not take into account data or results from the CAGE Project (1998 – 2000) or the DANIDA Sandveld Study (2003).

TABLE 1: GROUNDWATER USE IN THE OLIFANTS DORING WMA (NWRS)

Use	**Annual volume (million m^3/a)**
Irrigation	42 [(1)]
Agriculture: rural/livestock	1.5 [(2)]
Rural domestic	0.5 [(2)]
Municipal urban (bulk water)	2
Industrial/ Industrial/ Mining	-
Total	**46**

1) About 30 million m^3/a of the irrigation use is in the Sandveld (G30A-G30H) area (Danida 2003) while 12 million m^3/a is estimated to be abstracted from the TMG aquifers in the E10 (CAGE 2000) secondary catchment. It is considered that the groundwater usage for irrigation in the DWAF (2002) is underestimated.
2) In the rural areas of the Olifants-Doorn, the distinction between these two categories is difficult, and the combined estimate of 2 million m^3/a has been arbitrarily apportioned in a 3:1 ratio.
3) These values are not readily available and the numbers presented in the NWRS do not correlate with those presented in various regional studies undertaken since 1995. Similarly the studies themselves do not agree either on resource evaluation methodology or quantity. Thus this number is excluded.

Previous and Current Work

The CAGE Project (DWAF 2000) identified obvious deficiencies in the available hydroclimatic data from the E10 area (e.g., lack of high-altitude precipitation records and temperature altitude data, poor distribution of spring and stream-flow gauging). The lack of data impacts on the reliability of water balance studies and recharge estimation. The study emphasized the need for a regional groundwater-monitoring network for the (separate) Table Mountain Group (TMG) aquifers, with adequate spatial coverage from mountain recharge domain to coastal-plain discharge zones. It developed a quantitative approach to evaluate of the resource based on aquifer storage to complement recharge estimates.

The lack of and/or inaccessibility of area- and aquifer-specific data at the scale of a quaternary catchment, or group of related quaternary catchments, constitute a major hindrance to the optimal development of groundwater resources. In the Limpopo WMA and in WMAs of the Eastern Cape, the Groundwater Resources Information Projects (GRIP) envisages 1: 50 000 scale hydrogeological maps, beginning with the most stressed and ecologically sensitive catchments, depicting the groundwater resources, groundwater quality and exploration/-development potential, based upon the needs and priorities of the end user.

Extension of the GRIP concept to the Olifants/Doorn WMA, qualified by greater emphasis on accurate physical estimates of aquifer geometry, a rigorous choice of the theoretical approach to hydraulic characterization and the Internet as a publication/dissemination medium, is recommended in the CAGE Project recommendations (DWAF, 2000).

The DANIDA/ IWRM Project is developing groundwater guidelines in support of the introduction of Catchment Management Agencies (CMAs) into three South African “pilot” WMAs for the field trial and testing of the guideline document. Early phases of this study identified resource assessment as being “inadequate for the necessary planning and licensing with respect to groundwater”. However, due to funding constraints, the scope of the DANIDA/IWRM resource assessment activities is restricted to a focus on (1) the Lamberts Bay-Elands Bay region (G30E, G30F, G30G quaternary subcatchments) and (2) the Citrusdal region (mainly E10D, E10E and E10F quaternaries, with some marginal overlaps to the south, north and west into the G drainage basin around the town of Graafwater).

An extensive groundwater resource assessment covering the northwestern part of the area, centred around the river confluence between the Olifants (E1 secondary catchment) and the Doring-Tankwa (E2 secondary catchment), forms part of the Western Cape Olifants-Doring River Irrigation Study. WODRIS is an initiative of the provincial department of agriculture (PAWC) in support of emerging new farmers from previously disadvantaged communities along the lower Olifants River, and therefore has poverty alleviation objectives (see Section 2.6 below).

The primary management objective is to have an appropriate evaluation of groundwater resource potential for different aquifers. Such evaluation must include allocable abstraction volumes at different scales for different uses. It is necessary that expected water quality, expected yields, vulnerability to contamination, use of aquifer storage as well as recharge and surface groundwater interactions are considered.

The discrepancies in the available numbers, the uneven spatial coverage in different studies and uneven emphasis and investment on surface and groundwater, differences in scientific approach as well as the gaps in information, highlight the primary management objective of the groundwater strategy.

2.4 GROUNDWATER QUALITY

Groundwater quality is one of the main factors affecting the development of available groundwater resources. The majority of serious water quality problems are related to total dissolved solids (TDS), nitrates (NO_3) and fluorides (F). In the absence of chemical analyses, TDS may be roughly estimated from electrical conductivity (EC) measurements (1 mS/m ≅ 5 mg/l).

2.4.1. NATURAL

Groundwater quality is generally controlled by aquifer lithology and geochemistry. Accordingly groundwater quality in the Olifants/Doorn WMA varies significantly between the fractured-rock (quartzitic) aquifers and the "intergranular (weathered) and fractured" or regolith aquifers that overlie generally impermeable shale- or granite-dominated pre-Cape formations. The waters in true fractured-rock aquifers such as the TMG and the Witteberg Quartzites generally have an EC of less than 70 mS/m and are moderately acidic (pH 5.5 – 6). The regolith aquifers yield neutral to alkaline groundwater with an EC greater than 300 mS/m, locally > 1000 mS/m.

Malmesbury regolith aquifers have acceptable water quality only where there is potential for groundwater leakage from higher-quality TMG aquifers. Bokkeveld groundwater is of acceptable to marginal quality. In the E10 it has a mean pH of 7.7, relatively high salinity (Na = 31%, Cl = 42%) and low alkalinity (3%). The TDS is >3000mg/l or ~600mS/m. Compared with the Bokkeveld and Karoo regolith aquifers adjacent to it, the quality of groundwater from the Dwyka Formation seems very poor (300-1000 mS/m). Groundwater of the lowest quality (>1000 mS/m) is found in primary aquifers overlying Dwyka tillite and lower Ecca shale in the Kliprand area, and from Namaqua basement aquifers of low yield and low recharge potential in the northwest. The average EC for 186 groundwater-sampling points in the Nuwerus-Stofkraal-Bitterfontein area is 709 mS/m, ranging between 463-530 mS/m near Nuwerus and 566-720 mS/m near Bitterfontein.

The groundwater in the southwestern part of the WMA is generally of ideal or very good quality (EC < 70 mS/m). It is suitable for use in small towns and rural settlements where surface water scheme supplies do not penetrate or there are no surface water allocations.

2.4.2. POLLUTION

The threat of groundwater pollution increases with population growth and development, and can result from:

- domestic use in centres of concentrated human settlement;
- agriculture;
- industrial and mining activity; and
- waste disposal.

Existing DWAF vulnerability maps appear to underestimate the potential for aquifer pollution or contamination throughout the area. "Most vulnerable" areas are shown in the primary coastal aquifer south of and around Elands Bay, and also north of Lamberts Bay, in part reflecting the potential for seawater intrusion following the agricultural exploitation of groundwater here. Some areas of "moderate" aquifer vulnerability cover fractured-rock aquifers of the TMG south of Citrusdal, and Witteberg-Bokkeveld aquifers south of Wuppertal.

An assessment of the risk of microbial contamination of surface and groundwater by human and animal wastes was obtained by intersecting aquifer vulnerability maps with maps of potential surface faecal contamination. It indicated that there is a high risk for the coastal aquifers in the south-west part of the WMA and a medium risk for groundwater in the upper reaches of the Tankwa and Olifants Rivers, and in parts of the Oorlogskloof River catchment. Elsewhere the risk to groundwater is low (DWAF, 2002).

In the larger and smaller urban centres throughout the ISP-area it is imperative the WWTWs appreciate that the aquifers are vulnerable to contamination. There is indication of IRF locally increasing the nitrate concentration in the TMG in the Clanwilliam district. The importance of spring protection, well-head protection and management of IRF should be appreciated and understood also in the rural areas.

2.5 MANAGEMENT AND MONITORING REQUIREMENTS

The protection of groundwater resources and its long-term sustainability of supply require effective monitoring and "adaptive" management.

Groundwater monitoring programmes must involve regular measurements of:

- water levels;
- water quality (macro and trace elements and biological indicators);
- abstraction volumes;
- climatic variables - rainfall, temperature, EVT and snowfall; and
- hydrologic variables – spring flow (altitude, volume, water quality, seasonal and or climate event-related variation), baseflow in rivers.

Such systematic programmes are generally implemented for particular groundwater or conjunctive-use schemes, mostly tied to production boreholes. It is seldom if ever that trace elements and full biological tests are done. There is a need to identify sites where particular trace elements (e.g. arsenic and fluoride) should be monitored routinely (dolerite and granites respectively) as they can have a long-term toxic effect, particularly for pregnant women and children. There is also an imperative need for strategically placed *observation boreholes* exclusively dedicated to groundwater monitoring in locations distant from production wellfields.

Groundwater level, as monitored at one or more observation wells (piezometers), is the most important indicator of the state of the resource. One suitably located well, preferably placed furthest from outflow boundaries to surface waters and/or away from sites that are likely to be affected significantly by surface abstraction or by local (artificial) recharge from surface irrigation, can provide substantial information about the overall state of the resource, because the dynamic variability of groundwater levels throughout an aquifer has some components that are common to all wells in that aquifer.

Dynamic behaviour as a leaky storage for natural recharge is the defining characteristic of an aquifer as a groundwater resource (Bidwell, 2003). Most of the temporal variation in piezometric levels is caused by temporal variations in land-surface recharge, together with the effects of pumped abstraction. Due to the common dynamic components related to the seasonal variability of recharge, the value of groundwater level observations increases more with length of record than with number of observation sites. The design and pattern of monitoring in the WMA can be improved as can the data availability.

The amount of groundwater stored in an aquifer at any instant in time is governed by dynamic relationships between recharge inflows, through the overlying land surface and from rivers, and outflows to surface waters and pumped abstraction. Aquifer storage acts as a buffer between highly variable, climatically driven inflow processes and the less variable outflow that supports surface water ecosystems and rivers/streams. Because abstractions of groundwater for human use, and also land-use changes of certain kinds, alter this dynamic balance between recharge and the state of surface waters, the objective of groundwater resource management is “to determine the regime of abstraction that results in acceptable environmental effects” (Bidwell, 2003, p. 7).

The strategy of “adaptive management”, sometimes described as a process of “learning by doing” (Lowry and Bright, 2002), entails the development of policies as “experiments that test the responses of ecosystems to changes in people’s behaviour”, and is also conceived as “managing the people who interact with the ecosystem, not the management of the ecosystem itself” (Lowry and Bright, quoted in Bidwell, 2003, p. 6). An adaptive approach to groundwater management necessarily requires appropriate analytical tools or models to support it, which are (op. cit., p. 6):

- Conceptually presentable and plausible to stakeholders, and expressive of a collective understanding of participants about the:
  - physical operation of the groundwater system;
  - assessment of uncertainties;
  - prediction of the effects of various management actions;
- Capable of implementation in “real-time”mode consistent with the time scale of adaptive decision-making; and
- Suitable for use with (often sparse) available data.

2.6 POVERTY ALLEVIATION

Groundwater development impacts positively on poverty alleviation and general quality of life through:

- supply of more and/or cleaner water;
- saving of time on water collection, particularly affecting women and children, which could otherwise be given to small –scale economic activities (vegetable gardening etc.) that require ready access to water and education or economic activity that require time.

The potential of groundwater in this ISP-area to contribute to poverty alleviation and empowerment of small-scale and Resource-poor Farmers (RPFs) is significant, e.g. the recent provincial government

Western Cape Olifants-Doring River Study (WODRIS). At present there is also local government (municipality) funding of RPFs through:

- provision of use of municipal land for farming activities;
- provision of water to RPF activities at no cost; and
- provision of loans which will be repaid once the RPFs become profitable.

Even around those rural towns and villages where surface water supplies are available for RPF activities, groundwater can still be better developed and managed for conjunctive use and has the benefit of decentralisation and being away from the river stems.

3. OVERVIEW OF GROUNDWATER BY ISP SUB-AREA

As a component of the National Water Resource Strategy (NWRS), the Minister of Water Affairs and Forestry established the boundaries of the Olifants/Doring WMA, which is comprised of 88 quaternary subcatchments, and has initially been divided it into five sub-areas. However, the current Internal Strategic Perspective (ISP) exercise initially proposes eleven key sub-areas "to aid improved management" (Notes for First Workshop ISP; 1-2 October 2003).

Surface water sub-areas

These key *surface*-water sub-areas are:

- Upper Olifants, consisting of 10 quaternary sub-catchments (E10A-K);
- Sandveld, consisting of 8 quaternary sub-catchments (G30A-H);
- Koue Bokkeveld, consisting of 11 quaternary sub-catchments (E21A-L);
- Upper Doring, consisting of 7 quaternary sub-catchments (E22A-G);
- Tankwa, consisting of 10 quaternary sub-catchments (E23A-K);
- Lower Doring, consisting of 12 quaternary sub-catchments (E24A-M);
- Oorlogskloof, consisting of 4 quaternary sub-catchments (E40A-D;
- Hantams, consisting of 5 quaternary sub-catchments (E32A-E);
- Kromme, consisting of 8 quaternary sub-catchments (E31A-H);
- Lower Olifants/Sout, consisting of 8 quaternary sub-catchments (E33A-H); and
- Goerap, consisting of 5 quaternary sub-catchments (F60A-E).

Because the original sub-areas used in the Situational Assessment report(s) were more detailed they allow for more flexible cross referencing between the proposed IWRM domains sub-areas presented below from a groundwater perspective (see **Table 2** below). They also have a particular topographic and geological and hydrogeological character.

At the first workshop these areas were reduced to 6 sub-areas **(see Figure 2).** Each of the six comprise one or more of the previous eleven except for minor amendments to the boundary between the Upper and Lower Olifants sub-areas and the boundary between the Lower Olifants/Sout and the Knersvlakte.

The six sub-areas are tabled below.

- Upper Olifants, consists of quaternary sub-catchments E10A – E10H (lost the E10 J, K);
- Kouebokkeveld, consists of quaternary sub-catchments E21 A – L (unchanged);
- Doring consists of quaternary sub-catchments E22A-G, E23A – K, E24A-M, E40A – D. (i.e. the former Upper Doring, Tankwa, Lower Doring and Oorlogskloof sub-areas);
- Knersvlakte consists of quaternary sub-catchments E31A – H, E32A – E, E33A – E, F60A – E (i.e. the former Kromme, Hantams, Lower Olifants/Sout, Goerap;
- Lower Olifants consists of quaternary sub-catchments E10J, K; E33 F – H (added E10J, K); and
- Sandveld consists of quaternary sub-catchments G30A – H (unchanged).

The E10J and K have become part of the Lower Olifants sub-area but remain in the revised Olifants Sub-area. The E33A – E catchments were previously in the Lower Olifants/Sout sub-area and are in the revised Knersvlakte sub-area which also comprises the Goerap sub-sub-area together with the F60A - E.

Groundwater regions (Vegter)

From a groundwater perspective, the Olifants/Doring WMA straddles six “groundwater regions” (numbers and names below after Vegter, 2001and associated tables), namely:

- Northern part of No 57 – Swartland;
- No 48 – Northwestern Cape Ranges;
- No. 56 – Knersvlakte;
- Southern part of No. 27 – Namaqualand;
- No. 36 – Hantam; and
- No. 37 – Tanqua Karoo.

The main boundaries of these groundwater regions are primarily geological, namely (1) the base of the Karoo Sequence, which – for its greater part - separates the eastern regions No. 36 and 37 from all of those underlain by pre-Dwyka formations on its western side (Nos. 48, 56 and 27), and (2) the base of the Cape Supergroup, which separates region No. 48 from those underlain by pre-Cape formations on its southern and northern sides (i.e. No. 57 and 56, respectively).

A notable exception to this general boundary rule occurs around the triple junction between region Nos. 36, 48 and 56. A logical placing would be where the Karoo basal unconformity overlaps the Cape basal unconformity. At present the boundary between regions No. 36 and 56 extends south-westwards along the Cape unconformity until it approaches the drainage divide between the Lower Doring (E24) and Oorlogskloof (E40) catchments. The boundary between regions No. 36 and 48 is drawn along the latter topographic feature, which above the Karoo unconformity becomes the boundary between regions No. 36 and 37.

Consequently the Hantam groundwater region No. 36 incorporates in its southwestern corner a part of the Cape Supergroup, where it is restricted to a tapering wedge of the Nardouw Subgroup only. Older parts of the Table Mountain Group wedge out beneath the Nardouw within the boundary of groundwater region No. 48, and post-Nardouw formations of the Cape Supergroup are eroded away beneath the Karoo unconformity.

The essentially geological and topographic (not strictly hydrogeological) delineation of groundwater regions aimed to "obtain some degree of uniformity in respect of lithostratigraphy, physiography and climate without ending up with an unmanageable number of regions" (Vegter, 2001, p.62). It was noted that delineation of "hydro(geo)logical units requires establishment of groundwater divides and flow paths".

Integrated Water Resource Domains

A relatively simple refinement of the six groundwater regions in the Olifants-Doring WMA, linked to quaternary catchment boundaries and better reflecting patterns of groundwater storage/flow and surface-groundwater interaction, recognises two main hydrogeological provinces (Adamastor and Western Karoo, respectively), each subdivided into two subprovinces *that facilitate integrated ground- and surface water quantification objectives* (**Table 2**). These are described as Integrated Water Resource Management (IWRM) Domains.

Table 2: Relation between IWRM domains and WMA sub-areas

<table>
<tr><th>Province</th><th>Subprovince</th><th>Situational Assessment sub-areas</th></tr>
<tr><td rowspan="2">Adamastor</td><td>Cederberg</td><td>Sandveld (G30 A – H)
Upper Olifants (E10 A – K)
W Kouebokkeveld (E21G, H, J, K)
W Lower Doring (E24A, J, L, M, lower part of E24K)
Lower Oorlogskloof (E40D)</td></tr>
<tr><td>Knersvlakte</td><td>Lower Olifants/Sout,
Goerap</td></tr>
<tr><td rowspan="2">Western Karoo</td><td>Tankwa Karoo</td><td>Upper Doring
E Kouebokkeveld (E21A-F, L)
Tankwa
E Lower Doring (E24B-H, upper part of E24K)</td></tr>
<tr><td>Hantam</td><td>Upper Oorlogskloof (E40A-C)
Hantams
Kromme</td></tr>
</table>

The distribution of the TMG Peninsula Aquifer is the main determinant of the eastern boundary between the Cederberg and Tankwa subprovinces, which is here made to coincide approximately with the TMG-Bokkeveld contact while respecting quaternary boundaries (except in the E24K instance). This proposed modification of the "groundwater regions" concept represents a development towards a hierarchy of aquifer-related spatial domains relevant and useful to Integrated Water Resources Management (IWRM) purposes (see **Figure 4**).

The success in the exploration and development of groundwater in this WMA and elsewhere will depend upon an appropriate exploration and management strategy. It can be confidently stated that IWRM is not possible if aquifer specific information is not available. If quaternary averaged MAP is used rather than isohyets and if realistic groundwater usage figures are not available and regularly updated, regulation of groundwater usage will not be successful.

Approach to Evaluating Groundwater Potential

A simple and robust approach to evaluating the unused groundwater potential has been adopted in this study. An aquifer specific GIS based evaluation of recharge using three different approaches (Riemann, Mlisa, Hay, in preparation) was undertaken in-house using the MAP data from the WR90 study.

Recharge

The average of three different GIS based in-house models (fixed recharge based on amount of rain and weighted as a function of lithology as per DWAF (2002); fixed recharge rates and recharge rate as per Turc (1954) is used to evaluate vertical recharge *on an aquifer specific basis*, normalized per quaternary, provides values that reasonably coincide with those documented by Vegter (1995).

The model appears to overestimate recharge to the primary and regolith aquifers, as it is weighted by the outcrop extent of the aquifer rather than the storage capacity. Using a low (<5%) fixed recharge rate based on the average rainfall appears to overestimate in the flood hydrology/sheet flooding and regolith aquifers dominated eastern and northern areas of the WMA. The regolith and primary aquifers are generally thinly developed (less than 50m). These areas have high temperatures and less than 200mm/a rainfall. In general recharge is unlikely to occur in years wherein less than 200mm of rain is received and the aquifers are usually only recharged in the extreme event.

In contrast, the storage in the TMG aquifers is significant and the recharge figures for the Peninsula and Nardouw Aquifers are considered to be very conservative. They do not reflect the impact of snowfall on recharge and it is known that the rainfall in the high lying areas exceeds the 2100 mm/a maximum given in the WRC 90 database.

The Sandveld, the Knersvlakte and the Lower Olifants sub-areas are dominated by primary aquifer outcrop, relatively low rainfall (300 – 500mm/a) and high temperatures. The relatively high factor (1.5) for weighting based on lithology used in the DWAF model (DWAF, 2000) as well as the fixed recharge model for the primary aquifers positively skews the results.

Baseflow

The baseflow estimates vary widely between Hughes, Pitman and Schulze. More recently Van Tonder has weighted the above estimates to derive an “average” value. In many instances, if the Hughes values are used the baseflow exceeds the recharge estimated at a quaternary level and a sub-area scale particularly in the TMG dominated terrain. In other instances the values derived by Schulze appear to be inconsistent with known spring distribution and flow rates. Rather than use a weighted average of previous numbers (van Tonder and Hughes) that is more complex to evaluate the local application of, the Pitman values have been used in this study.

Usage

The NWRS or Baron and Seward (2000) usage numbers are subtracted to establish the unexploited groundwater potential unless more recent usage figures based on local studies are available (e.g. Upper Olifants and Sandveld sub-areas). An in-house model was developed to establish groundwater usage. Comment is made as regards any difference in the usage values. The existing Hydrogeological map series (1: 500 000 DWAF Hydrogeological map series) cannot be used to determine usage. It is based on the average yields for different areas and the NGDB database for documented boreholes. The NWRS usage figures are used unless local studies with ground truth data are available (e.g. Sandveld and Upper Olifants sub-areas).

Groundwater available for abstraction

The Pitman values for baseflow given per quaternary are subtracted from the recharge and 50% of the result is assumed to be available for abstraction in the Upper Olifants, Lower Olifants, Kouebokkeveld and Sandveld sub-areas and 20% thereof in the Doring and Knersvlakte areas. Current usage is substracted in order to establish the amount of groundwater *currently* available.

Using 50% or 20% of recharge less baseflow is a simple and robust, but not definitive, estimate to take into account the impact of abstraction, storage and accessibility limitations, the current and potential impacts of abstraction as well as the variation in rainfall over a number of years including drought years without discriminating between these influences. While a 50% factor could be considered conservative for primary aquifers that are generally more efficient than fractured rock aquifers, this is offset by the recharge factors noted above in the Sandveld and Lower Olifants sub-areas. Upper and lower limits have been described in the Sandveld and Lower Olifants sub-area.

In areas that are dominated by flood hydrology, low rainfall (<200mm/a), low aquifer storage, extensive fractured rock outcrop and limited to no baseflow component, the model (Recharge – Baseflow)/2 is inappropriate. It is considered that 20% rather than 50% of Recharge – Baseflow is a more accurate reflection of the processes and this has been used in the Doring and the Knersvlakte sub-areas to calculate Groundwater Potential.

It may be that with more detailed and aquifer specific study in certain sub-areas only 10% is available or that up to 80% could be available. More detailed aquifer specific studies in different IWRM domains would improve the confidence in these estimates.

Discussion

Comparisons are made with the Harvest Potential and the Exploitation Potential[8] maps for purposes of comparing the numbers generated in this study with the only other available regional scale estimates of groundwater usage and potential. The differences in the methodologies are clearly understood and acknowledged. It is beyond the scope and not the purpose of this study to debate or to defend the differences merely to note them.

There will always be differences of opinion on the safe yield of a wellfield or an aquifer. The only way in which any values presented can be refined is to use the groundwater and have a well designed monitoring network that is appropriately monitored and the data correctly interpreted to update and revise estimates for groundwater abstraction as well as management thereof. This is adaptive management and is a critical component of risk management. It is possible that the Groundwater Resource Assessment Phase 2 study currently underway will address the differences in methodology used to date and address the scientific issues raised in this study.

In general the values realized in this approach are _less_ than those documented in the Exploitation Potential (WSM 2000). The Exploitation Potential maps (DWAF 2000) indicate a total of 914 million m^3/a groundwater available for this WMA. The Exploitation Potential considers economic (accessibility) and environmental (impact, water quality) factors. Average borehole yield was considered as a proxy for transmissivity as the primary measure of exploitability. A value between 0 – 1 was assigned based on yields >3 l/s (0.7) or less 0.3 l/s (0.3) with other values ranging between and using transmissivity as the main consideration for area for this sub-area. A drought factor was applied. The impact of this factor is evident in the areas dominated by flood hydrology.

The Harvest Potential (Seward and Seymour 1996) is defined as the maximum volume of groundwater that may be abstracted per area without depleting the aquifers. It is based on the annual recharge and storage as estimated by Vegter (1995) combined with a rainfall reliability factor (20^{th} percentile precipitation divided by the median precipitation) as a measure of drought length. They appear to be more realistic in the Karoo dominated areas.

The ISP numbers are comparable with the NWRS but are higher in the TMG dominated areas. They are considered suitable for planning purposes and can be improved upon, once additional information becomes available in the Olifants and Kouebokkeveld areas.

The results and comparisons with available numbers are shown in the tables attached.

3.1 UPPER OLIFANTS (E10A – G)

This sub-area is a narrow N/S-trending valley bounded on the west by the Olifantsberge range, on the south by the Great Winterhoek range, and on the east by the Kouebokkeveld and Cederberg ranges. It

[8] Haupt's "Exploitation Potential" is the exploitation potential multiplied by a factor which is determined by borehole yields. Harvest Potential is an attempt to provide a maximum figure for groundwater available whereas Exploitation Potential is an attempt to estimate how much is practically abstractable.

consists of a major downfold (Olifants River Syncline) in the Table Mountain Group (TMG), containing two local outliers of Bokkeveld Group along the fold axis. Numerous major faults and fracture zones crosscut the structure, particularly along a NNW/SSE direction. Younger alluvial deposits occur around the river flood plain.

The E10 sub-area falls within the Cederberg Municipality, incorporating the town of Citrusdal (E10E). Citrusdal has experienced summer periods of failure in surface water supply from the Olifants River, and now obtains a groundwater supply from high-yielding boreholes (>20 l/s) in the Boschkloof wellfield. Citrus and other irrigated fruit farming activity is the economic mainstay in the valley. Groundwater is being increasingly seen as a solution to the summer shortfalls in irrigation water from the river in the portion upstream of the Clanwilliam Dam (E10D-F).

Groundwater quality varies significantly between the fractured-rock (quartzitic) aquifers and the "intergranular (weathered) and fractured" aquifers that overlie generally impermeable Bokkeveld shale formations. The TMG fractured-rock aquifers generally have an EC (TDS proxy) of less than 70 mS/m, whereas the regolith aquifers locally yield groundwater with EC greater than 300 mS/m.

Hot (>40°C) spring occurrences at The Baths and Warmwaterkloof (E10D), and various thermal artesian boreholes along the western side of the valley, indicate an active deep flow system from high (>1500 m) mountain recharge areas in the Kouebokkeveld and Great Winterhoek.

Groundwater from both shallow and deeper parts of the TMG fractured-rock aquifers provides the important base flow contribution to surface water drainage. Isotopic data from groundwater with a distinct TMG character abstracted along the coastal plain carry a high mountain signature and spring flow on the coast indicate lateral recharge in excess of local potential. Thus it has been postulated that groundwater that is recharged in the high lying area of the E10 also discharges in the coastal plain either as springs or subsurface into the primary aquifer in the Sandveld sub-area as well as directly at surface and sub surface along the coast. This hypothesis needs to be tested by drilling monitoring boreholes across the Peninsula, Piekenierskloof, Graafwater transition where it is cut by faults.

The groundwater yield (groundwater in use) is estimated at 4 million m^3/a in the NWRS documentation, probably representative only of the resource in alluvial and regolith aquifers in the axial part of the valley. Based on the CAGE hydrocensus data the abstraction as at 1999 was primarily from the Nardouw Aquifers (12 million m^3/a and 8 million m^3/a from remaining aquifers, totaling 20 million m^3/a.

The in-house usage model estimated that a maximum of 13 million m^3/a and 9 million m^3/a are abstracted from the Peninsula and the Nardouw aquifers respectively. The total usage is estimated at a maximum of 27 million m^3/a. Whilst the spatial pattern of usage is puzzling the total accords reasonably with the1999 CAGE data of ~12 from the TMG aquifers and ~20 million m^3/a abstraction in total. A usage of 12 million m^3/a was accepted at the second workshop for abstraction from the TMG.

For this study a value of 20 million m^3/a of groundwater usage is used.

The Pitman value for baseflow is 7.5 million m^3/a. The Hughes value for baseflow is 125 million m^3/a and would result in a groundwater deficit of 22million m^3/a.

The sum of estimated average recharge to all aquifers in this sub-area is 120 million m^3/a, of which the bulk is recharged to both the Peninsula and the Nardouw Aquifer.

In the E10C-G portion, a recharge-based approach indiscriminate of aquifer type or characteristics estimated allocable groundwater at ~25 million m^3/a (Conrad et al., 2003). A previous storage-based approach to *only* the confined Peninsula Aquifer in the CAGE study area (Hay and Hartnady 2000) estimated the deeper resource at ~45 million m^3/a. Haupt (1996) using the Water Situation Assessment Model (WSAM) estimated the Exploitable Potential in the E10C-G to be ~162 million m^3/a.

Of the 120 million m^3/a recharge estimated in this study, 73 million m^3 annually recharges the exposed portions of the Peninsula fractured-rock aquifer, 39 million m^3 recharges the Nardouw aquifer and 2.2 million m^3 recharges the shallow intergranular-and fractured system. About 2,5 million m^3 enters fractured aquifers other than TMG. 4 million m^3 recharges the primary aquifers, largely river alluvium.

Using the approach outlined in section 3 above *the available unexploited groundwater in this sub-area is* ***very conservatively*** *estimated to be 36 million* m^3*/a.*

It is supported by the CAGE study and the WRYM results in which the potential in the Peninsula aquifer in a conjunctive use scenario was evaluated to be 30 million m^3/a and in a storage based evaluation to be 45 million m^3/a.

The numbers are considered conservative with respect to earlier estimates in the range 457 million m^3. (Seymour 1996). The Harvest Potential and Exploitation Potential (WSM, 2000) are respectively estimated as 457 and 308 million m^3/a for this sub-area. It is not possible to understand or evaluate the discrepancies in the numbers at present because of the scale differences in the data available and insufficient published information on the assumptions governing the numbers at the quaternary catchment and aquifer specific scale.

The recharge estimates for the Peninsula and the Nardouw Aquifers which occupy the greatest outcrop area are ~ 112 million m^3/a. These aquifers have significant storage and even if the recharge to these aquifers were doubled (which is not wholly unreasonable in the case of the Peninsula Aquifer) the numbers remain disparate. It is necessary to evaluate using more detailed spatial and other input data than is available from published information how the Harvest Potential numbers were derived and to calibrate the recharge models using isotopic and other data (Hay, in preparation).

The estimates of unused groundwater potential in this sub-area and the rural nature of the population suggest that groundwater could contribute to widespread provision of the basic human need, as well as an allocation for irrigation via a conjunctive use scheme with or without the raising of the Clanwilliam Dam.

Issues

- The disparity in groundwater resource evaluation and quantification of sustainable pump rates is of concern and requires rationalization. It is necessary to prioritise detailed resource evaluation with respect to existing use, catchment/aquifer stress and dependency, particularly above the length of the Olifants River above the Clanwilliam Dam and as far as Klawer;
- There is concern over deep-drilling abstractions taking place in the Citrusdal area. The consequences of groundwater abstraction may or may not transect quaternary and tertiary catchment boundaries;
- It is uncertain to what extent groundwater abstraction in the E10 secondary catchment may impact on groundwater availability in the Sandveld and *vice versa*. It is necessary to establish the transmissivity of the Piekenierskloof Formation and the Graafwater Formation as well as potential for hydraulic connection with the Peninsula Aquifer arising from structural discontinuities to objectively evaluate this concern;
- Registration of farmer's boreholes requires attention;
- Exploration and management of the confined artesian basin requires consideration as *ad hoc* development and management of the aquifer could lead to significant degradation of the resource. Artesian groundwater needs to be controlled, perhaps through proclamation of a Groundwater Control Area;
- (Groundwater quantity) There are differences of professional opinion as to what the safe yield is of a wellfield or an aquifer in this area. ACTION: Prepare a best international practise standard for fractured rock aquifer resource and wellfield evaluation using quantitative methodologies applicable to fractured rock ACTION: Evaluate the level of certainty needed with regard to the local and regional scale use and level of stress in the aquifer or SW/GW/ECO system, taking into account local priorities and political sentiment;
- Groundwater management: Groundwater allocations particularly where aquifer storage capacity can be considered over more than one season must take into account the worth of the use of water, the period needed for this use and the time needed for aquifer levels to recover from possible temporary over abstraction. This is a resource management issue and shall require cooperative governance;
- Licensing/Groundwater: There is lack of clarity on RDM as regards the evaluation process for issuing of licenses, hence license applications are taking up to five years or more to be processed, possibly due to is a lack of capacity (competence confidence and legal context know how) to deal with the license applications. *Actions:* Institute formal training for staff in how to deal constructively with license applications and what would be appropriate conditions with reasonable compliance with the law. Review and revise DWAF procedures and chain of communication/command with regard to processing of licensing applications. RO Geohydrology recommends that profession-specific input is identified and the co-ordination for finalisation of license applications is centralized;
- Licensing/Groundwater: It is possible that in the Reserve determination process that access to groundwater will be lost or reduced in some areas. ACTION: Prepare plan on how to manage this process and determine constructive intervention;

- The feasibility/desirability of allocating groundwater to resource-poor farmers, possibly away from river stems as opposed to increasing allocations to established farmers who primarily occupy riparian land.

3.2 SANDVELD (G30)

This sub-area bounded on the west by the Atlantic coastline, on the east by the Olifantsberge range, and on the south by the Piketberg range. It is underlain on the eastern side by a major upfold (Porterville Antcline) in the pre-Cape basement (Malmesbury Group) and overlying Table Mountain Group (TMG), which in this area consists mainly of the lower section (Piekenierskloof, Graafwater and Peninsula Formations). On the western side, localized synclinal downfolds plunge in a northwesterly direction from the Piketberg divide, subparallel to a major fault that crosses the coastline near Elands Bay. Numerous other major faults and fracture zones crosscut the fold structures, particularly along a NNW/SSE direction, extending across the Olifantsberge divide with the adjacent E10 sub-area.

Along the coastal plain, young wind-deposited sands cover older marine deposits related to former high stands of sea level, and also more localized fluvial deposits in buried palaeochannels related to former low stands of sea level during times of much less arid palaeoclimate. In certain central areas of the Sandveld it is postulated that these deeper-lying, fluvial, intergranular aquifers are mainly recharged, not from the overlying land surface, but from lateral inflows of far-traveled (E10 source area and local highlands e.g. Piketberg) groundwater from fracture systems in the underlying TMG units. Isotopic and hydrochemical (macro and trace) data from relevant Sandveld and TMG boreholes support this hypothesis (Cage Study, DWAF 2000).

The G30 sub-area is divided between the Cederberg Municipality, here incorporating the towns of Elands Bay (G30E), Lamberts Bay and Graafwater (G30G), and the Matzikama Municipality, here incorporating the coastal settlements of Strandfontein and Doring Bay (G30H). Apart from fishing and eco-tourism around the coastal resort towns, potato farming, using center-pivot irrigation technology, is the economic mainstay on parts of the G30 coastal plain. All of these activities are entirely dependent on groundwater, except in a restricted northern part of the G30H, where a canal from the Olifants River Government Scheme, reaches Strandfontein and Doring Bay, and along the Verlorevlei drainage (G30B-E), supplied by perennial stream flows from the Olifantsberge and northern Piketberg.

Groundwater quality varies significantly between the fractured-rock (quartzitic TMG) aquifers discharge, the primary aquifer of marine origin, the primary aquifer of alluvial origin and the fractured dolerite dyke aquifer (of limited extent). The TMG underlies the primary sediments except in the extreme south of the sub-area which is underlain by Malmesbury bedrock. TMG fractured-rock aquifers generally have an EC (TDS proxy) of less than 70 mS/m, whereas the primary aquifers have a EC varying between <80 and up to 800 mS/m depending upon whether the sample was taken from palaeochannels which receive TMG discharge or the primary aquifers of marine origin and whether saline intrusion is evident or not. The pH varies from 5.4 to >7.8.

The usage of 30 million m^3/a (DANIDA 2003) is used since it is the only value based on ground studies and is recent.

Groundwater usage is variably estimated. It has been estimated to be 30 million m^3/a in the G30 A – H (Danida 2003) but does not consider abstraction from the Peninsula aquifer. Baron and Seward (2000) estimate usage to be 30 million m^3/a, the number used in the NWRS. An in-house model estimates 76 million m^3/a and includes abstraction from all aquifers including the fractured rock aquifers on the western limb of the Olifants Doring River syncline. If the DANIDA groundwater usage figures are correct then there is considerably more groundwater available than previously thought.

Using the in-house ISP model total groundwater recharge is estimated to be 135 million m^3/a. This comprises of 56 million m^3/a into the Primary Aquifer, 40 million m^3/a recharges the Peninsula Aquifer, 14 million m^3/a the intergranular and fractured aquifer and 24 million m^3/a recharges the fractured aquifers other than the Peninsula or Nardouw.

The recharge to the primary aquifer, which occupies 44% of the sub-area surface, could be overestimated in this study. Generally if the rainfall is less than 200 mm/a, no vertical recharge is considered. In this sub-area it varies between ~300 – 500mm/a and a fixed recharge rate of 4% was assigned in one model. This yielded the lowest in the recharge range of 31 – 71 million m^3/a to the primary aquifer calculated using different methods. The DWAF model allocates a factor of 1.5 to recharge to primary aquifers accounting for the high-end value.

The extent to which there is hydraulic connection between the Peninsula Aquifer and thus lateral recharge to the coastal plain is a function of the hydraulic connectivity across the Piekernierskloof and Graafwater Formations with the latter being of a less transmissive nature (see section 3.1 above). No lateral recharge has been taken into account.

For consistency the Pitman value of 1 million m^3/a for baseflow is used.
Pitman estimates the baseflow to be 0.75 million m^3/a. Discharge from the Peninsula Aquifer to the primary aquifer based on spring hydrocensus data collected for the CAGE project was estimated to be 0.7 – 2 million m^3/a and considered to be underestimated. Hughes estimates the baseflow to be 10 million m^3/a.

The unexploited groundwater potential is 37 million m^3/a.
It is noted that use of 50% in this study estimation of *Groundwater Available for Abstraction/Potential* is conservative for intergranular aquifers, but considered appropriate given the uncertainty as regards the recharge and baseflow numbers. Groundwater Potential could be as low as 12 million m^3/a. (using lowest model recharge value for primary aquifers, highest baseflow (Hughes) but lowest usage (Danida, 2003)). The worst-case scenario (lowest recharge value, highest abstraction (Umvoto model) and highest baseflow (Hughes)) results in a groundwater deficit of 14 million m^3/a, with the G30F-H being stressed at present abstraction rates.

The Harvest Potential (Seward and Seymour 1996) and the Exploitation Potential (WSM 2000) for this sub-area as per the DWAF Hydrogeological series are given as 224 and 136 million m^3/a respectively. The former is significantly higher than the estimated total recharge of 132 million m^3/a obtained in this study.

The G30F is reported in the Danida study to be stressed. Outside of these catchments it would be expected that any declining water levels, seawater intrusion would be a result of inappropriate aquifer management rather than groundwater shortage or over abstraction

Issues:

- Stressed areas/future requirements: Elands Bay (G30F), Lamberts Bay, Graafwater, Nuwedorp and Leipoldtville are dependent on groundwater and there are concerns because there are no backup supplies to these towns;
- Between Elands Bay and Lamberts Bay, the G30F is considered to be a stressed aquifer (Danida 2003). Results of this study suggest that the G30 G and H and Strandfontein area should be monitored for early warning signs of stress and seawater intrusion. ACTION: Prepare monitoring plans and once the resource has been reliably quantified and seasonal and spatial patterns of recharge are understood, management plans can be established and tested in practice;
- The Wadrif Wetland is considered to be particularly vulnerable to groundwater mismanagement.
- There is concern that Sandveld groundwater availability may be influenced by the water abstraction from the Upper Olifants sub-area and *vice versa*. It is necessary to establish the transmissivity of the Piekenierskloof Formation and the Graafwater Formation as well as potential for hydraulic connection with the Peninsula Aquifer, arising from structural discontinuities to objectively evaluate this concern;
- Potato farmers in the Sandveld are polluting the groundwater with their effluent and are abstracting groundwater without proper licence arrangements. Pollution from vineyards also has a seasonal effect, and to a lesser degree also lucerne and barley wheat. ACTION: Groundwater should be protected from pollution by establishing recharge zone protection and wellhead protection standards, and monitoring agricultural practise and effluent discharge;
- There is a need to evaluate the potential for utilization of poor quality groundwater and to blend it with surface water or treat it using reverse osmosis;
- Evaluation of the groundwater Reserve of coastal vleis and estuaries and the dependence of these ecosystems on perennial spring discharge is important;
- WWTWs and the use of septic tanks will have an impact on groundwater quality (e.g. Redelinghuys) and should be monitored;
- Cumulative impacts of individual or small-scale groundwater developments are insufficiently documented;
- There is no Working-for-Water programme in the Sandveld, but the impact of clearing alien vegetation on groundwater discharge and recharge should be monitored, in order to inform prioritisation of alien clearing as a component of groundwater catchment management;
- The Sandveld Forum has been experiencing poor support and cohesion, perhaps due to the fact that as a groundwater dependent area, there is no history of user cooperation as practiced elsewhere with irrigation boards;
- There is a need to educate people on utilising and monitoring groundwater particularly at municipalities;
- In order to adequately monitor and protect groundwater resources from contamination by irrigation return flow and/or seawater intrusion, the monitoring data that is required is of a background, diffuse and a point source nature. At present the relevant data from the RO Water

Quality sub-directorate is not being integrated into the groundwater database in a routine manner and neither does the capacity currently exist within the hydrogeological division to evaluate the data itself;

- Groundwater monitoring sites are considered adequate by RO, but the frequency of monitoring requires attention. The groundwater needs to be monitored more regularly, with particular emphasis on the piezometric levels and electrical conductivity (as a WQ proxy measure). Biological monitoring is required. The monitoring network design requires careful evaluation as regards bedrock discharge and lateral recharge to the primary aquifers.

3.3 KOUE BOKKEVELD (E21)

This sub-area of the Riet and Leeu river drainages lies between the Kouebokkeveld and southern Cederberg ranges on the west (E10 boundary), and the Swartruggens range on the east (E22 boundary. It is underlain by formations of the Table Mountain Group (TMG), Bokkeveld Group and Witteberg Group, affected by several N/S-trending open fold axes. Major faults and fracture zones crosscut these structures, particularly along a NNW/SSE direction crossing the adjacent E10 boundary divided within TMG fractured-rock aquifers. Younger alluvial deposits occur in restricted areas around the river flood plains.

There are no towns in this area, hence no municipal supply schemes, but there is intensive agricultural (over-)development, mainly deciduous fruit and vegetables, on lands underlain by Bokkeveld shales on the western side of the area (E21D, E21G) and numerous boreholes have been drilled around the TMG-Bokkeveld contact here.

According to current NWRS (under-)estimates the available groundwater resource is 5 million m^3/a, and the total demand exceeds the available surface water resource by about 7 million m^3/a, mainly met by groundwater and return flow. Unless significant water conservation and demand management can be implemented, any further agricultural development would depend on the discovery of an additional groundwater resource, which could possibly be realised by deep exploration of the TMG Peninsula Aquifer in confined artesian settings.

The most important aquifers are the Peninsula, the Nardouw and the Witteberg quartzites. These aquifers are thicker than 100 – 200 metres thus having significant storage potential. The groundwater quality is acidic to neutral with the Witteberg becoming alkaline in places. The EC varies but is generally less than 75 mS/m varying between <10 and 75 with discreet outliers above 100 and 200 mS/m. These outliers are associated with the contact zone with the regolith aquifers.

To date the Peninsula aquifer and the Witteberg Series are under-exploited. This is true for both aquifers throughout the Western and the Eastern Cape, but more particularly the Witteberg which is as yet also seldom considered or given strategic priority in local and regional studies. The Witpoort Formation is the preferred target in the Witteberg Series and the regolith aquifer.

The regolith aquifer comprises all pre-Cape rocks (Malmesbury and Namakwa/Gariep and Nama sediments), the Karoo sequence and the Bokkeveld group. In general the groundwater quality in the regolith (weathered and fractured rock) is poor although the recharge estimate (see **Appendix B**) indicates 14 million m^3/a. The boreholes are generally drilled to depths below 100 m and yields are low (<5/s. The water is alkaline and the EC is largely above 100 mS/m. The exception are the Bokkeveld Sandstone Formations which have a lower EC (<75 mS/m and often yield between 5 and 20 l/s. The groundwater yield in the Bokkeveld sandstones is dependent upon local discharge from the TMG.

The NWRS usage figure of 5 million m^3/a is used in this study

Haupt (2000) estimated the groundwater use at 18.5 million m^3/a. The in-house model estimates usage at 14 million m^3/a.

The recharge is estimated at 110 million m^3/a

The Peninsula receives an estimated average of 26 million m^3/a, the Nardouw 32 and the Witteberg quartzites 34 million m^3/a. The regolith and primary aquifers receive an estimated 14 and 3 million m^3/a respectively.

The baseflow is 7.3 million m^3/a. (Pitman)

Hughes has estimated the baseflow to be 86 million m^3/a. If this were correct there would be a groundwater deficit of 2 million m^3/a in this sub-area.

The unexploited groundwater potential is very conservatively estimated to be 37.5 million m^3/a.

The Harvest Potential and the Exploitation Potential are given as 284 and 178 million m^3/a respectively for this sub-area. Both these numbers are significantly higher than the estimated recharge of 109 million m^3/a for the area. It is possible that the recharge to the TMG aquifers and the Witteberg that dominate the area has been under-estimated as it is known that the high mountain rainfall is very conservative and that snowfall would play an important role in groundwater recharge in this area. It is considered that recharge would reach as much as 45% of precipitation in the high lying areas whereas a maximum of 21% has been used in the in-house models in this study.

This difference would still not account for the discrepancy. It warrants more detailed study.

Issues:

- No groundwater issues were recorded. It is critical however to improve the groundwater resource evaluation in this water short sub-area.

3.4 DORING (E22, E23, E24, E40)

This large, geologically heterogeneous ISP sub-area has four main divisions, i.e., the Upper Doring, Tankwa, Lower Doring and Oorlogskloof areas, each separately described in the following subsections.

3.4.1 Upper Doring (E22)

This sub-area lies between the Swartruggens range on the west (E21 boundary), the Witteberg range on the south (J drainage boundary), and a ridge extending from the escarpment range (E24 boundary). It is underlain by formations of the Witteberg Group, Dwyka Formation, Ecca Group, and lower Beaufort Group. These strata generally dip at shallow angles eastward, but in the south-east (E22A-D) they are affected by several ENE/WSW-trending open fold axes related to the folding in the Witteberg range. The E22E subcatchment lies at the SE termination of a NW/SE fault system that is related to the major TMG faults and fracture zones in the southern Cederberg. Younger alluvial deposits occur in restricted areas around the river flood plains.

The Witteberg and the regolith are the largest primary aquifers in the sub-area. The regolith aquifers comprise the Dwyka and the Ecca Formations which generally yield non-potable water and very little of it. The groundwater in the Witteberg has an EC <75 mS/m and a pH varying between 5 and 8.5 but generally being <7.

Due to the flood hydrology it is generally the infrequent events that recharge the aquifers in this area. The recharge estimate for the Witteberg is estimated to be 26 million m^3/a and to the regolith aquifer 29 million m^3/a. There is a small exposure of the Nardouw in this area that can be discounted. Recharge to the alluvial aquifers is estimated to be 2 million m^3/a. The water quality in the alluvial aquifer will vary depending upon the runoff provenance.

The total usage in the sub-area is estimated in this study to be ~ 2 million m^3/a. The Harvest Potential and Exploitation Potential for this sub-area is given as 55 million m^3/a and 29,5 million m^3/a respectively. The recharge estimates (57 million m^3/a) obtained in this study and the Groundwater Harvest Potential are in reasonable accord.

Much of the unexploited groundwater is of very poor water quality and given relatively low yields would be capital intensive and not suited for any large-scale supply. Emphasis must be given to the Witteberg Aquifer and the alluvium for storage potential and contributions to base flow.

3.4.2 Tankwa (E23)

The Tankwa Karoo is bounded on the east by the escarpment range and its southern promontory ridge (J Drainage boundary), which form a triangular amphitheatre leading down to a confluence with the main stem of the Doring. It is underlain by generally gentle-dipping strata of the Dwyka Formation, Ecca Group, and lower Beaufort Group, affected by mild folding in the south. Younger alluvial deposits occur in restricted areas around the Tankwa river stem.

The largest aquifer is regolith comprising the Karoo sequence (Dwyka and Ecca). While the recharge is estimated to be 63 million m^3/a the water quality is very poor and the yields are very low. There is ~4.5 million m^3/a recharge estimated to the alluvial aquifers and water quality will be controlled by runoff provenance and therefore likely to be of poor quality. The groundwater Harvest Potential is estimated at 51 million m^3/a and the Exploitation Potential at 28 million m^3/a. The total groundwater usage is estimated at <1 million m^3/a. The best available sources would be in the fractured dolerite dykes and the alluvium. Recharge in to these aquifers is estimated to be 1 million m^3/a and 4 million m^3/a respectively. Storage potential is unknown.

Given the groundwater quality and low yields the rainfall harvesting and use of the storage in the alluvium is recommended rather than conventional groundwater exploration.

3.4.3 Lower Doring (E24)

This heterogeneous area is bounded on the east by the escarpment range, which has promontories and subcatchments (E24C, D, E, F, K) leading to confluences on the right bank of the Doring; on the west by the northern Cederberg range (E10 boundary), runoff from which feeds tributary subcatchments (E24A, B, L) on the left bank. Between these areas lie central subcatchments (E24H, J, M) along the main river stem. A small area of pre-Cape Gariep Group occurs along the Klawer Fault in the E24M area around the Olifants-Doring river confluence. The western and central stem subcatchments are underlain by gently folded formations of the Table Mountain Group, Bokkeveld Group, and Witteberg Group. The eastern subcatchments are underlain by gently east-dipping strata of the (upper) TMG, Bokkeveld Group, Dwyka Formation, Ecca Group, and lower Beaufort Group. Karoo dolerite intrusives (dykes and sills) are abundant in strata above the Dwyka Formation. Younger alluvial deposits occur in restricted areas around the river courses.

The total recharge estimate for this area is 122 million m^3/a of which ~ 55 million m^3/a is to the TMG aquifers, 10 million m^3/a to the primary aquifers on the coastal plain, 7 million m^3/a to the Witteberg and 6 million m^3/a to the dolerite dykes. The balance is to the regolith aquifers that dominate the eastern sub catchments. The total usage is estimated to be 19 million m^3/a, with the greatest volume being abstracted from the Nardouw (7 million m^3/a) and the regolith aquifers (10 million m^3/a).

The Harvest Potential and the Exploitation Potential is given as 174 million m^3/a and 105 million m^3/a respectively. The recharge estimates have not been reconciled with those prepared for the WODRIS study in which more detailed geological and rainfall data was used. The estimates in this study are conservative. It is considered that at least 63 million m^3/a would be available primarily in the fractured rock aquifers.

3.4.4 Oorlogskloof (E40)

This sub-area extends in a relatively narrow belt from the escarpment range (Lower Orange WMA boundary) in the east, curving south along a canyoned stretch in the Nardouwberge range on the west (E33 boundary), to its confluence with the Doring River. A small area of pre-Cape Nama Group occurs near the southwards bend in the E40C subcatchment and in small inliers father south (E40D). The western subcatchments (E40C, part of E40 D) are underlain by sub-horizontal formations of the Cedarberg Formation and Nardouw Subgroup (Table Mountain Group), and a narrow wedge of the Bokkeveld Group. The eastern part of E40C and the remaining subcatchments (E40A, B) strata of the Dwyka Formation, Ecca Group, and lower Beaufort Group and Karoo dolerite intrusives (dykes and sills) are abundant in strata above the Dwyka Formation.

The estimated total recharge is 44 million m^3/a. Most of the usage is from the regolith aquifers with minor amounts from the dolerite dykes. The Harvest Potential and the Exploitation potential are given as 57 million m^3/a and 32 million m^3/a, respectively.

The groundwater in the Oorlogskloof sub-area will be of a poor quality requiring reverse osmosis unless it is abstracted from the dolerite aquifer. Yields are low and it would be suitable only for stock watering. It is not possible in this study to reconcile the numbers without detailed examination of local scale studies. This is beyond the scope of this study.

3.4.5 Sub-area summary

For the entire Doring ISP sub-area, *the NMWRS usage figure of 3.3 million m^3/a is used.*
Haupt (2000) estimated the groundwater use at 4.6 million m^3/a. The in-house model estimates usage at 40 million m^3/a.

The recharge is estimated at 294 million m^3/a
The Peninsula Aquifer receives an estimated average of 11 million m^3/a, the Nardouw 60 million m^3/a and the Witteberg quartzites 32 million m^3/a. The regolith and primary aquifers receive an estimated 162 million m^3/a and 17 million m^3/a respectively. Fractured dolerite dykes and sills receive an estimated 12 million m^3/a.

The baseflow is 0.5 million m^3/a. (Pitman)
Hughes has estimated the baseflow to be 17,5 million m^3/a.

The unexploited groundwater potential is very conservatively estimated to be 58,4 million m^3/a. using 20% of (Recharge – baseflow)
If a 50% factor is used the Groundwater Potential is 107 million m^3/a

The Harvest Potential and the Exploitation Potential are given as 338 million m^3/a and 194 million m^3/a, respectively, for this sub-area. Both these numbers are higher than the estimated recharge and the unexploited groundwater determined in this study. The recharge values are dominated by the large outcrop of regolith aquifers and the use is also primarily in this aquifer. There groundwater quality is poor and the aquifer is inefficient. It is possible that the higher potential (107 – 198 million m^3/a) could not be realized in practical terms. However to evaluate this will require more detailed study, in particular quantifying the long term recharge average in a flood hydrology dominated environment as well as the possible discharge of groundwater from the TMG aquifers into the Doring River catchment.

Issues:

- Monitoring systems should be put in place in the upper, more mountainous reaches of the rivers, mainly in the form of weather stations so that the inter-relationship between the presence of snow and the low flows experienced during the summer months can be closely studied;
- Potato farmers are abstracting groundwater without proper licence agreements.
- Calvinia (small dam and three boreholes) and Nieuwoudtville (one borehole) are reliant on groundwater and are stressed urban supply areas;
- There is a need to evaluate the potential for utilization of poor quality groundwater and to blend it with surface water or treat it using reverse osmosis.

3.5 KNERSVLAKTE (E31A-H, E32, E33A-F, F60)

This ISP sub-area comprises the Hantam, the Kromme, the Lower Olifants and the Goerap areas.

3.5.1 Hantams (E32)

This area extends from the escarpment range (Lower Orange WMA boundary) in the east to a confluence with the Krom River in the west, before the latter joins the Sout River. The western, terminal subcatchment (E32E) is underlain by gently dipping formations of the Nama Group, a northward thinning wedge of Nardouw Subgroup (Table Mountain Group) in the south, covered by Dwyka Formation tillite along its eastern border. The eastern subcatchments (E32D-A) expose strata of the Dwyka Formation and Ecca Group, overlying upper Nama beds (in the western part of E32D). Karoo dolerite intrusives (dykes and sills) are abundant in strata above the Dwyka Formation.

The recharge is estimated to be 47 mm^3/a. The primary usage is from the regolith aquifers (12 million m^3/a) and the dolerite dykes (3 million m^3/a). Given the low volume high dependency pattern of usage it is assumed that it would be economic for stock watering and domestic use.

The Harvest potential and the Exploitation potential are given as 41 million m^3/a and 22 million m^3/a, respectively. The numbers are in reasonable accord with the results of this study.

3.5.2 Kromme (E31)

The northern boundary of this sub-area extends across a topographically subdued portion of the Great Escarpment divide (Lower Orange WMA boundary) around a region of endoreic drainage (E31A subcatchment), which is postulated to have been connected several tens of millions of year ago to an extensive palaeo-drainage system in the southern part of the Lower Orange WMA. During the climatically much wetter conditions at that time, the present Olifants-Doring River was a relatively minor southern tributary of this major Bushmanland-Karoo river system.

The western, terminal subcatchment (E31H) is underlain by gently dipping formations of the Nama Group overlying basement graniotids of the Namaqualand Metamorphic Complex (NMC). NMC basement underlies Dwyka Formation tillite and Ecca Group shale in the western part of the sub-area (E31A, D, E, G, H). The eastern subcatchments (E31B-C) expose strata of the Dwyka Formation and lower Ecca Group, overlying NMC basement (in the western part of E31C). Karoo dolerite intrusives (dykes and sills) are abundant in strata above the Dwyka Formation. Extensive alluvial cover sediments occur above Dwyka bedrock near Kliprand (eastern part of E31A) and above NMC bedrock lower down in the E31D and E31 H subcatchments. These younger cover deposits may be related to the former floodplain of the Bushmanland-Karoo palaeo-drainage.

The groundwater quality is poor.

There is a large difference between the recharge estimates obtained in this study, and the groundwater Harvest Potential and Exploitation values given in the DWAF Hydrogeological series. These are 70 million m^3/a, 16 million m^3/a and 8 million m^3/a respectively. The most conservative value has been selected to be used in this study.

It is most likely that the recharge models used over estimate recharge in this arid flood hydrology environment where the MAP is under 200 mm per annum and for practical purposes, it is common practise to assume that zero recharge is recorded since aquifers are only recharged in extreme events. In this situation the storage of the aquifer is critical to evaluating the potential and this, although not explicitly documented for this area or these aquifers, was taken into account in the *Harvest Potential* calculations by WSM (2000).

For strategic planning purposes it is considered that there would be limited groundwater potential in this sub-area. Reports of declining water levels in the small town supplies support this.

3.5.3 Lower Olifants/Sout (E33A – E)

The eastern boundary of this sub-area extends northwards along the crest of the Nardouw escarpment around Van Rhyns Pass and across the north-eastern section of the Knersvlakte plain around the area of the Kromme, Hantams and Sout river confluences, part of the ancient flood plain of the now decapitated Bushmanland-Karoo river system.

Except for a thin fringe of TMG formations around its south-eastern and south-western margins, this sub-area is underlain mainly by Nama Group overlying basement granitoids of the Namaqualand Metamorphic Complex (NMC) in its northeastern part, and by Gariep Group strata overlying reworked NMC basement in its south-western part. Karoo intrusives (dykes and subvolcanic complexes occur in some part of the area. Extensive alluvial cover sediments occur above NMC and Nama bedrock in the Knersvlakte parts of the E33A, E33B and E33D subcatchments. These particular cover deposits may be related to the former floodplain of the Bushmanland-Karoo palaeodrainage.

The sub-area is dominated by the primary and regolith aquifers with a small exposure of the Peninsula and the Nardouw aquifers.

The recharge and usage values obtained, using the models in this study, are estimated to be 95 mm^3/a and 52 million m^3/a respectively. These are not considered to be reliable and further work would be required. The Harvest potential and the Exploitation Potential are calculated to be 33 million m^3/a and 20 million m^3/a respectively. As in the Hantam sub-area the rainfall to the primary aquifers is below 200 mm/a and recharge is expected to be infrequent and related to extreme events. Thus the average obtained from the three recharge models used in this study would not be appropriate as it is skewed.

The lowest recharge value obtained for the Primary aquifer in this sub-area is 40 million m^3/a. The lowest recharge value obtained for the regolith aquifers is 22 million m^3/a i.e. a lower estimate of 62 million m^3/a, still considered somewhat high. It is not specified how the Harvest Potential recharge and storage estimates were made at the aquifer specific nor quaternary scale and the numbers cannot be reconciled.

It is sufficient for strategic planning purposes to record that the groundwater potential is limited by aquifer storage that is at this stage unknown. The recharge processes and patterns with respect to the historical rainfall record are also unknown. Given this the predictions must be conservative. However it is critical that correct groundwater usage figures are established.

3.5.4 Goerap (F60)

The eastern boundary of this sub-area extends northwards along the crest of the Nardouw escarpment around Van Rhyns Pass and across the north-eastern section of the Knersvlakte plain around the area of the Kromme, Hantams and Sout river confluences, part of the ancient flood plain of the now decapitated Bushmanland-Karoo river system.

Except for a thin fringe of Nama formations along faulted contacts near its north-eastern boundary, this sub-area is underlain mainly by reworked NMC basement, overlain by Gariep Group formations and small outliers of TMG in its south-western part. Karoo intrusives (dykes and subvolcanic complexes occur in some part of the area. Aeolian, shallow-marine and alluvial terrace deposits occur in a belt along the coastal plain.

The young wind-deposited sands cover older marine deposits related to former high stands of sea level, and also more localized fluvial deposits in buried palaeochannels related to former low stands of sea level during times of much less arid palaeoclimate. The F60E area is of particular interest with regard to possible former fluvial and estuarine deposits related to a more northerly mouth of the palaeo-Olifants system.

The area is dominated by the regolith and the primary aquifers and experiences a rainfall of close to or less than 200 mm/a. The average groundwater recharge in this study in the Goerap sub-area is estimated to be 25.5 million m^3/a and the lowest estimate would be 18 million m^3/a. The usage is estimated to be ~ 3 million m^3/a, the Harvest Potential is recorded as 15 million m^3/a and the Exploitation potential as 7 million m^3/a.

It is recommended that the most conservative value for *Unexploited Groundwater Potential* is 7 million m^3/a. DWAF figures are used for strategic planning purposes.

3.5.5 Sub-area summary

The NWRS value for groundwater usage is 3 million m^3/a.
The groundwater usage is primarily in the regolith aquifer with some use of the primary aquifer. The actual groundwater usage figures are unknown. The in-house model indicates very high groundwater usage of 34 million m^3/a, which is most likely an indication of a high number of dry or abandoned boreholes since a success rate was not applied.

The Pitman value for baseflow is zero million m^3/a.
The Hughes model gives baseflow as 0 million m^3/a.

Recharge in this sub-area is 207 million m^3/a.

The unexploited groundwater Potential is 38 million m3/a.

The NWRS indicates 19 million m^3/a unexploited groundwater potential. **We recommend that the lower figure be used for planning purposes, until updated usage and recharge figures are available.** The area in general receives less than 200 mm/a rainfall, and is dominated by large outcrop areas of regolith aquifer and thus limited aquifer storage. Recharge would only happen in the extreme event.

The Harvest Potential and Exploitation Potential are given as 82 million m^3/a and 42 million m^3/a, respectively. It is most important that the correct usage values are obtained and the impact of recharge in extreme events only is better understood in order to refine the unexploited groundwater potential. The results of the robust method used in this study and the Groundwater Exploitation Potential are otherwise in reasonable accord.

Issues:

- Water has a high salinity, generally not of a potable standard (TDS of 1000 mg/l at best);
- Loeriesfontein (six boreholes) is reliant on groundwater and is a stressed urban supply area;
- Monitoring/paucity of data: The groundwater situation in the E31 sub-area needs to be studied;
- Groundwater management: Groundwater allocations particularly where aquifer storage capacity can be considered over more than one season must take into account the worth of the use of water, the period needed for this use and the time needed for aquifer levels to recover from possible temporary over abstraction. This is a resource management issue and shall require cooperative governance;
- Bitterfontein (seven boreholes), Nuwerus, Rietpoort and Mulsvlei urban supply areas are reliant on groundwater and are stressed;
- Bitterfontein has a desalination plant, which for the local municipality is too costly to run, although running costs have been reduced considerably over time;
- There is a need to evaluate the potential for utilization of poor quality groundwater and to blend it with surface water or treat it using reverse-osmosis.

3.6 LOWER OLIFANTS (E33F – H, E10J-K)

This sub-area covers the lower main stem of the Olifants River below Klawer (E33G-H), the Troe-Troe (E33F) tributary in the Vanrhynsdorp area, and the main stem of the Olifants below Clanwilliam Dam and around the Doring confluence (E10J-K). The E33F-H catchments area is underlain mainly by low-grade metamorphic schists, limestone and marbles of the Nama and Gariep Groups, locally overlain by aeolian, shallow-marine and alluvial terrace deposits. The E10J-K catchments are underlain by gently folded and faulted Table Mountain Group (TMG) units, with localized outcrop of lower Bokkeveld Group around Clanwilliam (E10J).

The Baron and Seward (2000) value for groundwater usage of 1 million m^3/a is used
The groundwater usage is primarily in the primary aquifer along the coast and in the regolith aquifer with some use of the TMG aquifers. The actual groundwater usage figures are unknown. The in-house model indicates very high groundwater usage of 52 million m^3/a which could be an indication of a high number of dry or abandoned boreholes. Haupt (2000) estimated 0.28 million m^3/a.

The Pitman value for baseflow is 0.77 million m^3/a.
The Hughes model gives baseflow as 9 million m^3/a.

Recharge in this sub-area is 60 million m^3/a.
A total of 21 million m^3/a is to the primary aquifer, 17 million m^3/a and 14 million m^3/a to the Peninsula and Nardouw Aquifers respectively, and a nominal 7 million m^3/a to the regolith aquifers.

The Unexploited Groundwater Potential is 29 million m^3/a.
This is largely a function of what the current groundwater usage is. If it is as low as indicated by Haupt (2000), there is 24 million m^3/a available. If the modeled usage and Pitman baseflow is used, there is a 22 million m^3/a groundwater deficit. The groundwater exploitation figure given (Haupt 2000) is 55 million m^3/a.

It is necessary to establish confident groundwater usage and baseflow numbers in this water short area where there is significant recharge to the fractured TMG aquifers as well as the primary aquifer.

Issues:

- There is a need to integrate the results of the WODRIS study into groundwater resource planning and evaluation in this area;
- Licensing/Groundwater: It is possible that in the Reserve determination process that access to groundwater will be lost or reduced in some area (e.g. the E33F is considered as a stressed catchment ACTION: Prepare plan on how to manage this process and determine constructive intervention;
- Groundwater quantity and quality: The groundwater table is being lowered and the groundwater quality is deteriorating in the E33F subcatchment (Troe-Troe River) due to agricultural use and irrigation return flows;
- There is a need to evaluate the potential for utilization of poor quality groundwater and to blend it with surface water or treat it using reverse osmosis.

GROUNDWATER/SURFACE WATER LINKAGE

There is little to no quantitative knowledge of surface groundwater interaction in this WMA. Studies funded by the RDM office of DWAF and research is underway but study domains are restricted and not necessarily defined by an IWRM concept or domain for planning purposes.

A current WRC funded study on ecological impacts of groundwater abstraction from the TMG is focusing on establishing the groundwater dependency of wetlands and seep zones in high lying mountainous areas of the Breede WMA. Preliminary results show that the surface groundwater interaction is situated at lithological and or structural defined regions as was postulated in the CAGE project.

There is ongoing work undertaken on the vleis of the Sandveld in order to establish the groundwater contribution to the ecosystems. Concerns have been raised about the impact of abstraction on the ecosystems. It has been pointed out however that the study area is defined by lateral discharge along palaeochannels into the vlei as well as a wellfield situated within the vlei.

Baseflow is low to zero in the regolith dominated sub-areas of the Doring and Knersvlakte sub-areas, indicating a very low, negligible groundwater contribution to surface water bodies.

In the TMG dominated areas of the WMA, elevation and depth of boreholes is a more critical factor to consider than distance from a river in regulating groundwater abstraction with regards to impact on baseflow. In general the upper 50 m of the TMG aquifers are annealed in the transmissive zones. Most of the baseflow in rivers is originated from perennial springs and seep zones. Interaction between surface and groundwater from the TMG within the river course is limited to a few areas, where the Bokkeveld Formation is eroded. Impact on springs can be managed by supplementing the decrease in spring flow from managed wellfields.

Springs were documented during the CAGE study and V-notches established at selected sites. To date the monitoring data obtained has not been interpreted. The Peninsula Aquifer daylights as perennial springs on the contact with the Cederberg Shale Formation, along palaeochannels on the coastal plain and as high lying seasonal seep zones primarily on the eastern limb of the syncline. The Nardouw Aquifer contributes to baseflow as seep zones at the Bokkeveld contact within the valley and more directly in the upper reaches of the Olifants River and some 15 km north of Citrusdal, where the Bokkeveld is not present.

Most of the streams and rivers in the upper regions and the relatively dry areas of the WMA are considered detached (piezometric level at all times below streambed and no discharge to surface water), intermittent (piezometric level slopes towards the stream and recharge occurs at intervals or occasionally) or famished (piezometric level slopes towards the stream, but groundwater does not reach due to evapo-transpiration (definitions by Vegter and Pitman, 1996). Relevant surface groundwater interaction is therefore limited to perennial springs (see above) and rivers embedded in alluvial aquifers.

The bigger effluent rivers with riparian zones, constituting the alluvial aquifers, are located in climatic regions of low rainfall and high evaporation. These aquifers are not considered relevant for water resource development. Rivers do normally not act as source for groundwater recharge. However, in the event of floods the river becomes influent and recharges the groundwater, if the storage capacity is sufficient. It is suggested that it would be appropriate strategy to consider rainfall harvesting or water banking using the alluvial aquifers in these circumstances.

A similar strategy can be adopted in the management of the TMG storage, viz., drawdown of the groundwater table in summer in order to enhance recharge in the winter and optimize the evaporation free storage. This is another approach to water banking, because winter floods can be stored in an aquifer. This opportunity is borne out by isotopic results that indicate that up to 90% of floods comprise of rejected groundwater recharge in these areas.

SUMMARY OF TABLES

Table 1: Recharge and baseflow in million m^3/a

Sub-area	Recharge (Umvoto model)	Recharge (Vegter)	Baseflow (Pitman)	Baseflow (Hughes)
Upper Olifants	120	98	7.5	125
Sandveld	135	122	0.8	10.3
Doring	294	193	0.5	17.5
Kouebokkeveld	110	125	7.3	87
Knersvlakte	207	73	0	0
Lower Olifants	60	46	0.8	9.1
Total	**926**	**657**	**17**	**246**

Note: The Baseflow given by Hughes exceeds recharge and or is close to 80% of recharge. Given the high storage and rate of recharge in TMG dominating these sub-areas this is not considered realistic. Increasing use and monitoring of the aquifer(s) will result in increasing certainty as regards the quantification of surface groundwater interaction and the impacts of abstraction.

Table 2: Groundwater Usage in million m^3/a

Sub-area	Usage (NWRS)	Usage (Baron and Seward 2000)	Usage based on NGDB and WRC Yield map (1)	Usage (ISP)	Comment
Upper Olifants	4	26	19	20	Cage Study results
Sandveld	30	55	77	30	Danida Sandveld Study results
Doring	3	5	40	3	NWRS selected
Kouebokkeveld	5	18	14	5	NWRS selected
Knersvlakte	3	3	34	3	NWRS selected
Lower Olifants		<1	51	1	Included in Upper Olifants in NWRS
Total	**45**	**108**	**235**	**62**	

1) The method used to estimate usage would significantly over estimate in the Karoo-dominated sub-areas due to high % of dry boreholes and assumed pumping regime in model.

Table 3: ISP Groundwater Available for Development in million m^3/a

Sub-area	Recharge (Umvoto)	Baseflow (Pitman)	Usage (ISP)	%	Groundwater Available for Development
Upper Olifants	120	7.5	20	50	36
Sandveld	135	0.8	30	50	37
Doring	294	0.5	3	20	55.5
Kouebokkeveld	110	7.3	5	50	46
Knersvlakte	207	0	3	20	38
Lower Olifants	60	0.8	1	50	28
Total	926	16.9	**62**		**240.5**

1) 20% or 50% of (Recharge – Baseflow) less usage = Groundwater Available for Development. It could be as low as 10% or as much as 80% if additional information is obtained.

Table 4: Comparison of available Groundwater Available for Development Values in million m^3/a

Sub-area	Harvest Potential	Exploitation Potential (WSM 2000)	NWRS	ISP	Comment
Upper Olifants	457	308	50	36	
Sandveld	224	136	42	37	
Doring	338	194	62	55.5	
Kouebokkeveld	285	179	26	46	
Knersvlakte	82	42	19	38	Select NWRS value
Lower Olifants	89	55		28	Lower Olifants included in Upper Olifants number in NWRS
Total	**1475**	**913**	**199**	**240.5**	

1) The Groundwater Potential estimated in this study for the Olifants (Upper and Lower) and the Kouebokkeveld is considered to be very conservative for reasons discussed in text.

2) The NWRS value for the Knersvlakte is recommended to be used for planning purposes until ground-truthed updated figures of usage and recharge become available. We recommend that the NWRS numbers be revised accordingly (see table 2 below). The total Groundwater Potential for development would be 240 million m^3/a

SUMMARY TABLE OF POTENTIAL AND CURRENT SUPPLY

ITEM	Groundwater Available for Exploitation/ Development	Groundwater Supply
Unit	Million m^3/a	Million m^3/a
Ref	ISP	NWRS, DANIDA, CAGE
Formula	Recharge – baseflow/2 or 5 less Supply	
Kouebokkeveld	46	5.0
Sandveld	37	30
Olifants	28 (Lower) + 36 (Upper)	21
Knersvlakte	19	3.0
Doring	55.5	3.3
Total	**221.5**	**62.3**

Groundwater References: Studies in the Olifants Doring WMA since 1978

Anon (2000). *Olifants/Doring River: Follow-up study to investigate the proposed irrigation schemes* - Contract No. 259 - 2000/2001. Study proposal. A. G. P. Ltd.

Hartnady, C.J.H., and E.R. Hay (2002). Western Cape Olifants Doring Study (WODRIS). Phase A. *Hydrogeological inception report*.

Aartsma, H. and A. Malan (2003). Western Cape Olifants/Doring River Irrigation Study. *Bulk water conveyance options for irrigation*. Volume IIB: Draft 1. Contract Number: 259-2000/2001. Arcus Gibb.

Aartsma, H. and A. Malan (2003). Western Cape Olifants/Doring River Irrigation Study. *Bulk water conveyance options for irrigation*. Volume IIa: Draft 1. Contract Number: 259-2000/2001. Arcus Gibb.

Aartsma, H. and A. Malan (2003). Western Cape Olifants/Doring River Irrigation Study. *Bulk water conveyance options for irrigation.* Volume I: Draft 1. Contract Number: 259-2000/2001. Arcus Gibb.

BKS and Ninham Shand (1998). Olifants/Doring River Basin Study. *Synthesis of environmental studies Annexure C: Botanical.*

BKS and Ninham Shand (1998). Olifants/Doring River Basin Study. *Synthesis of environmental studies Annexure A: Riverine.*

Board, W., D. J. Hagen, et al. (2003). Western Cape Olifants/Doring River Irrigation Study. *Surface water resources development options.* Volume II: drawings. Contract Number: 259-2000/2001. Arcus Gibb.

Board, W., D. J. Hagen, et al. (2003). Western Cape Olifants/Doring River Irrigation Study. *Surface water resources development options*. Volume I. Draft 1. Contract Number: 259-2000/2001. Arcus Gibb.

Boucher, C. (2002). Western Cape Olifants/Doring River Irrigation Study. *Botanical report.* Draft 2. Contract No. 259 - 2000/2001. A. G. P. Ltd.

Brown, C. A. and E. G. Day (1997). Olifants/Doring Basin Study. *Impacts of water resource developments on the riverine ecosystem*. Volume 3: Doring River situation assessment. Southern Waters cc.

Brown, C., K. Riemann, *et al*. (2003). *Potential impacts to surface ecosystems as a result of groundwater abstraction*. Western Cape Olifants/ Doring River Irrigation Study (WODRIS).

Brown, C. A., K. Riemann, *et al*. (2003). Western Cape Olifants/Doring River Irrigation Study (WODRIS). *Potential impacts to surface ecosystems as a result of groundwater abstraction*. Draft report.

CSIR (1990). *Preliminary assessment of the potential for fresh water extraction from the Olifants Estuary.*

Dallas, H. F. (1997). Olifants/Doring Basin Study. *Impacts of water resource developments on the riverine ecosystem. Volume 2: Olifants River situation assessment*.

De Smidt, K. and A. H. M. Görgens (1992). Olifants River System Analysis. *Operating rule determination by use of stochastic hydrology - present and future development*. Ninham Shand, DWAF.

Du P. le Grange, A. (2001). Olifants/Doring River: Follow-up study to investigate the proposed irrigation schemes - Contract No. 259 - 2000/2001. *Draft Inception Report*. Draft 1. A. G. P. Ltd.

DWAF (2003). Olifants- Doring water management area. *Olifants-Doring ISP*. *Notes for the first work: internal strategic perspective*. 1-2 October 2003.

Esterhuizen, D., M. van Veelen, *et al*. (2000). *Olifants/Doring River Rapid Reserve Assessment for three predetermined sites*. Draft Copy.

Feuchtwanger, T. (1979). *Thermal infrared survey of the south west coastal area, between Melkbosstrand and of the Olifantsriver*. DWAF.

GEOSS and SRK (2003). Olifants-Doorn groundwater guidelines. *Trial implementation and testing. Draft final version 1: minus monitoring*.

Hagen, D. J., J. McStay, *et al*. (2001). Western Cape Olifants/Doring River Irrigation Study. *Physical characteristics and present land use*. Draft 1.

Hartnady, C. J. H. and E. R. Hay (2001). Western Cape Olifants-Doring Irrigation Study (WODRIS): *Task 3 - Phase A.* 1st Meeting.

Hartnady, C. J. H. and E. R. Hay (2001). Western Cape Olifants-Doring Irrigation Study (WODRIS). *The challenge: to find innovative solutions for Sustainable water management*. 2nd Presentation to the Groundwater Working Group: Task 3 - Phase A and B results.

Hartnady, C. J. H. and E. R. Hay (2002). *The use of structural geology and remote sensing in hydrogeologial exploration of the Olifants and Doring River Catchments. A synthesis of the hydrogeology of the Table Mountain Group. Formation of a research strategy*. K. Pietersen and R. Parsons.

Hartnady, C. J. H. and E. R. Hay (2002). *Experimental deep drilling at Blikhuis, Olifants River valley, Western Cape: motivation, setting and current progress. A synthesis of the hydrogeology of the Table Mountain Group. Formation of a research strategy*. K. Pietersen and R. Parsons.

Hay, E. R. and C. J. H. Hartnady (1997). *Hydrogeology and groundwater resource potential of the Olifants/Doring River Basin, Western and Northern Cape Provinces*.

Hay, E. R. and C. J. H. Hartnady (2002). Western Cape Olifants Doring Study (WODRIS). *Phase B. Hydrogeological reconnaissance report.*

Hay, E. R. and C. J. H. Hartnady (2003). Western Cape Olifants/ Doring River Irrigation Study (WODRIS). *Task 3 - Phase B. Subsurface water: hydrogeological reconnaissance report*.

Hay, E. R. and C. J. H. Hartnady (2003). Western Cape Olifants/ Doring River Irrigation Study (WODRIS). *Task 3 - Phase A. Subsurface water: hydrogeological inception report*.

Hester, A. and N. Carter (2003). Western Cape Olifants/Doring River Irrigation Study. *Environmental synthesis report. Draft 1. Contract Number: 259-2000/2001*. Arcus Gibb.

Howard, G. (1998). Olifants/Doring River Basin Study. *Water resources evaluation: Hydrology*.

King, J. M. and C. A. Brown (1997). Olifants/Doring Basin Study. *Impacts of water resource developments on the riverine ecosystem. Volume 1: assessment of impacts*. Southern Waters cc.

Lambrechts, J. J. N. and B. H. A. Schloms (1998). Olifants/Doring River Basin Study. *Soils and irrigation potential investigation*. Final report. BKS and Ninham Shand.

Langhout, C. (1998). Olifants/Doring River Basin Study. *Physical characteristics and land use*.

Laubscher, J. (1998). Olifants/Doring River Basin Study. *Financial viability of irrigation schemes.*

Luger, M. (1998). Olifants/Doring River Basin Study. *Synthesis of environmental studies.* BKS and Ninham Shand.

McKenzie, R. S., N. W. Schäfer, *et al*. (1990). Olifants River System Analysis. *Yield analysis of the area upstream of Bulshoek Dam*. BKS Inc., DWAF.

Murray, S. L. and A. H. M. Görgens (1994). Olifants River System Analysis. *Hydrology of the Doring River*. Ninham Shand, DWAF.

Ninham Shand (2002). Olifants/Doring Water Management Area. *Water resources situation assessment. Main Report*: Volume 2: appendices.

Ninham Shand (2002). Olifants/Doring Water Management Area. *Water resources situation assessment. Main Report: Volume 1.*

Riemann, K. and L. Groenewald (2003). Western Cape Olifants/ Doring River Irrigation Study (WODRIS). Task 3 - Phase D. *Sub-surface water: hydrocensus report.*

Riemann, K. and L. Groenewald (2003). Western Cape Olifants/Doring River Irrigation Study (WODRIS). Task 3 - Phase D. *Groundwater: hydrocencus report*. Draft.

Rooseboom, A. (1998). Olifants/Doring River Basin Study. *Reservoir sedimentation report*. BKS and Ninham Shand.

Rosewarne, P., C. J. H. Hartnady, *et al*. *Exploration for deep artesian groundwater resources in the Table Mountain Group fractured-rock aquifer: meeting Citrusdal community water supply needs from "hydrotect" structures in the Olifants River syncline*. Research project proposal to the Water Research Commission.

Schreuder, D. N. (1978). *'n Oorsig van die grondwaterpotensiaal van die area tussen die Berg- tot Olifantsrivier*. Weskus Projek: Berg- tot Olifantsrivier. DWAF.

Tharme, R. E. (1993). Proposed Rosendaal Dam: *Instream Flow Requirements of the Olifants River (Western Cape), upstream of Clanwilliam Dam*. Freshwater Research Unit and University of Cape Town, Citrusdal Irrigation Board.

Theron, T. P. (1998). Olifants/Doring River Basin Study. *Water resources development options*.

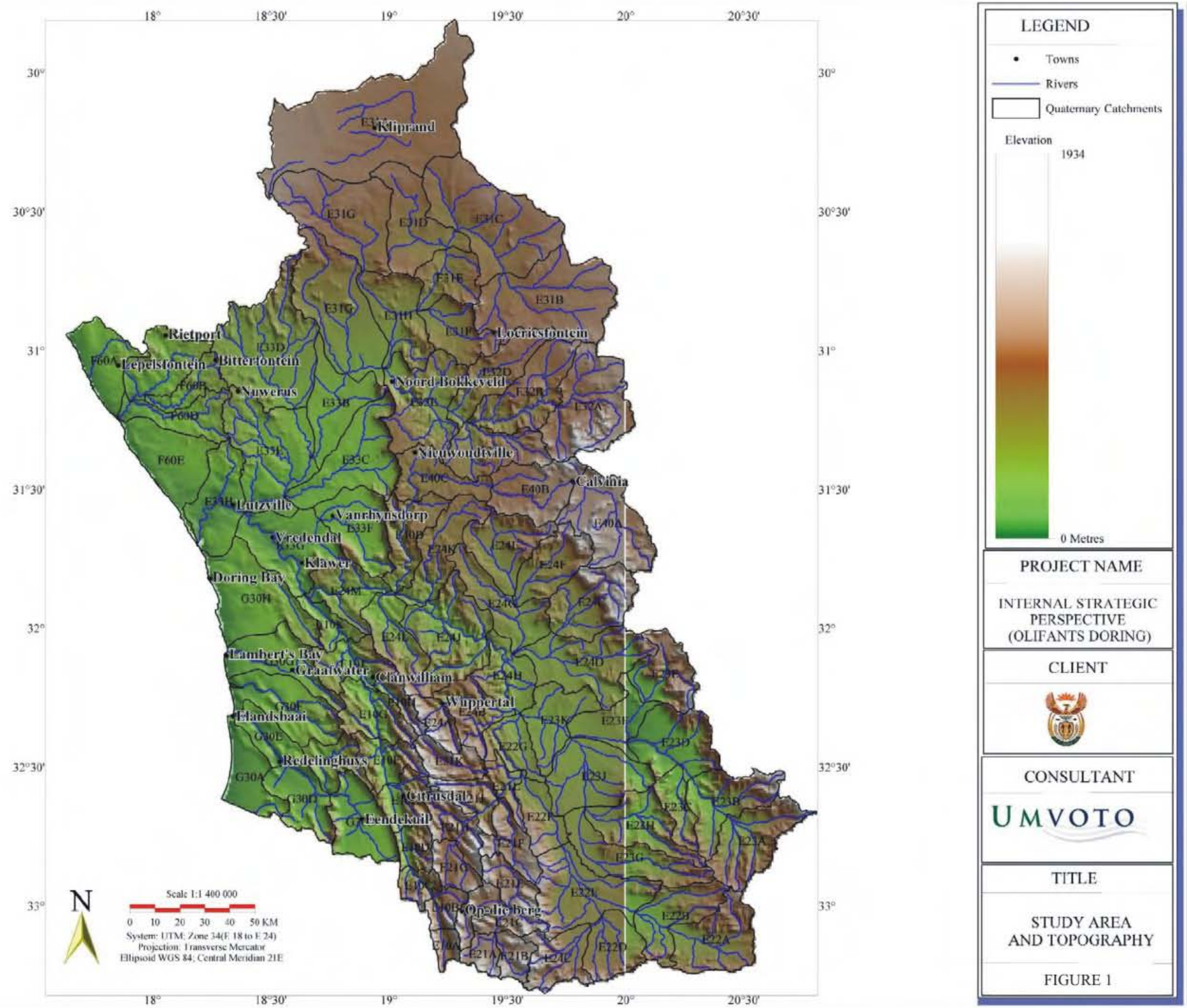
Titus, R., S. Adams, *et al*. (2002). *Groundwater situation assessment in Olifants/Doorn Water Management Area* (Version 1.0). Groundwater Group, DWAF.

van Veelen, M., T. Baker, *et al*. (1998). Olifants/Doring River Basin Study. *Water quality assessment*. BKS and Ninham Shand.

Visser, J. (2000). List of projects/initiatives/studies in the Olifants/Doring Catchment Area. DWAF.

Yates, R. (2002). Western Cape Olifants/Doring River Irrigation Study. *Archaeological heritage impact assessment*. Draft 2. Contract No. 259 - 2000/2001. A. G. P. Ltd.

Groundwater Figures



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Rietport
Lepelsfontein
Bitterfontein
Nuwerus
Loeriesfontein
Noord Bokkeveld
Nieuwoudtville
Calvinia
Lutzville
Vanrhynsdorp
Vredendal
Klawer
Doring Bay
Lambert's Bay
Graafwater
Clanwilliam
Wuppertal
Elandsbaai
Redelinghuys
Citrusdal
Eendekuil
Op-die-berg
Scale 1:1 400 000
0 10 20 30 40 50 KM
System: UTM; Zone 34(E 18 to E 24)
Projection: Transverse Mercator
Ellipsoid WGS 84; Central Meridian 21E
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LEGEND
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Rivers
Quaternary Catchments
Elevation
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PROJECT NAME
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TITLE
STUDY AREA AND TOPOGRAPHY
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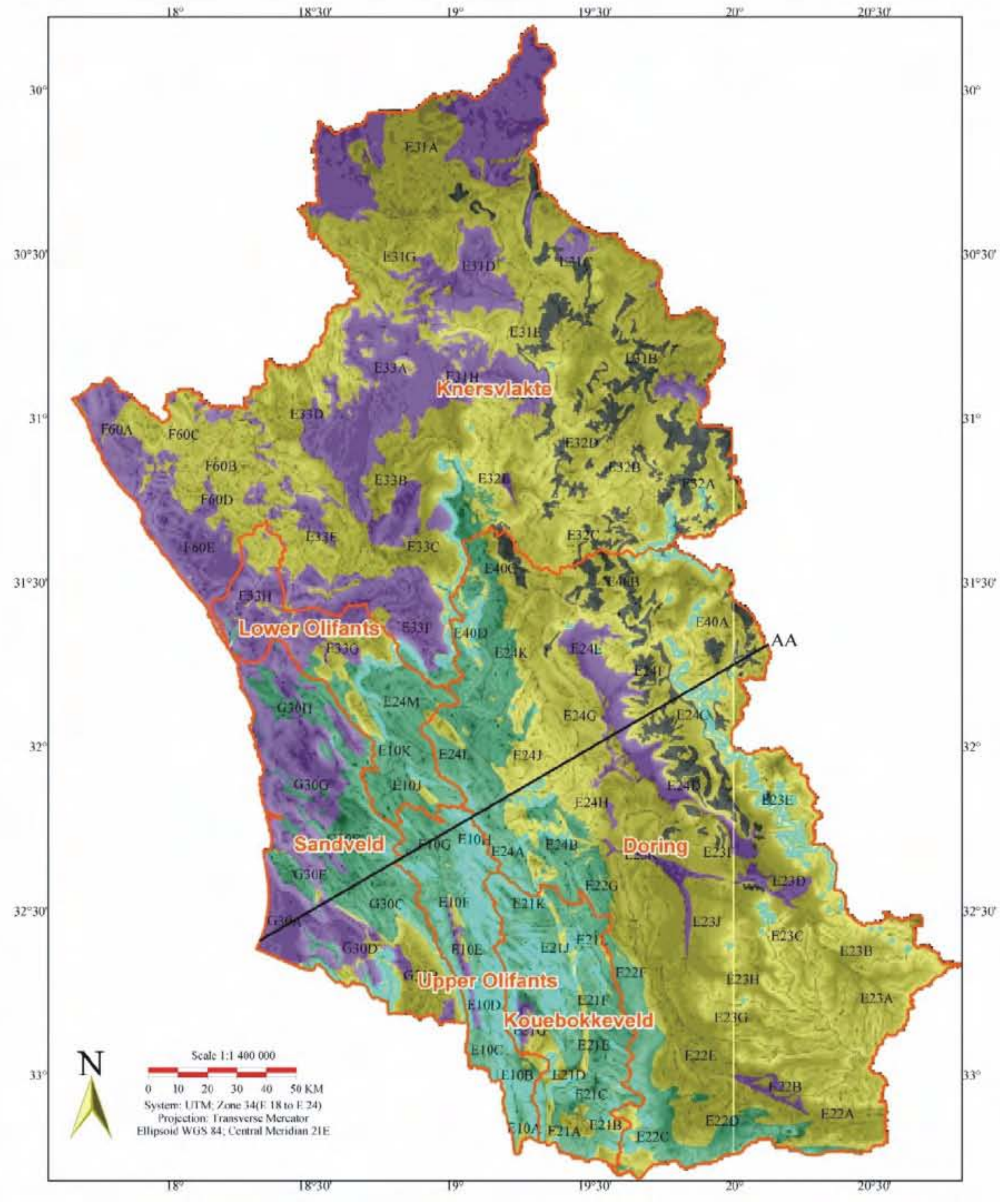


LEGEND

Quaternary Catchments

ISP Subareas

Slope between 35-80 degrees

Aquifer Types (revised)

Intergranular

Fractured

Intergranular (weathered) & fractured

Fractured dolerite

Cross section line

PROJECT NAME

INTERNAL STRATEGIC PERSPECTIVE (OLIFANTS DORING)

CLIENT

CONSULTANT

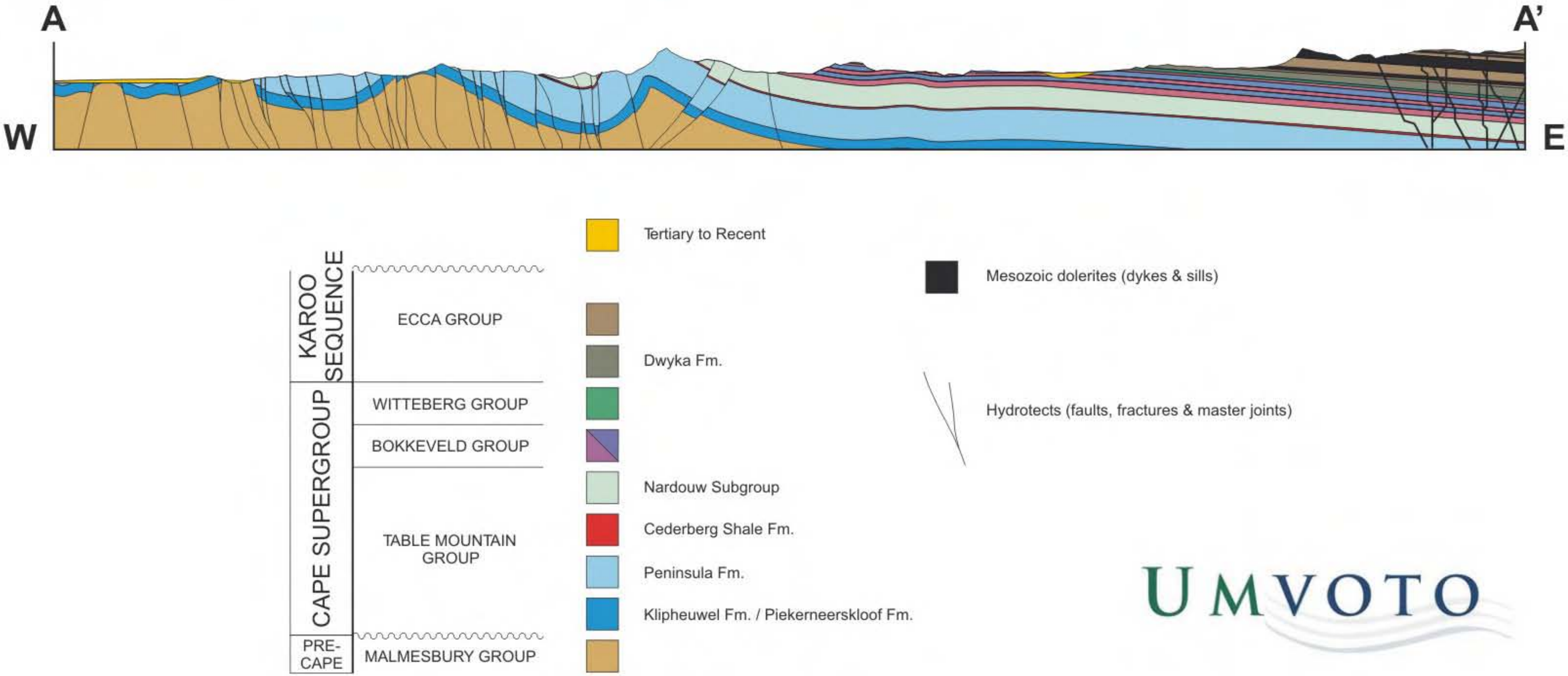
UMVOTO

TITLE

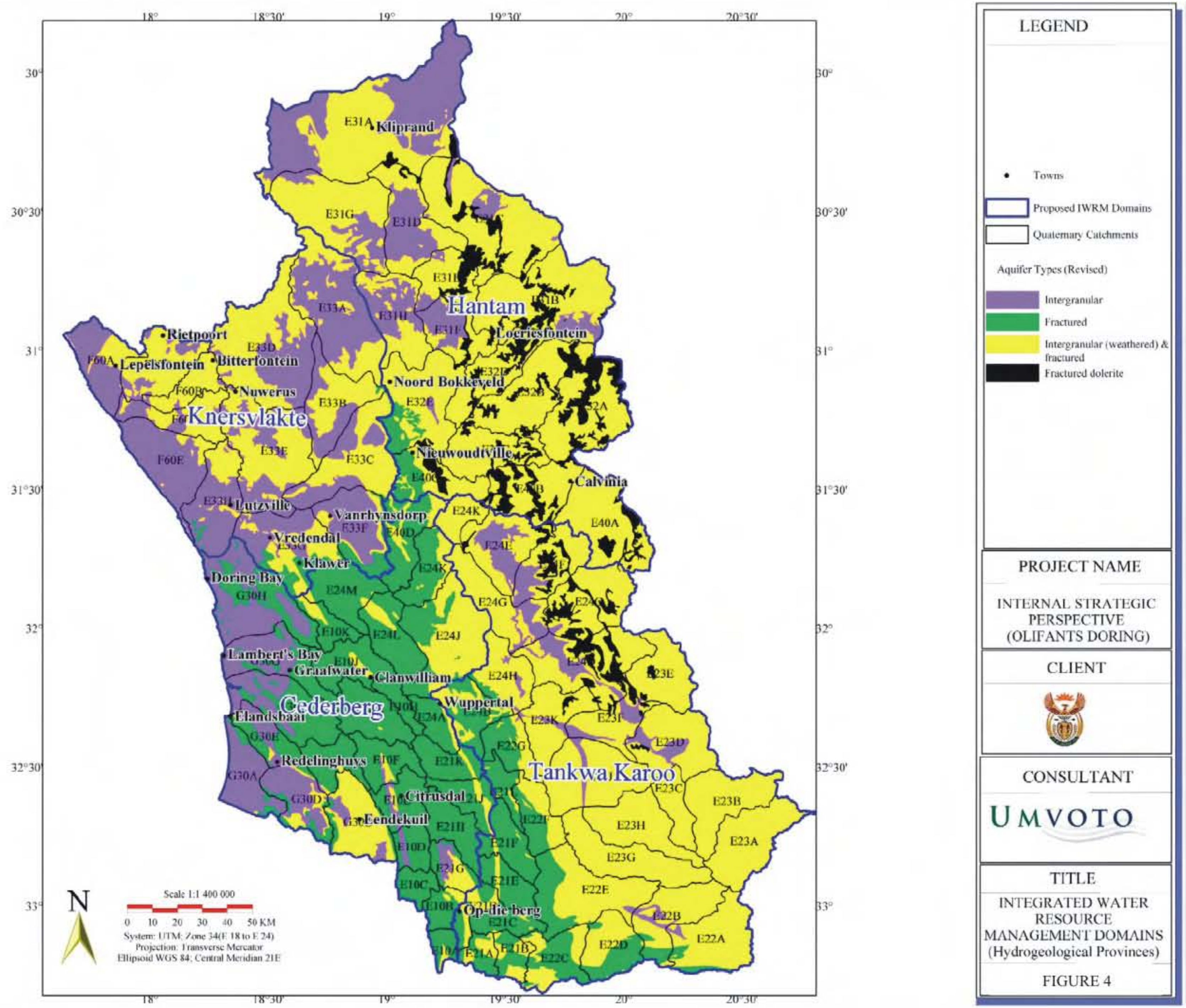
SLOPE MODEL and SURFACE SUBAREAS

FIGURE 2

Figure 3 OLIFANTS - DORING WMA GEOLOGICAL CROSS SECTION



UMVOTO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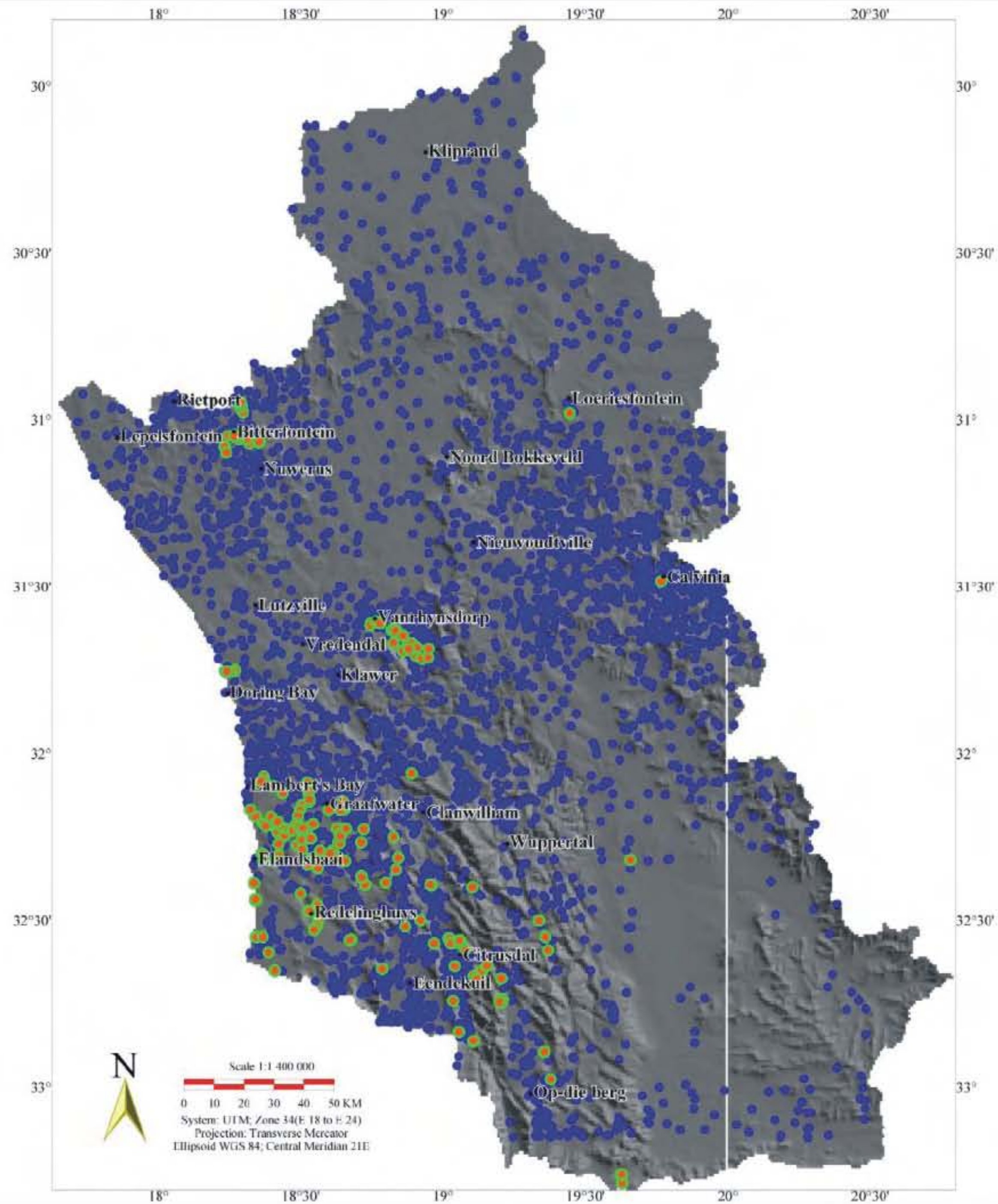
18°30'
19°
19°30'
20°
20°30'
30°
30°30'
31°
31°30'
32°
32°30'
33°
Kliprand
E31A
E31G
E31D
Hantam
E33A
Rietpoort
E33D
Lepelsfontein
Bitterfontein
F60A
F60B
Nuwerus
Loeriesfontein
Noord Bokkeveld
E32E
E33B
Knersvlakte
E33E
E33C
F60E
Nieuwoudtville
Calvinia
Lutzville
Vanrhynsdorp
E33F
E40D
E24K
E40A
Vredendal
Klawer
Doring Bay
G30H
E24M
E24E
E24G
E10K
E24L
E24J
Lambert's Bay
Graafwater
Clanwilliam
E24H
E23E
Elandsbaai
Cederberg
Wupperthal
E24A
E23K
E23D
G30E
Redelinghuys
Tankwa Karoo
G30A
E23C
E23B
Citrusdal
G30D
Eendekuil
E23H
E23A
E23G
E22E
Op-die-berg
E22B
E22D
E22A
E22C
N
Scale 1:1 400 000
0 10 20 30 40 50 KM
System: UTM: Zone 34(E 18 to E 24)
Projection: Transverse Mercator
Ellipsoid WGS 84; Central Meridian 21E
LEGEND
Towns
Proposed IWRM Domains
Quaternary Catchments
Aquifer Types (Revised)
Intergranular
Fractured
Intergranular (weathered) & fractured
Fractured dolerite
PROJECT NAME
INTERNAL STRATEGIC PERSPECTIVE (OLIFANTS DORING)
CLIENT
CONSULTANT
UMVOTO
TITLE
INTEGRATED WATER RESOURCE MANAGEMENT DOMAINS (Hydrogeological Provinces)
FIGURE 4



LEGEND

- Towns
- National Geohydrological Database (NGDB) boreholes
- DWAF Geohydro-Monitoring Sites

PROJECT NAME

INTERNAL STRATEGIC PERSPECTIVE (OLIFANTS DORING)

CLIENT

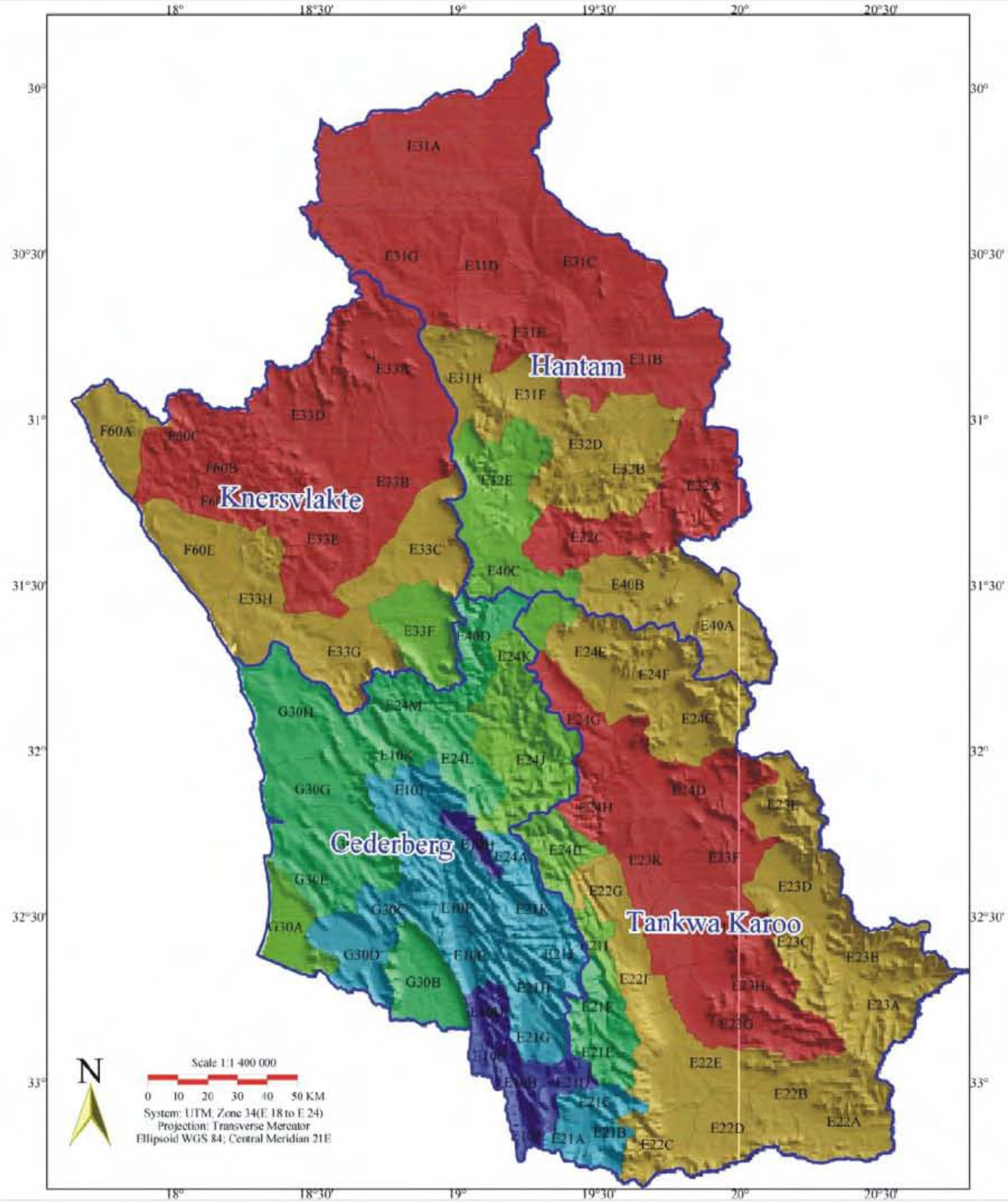
CONSULTANT

UMVOTO

TITLE

NGDB BOREHOLES AND DWAF MONITORING SITES

FIGURE 5



LEGEND

Quaternary Catchments
Proposed IWRM Domains

Estimated Recharge

- 5 - 10
- 11 - 15
- 16 - 20
- 21 - 30
- 31 - 50
- 51 - 76

PROJECT NAME

INTERNAL STRATEGIC PERSPECTIVE (OLIFANTS DORING)

CLIENT

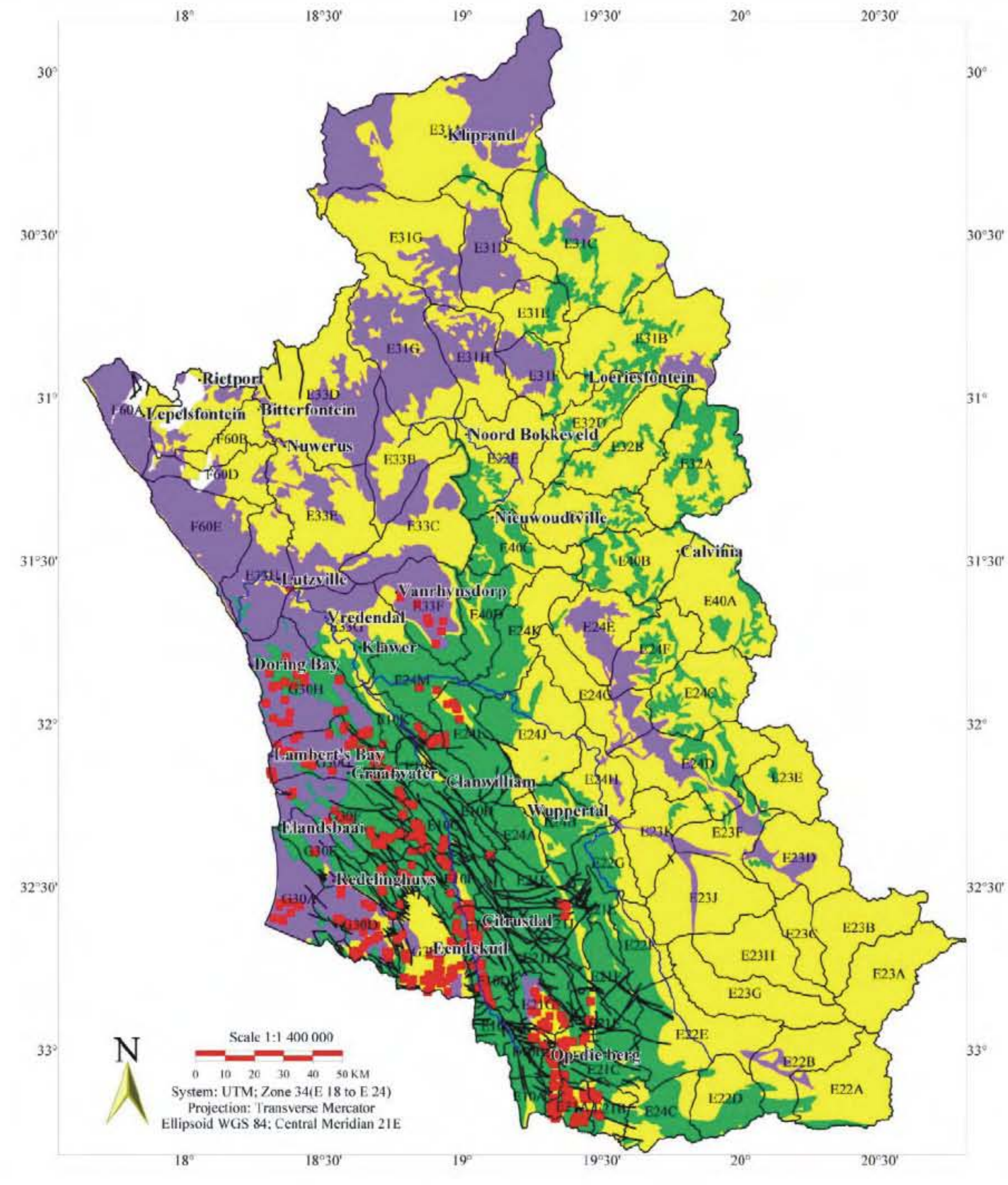
CONSULTANT

UMVOTO

TITLE

ESTIMATED GROUNDWATER RECHARGE

FIGURE 6



LEGEND

- Towns
- Hydrocemical Samples
- Rivers
- Faults
- Quaternary Catchments

Aquifer Type

- Intergranular
- Fractured
- Intergranular (weathered) & fractured

PROJECT NAME

INTERNAL STRATEGIC PERSPECTIVE (OLIFANTS DORING)

CLIENT

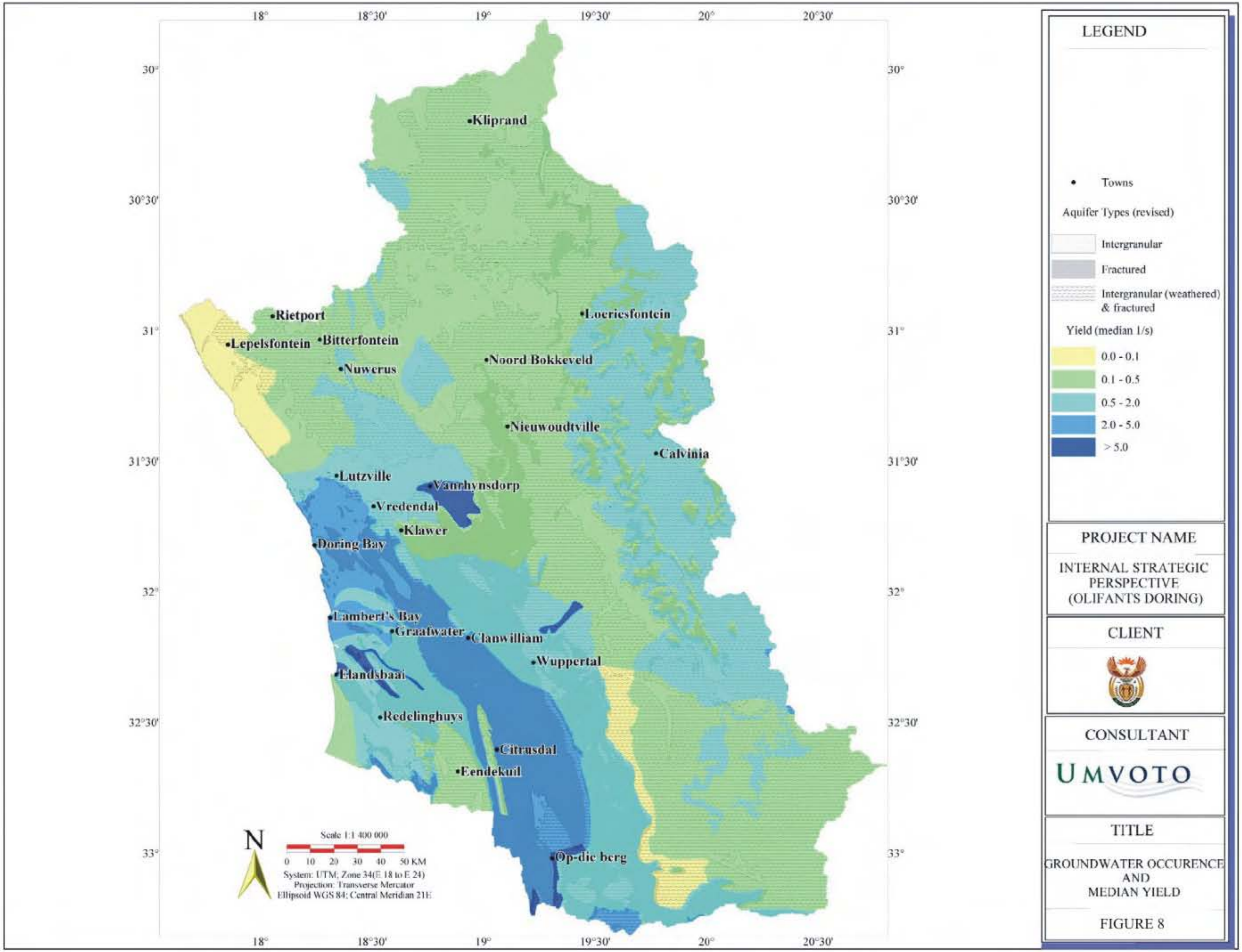
CONSULTANT

UMVOTO

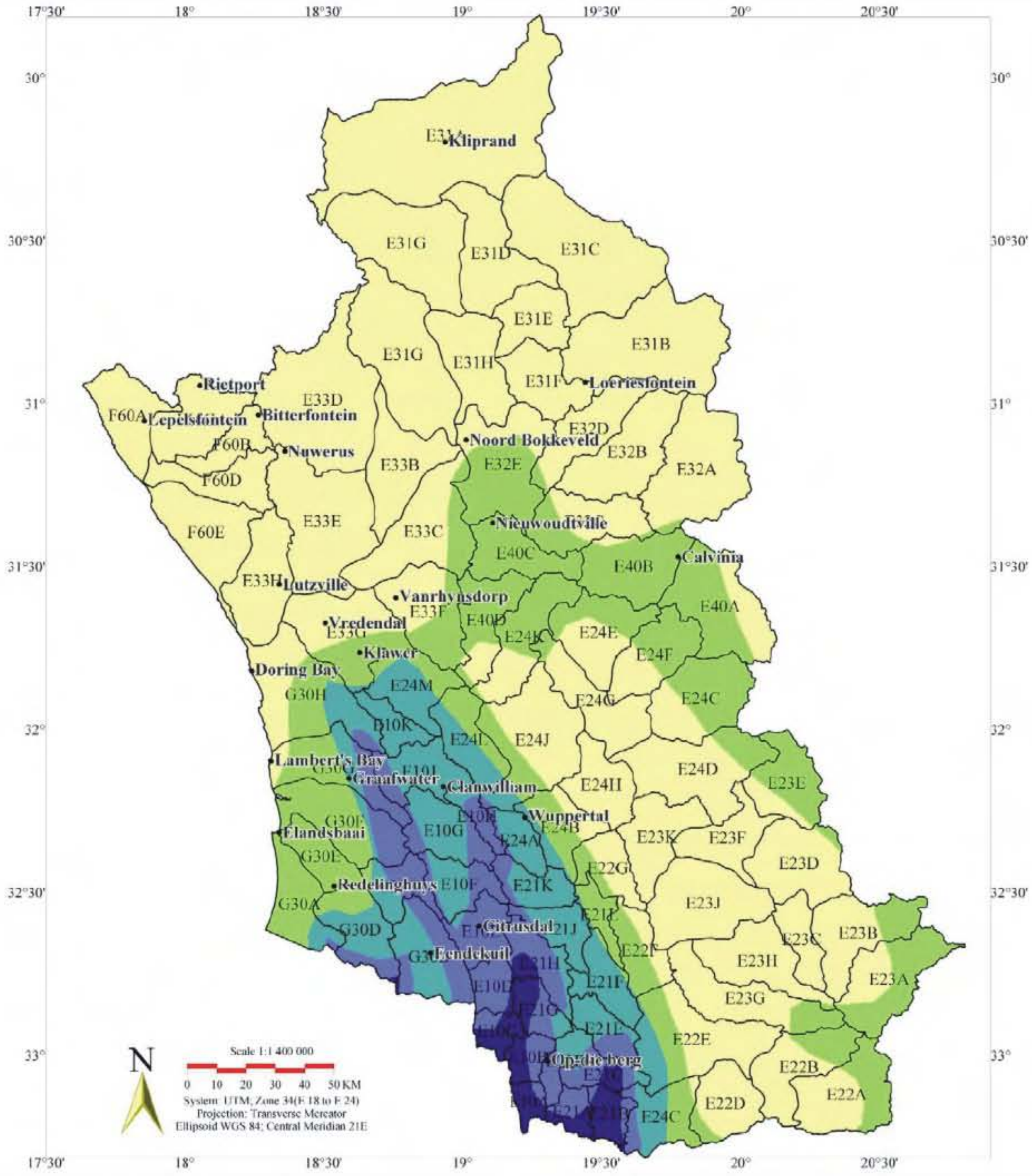
TITLE

CAGE HYDROCHEMICAL SAMPLE POSITIONS

FIGURE 7



18°
18°30'
19°
19°30'
20°
20°30'
30°
30°30'
31°
31°30'
32°
32°30'
33°
Kliprand
Rietport
Lepelsfontein
Bitterfontein
Nuwerus
Loeriesfontein
Noord Bokkeveld
Nieuwoudtville
Calvinia
Lutzville
Vanrhynsdorp
Vredendal
Klawer
Doring Bay
Lambert's Bay
Graafwater
Clanwilliam
Wuppertal
Elandsbaai
Redelinghuys
Citrusdal
Eendekuil
Op-die berg
N
Scale 1:1 400 000
0 10 20 30 40 50 KM
System: UTM; Zone 34(E 18 to E 24)
Projection: Transverse Mercator
Ellipsoid WGS 84; Central Meridian 21E
LEGEND
Towns
Aquifer Types (revised)
Intergranular
Fractured
Intergranular (weathered) & fractured
Yield (median l/s)
0.0 - 0.1
0.1 - 0.5
0.5 - 2.0
2.0 - 5.0
> 5.0
PROJECT NAME
INTERNAL STRATEGIC PERSPECTIVE (OLIFANTS DORING)
CLIENT
CONSULTANT
UMVOTO
TITLE
GROUNDWATER OCCURENCE AND MEDIAN YIELD
FIGURE 8



LEGEND

• Towns

Quaternary Catchments

Rate of Recharge(mm per annum)

- 0 - 10
- 10 - 25
- 25 - 37
- 50 - 75
- 75 - 110
- 110 - 160

PROJECT NAME

INTERNAL STRATEGIC PERSPECTIVE (OLIFANTS DORING)

CLIENT

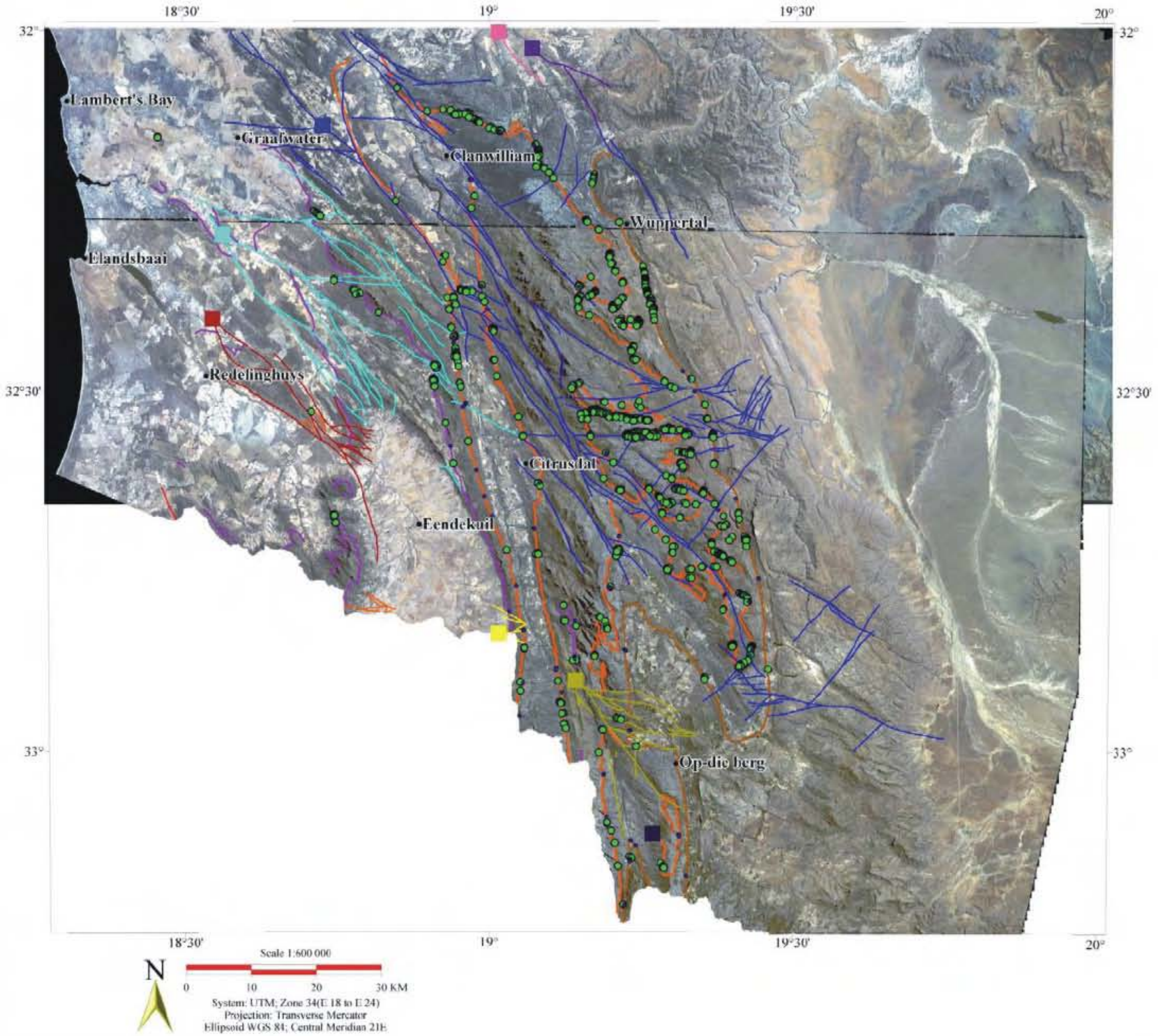
CONSULTANT

UMVOTO

TITLE

RECHARGE TO GROUNDWATER

FIGURE 9



LEGEND

Towns

Low Rank Vegetation Anomaly
- 3 - 5
- 5 + 5

Fracture End Points
- 1
- 12
- 14
- 2
- 3
- 5
- 6
- 7

Fracture Connectivity
- 1
- 12
- 14, 15
- 2
- 3
- 4
- 5
- 6
- 7
- 8

Geology Contacts
- NARDOUW_BOKKEVELD
- PENINSULA_CEDARBERG
- PIEKENIERSKLOOF_GRAAFWATER

PROJECT NAME

INTERNAL STRATEGIC PERSPECTIVE (OLIFANTS DORING)

CLIENT

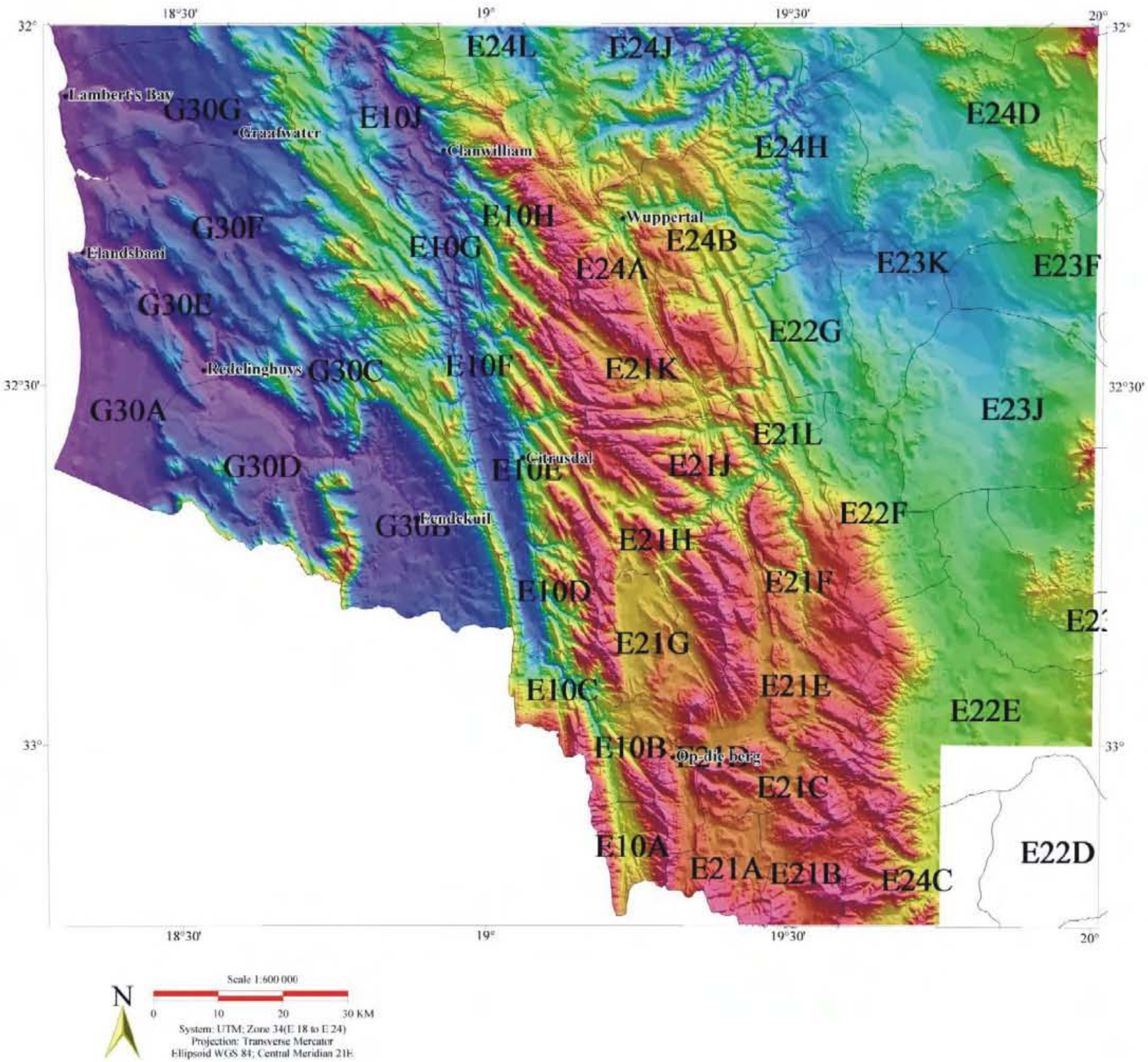
CONSULTANT

UMVOTO

TITLE

FRACTURE CONNECTIVITY & VEGETATION CHANGE ANALYSIS

FIGURE 10



LEGEND

• Towns

Quaternary Catchments

1374

166 mm

PROJECT NAME

INTERNAL STRATEGIC PERSPECTIVE (OLIFANTS DORING)

CLIENT

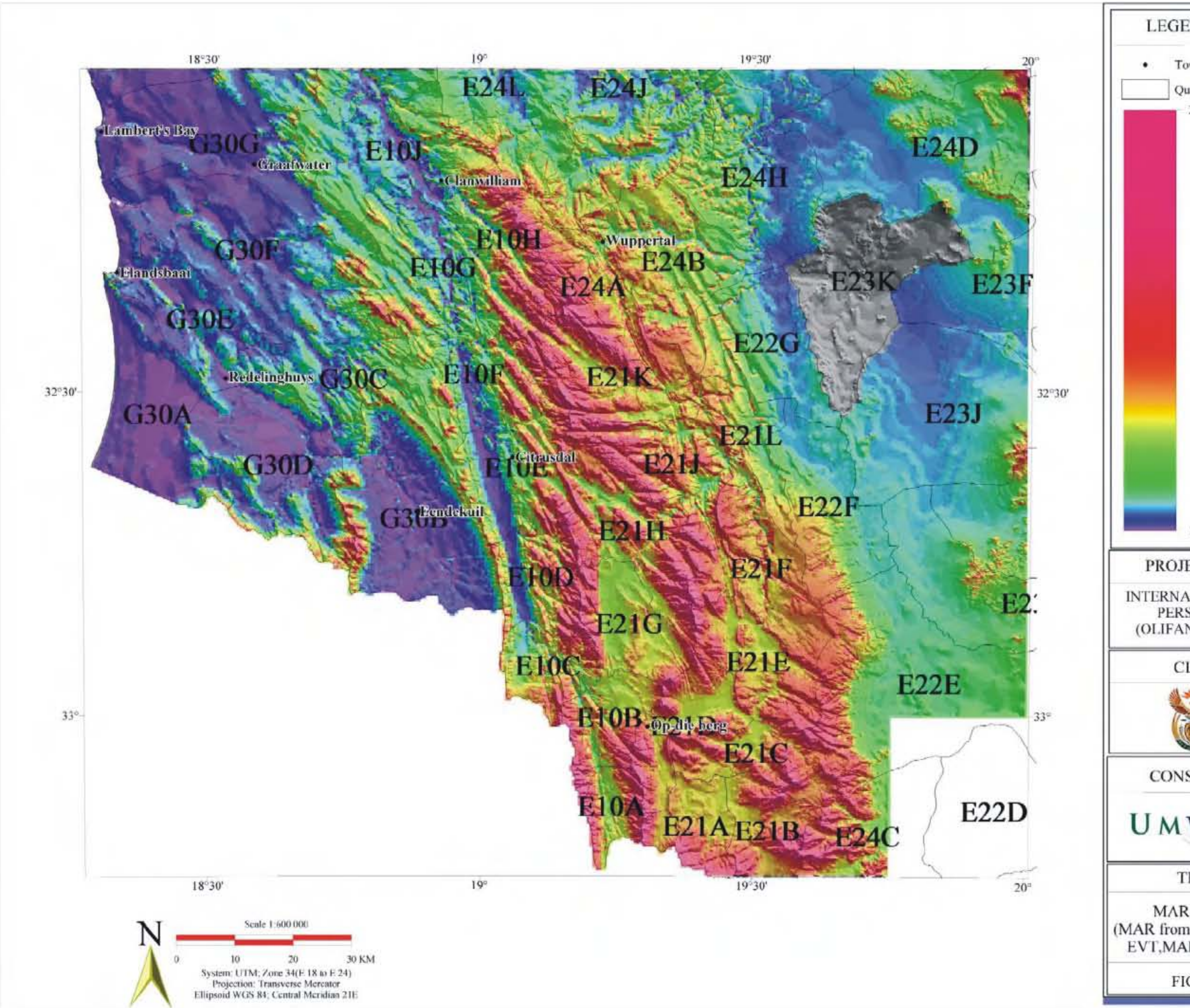
CONSULTANT

UMVOTO

TITLE

RAINFALL MODEL (from elevation)

FIGURE 11a



PROJECT NAME

INTERNAL STRATEGIC PERSPECTIVE (OLIFANTS DORING)

CLIENT

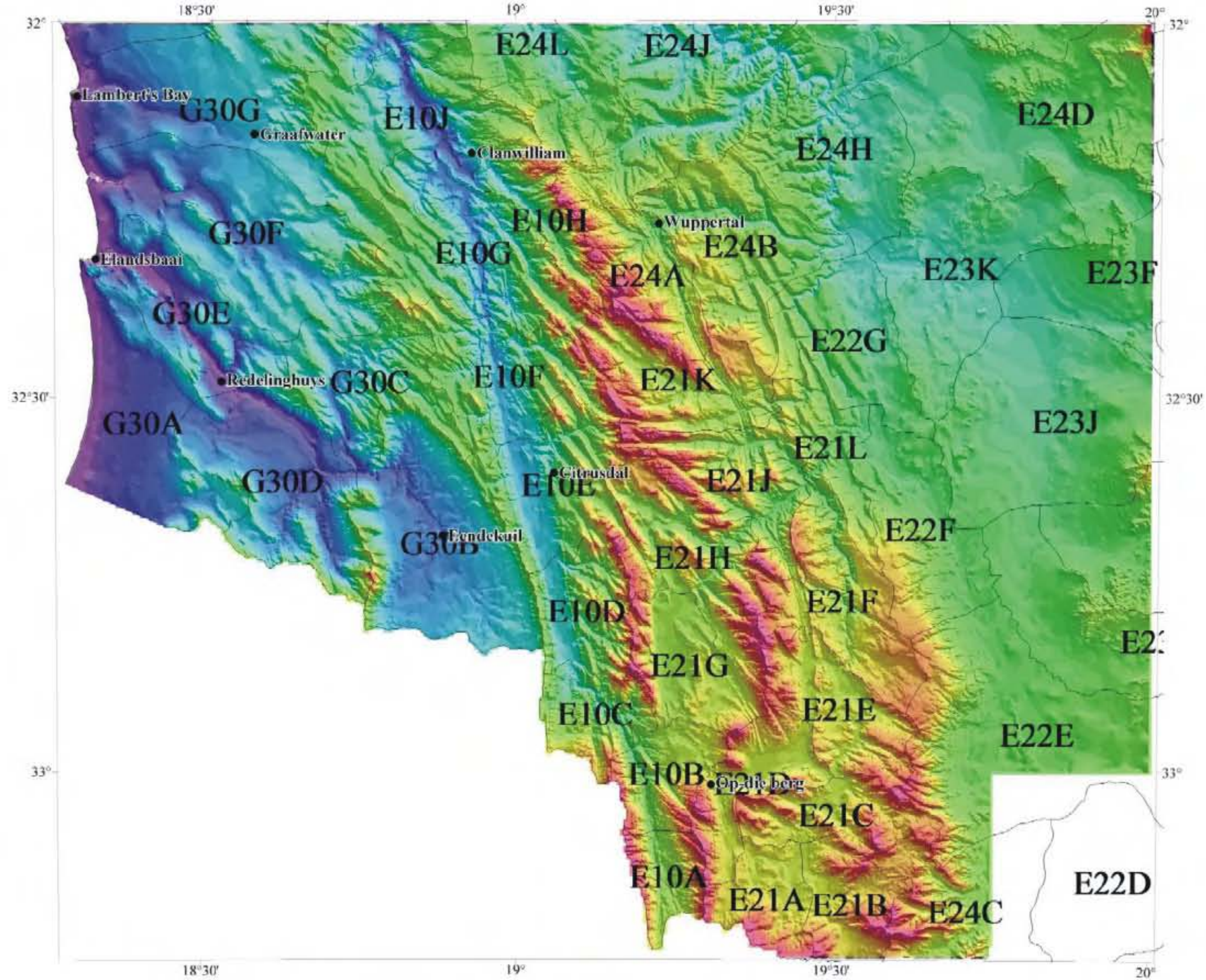
CONSULTANT

UMVOTO

TITLE

MAR MODEL (MAR from Slope,Rainfall, EVT,MAR calibration)

FIGURE 11b



N

Scale 1:600 000

0 10 20 30 KM

System: UTM; Zone 34(E 18 to E 24)
Projection: Transverse Mercator
Ellipsoid WGS 84; Central Meridian 21E

LEGEND

● Towns

Quaternary Catchments

496

170 mm

PROJECT NAME

INTERNAL STRATEGIC PERSPECTIVE (OLIFANTS DORING)

CLIENT

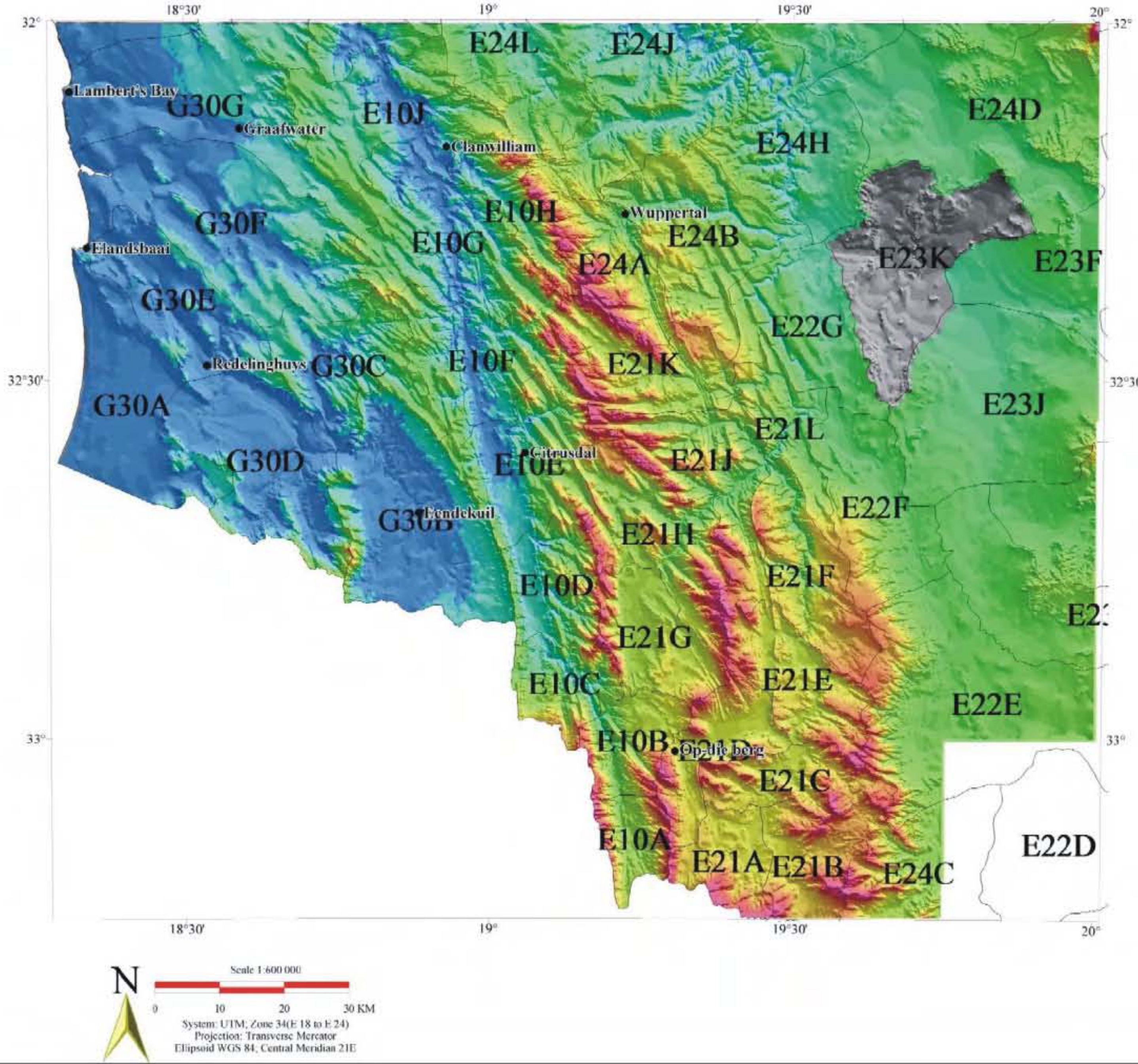
CONSULTANT

UMVOTO

TITLE

EVT MODEL (Avrg Temp Max May to August)

FIGURE 11c



LEGEND

- Towns
- Quaternary Catchments

0

614 mm

PROJECT NAME

INTERNAL STRATEGIC PERSPECTIVE (OLIFANTS DORING)

CLIENT

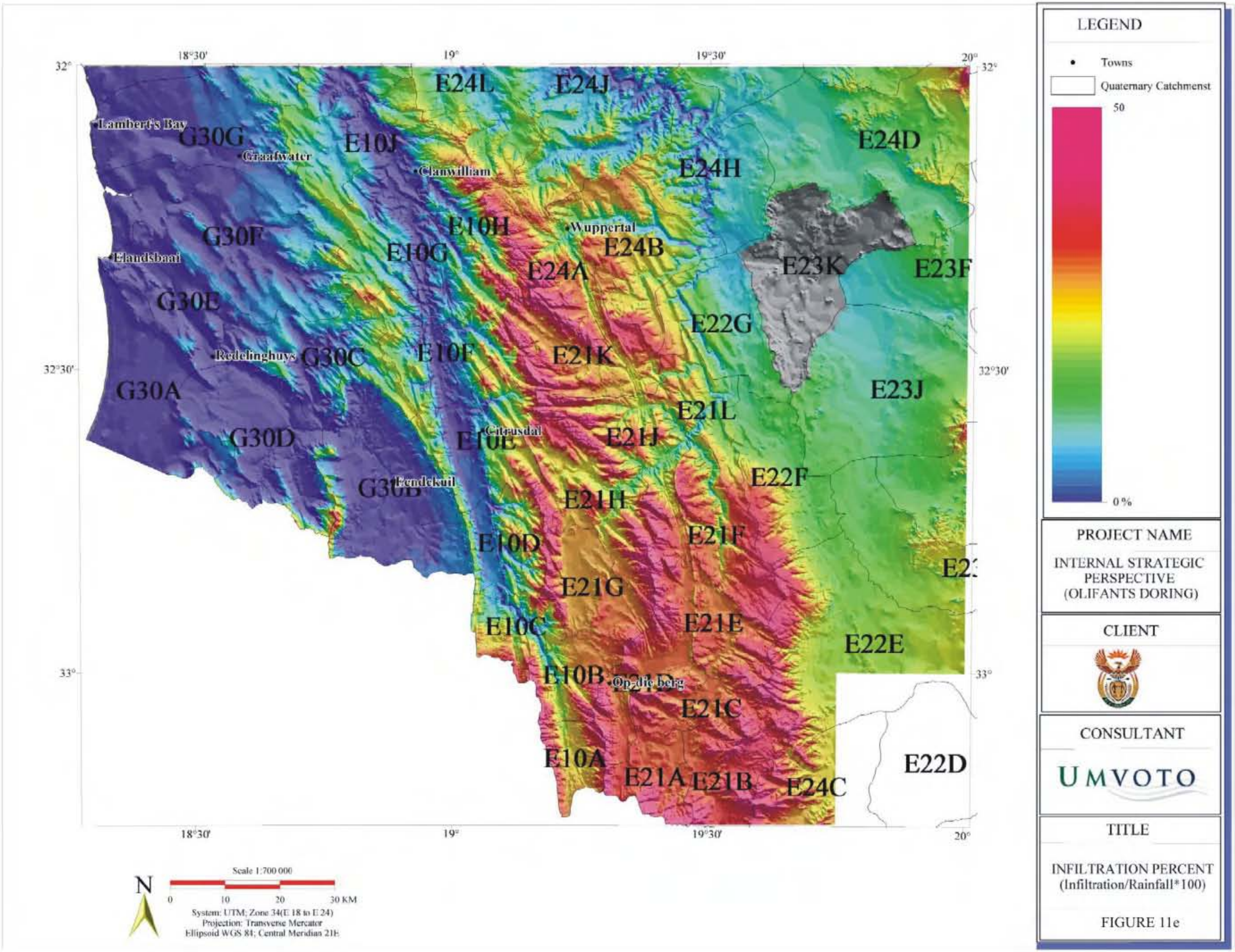
CONSULTANT

UMVOTO

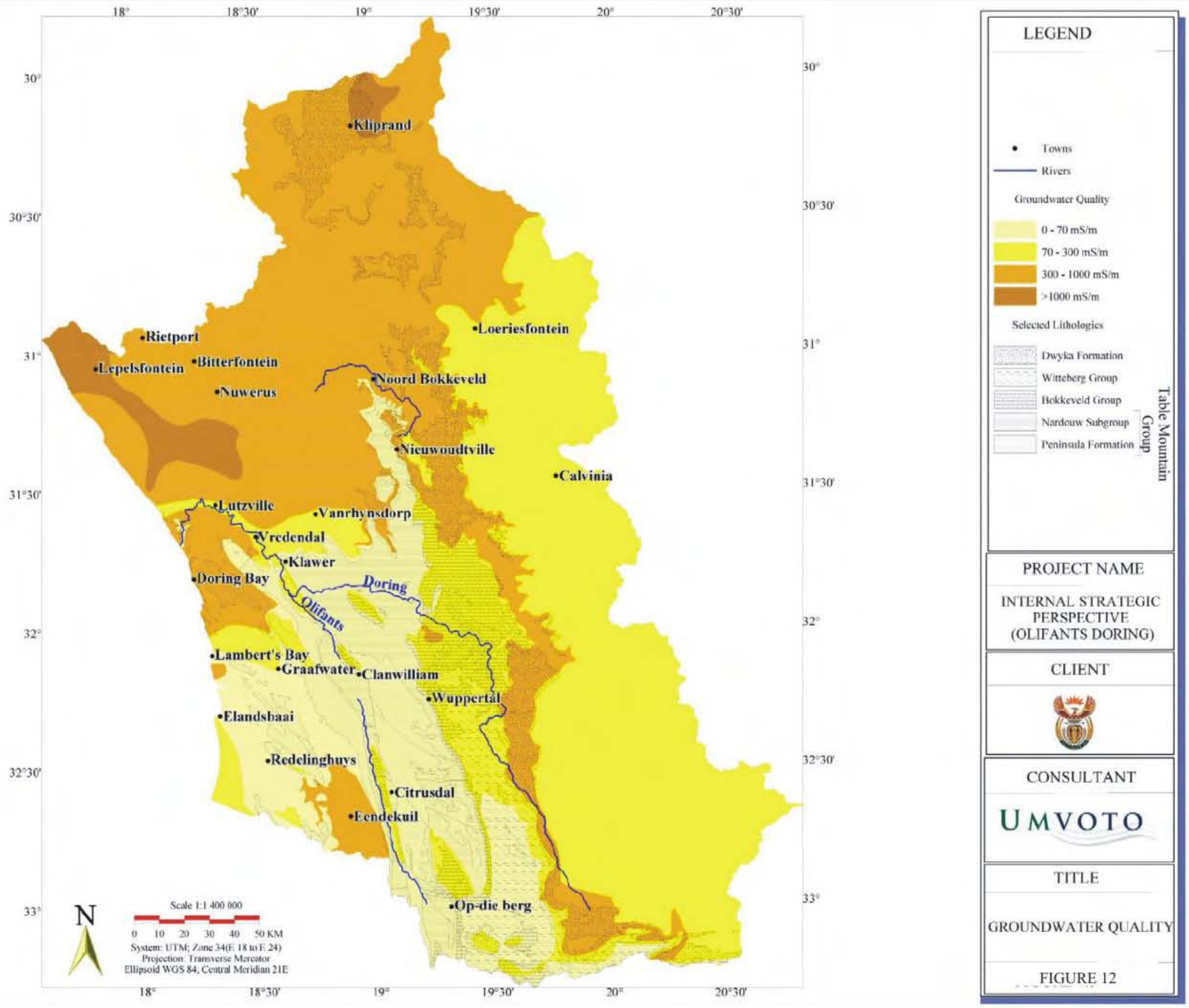
TITLE

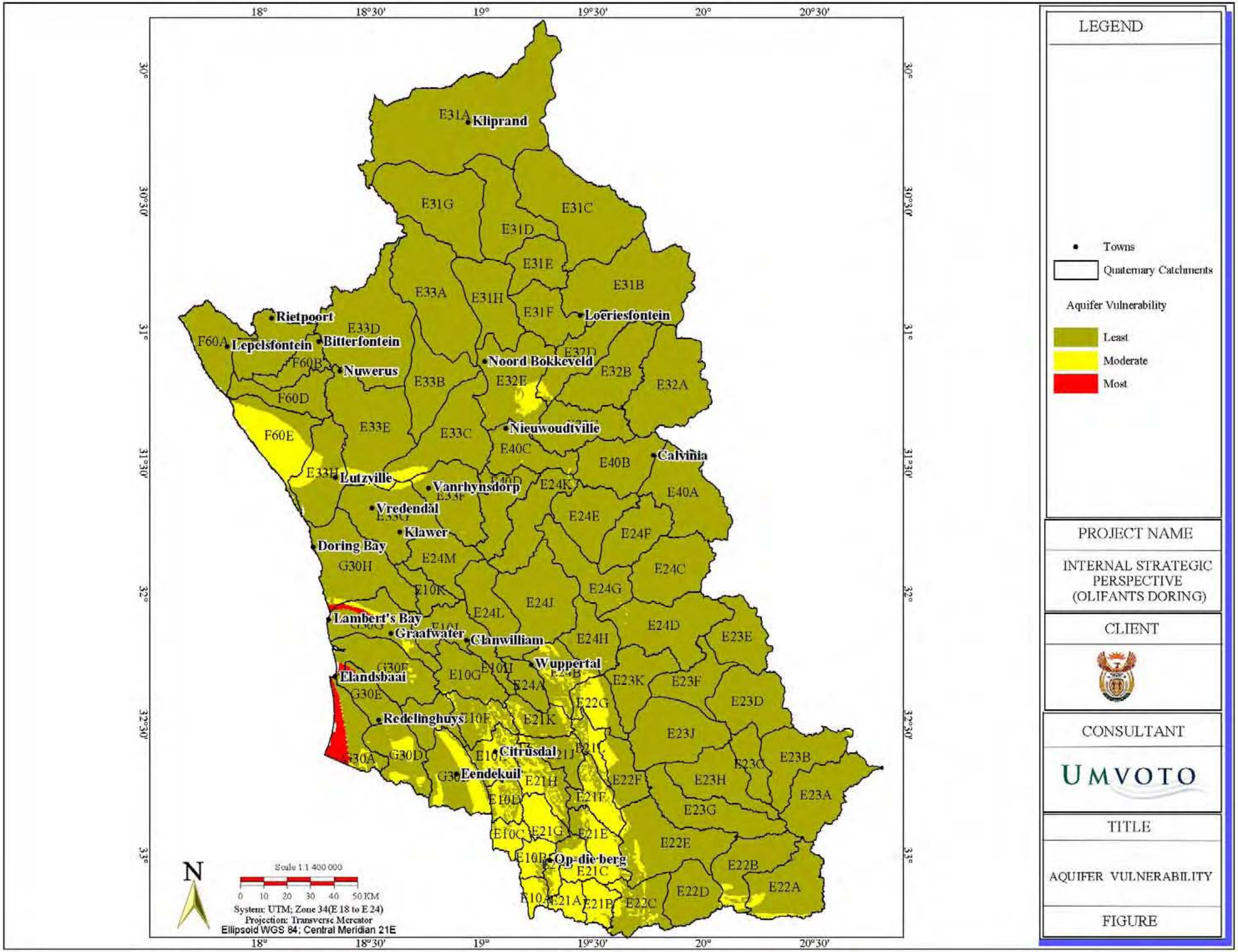
INFILTRATION MODEL (from rainfall(EVT-MAR))

FIGURE 11d



18°30'
19°
19°30'
20°
32°
32°30'
33°
E24L
E24J
Lambert's Bay
G30G
Graafwater
E10J
Clanwilliam
E24H
E24D
E10H
Wuppertal
E24B
G30F
E10G
Elandsbaai
E24A
E23K
E23F
G30E
E22G
Redelinghuys
G30C
E10F
E21K
G30A
E23J
E21L
G30D
Citrusdal
E10E
E21J
Piekenierskloof
E22F
G30B
Sandkuil
E21H
E21F
E10D
E21G
E10C
E21E
E22E
E10B
Op-die-berg
E21D
E21C
E10A
E21A
E21B
E24C
E22D
N
Scale 1:700 000
0
10
20
30 KM
System: UTM; Zone 34(E 18 to E 24)
Projection: Transverse Mercator
Ellipsoid WGS 84; Central Meridian 21E
LEGEND
Towns
Quaternary Catchmenst
50
0 %
PROJECT NAME
INTERNAL STRATEGIC PERSPECTIVE (OLIFANTS DORING)
CLIENT
CONSULTANT
UMVOTO
TITLE
INFILTRATION PERCENT (Infiltration/Rainfall*100)
FIGURE 11e


18°
18°30'
19°
19°30'
20°
20°30'
30°
30°30'
31°
31°30'
32°
32°30'
33°
Kliprand
Rietport
Lepelsfontein
Bitterfontein
Nuwerus
Loeriesfontein
Noord Bokkeveld
Nieuwoudtville
Calvinia
Lutzville
Vanrhynsdorp
Vredendal
Klawer
Doring Bay
Doring
Olifants
Lambert's Bay
Graafwater
Clanwilliam
Wuppertal
Elandsbaai
Redelinghuys
Citrusdal
Eendekuil
Op-die berg
N
Scale 1:1 400 000
0 10 20 30 40 50 KM
System: UTM; Zone 34(E 18 to E 24)
Projection: Transverse Mercator
Ellipsoid WGS 84; Central Meridian 21E
LEGEND
Towns
Rivers
Groundwater Quality
0 - 70 mS/m
70 - 300 mS/m
300 - 1000 mS/m
>1000 mS/m
Selected Lithologies
Dwyka Formation
Witteberg Group
Bokkeveld Group
Nardouw Subgroup
Peninsula Formation
Table Mountain Group
PROJECT NAME
INTERNAL STRATEGIC PERSPECTIVE (OLIFANTS DORING)
CLIENT
CONSULTANT
UMVOTO
TITLE
GROUNDWATER QUALITY
FIGURE 12



18° 18°30' 19° 19°30' 20° 20°30'
30° 30°30' 31° 31°30' 32° 32°30' 33°
Kliprand
Rietpoort
Lepelsfontein
Bitterfontein
Nuwerus
Loeriesfontein
Noord Bokkeveld
Nieuwoudtville
Calvinia
Lutzville
Vanrhynsdorp
Vredendal
Klawer
Doring Bay
Lambert's Bay
Graafwater
Clanwilliam
Wuppertal
Elandsbaai
Redelinghuys
Citrusdal
Eendekuil
Op-die-berg
E31A E31G E31C E31D E31E E31B E31H E31F E33A E33D E33B E33E E33C E33H
E32E E32D E32B E32A E40C E40B E40A E40D E24K E24E E24F E24C E24G E24J E24L E24M E24D E24H
E23E E23K E23F E23D E23J E23B E23C E23H E23A E23G E22E E22B E22A E22D E22C E22G E22F
E21K E21J E21C E21H E21F E21G E21E E21C E21A E21B E24A
E10K E10J E10H E10G E10F E10E E10D E10C E10B E10A
F60A F60B F60D F60E G30H G30G G30F G30E G30D G30A G30C
N
Scale 1:1 400 000
0 10 20 30 40 50 KM
System: UTM; Zone 34(E 18 to E 24)
Projection: Transverse Mercator
Ellipsoid WGS 84; Central Meridian 21E
LEGEND
Towns
Quaternary Catchments
Aquifer Vulnerability
Least
Moderate
Most
PROJECT NAME
INTERNAL STRATEGIC PERSPECTIVE (OLIFANTS DORING)
CLIENT
CONSULTANT
UMVOTO
TITLE
AQUIFER VULNERABILITY
FIGURE

Appendix 5

Rivers and Towns

APPENDIX 5: RIVERS AND TOWNS

Quaternaries	Rivers / river reaches	Towns / settlements
Upper Olifants (quats E10A – E10K)		
E10A	Upper Olifants River	Visgat, Sandvlakte
E10B	Upper Olifants River, Dwars River	Boskloof, Blomhof
E10C	Ratel River, Upper Olifants River	Grootfontein
E10D	Upper Olifants River	Breekarm, Thee River
E10E	Upper Olifants River	Citrusdal, Driefontein
E10F	Upper Olifants River, Palmietfontein River, Heks River	Brakfontein, Kweekkraal
E10G	Olifants River, Rondegat River	Holfontein, Langfontein
E10H	Jan Dissels River	Bovlei, Dwars River
Lower Olifants (quats E33G, E33H, E24M, E10K, E10J)		
E33G	Olifantsriver, Klein River, Troe-troe River	Vredendal, Klawer
E33H	Olifantsriver, Jaagleegte, Droëkraal's River	Lutzville, Ebenhaezer, Papendorp, Monte Carlo, Tahiti
E24M	Doring River, Olyvenhouts River	De Lille, Ribbokfontein, Hardevlak, Taaibosdam
E10J	Olifants River, Kliphuis River, Seekoeivlei River	Clanwilliam, Tierkloof, Nortiershof
E10K	Olifants River, Netvlei River	Voorspoed, Doornkloof
Doring (quats E24A – L, E40A – D, E22A – E22G, E23A – K)		
E24A	Tra-tra River, Dassieboskloof River, Eselbank River	Eselbank, Wuppertal, Vaalfontein
E24B	Matjiesfontein River, Tra-tra River,	Prins se Kraal, Hartsvlak, Beukeskraal
E24C	Bos River, Biesra River, Matjieskloof 's River, Oliewenbos' River	Annex, Dagbreek, Dassieberg, Ratelklip
E24D	Bos River, Gannakuils River, Klipbankshoek River	Witvlak, Dorsdam, Bo-Stompiesfontein, Varsfontein
E24E	Rietpoort River, Wolf River, Kliprug River, Twakboomleegte	Weltevreden, Karringmelkplaat
E24F	Bloukrans River, Draaikraal River, Nooiens River	Kleinhoek, Wolf River Vlakkraal
E24G	Wolf River, Soutpans River, Karmoe River	Karmoe, Kalgat, Spaarbos, Vryheid
E24H	Doring River	Reenen, Twee Damme, Onder-Stompiesfontein
E24J	Doring River, Avontuur River, Putslaagte, Duiwelsleegte, Biedou River	Mietjiesfontein, Middelberg, Kleinhoek, Kanetfontein, Hoenderfontein
E24K	Doring River, Brak River, Sout River, Paalkraal River	Moedverloor, Sonderwaterkraal, Lokenburg
E24L	Brandewyn River, Kraaiboslaagte	Teelkliphuis, Sandkraal, Boontjieskloof, Alpha
E40A	Oorlogskloof River, Droë River, Kieskie River, Vlakfontein's River, Kliprug's River, Brakfontein's River	Brakfontein, Hope Valley, Vlakfontein, Kieskie, Klipkraal
E40B	Oorlogskloof River, Droëboom's River, Agterplaas River	Oorlogskloof, Fairview, Platberg, Doega
E40C	Oorlogskloof River, Vaaldam se Laagte, Rietvlei River	De Laande, Nieuwoudtville, Keiserfontein
E40D	Oorlogskloof River, Koebee River, De Hoop's River, Kleigats River, Kelderfontein River	Schoongezicht, Daggafontein, De Hoop, Erensfontein, Klipheuwel

Quaternaries	Rivers / river reaches	Towns / settlements
E22A	Groot River, Kraai River, Patats River, Wolwe River	Seekoeigat, Rietkloof, Snyderskloof
E22B	Groot River, Adamskraal River, Muishond River, Smitswinkel River	Perdekraal, Bantamsfontein, Brandeberg
E22C	Droëlands River, Doring River	Swartkop, Kommando, Rooifontein, Bo-Bos
E22D	Doring River, Karee River, Kolkies River, Bulsjaagte	Sadawa, Platfontein, Vaalkloof
E22E	Groot River, Doring River, Droëlaagte, Ongeluks River, Beukesfontein River	Damskraal, Mowardouwskloof, Kareekolk
E22F	Doring River	Gansfontein, Matjiesfontein, Doornfontein
E22G	Doring River, Brakfonteinspruit	Brakfontein, Rouxvlei
E23A	Tankwa River, Kareekloof River, Wilgebos River, Kleinpoorts River	Tuinplaas, Langhuis, Wilgebos, Boesmanshoek
E23B	Tankwa River, Witfontein se Laagte, Bobbejaankransivier, Windheuwels River	Pruimboshoek, Waterval, Ashoek, De Hoop
E23C	Agterste River, Brak River, Houthoek River	Jordaanskraal, Dagbreek, Houthoek
E23D	Tankwa River, Modderfontein, Karee River, Kranskraal River	Olivierskraal, Diepkloof, Welgemeen, Blouheuwel
E23E	Renoster River	Platfontein, Brakfontein se Kop, Uintjiesbos
E23F	Tankwa River	Middeldrif, Oubaaskraal
E23G	Ongeluks River	Sandfontein, Bloukrans, Jukfontein
E23H	Gemsbok River, Brak River	Gemsbokfontein, Newefontein, Popeliersbos
E23J	Ongeluks River, Sandlaagte, Tandskoonmaak se laagte	Die Bos, Langdoring, Stofbakkies
Knersvlakte (quats E31A – H, E32A – E, E33A – F, F60A – F60E)		
E31A	Nabab se Laagte, Dasbab, Schalk se Laagte, Saraip se Laagte	Norabees, Biesiepan, Rooimond
E31B	Droëlaagte, Krom River	Bokvlak, Dirk se Muur, Van Eden se puts, Harspruit
E31C	Kaboes River, Rooiberg River, Leeuberg River, Krom River, Sandkraal River, Groot Hartbeeslaagte	Die Kop, Springboktand, Lospersplaas
E31D	April's River, Dieplaagte	Springbokkeel, Jakkalsputs, Vaalkop
E31E	Krom River	Volstruisbeen, Brandkraal, Hars River
E31F	Kamdanie River	Loeriesfontein, Welbedacht, Bloupoort
E31G	Alwynsfontein se Laagte	Bitterfontein, Alwynsfontein, Dooddrink
E31H	Twee River, Krom River, Rooisloot	Krip se Berg, Bloubok, Ezelskopvlakte
E32A	Hantams River, Dwars River, Toring River, Groot River, Elandsfontein River, Klipwerf River, Langfontein River, Slingersfontein River, Koelfontein River,	Manelsfontein, Brandwag, Tafelberg, Slingerfontein
E32B	Brassefontein River, Hantams River, Theronje River, Brak River	Kareeboomwater, Tweefontein, Nooitgedag
E32C	Beeswater's River, Hol River, Klein-Toring River, Soetlandsfontein River	Rietfontein, Louwsrus, Nuweplaas, Uitvlug
E32D	Kransgat River, Kranskraal River, Koppieskraal River	Koringhuis, Vosfontein, Rheboksfontein
E32E	Hantams River, Doring River, Rondekop River, Grasberg	Brandkop, Jobskraal, Heitoes

Quaternaries	Rivers / river reaches	Towns / settlements
	River, Soetfontein River	
E33A	Sout River, Spitskop's River, Bontemmer se Laagte, Lodewyk se Grip	Wielspoort, Slagkop, Duikervlakte, Leeukuil
E33B	Sout River, Gemsbok River	Kwaggakop, Jakkalsdraai, Kalkgat Noord
E33C	Kleinfontein River, Klipgat River, Elandsvoetpad River, Grootdrif River, Halfpad River, Vars River, Kraai River	Bruinskop, Winterplaas, Mimosa, Vars River
E33D	Geelbeks River, Klein-Riet River, Nabeeb River	Kareeberg, Tafelberg, Finkelskolk, Blesberg
E33E	Kraalboskolklaagte, Groot-Graafwater River, Rooiberg River, Sout River, Moedverloor River, Volstruislaagte, Hol River	Nuwerus, Goedehoop, Dikneus, Soutfontein
E33F	Droë River, Palmietfontein River, Langkloof River, Boonzaierswerf River, Troe-troe River	Vanrhynsdorp, Diepvlei, Uitvlugt, Witwater
F60A	Brak River	Kotzesrus, Lepelfontein, Waterval
F60B	Klein-Goerap River	Bitterfontein, Jakkalsfontein
F60C	Sout River, Boegoekom River	Rietpoort, Geelfontein, Witvlei
F60D	Groot-Goerap River, Varsbrak River	Goerap, Waterklip, Varsbrak
F60E		Graafwater, Mauritskolk, Blouvlei
Kouebokkeveld (quats E21A – E21L)		
E21A	Kruis River	Long Acres, Odessa, De Erf
E21B	Welgemoeds River	Roggevlei, Appelkloof
E21C	Winkelhaak River	Winkelhaak, Lochlynne
E21D	Houdenbek River	Wadrif, Houdenbek, Rocklands, Kleinfontein
E21E	Riet River	Suurvlakte, Peerboomshoek, Rietvlei
E21F	Riet River	Jonkershoek, Sonderwater, Kleinveld
E21G	Lang River	Kraaivoëlfontein, Bo-Bokfontein, Elim
E21H	Twee River, Klein River	Pompieshoek, Bergplaas, Sandfontein
E21J	Groot River, Brandkraals River, Breekkrans River	Dwarskloof, Nuwerus, Varkkloof
E21K	Krom River, Driehoek River, Dwars River	Dwars River, Krom River, Uitsig
E21L	Groot River, Matjies River	-
Sandveld (quats G30A-G30H)		
G30A		Redelinghuys, Witklip
G30B	Kruismans River, Huis River	Eendekuil, Duikerfontein, Krom River
G30B	Jansekraal River	Mieliedraai, Sterkfontein
G30D	Hol River	Eselsfontein, Goergap
G30E	Verlorevlei	Pietersfontein, Elandsbaai
G30F	Langvlei River	Leipoldville, Sandberg
G30G	Jakkals River	Graafwater, Kompagniesdrif
G30H		Strandfontein, Doringbaai, Nooitgedacht

Appendix 6

Previous and Existing Municipalities

APPENDIX 6: PREVIOUS AND EXISTING MUNICPALITIES

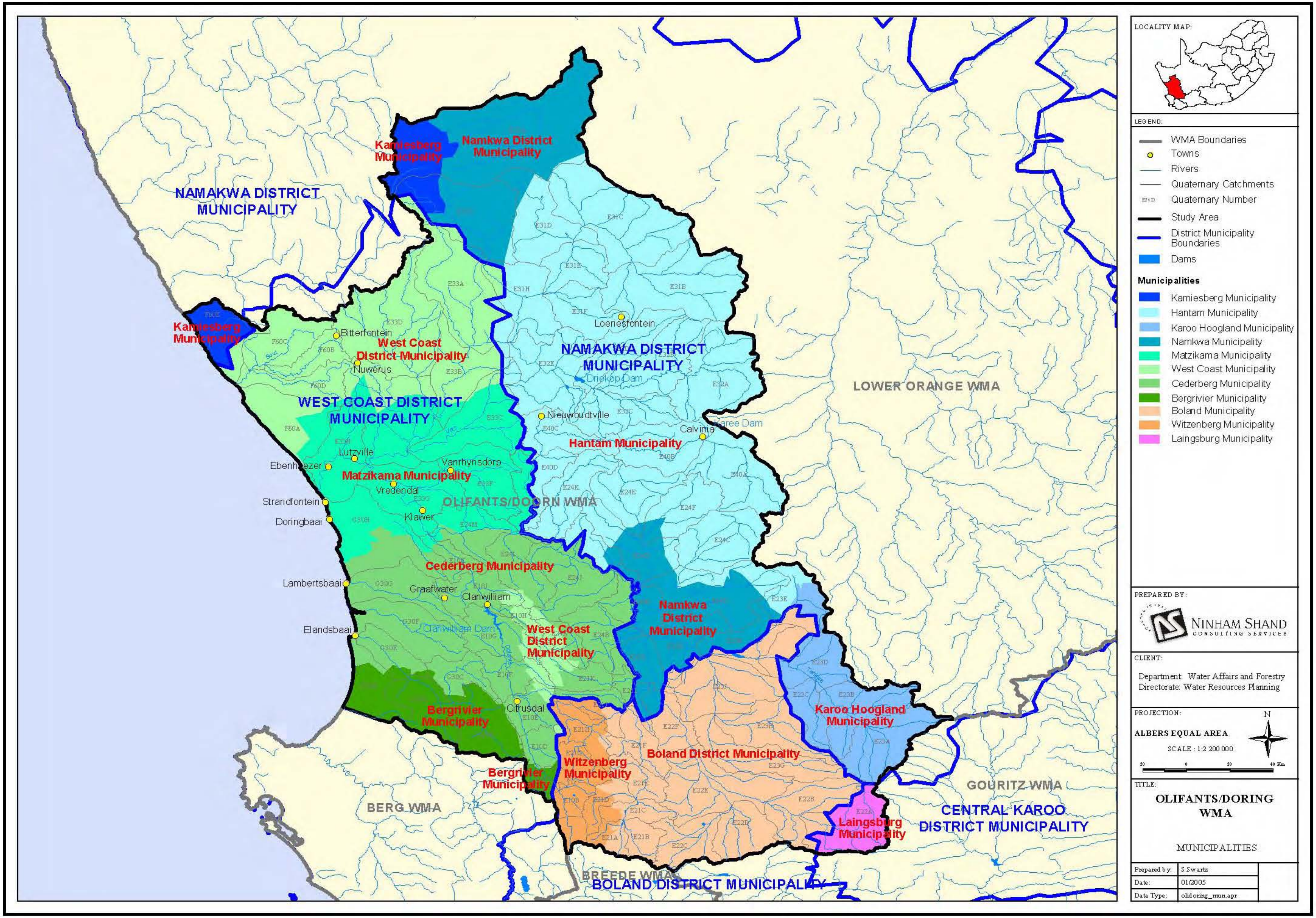
Previous Municipalities within the Olifants/Doorn WMA (Figure 1)

- Namakwa Municipality
- Spitsberg Municipality
- Hantam Municipality
- van Rhynsdorp Municipality
- Vredendal Municipality
- Clanwilliam Municipality
- Piketberg Municipality
- Witzenberg Municipality
- Roggeveld Municipality
- Laingsburg Municipality
- Matroosberg Municipality

Existing (New) Municipalities within the Olifants/Doorn WMA

The boundaries of the above municipalities were modified to create several new municipalities:

- Kamiesberg Municipality
- Northern Cape District Municipality
- Western Cape District Municipality
- Hantam Municipality
- Matzikama Municipality
- Cederberg Municipality
- Berg River Municipality
- Witzenberg Municipality
- Frasuwil Municipality
- Laingsburg Municipality


LOCALITY MAP:
LEGEND:
WMA Boundaries
Towns
Rivers
Quaternary Catchments
Quaternary Number
Study Area
District Municipality Boundaries
Dams
Municipalities
Kamiesberg Municipality
Hantam Municipality
Karoo Hoogland Municipality
Namkwa Municipality
Matzikama Municipality
West Coast Municipality
Cederberg Municipality
Bergrivier Municipality
Boland Municipality
Witzenberg Municipality
Laingsburg Municipality
PREPARED BY:
NINHAM SHAND CONSULTING SERVICES
CLIENT:
Department: Water Affairs and Forestry
Directorate: Water Resources Planning
PROJECTION:
ALBERS EQUAL AREA
SCALE : 1:2 200 000
TITLE:
OLIFANTS/DORING WMA
MUNICIPALITIES
Prepared by: S.Swartz
Date: 01/2005
Data Type: olidoring_mun.apr
NAMAKWA DISTRICT MUNICIPALITY
Kamiesberg Municipality
Namkwa District Municipality
West Coast District Municipality
WEST COAST DISTRICT MUNICIPALITY
Matzikama Municipality
OLIFANTS/DOORN WMA
Hantam Municipality
LOWER ORANGE WMA
Cederberg Municipality
Namkwa District Municipality
Bergrivier Municipality
Witzenberg Municipality
Boland District Municipality
Karoo Hoogland Municipality
Laingsburg Municipality
GOURITZ WMA
CENTRAL KAROO DISTRICT MUNICIPALITY
BERG WMA
BREEDE WMA
BOLAND DISTRICT MUNICIPALITY
Bitterfontein
Nuwerus
Loeriesfontein
Driekop Dam
Nieuwoudtville
Calvinia
Karee Dam
Lutzville
Ebenhaezer
Vanrhynsdorp
Vredendal
Strandfontein
Doringbaai
Klawer
Lambertsbaai
Graafwater
Clanwilliam
Clanwilliam Dam
Elandsbaai
Citrusdal

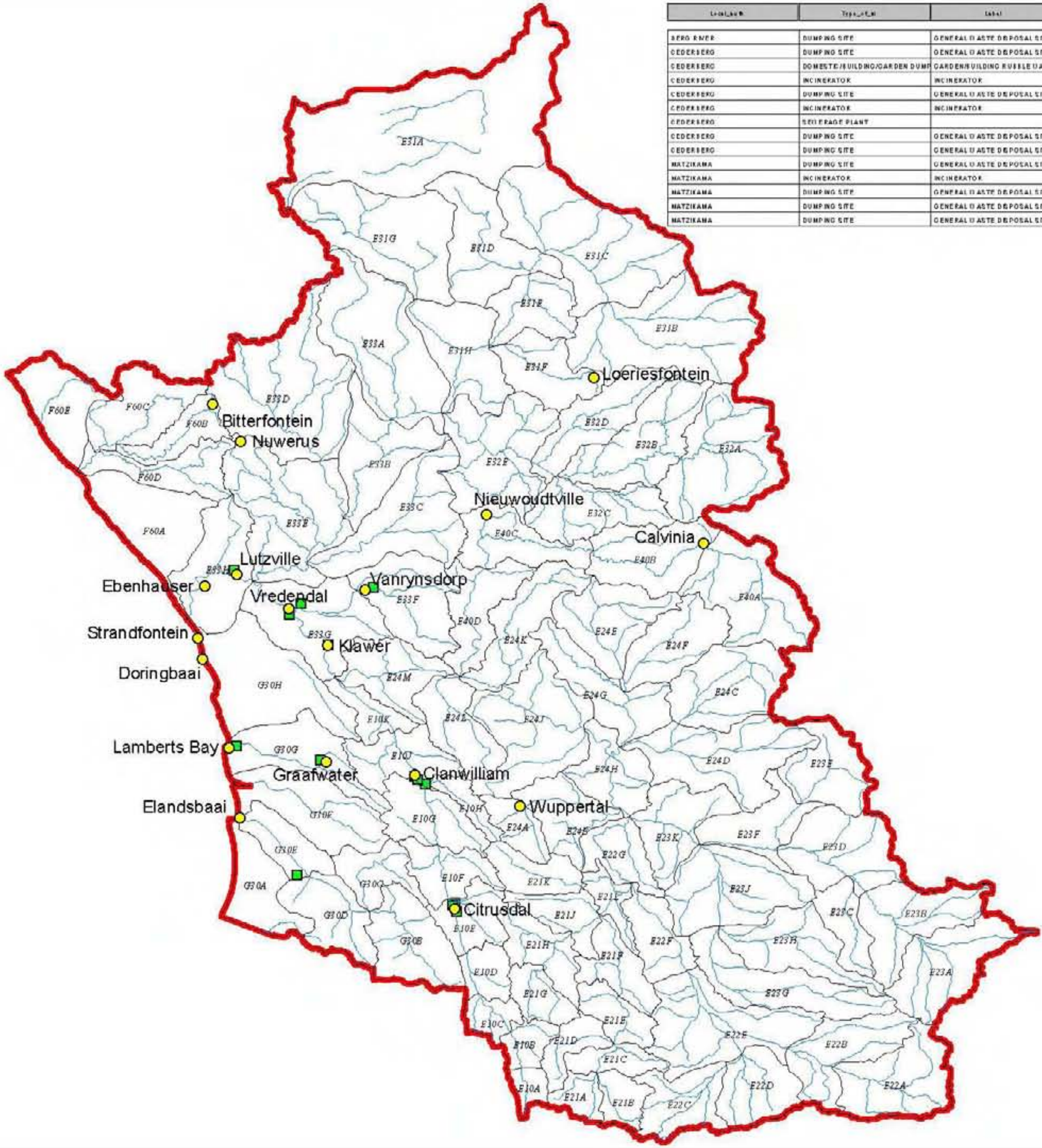
Appendix 7

Wastewater Treatment Works and Solid Waste Disposal Sites

APPENDIX 7: WASTEWATER TREATMENT WORKS AND SOLID WASTE DISPOSAL SITES

Quaternary	Controlling Authority	Name	Capacity	Disposal
Upper Olifants (quats E10A – E10H)				
E10E		Citrusdal Sewage Treatment Works	960 kl/ day	
Lower Olifants (quats E33G, E33H, E24M, E10K, E10J)				
E33G		Klawer Sewage Treatment Works	25 600 kl/ day	
E33G		Vredendal Sewage Treatment Works	3 000 kl/ day	
E33G		Vredendal South Sewage Treatment Works	1 000 kl/ day	
E33G		Vredendal North Sewage Treatment Works	1 000 kl/ day	
E33H		Lutzville Sewage Treatment Works	18 379 kl/day	
E10J		Clanwilliam Sewage Treatment Works	687 kl/ day	
Doring (quats E24A – L, E40A – D, E22A – G, E23A – E23K)				
Knersvlakte (quats E31A – H, E32A – E, E33A – F, F60A – E)				
E33F		Vanrhynsdorp Oxidation dam system	18 379 kl/day	
Kouebokkeveld (quats E21A – E21L)				
Sandveld (quats G30A-G30H)				
G30B		Eendekuil Oxidation dam system	138 kl/day	
G30E		Elandsbaai Sewage Treatment Works	225 kl/ day	
G30G		Graafwater New Oxidation dam system	250 kl/ day	
G30G		Lambertsbaai Oxidation dam system		
G30H		Strandfontein Oxidation dam system		

Local_auth	Type_of_si	Label	Name_area
BERG RIVER	DUMPING SITE	GENERAL WASTE DISPOSAL SITE	REDELINGHUYS
CEDERBERG	DUMPING SITE	GENERAL WASTE DISPOSAL SITE	CITRUSDAL
CEDERBERG	DOMESTIC/BUILDING/GARDEN DUMP	GARDEN/BUILDING RUBBLE WASTE	CITRUSDAL
CEDERBERG	INCINERATOR	INCINERATOR	CITRUSDAL
CEDERBERG	DUMPING SITE	GENERAL WASTE DISPOSAL SITE	CLANWILLIAM
CEDERBERG	INCINERATOR	INCINERATOR	CLANWILLIAM
CEDERBERG	SEWERAGE PLANT		CLANWILLIAM
CEDERBERG	DUMPING SITE	GENERAL WASTE DISPOSAL SITE	GRAAFWATER
CEDERBERG	DUMPING SITE	GENERAL WASTE DISPOSAL SITE	LAMBERTS BAY
MATZIKAMA	DUMPING SITE	GENERAL WASTE DISPOSAL SITE	VREDENDAL
MATZIKAMA	INCINERATOR	INCINERATOR	VREDENDAL
MATZIKAMA	DUMPING SITE	GENERAL WASTE DISPOSAL SITE	VAN RHYNSDORP
MATZIKAMA	DUMPING SITE	GENERAL WASTE DISPOSAL SITE	LUTZVILLE
MATZIKAMA	DUMPING SITE	GENERAL WASTE DISPOSAL SITE	KLAWER



LOCALITY MAP:

LEGEND:

- WMA Boundaries
- Towns
- Rivers
- Quaternary Catchment
- E24D Quaternary Number
- Waste

PREPARED BY:

NINHAM SHAND CONSULTING SERVICES

CLIENT:

Department: Water Affairs and Forestry
Directorate: Water Resources Planning

PROJECTION:

GEOGRAPHIC

SCALE : 1:2 100 000

10 0 10 20 30 40 Kilometers

N

TITLE:

OLIFANTS/DORING WMA

SOLID WASTE & WASTE WATER SITES

Prepared by:	A.Lawrence
Date:	07/2004
Data Type:	oli_wastewater.apr

Appendix 8

General Authorisations

APPENDIX 8: GENERAL AUTHORISATIONS

NO. 399 **26 March 2004**

REVISION OF GENERAL AUTHORISATIONS IN TERMS OF SECTION 39 OF THE NATIONAL WATER ACT, 1998 (ACT NO. 36 OF 1998)

I, ARNOLD MICHAEL MULLER, Director-General of the Department of Water Affairs and Forestry and duly authorised in terms of section 63 of the National Water Act, 1998 (Act No 36 of 1998) have revised and amended General Authorisations No 1191 published in the Government Gazette No. 20526 dated 8 October 1999,as contained in the Schedule hereto.

Sgn. A M Muller
DIRECTOR-GENERAL: WATER AFFAIRS AND FORESTRY
DATE: 18 March 2004

SCHEDULE

1. THE TAKING OF WATER FROM A WATER RESOURCE AND STORAGE OF WATER

[Sections 21(a) and (b)]

Purpose of this authorisation

1.1. The authorisation permitted in terms of this Schedule replaces the need for a water user to apply for a licence in terms of the National Water Act for the taking or storage of water from a water resource, provided that the taking or storage is within the limits and conditions set out in this authorisation.

Exclusion

1.2. This authorisation does not apply-

(a) to any lawful taking and storage within a government water control area, a government water work, a catchment control area or an irrigation district as defined in the Water Act, 1956 (Act No. 54 of 1956) prior to its repeal;

(b) to a person who does not have lawful access to any waterwork or water resource;

(c) to wetlands, the dewatering of mines or storage of water underground;

(d) to an exclusion zone of 750 metres inland from the high water mark; and

(e) to an area where the limits of taking and storage of water were reduced in terms of section 9B (1C) of the Water Act, 1956 (Act No 36 of 1956).

Compliance with National Water Act and other laws

1.3.(1) This authorisation does not-

(a) apply to any water use under Schedule 1 of the National Water Act;

(b) replace any existing authorisation that is recognised under the National Water Act; or

(c) exempt a person who uses water from compliance with any other provision of the National Water Act unless stated otherwise in this notice, or any other applicable law, regulation, ordinance or by-law.

(2) In the case of the taking of water for industrial purposes the provisions of section 7 of the Water Services Act, 1997 (Act No. 108 of 1997), must be met.

(3) A person who uses water in terms of this authorisation is exempt from compliance with section 22(2)(e) of the National Water Act.

Area of applicability

1.4 This authorisation is applicable throughout the Republic of South Africa, except as excluded in paragraph 1.2 above and the areas set out in-

(a) Table 1.1 for the taking of surface water;

(b) Table 1.2 for the taking of groundwater; and

(c) Table 1.3 (a) and (b) for storage of water.

Duration of authorisation

1.5. This authorisation will be valid for a period of five years from the date of publication of this notice, unless-

(a) it is amended at any review period, which period shall be at intervals of three years from the date of publication of this notice;

(b) the period is extended by a notice in the *Gazette*;

(c) it is replaced with a General Authorisation in relation to a specific water resource or within a specific area; or

(d) the water user is required to apply for a licence in terms of the National Water Act.

Definitions

1.6. In this authorisation unless the context indicates otherwise, any word or expression to which a meaning has been assigned in terms of the National Water Act shall have that meaning, and-

"**monitoring programme**" means a programme for taking regular measurements of the quantity and/or quality of a water resource, waste or wastewater discharge at specified intervals and at specific locations to determine the chemical, physical and biological nature of the water resource, waste or wastewater discharge;

"small industrial users" means water users who qualify as work creating enterprises that do not use more than twenty cubic metres per day and identified in the Standard Industrial Classification of All Economic Activities (5th edition), published by the Central Statistics Service, 1993, as amended and supplemented, under the following categories:-

(a) 1: food processing
(b) 2: prospecting, mining and quarrying;
(c) 3: manufacturing;
(d) 5: construction;

"**storage**" means storing water not containing waste, in a watercourse or off-channel storage;

"**taking**" means the abstraction of water from a water resource.

Taking and storage of water

1.7. A person who-

(a) owns or lawfully occupies property registered at the Deeds Office at the date of this notice; or

(b) lawfully occupies or uses land that is not registered or surveyed; or

(c) lawfully has access to land on which the use of water takes place,

may:

(i) on that property or land take groundwater as set out in Table 1.2, outside of the areas set out in paragraph 1.2 above;

(ii) take surface water for that property or land as set out in Table 1.1, outside of the areas set out in paragraph 1.2 above at a rate of up to 15 litres per second not exceeding 150 000 cubic metres per annum; and

(iii) subject to Tables 1.3(a) and (1.3(b)) store up to 50 000 cubic metres of water,

if the taking or storing of water-

(aA) does not impact on a water resource or any other person's water use, property or land;

(aB) is not excessive in relation to the capacity of the water resource and the needs of other users; and

(aC) is not detrimental to the health and safety of the public in the vicinity of the activity.

Registration of water use

1.8.(1) A person who uses water in terms of this authorisation must submit to the responsible authority a registration form or any other further information requested in writing by the responsible authority for the registration of the water use before commencement of-

(a) taking more than 50 cubic metres from surface water or 10 cubic metres from groundwater on any given day; or

(b) a combined storage of more than 10 000 cubic metres of water per property.

(2) On written receipt of a registration certificate from the Department, the person will-

(a) be regarded as a registered water user; and
(b) be liable for water charges as per the Department's pricing strategy.

(3) All forms for registration of water use are obtainable from the Regional offices of the Department, as well as from the Departmental web-site at http:\\www.dwaf.gov.za

Precautionary practices

1.9 (1) The water user must ensure that any dam complies with the requirements of Chapter 12 of the National Water Act.

(2) The water user must follow acceptable construction, maintenance and operational practices to ensure the consistent, effective and safe performance of the taking and storage of water.

(3) Where water is stored in a watercourse, the water user must take reasonable measures to ensure that the movement of aquatic species is not prevented, including those species that normally migrate through the watercourse.

(4) Outlet pipes at the lowest practical level must be provided on all storage structures for Reserve releases.

Record-keeping and disclosure of information

1.10. (1) The water user must ensure the establishment of monitoring programmes to measure the quantity of water taken and/or stored, as follows-

(a) the quantity of groundwater or surface water abstracted must be metered or gauged and the total recorded as at the last day of each month;

(b) in the case of irrigation and where no meter or gauge is used, the quantity of water abstracted may be calculated according to methods set by the responsible authority; and

(c) the quantity of water stored must be recorded as at the last day of each month.

(2) Upon the written request of the responsible authority the water user must-

(a) ensure the establishment of any additional monitoring programmes; and

(b) appoint a competent person to assess the water use measurements made in terms of this authorisation and submit the findings to the responsible authority for evaluation.

(3) Subject to paragraph 1.10. (2) above, the water user must, for at least five years, keep a written record of all taking and storage of surface or groundwater. This information must be made available upon written request to the responsible authority.

Inspections

1.11. Any property or land in respect of which a water use has been authorised in terms of this notice must be made available for inspection by an authorised person in terms of section 125 of the National Water Act.

Offences

1.12. A person who contravenes any provision of this authorisation is guilty of an offence and is subject to the penalty set out in section 151(2) of the National Water Act.

NOTE: Information regarding the drainage regions referred to in Tables 1.1, 1.2, 1.3 (a) and (b) can be obtained from the Department, upon written request.

TABLE 1.1 Areas excluded from General Authorisation for the taking of surface water

Primary drainage region	Secondary/Tertiary/Quaternary drainage region and excluded resources	Description of main river in drainage region for information purposes
A	All catchments	Limpopo River
B	All catchments	Olifants River
D	Orange River downstream of Gariep Dam	
	D13	Kraai River
E	E10A to K	Olifants River above the confluence with the Doring River
	E21	Groot River
G	G10	Berg River

Primary drainage region	Secondary/Tertiary/Quaternary drainage region and excluded resources	Description of main river in drainage region for information purposes
	G21 G22A, B ,F and J G30 G40A to E G40H G40 J to L G50B, C, E and F	Diep River Eerste River Verlorevlei River Bot River Onrus River (De Bos Dam Catchment) Klein River Nuwejaars River
H	H 10A to L, excluding H10J H20A H30 H40B to H 40L H50A and B H60 A to F H70 C, D and E H80A to E H90	All Tributaries, that is, Titus-, Koekedouw-, Dwars-Holsloot, Wabooms and Slang Rivers to confluence with Breede River upstream of Greater Brandvleidam (excluding Molenaars River) Hex River to confluence with Breede River Kingna River All tributaries to Breede River contributing to and downstream of Greater Brandvlei Dam to confluence with the Kingna River Tributaries to confluence and main stream Breede River to s/e boundaries of Zanddrift and Langeberg WUAs Tributaries of Sonderend River to confluence with the Breede River Tradouws River to confluence with Buffeljags River Duivenhhoks River Goukou River
J	J12 J25 J31 to 35 J40C	Touws River Gamka River Olifants River Langtou and Weyers Rivers
K	K10 K20 K30A K40C K50 and K60 K70A K70B K80A to F K90A to G	Little Brak River Great Brak River Maalgate River Karatara River Knysna, Keurbooms Rivers Buffels River Bloukrans River Lottering, Storms, Sanddrif, Groot, Tsitsikamma, Klippedrift Rivers Kromme, Seekoei, Kabeljous Rivers
L	L81 L82 L90	Baviaanskloof River Kouga River Lower Gamtoos River Tributaries
M	M10 M20 M30	Swartkops River Van Stadens River, Maitland River Coega River, Van Stadens River
N	N11, N12	Sundays River upstream of Vanrynevelds Pass Dam
P	P10 P30 P40	Bushmans River Kowie River Kariega River
Q	Q41A, Q41B, Q41C, Q41D, Q44A, Q44B Q42A and B Q43A and B Q92 Q94	Tarka River Elands River Vlekpoort River Koonap River Kat River
R	R20 R30A, B, C and D R30E and F	Buffalo River Kwenxura, Kwelera, Gonubie Rivers Nahoon River
S	S20A S32A to C	Indwe River upstream of the Doring River Dam, Swart Kei River upstream of the Klipplaat confluence Klipplaat River upstream of Waterdown Dam

Primary drainage region	Secondary/Tertiary/Quaternary drainage region and excluded resources	Description of main river in drainage region for information purposes
	S32D and E S40A, B and C S50A, B and C S60A and B S60C and D	Thorn, Thomas Rivers Tsomo, Kwa-Qokwama and Mbokotwa Rivers Kubusi River upstream of Wriggleswade Dam Toise River Xilinxa River upstream of the Xilinxa Dam
T	T11A and B T35A, B, C, D, F and G	Slang, Xuka Rivers Tsitsa, Pot, Mooi, Inxu, Wildebees, Gatberg Rivers
U	U20 and U40	Mgeni, Mvoti Rivers
V	V11 V20 V31 V32 V60 V70	Upper Thukela River Mooi RiverBuffels/Slang River Buffels River Sundays River Bushmans River
W	W12 W20 W21A W30 (excluding W 31 [see Table 3.1(a)]	Mhlatuze River Mfolozi River White Mfolozi River upstream of Klipfontein Dam Hluhluwe and Mkuzi Rivers
X	All catchments (excluding X 11, X 12, X 21 A, B, C, F and G [See table 1.3(a)]	Nkomati River

Table 1.2 Groundwater Taking Zones: Quaternary Drainage Regions
The Table refers to the size of the property on which the General Authorisation is applicable

Zone A NO WATER MAY BE TAKEN FROM THESE DRAINAGE REGIONS EXCEPT AS SET OUT UNDER SCHEDULE 1 AND SMALL INDUSTRIAL USERS.		Zone B 45 M³ PER HECTARE PER ANNUM MAY BE TAKEN FROM THESE DRAINAGE REGIONS AND SMALL INDUSTRIAL USERS.		Zone C 75 M³ PER HECTARE PER ANNUM MAY BE TAKEN -FROM THESE DRAINAGE REGIONS AND SMALL INDUSTRIAL USERS.		Zone D 150 M³ PER HECTARE PER ANNUM MAY BE TAKEN FROM THESE DRAINAGE REGIONS AND SMALL INDUSTRIAL USERS.		Zone E 400 M³ PER HECTARE PER ANNUM MAY BE TAKEN FROM THESE DRAINAGE REGIONS AND SMALL INDUSTRIAL USERS.	
A21C,D	F60A-E	A10B,C	E22A,B,E-G	A10A	K10A,B	A21A,B	K10D-F	E10A-D	L82A-H,J
A21E-G,K,L	G21A,B,E,F	A21J	E23A,B,E	A21H	L21D	B20A,B	K20A	G10A,B,G	P20B
A23A,E	G22A-E	A22B-D	E24B,C,E,F	A22AE,G	L70A,B,E	B31B,F-H	K30A-D	G22F	T52L
A24A,B,C,J	G30E	A23D	E32C,E	A23B,C,F-H,J-L	L90B	B32G	K40B,C,D	G40A-E,G,H,J,L,M	T60D
A32E	H10C	A31B,F,G-J	E33G	A24D-H	N11A,B	C11A,B,D,F-H,K	K90E-G	G50A,F,J,K	U20M
A41D,E	H70F	A32A-C,D	E40B	A31A,D,E	N12A,B	C12E-G,K	L50A	H10B-F-H,J,K	U30A,C
A42J	J11F,G	A41C	F30C	A41A,B	N21B,D	C23B-E	L70C,F	H20B-G	U40C,E,F,J
A50A-C	J21A-E	A42A-C,D,E,G,H	F50B,C,E	A42F	N40A,B,D,E	C24A	L90A,C	H40B,K	U60C
A50G,H,J	J22D-F,J,K	A50D-F	H40F	A61B,C-E	P10A,B,D-G	C33C	M20B	H60A,C,D	U70C,D
A61J	J23A-D,F,G	A61A,F,G	J11A-E	A61H	P30A-C	C92C	N40F	H80B,C,F	V50C
A63A-E	J24B-F	A62A,E,G,J	J12C,E,J,K	A62B-D,F,H	P40A-D	E10E-H,J,K	P20A	H90C	W11A
A71A-L	J32A-D	A91J,K	J22A-C,G,H	B11A-H,J,K	Q11A-D	E21D,F-H,J,K	T40E-F	J34A,C	W12F,H,J
A72A,B	J33E	B11L	J23H	B12A-E	Q12A,B	E24A,L,M	T52M	J34C	W21K
A80A-F	L11E,G	B20D	J24A	B20E-H,J	Q14D	E40D	T60A,G,H	J40B	W23B-D
A80G-J	L12A-D	B31E	J31D	B31A	Q21A	G10C-E,H	U10L,M	K10C	W31J-L
A91A-H	L22B,C	B41B,D,H,J	J32E	B32A-F,H,J	Q41A-D	G21C-D	U20F,G,K,L	K40A,E	W45A,B
A92A-D	L23A-D	B42C,E,G,H	J33C	B41A,E,K	Q42A,B	G22G,H,K	U30D,E	K50A,B	W57K
B20C	L30B,D	B51C	L11A-D,F	B51A,B,F,H	Q91C	G40F	U40D,G,H	K60A-G	W32A,B,H
B31C,D,J	L40B	B52A,B,E	L21A-C,E,F	B52C,D,F-H,J	Q92A,B,D,E,G	G50B-E	U50A	K70A,B	W70A
B41C,F,G	N14B-D	B60G	L22A,D	B60A-D,H,J	Q93A-D	H10L	U60D-F	K80A-F	
B42A,B	N21A	B71C,F,G	L30A,C	B71A,H,J	Q94A-F	H20A,H	U70B,F	K90A-D	
B42D,F	N22A,E	B72A,F-H,J	L40A	B72B-D,K	R10C-E,G,H,J-M	H30A-E	U80B,E,G,J	L70G	
B51E,G	N23B	B73A,H,J	L50B	B73B-G	R20B,D-G	H40A,C-E,G,H,J,L	V40D,E	L81A-D	
B60E,F	N24B-D	B82A-F,J	L60A,B	B81H,J	R30A-F	H50A	V50A,B		
B71B,D,E	N30A-C	B83A-E	L70D	B82G-H	R40A-C	H60B,E,F,H,J	W11B		
B72E	N40C	B90A-H	N12C	C11C,E,J,L,M	R50A-B	H70C-E,K	W12A,B,D		
B81A,B,D	Q12C	C22H,J	N13A-C	C12A-D,H,J,L	S20A,B-D	H80A,E	W13A,B		
C51K	Q13B,C	C24H	N14A	C13A-H	S31A,D,F,G	H90A,B	W21G,H,J		
C52L	Q14A-C,E	C31F	N21C	C21A-G	S32A-C,F-H,J-M	J12A,B	W32C,F,G		
C91D	Q21B	C51H,J,L,M	N22B-D	C22A-G,K	S40A-F	J13C	W42D,E,F		
C91E	Q22B	C52H,K	N23A	C23A,F-H,J-L	S50A-E-H,J	J23J	W51C		
D31B	Q30B-E	C70D	N24A	C24B,C,G,J	S60C-E	J25A-E	W52B,C		

Zone A **NO WATER MAY BE TAKEN FROM THESE DRAINAGE REGIONS EXCEPT AS SET OUT UNDER SCHEDULE 1 AND SMALL INDUSTRIAL USERS.**		**Zone B** **45 M^3 PER HECTARE PER ANNUM MAY BE TAKEN FROM THESE DRAINAGE REGIONS AND SMALL INDUSTRIAL USERS.**		**Zone C** **75 M^3 PER HECTARE PER ANNUM MAY BE TAKEN -FROM THESE DRAINAGE REGIONS AND SMALL INDUSTRIAL USERS.**		**Zone D** **150 M^3 PER HECTARE PER ANNUM MAY BE TAKEN FROM THESE DRAINAGE REGIONS AND SMALL INDUSTRIAL USERS.**		**Zone E** **400 M^3 PER HECTARE PER ANNUM MAY BE TAKEN FROM THESE DRAINAGE REGIONS AND SMALL INDUSTRIAL USERS.**	
D33A,C-E,K	Q44A-C	C91A-C	P10C	C25A-F	S70A-F	J31A-C,	W53A,B		
D41C-H,J,-M	Q50A,B	D14C,D	Q13A	C31B-E	T11C,F-H	J33A,F	W54C-E		
D42A-E	Q60C	D16F,G	Q22A	C32A-D	T12A-G	J34B,D-F	W55B,C,D		
D51C	Q80A-C,F	D21A,D,E,H	Q30A	C33A,B,C	T13A-C	J35B-F	W56A,B		
D53D-H,J	U20H	D22C	Q43A,B	C41A-H,J	T31A-H	J40A,C	W57J		
D54A-G	V11C,D	D31A,C,D,E	Q50C	C42A-H,J-L	T33A,B,D,F-H		X12C-F		
D55L	V70A	D33B,F-H,J	Q60A,B	C43A-D	T40G		X23A,C,D		
D56H,J	W41G	D34G	Q70A-C	C51A-G	T52J		W43E,F		
D57A-E	W42G,J,L	D41B,G,L	Q80D,E,G	C52A-G,J	T60C,J				
D58A,C	W44D	D51A,B	Q91A,B	C60A-H,J	T90A				
D62A-E	W51E	D52A-F	Q92C,F	C70A-C,E-H,J,K	U20J				
D73A,C-F	W52D	D53A-C	R10A,B,F	C81A-E,G-H,J-M	U30B				
D81A-G	X11D,F	D55A-H,J,K,M	R20A,C	C82A-H	U40B				
D82A-H,J-L	X21A-D,F,G	D56A-G	S31B,C,E	C83A-H,J-M	U70E				
E22D	X31F	D58B	S32D,E	C92A,B,C	U80A,C,D,FH,K, L				
E23C,D,F-H,J,K	X32B,E	D61A-H,J-M	S60A,B	D12A-F	V11F,K,M				
E24D,G,H	A22H,J	D62F-H,J	T11A,B,D,E	D13A-H,J-M	V12E,G				
E31A-H	A31C	D71C,D	T13D,E	D14A,B,E-H,J,K	V13B,C,E				
E32A,B,D	C24D-F	D72A-C	T20A-G	D15G,H	V14A-E				
E33A-E,H	C31A	D73B	T31J	D18K,L	V20G,H,J				
E40A	G10K-M	B81C,E-G	T32A-H	D21F,G	V31C-H,J,K				
F10A-C	G30A-H	C81F	T33C,E,J,K	D22A,B,D,G,H,L	V32A-H				
F20A-E	M10A-D		T34A-E,F-H,J,K	D23A,C-H,J	V33A-D				
F30A,B,D-G	M20A		T35A-D-H,J-M	D24A-H,J-L	V40A-C				
F40A-H	M30A,B		T36A,B	D32A-H,J,K	V50D				
F50A,D,F,G			T40A-D	D34A-F	V60C,E-H,J,K				
			T51A-H,J	D35A-H,J,K	V70F,G				
			T52A-H,K	D41A	W11C				
			T60B,E,F,K	D71A,B	W12E				
			T70A-G	E21A-C,E,L	W21A-F,L				
			T80A-D	E22C	W22A,F				
			T90B-G	E24J,K	W31A,G,K				
			U10A-H,J,K	E33F	W32D,E				
			U20A-E	E40C	W41D				
			U40A	G10F,J	W42A-C,E,F				
			U60A,B	G40K	W44B,C,E				
			U70A	G50G,H	W51A,B,D,F				
			V11A,B,E,G,H,J,	H10A	W52A				

Zone A NO WATER MAY BE TAKEN FROM THESE DRAINAGE REGIONS EXCEPT AS SET OUT UNDER SCHEDULE 1 AND SMALL INDUSTRIAL USERS.		Zone B 45 M^3 PER HECTARE PER ANNUM MAY BE TAKEN FROM THESE DRAINAGE REGIONS AND SMALL INDUSTRIAL USERS.		Zone C 75 M^3 PER HECTARE PER ANNUM MAY BE TAKEN -FROM THESE DRAINAGE REGIONS AND SMALL INDUSTRIAL USERS.		Zone D 150 M^3 PER HECTARE PER ANNUM MAY BE TAKEN FROM THESE DRAINAGE REGIONS AND SMALL INDUSTRIAL USERS.		Zone E 400 M^3 PER HECTARE PER ANNUM MAY BE TAKEN FROM THESE DRAINAGE REGIONS AND SMALL INDUSTRIAL USERS.	
			L						
			V12A-D,F	H50B	W53C-E				
			V13A,D	H60G,K,L	W54A-B				
			V20A-F	H70A,B,G,H,J	W55A				
			V31A,B	H80D	X11A-C,H,J,K				
			V60A,B,D	H90D,E	X12A,B,H,K				
			V70B-E	J11H,J,K	X13H,J-L				
			W12C,G	J12D,F-H,L,M	X14H				
			W22B-E,G,H,J-L	J13A,B	X21H,K				
			W23A	J23E	X22C,D				
			W31B-F,H	J33B,D	X23B,E,F				
			W41A-C,E,F	J35A	X24A-H				
			W42H,K,M	J40D,E	X31A,K-M				
			W44A		X32C,F-H,J				
			X11E,G		X40C				
			X12G,J		S10A-J				
			X13A						
			X14A,B,D-G						
			X21E,J						
			X22A,B,E-H,J,K						
			X23G,H						
			X31B-E,G,H,J						
			X32A,D						
			X33A-D						
			X40A,B,D						

TABLE 1.3 (a) Areas excluded from General Authorisation for any storage of water

Primary drainage region	Secondary/Tertiary/Quaternary drainage region	Description of main river in drainage region for information purposes
X	X11, X12 X21A, B, C X21F,G	Komati River Catchment upstream of Swaziland Crocodile River Catchment upstream of Kwena Dam Elands River Catchment upstream of Waterval Onder
B	B1 B2 B3 B4	Olifants and Klein-Olifants River Wilge River Elands River Steelpoort River
U	U 20 A to M	Mgeni River
W	W 31 W 51 t0 57	Mfolozi River Usutu River

TABLE 1.3 (b) Areas excluded from General Authorisation for storage of water in excess of 10 000 cubic metres and falling outside government control areas proclaimed under the Water Act No 54 of 1956.

Primary drainage region	Secondary/Tertiary/Quaternary drainage region	Description of main river in drainage region for information purposes
A	All catchments	Limpopo River
B	All catchments excluding B1 to B 4 (see Table 1.3(a))	Olifants River and all tributaries
C	C11, C12, C13, C20, C40, C50, C60, C70, C81, C82, C83 and C90	Vaal River and all tributaries
V	V11 V13B	Assegaai River Tugela River

2. ENGAGING IN A CONTROLLED ACTIVITY, IDENTIFIED AS SUCH IN SECTION 37(1): IRRIGATION OF ANY LAND WITH WASTE OR WATER CONTAINING WASTE GENERATED THROUGH ANY INDUSTRIAL ACTIVITY OR BY A WATERWORK

[Section 21(e)]

Purpose of this authorisation

2.1. The authorisation permitted in terms of this Schedule replaces the need for a water user to apply for a licence in terms of the National Water Act provided that the irrigation is within the limits and conditions set out in this authorisation.

Exclusion

2.2. This authorisation does not apply to a person who is not the lawful occupier of the land on which the wastewater irrigation takes place.

Compliance with National Water Act and other laws

2.3. (1) This authorisation does not-

(a) replace any existing authorisation that is recognised under the National Water Act; or

(b) exempt a person who uses water from compliance with any other provision of the National Water Act unless stated otherwise in this notice, or any other applicable law, regulation, ordinance or by-law.

(2) A person who uses water in terms of this authorisation is exempt from compliance with section 22(2)(e) of the National Water Act.

Area of applicability

2.4. This authorisation is applicable throughout the Republic of South Africa.

Duration of authorisation

2.5. This authorisation will be applicable for a period of five years from the date of publication of this notice, unless-

(a) it is amended at any review period, which period shall be at intervals of three years from the date of publication of this notice;

(b) the period is extended by a notice in the *Gazette*;

(c) it is replaced with a General Authorisation in relation to a specific water resource or within a specific area; or

(d) the water user is required to apply for a licence in terms of the National Water Act.

Definitions

2.6. In this authorisation, unless the context indicates otherwise, any word or expression to which a meaning has been assigned in terms of the National Water Act shall have that meaning, and-

"biodegradable industrial wastewater" means wastewater that contains predominantly organic waste arising from industrial activities and premises including-
(a) milk processing;
(b) manufacture of fruit and vegetable products;
(c) sugar mills;
(d) manufacture and bottling of soft drinks;
(e) water bottling;
(f) production of alcohol and alcoholic beverages in breweries, wineries or malt houses;
(g) manufacture of animal feed from plant or animal products;
(h) manufacture of gelatine and glue from hides, skin and bones;
(i) abattoirs;
(j) fish processing; and
(k) feedlots;

"**commercial activity**" means those activities identified in the Standard Industrial Classification of All Economic Activities (5th Edition), published by the Central Statistics Service, 1993, as amended and supplemented, under the following categories-

a) 6: wholesale and retail trade,
b) 7: transport, storage and communication,
c) 8: business services,
d) 9: community, social and personal services,
e) 0: personal and other services;

"**domestic wastewater**" means wastewater arising from domestic and commercial activities and premises, and may contain sewage;

"**irrigation**" means the application of wastewater for the purpose of crop production, and includes the cultivation of pasture;

"**monitoring programme**" means a programme for taking regular measurements of the quantity and/or quality of a water resource, waste or wastewater discharge at specified intervals and at specific locations to determine the chemical, physical and biological nature of the water resource, waste or wastewater discharge;

"**organic waste**" means waste of non-anthropogenic origin that is readily biodegradable in the environment and does not contain any toxic substances that may accumulate in the environment;

"**primary treatment**" means treatment of wastewater by a physical process, which may involve maceration, sedimentation, screening and grit removal;

"**secondary treatment**" means treatment of wastewater by a biological process, through solar and other energy, bacteria, algae and a variety of aquatic biota, to remove organic matter;

"**wastewater**" means water containing waste, or water that has been in contact with waste material.

Irrigation with wastewater

2.7. A person who-

(a) owns or lawfully occupies property registered in the Deeds Office as at the date of this notice;

(b) lawfully occupies or uses land that is not registered or surveyed; or

(c) lawfully has access to land on which the use of water takes place,

may on that property or land

(i) irrigate up to 2000 cubic metres of domestic and biodegradable industrial waste water on any given day provided the-

(a) faecal coliforms do not exceed 1000 per 100 ml;

(b) Chemical Oxygen Demand (COD) does not exceed 75 mg/l;

(c) pH is not less than 5,5 or more than 9,5 pH units;

(d) Ammonia (ionised and un-ionised) as Nitrogen does not exceed 3 mg/l;

(e) Nitrate/Nitrite as Nitrogen does not exceed 15 mg/l;

(f) Chlorine as Free Chlorine does not exceed 0,25 mg/l;

(g) Suspended Solids does not exceed 25 mg/l;

(h) Electrical Conductivity does not exceed 70 milliSiemens above intake to a maximum of 150 milliSiemens per metre (mS/m);

(i) Ortho-Phosphate as phosphorous does not exceed 10 mg/l;

(j) Fluoride does not exceed 1 mg/l; and

(k) Soap, oil or grease does not exceed 2,5 mg/l.

(ii) irrigate up to 500 cubic metres of domestic or biodegradable industrial wastewater on any given day, provided the-

(a) electrical conductivity does not exceed 200 milliSiemens per metre (mS/m);

(b) pH is not less than 6 or more than 9 pH units;

(c) Chemical Oxygen Demand (COD) does not exceed 400 mg/l after removal of algae;

(d) faecal coliforms do not exceed 100 000 per 100 ml; and

(e) Sodium Adsorption Ratio (SAR) does not exceed 5 for biodegradable industrial wastewater;

(ii) irrigate up to 50 cubic metres of biodegradable industrial wastewater on any given day, provided the-

(a) electrical conductivity does not exceed 200 milliSiemens per metre (mS/m);

(b) pH is not less than 6 or more than 9 pH units;

(c) Chemical Oxygen Demand (COD) does not exceed 5 000 mg/l after removal of algae;

(d) faecal coliforms do not exceed 100 000 per 100 ml; and

(e) Sodium Adsorption Ratio (SAR) does not exceed 5 for biodegradable industrial wastewater,

if the irrigation of wastewater-

(aA) does not impact on a water resource or any other person's water use, property or land; and

(aB) is not detrimental to the health and safety of the public in the vicinity of the activity.

Registration of irrigation with wastewater

2.8.(1) A person who irrigates with wastewater in terms of this authorisation must submit to the Responsible authority a registration form or any other information requested in writing by the Responsible authority for the registration of the water use before commencement of irrigation.

(2) On written receipt of a registration certificate by the Department, the person will be regarded as a registered water user.

(3) All forms for registration of water use are obtainable from the Regional offices of the Department as well as from the Departmental web-site at http:\\www.dwaf.gov.za

Location of irrigation with wastewater

2.9. Wastewater irrigation in terms of this authorisation is only permitted if the irrigation takes place-

(a) above the 100 year flood line, or alternatively, more than 100 metres from the edge of a water resource or a borehole which is utilised for drinking water or stock watering, which ever is further; and

(b) on land that is not, or does not, overlie a Major Aquifer (identification of a Major Aquifer will be provided by the Department, upon written request).

Record-keeping and disclosure of information

2.10. (1) The water user must ensure the establishment of monitoring programmes to monitor the quantity and quality of the wastewater to be irrigated prior to commencement of irrigation and thereafter, as follows-

(a) the quantity must be metered and the total recorded weekly; and

(b) the quality must be monitored monthly as at the last day of each month by grab sampling, at the point at which the wastewater enters the irrigation system for all parameters listed in subparagraphs 2.7.(i) and (ii).

(2) The methods for the measurement of specific substances and parameters in any wastewater must be carried out-

(a) by a laboratory that has been accredited under the South African National Accreditation System (SANAS) in terms of SABS Code 0259 for that method; or

(b) as approved in writing by the responsible authority.

(3) Upon the written request of the responsible Authority the water user must-

(a) ensure the establishment of any additional monitoring programmes; and

(b) appoint a competent person to assess the water use measurements made in terms of this authorisation and submit the findings to the responsible authority for evaluation.

(4) Subject to paragraph 2.10. (3) above, the water user must keep a written record of the following wastewater irrigation and related activities, for at least three years-

(a) demarcate the location of the irrigation area on a suitable scale map and the extent of the area under irrigation on a 1: suitable scale map;
(b) details of the crop(s) and the area under irrigation;
(c) the irrigation management techniques being practised;
(d) quantity of wastewater irrigated;
(e) quality of wastewater irrigated;
(f) details of the monitoring programme;
(g) details of failure and malfunctions in the irrigation system and details of measures taken, and

such information must be made available upon written request to the responsible authority.

(5) Any information on the occurrence of any incident that has or is likely to have a detrimental impact on the water resource quality must be reported to the responsible authority.

Precautionary practices

2.11. (1) The water user must follow acceptable construction, maintenance and operational practices to ensure the consistent, effective and safe performance of the wastewater irrigation system, including the prevention of-

(a) waterlogging of the soil and pooling of wastewater on the surface of the soil;
(b) nuisance conditions such as flies or mosquitoes, odour or secondary pollution;
(c) waste, wastewater or contaminated stormwater entering into a water resource;
(d) the contamination of run-off water or stormwater;
(e) the unreasonable chemical or physical deterioration of, or any other damage to, the soil of the irrigation site; the unauthorised use of the wastewater by members of the public; and
(f) preventing of people being exposed to the mist originating from the industrial waste.

(2) All reasonable measures must be taken for storage of the wastewater used for irrigation when irrigation cannot be undertaken.

(3) Suspended solids must be removed from any wastewater, and the resulting sludge disposed of according to the requirements of any relevant law or regulation, including-

(a) "Permissable utilisation and disposal of sewage sludge" Edition 1, 1997. Water Research Commission Report No TT 85/97 as amended from time to time; and

(b) "Guide: Permissable utilisation and disposal of treated sewage effluent", 1978. Department of National Health and Population Development Report No. 11/2/5/3, as amended from time to time (obtainable from the Department upon written request).

(4) All reasonable measures must be taken to provide for mechanical, electrical, operational, or process failures and malfunctions of the wastewater irrigation system.

(5) All reasonable measures must be taken to collect stormwater runoff containing waste or wastewater emanating from the area under irrigation and to retain it for disposal;

Inspections

2.12. Any property or land in respect of which a water use has been authorised in terms of this notice must be made available for inspection by an authorised person in terms of section 125 of the National Water Act.

Offences

2.13. A person who contravenes any provision of this authorisation is guilty of an offence and is subject to the penalty set out in section 151(2) of the National Water Act.

3 DISCHARGE OF WASTE OR WATER CONTAINING WASTE INTO A WATER RESOURCE THROUGH A PIPE, CANAL, SEWER OR OTHER CONDUIT; AND DISPOSING IN ANY MANNER OF WATER WHICH CONTAINS WASTE FROM, OR WHICH HAS BEEN HEATED IN, ANY INDUSTRIAL OR POWER GENERATION PROCESS

[Sections 21(f) and (h)]

Purpose of this authorisation

3.1. The authorisation permitted in terms of this Schedule replaces the need for a water user to apply for a licence in terms of the National Water Act provided that the discharge is within the limits and conditions set out in this authorisation.

Exclusion

3.2. This authorisation does not apply to a person who discharges wastewater-

(a) through sea outfalls;
(b) to an aquifer;
(c) any other groundwater resource; or
(d) or any water resource with a closed drainage system.

Compliance with National Water Act and other laws

3.3.(1) This authorisation does not-

(a) apply to any water use under Schedule 1 of the National Water Act;

(b) replace any existing authorisation that is recognised under the National Water Act;

(c) exempt a person from compliance with section 7(2) of the Water Service Act, 1997 (Act No. 108 of 1997);

(d) exempt a person who uses water from compliance with any other provision of the National Water Act unless stated otherwise in this notice, or any other applicable law, regulation, ordinance or by-law; or

(e) apply to a category A mine .

(2) A person who uses water in terms of this authorisation is exempt from compliance with section 22(2)(e) of the National Water Act.

Area of applicability

3.4 This authorisation is applicable throughout the Republic of South Africa, except as excluded in paragraph 3.2 above.

Duration of authorisation

3.5. This authorisation will be applicable for a period of five years from the date of this notice, unless-

(a) it is amended at any review period, which period shall be at intervals of three years from the date of publication of this notice;

(b) the time period is extended by a further notice in the *Gazette*;

(c) it is replaced with an authorization in relation to a specific water resource or within a specific area; or

(d) the water user is required to apply for a licence in terms of the National Water Act.

Definitions

3.6. In this authorisation unless the context indicates otherwise, any word or expression to which a meaning has been assigned in terms of the National Water Act shall have that meaning, and-

"**category A mine**" means-

(a) any gold or coal mine;
(b) any mine with an extractive metallurgical process, including heap leaching; or
(c) any mine where sulphate producing or acid generating material occurs in the mineral deposit;

"**commercial activity**" means those activities identified in the Standard Industrial Classification of All Economic Activities (5^{th} Edition), published by the Central Statistics Service, 1993, as amended and supplemented, under the following categories-
a) 6: wholesale and retail trade,
b) 7: transport, storage and communication,
c) 8: business services,
d) 9: community, social and personal services,
e) 0: personal and other services;

"**complex industrial wastewater**" means wastewater arising from industrial activities and premises, that contains-
a) a complex mixture of substances that are difficult or impractical to chemically characterise and quantify, or
b) one or more substances, for which a wastewater limit value has not been specified, and which may be harmful or potentially harmful to human health, or to the water resource (identification of complex industrial wastewater will be provided by the Department upon written request);

"**domestic wastewater**" means wastewater arising from domestic and commercial activities and premises, and may contain sewage;

"**domestic wastewater discharge**" means a wastewater discharge consisting of 90% or more domestic wastewater, by volume, that is collected, treated and subsequently disposed of;

"**industrial activity**" means those activities identified in the Standard Industrial Classification of All Economic Activities (5th Edition), published by the Central Statistics Service, 1993, as amended and supplemented, under the following categories-

a) 2: mining and quarrying,
b) 3: manufacturing,
c) 4: electricity, gas and water supply,
d) 5: construction;

"**industrial wastewater discharge**" means a wastewater discharge consisting of more than 10% industrial wastewater, by volume, that is collected, treated and subsequently disposed of;

"**intake**" is water taken from a water resource, and excludes water taken from any source that is not a water resource;

"**monitoring programme**" means a programme for taking regular measurements of the quantity and/or quality of a water resource, waste or wastewater discharge at specified intervals and at specific locations to determine the chemical, physical and biological nature of the water resource, waste or wastewater discharge;

"**listed water resources**" are those water resources listed in Table 3.3 and include any tributary of a listed water resource, and any water resource draining the catchment area of a listed water resource;

"**wastewater**" means water containing waste, or water that has been in contact with waste material;

"**wastewater limit value**" means the mass expressed in terms of the concentration and/or level of a substance which may not be exceeded at any time. Wastewater Limit Values shall apply at the last point where the discharge of wastewater enters into a water resource, dilution being disregarded when determining compliance with the wastewater limit values. Where discharge of wastewater does not directly enter a water resource, the wastewater limit values shall apply at the last point where the wastewater leaves the premises of collection and treatment.

Discharging of domestic and industrial wastewater into water resources

3.7. (1) A person who-

(a) owns or lawfully occupies property registered in the Deeds Office as at the date of this notice;

(b) lawfully occupies or uses land that is not registered or surveyed, or

(c) lawfully has access to land on which the use of water takes place.

may on that property or land outside of the areas excluded in paragraph 3.4 above,

(i) discharge up to 2 000 cubic metres of wastewater on any given day into a water resource that is **not** a listed water resource set out in Table 3.3, provided the discharge-

(a) complies with the general wastewater limit values set out in Table 3.1;

(b) does not alter the natural ambient water temperature of the receiving water resource by more than 3 degrees Celsius; and

(c) is not a complex industrial Wastewater.

(ii) discharge up to 2 000 cubic metres of wastewater on any given day into a listed water resource set out in Table 3.3, provided the discharge -

(a) complies with the special wastewater limit values set out in Table 3.1;

(b) does not alter the natural ambient water temperature of the receiving water resource by more than 2 degrees Celsius; and

(c) is not a complex industrial wastewater,

if the discharging of wastewater-

(aA) does not impact on a water resource or any other person's water use, property or land; and

(aB) is not detrimental to the health and safety of the public in the vicinity of the activity.

(2) A person may not discharge stormwater runoff from any premises containing waste, or water containing waste emanating from industrial activities and premises, into a water resource.

TABLE 3.1: Wastewater limit values applicable to discharge of wastewater into a water resource

SUBSTANCE/PARAMETER	GENERAL LIMIT	SPECIAL LIMIT
Faecal Coliforms (per 100 ml)	1 000	0
Chemical Oxygen Demand (mg/l)	75 (i)	30(i)
pH	5,5-9,5	5,5-7,5
Ammonia (ionised and un-ionised) as Nitrogen (mg/l)	6	2
Nitrate/Nitrite as Nitrogen (mg/l)	15	1,5
Chlorine as Free Chlorine (mg/l)	0,25	0
Suspended Solids (mg/l)	25	10
Electrical Conductivity (mS/m)	70 mS/m above intake to a maximum of 150 mS/m	50 mS/m above background receiving water, to a maximum of 100 mS/m
Ortho-Phosphate as phosphorous (mg/l)	10	1 (median) and 2,5 (maximum)
Fluoride (mg/l)	1	1
Soap, oil or grease (mg/l)	2,5	0
Dissolved Arsenic (mg/l)	0,02	0,01
Dissolved Cadmium (mg/l)	0,005	0,001
Dissolved Chromium (VI) (mg/l)	0,05	0,02
Dissolved Copper (mg/l)	0,01	0,002
Dissolved Cyanide (mg/l)	0,02	0,01

SUBSTANCE/PARAMETER	GENERAL LIMIT	SPECIAL LIMIT
Dissolved Iron (mg/l)	0,3	0,3
Dissolved Lead (mg/l)	0,01	0,006
Dissolved Manganese (mg/l)	0,1	0,1
Mercury and its compounds (mg/l)	0,005	0,001
Dissolved Selenium (mg/l)	0,02	0,02
Dissolved Zinc (mg/l)	0,1	0,04
Boron (mg/l)	1	0,5

(i) After removal of algae

Registration of discharges into water resources

3.8. (1) A person who discharges wastewater into a water resource in terms of this authorisation must submit a registration form for registration of the water use before commencement of the discharge.

(2) On written receipt of a registration certificate by the Department, the person will be regarded as a registered water user.

(3) All forms for registration of water use are obtainable from the Regional offices of the Department, as well as from the Departmental web-site at http:\\www.dwaf.gov.za

Record-keeping and disclosure of information

3.9. (1) The water user must ensure the establishment of monitoring programmes to monitor the quantity and quality of the discharge prior to the commencement of the discharge, as follows-

(a) the quantity of the discharge must be metered and the total recorded weekly; and

(b) the quality of domestic wastewater discharges must be monitored monthly by grab sampling and analysed for specific substances and parameters as required by the responsible authority. as set out in Table 3.2.

TABLE 3.2: Monitoring requirements for domestic wastewater discharges

DISCHARGE VOLUME ON ANY GIVEN DAY	MONITORING REQUIREMENTS
10 to 100 cubic metres	pH Electrical Conductivity (mS/m) Faecal Coliforms (per 100 ml)
100 to 1000 cubic metres	pH Electrical Conductivity (mS/m) Faecal Coliforms (per 100 ml) Chemical Oxygen Demand (mg/l) Ammonia as Nitrogen (mg/l) Suspended Solids (mg/l)
1 000 to 2 000 cubic metres	pH Electrical Conductivity (mS/m) Faecal Coliforms (per 100 ml) Chemical Oxygen Demand (mg/l) Ammonia as Nitrogen (mg/l) Nitrate/Nitrite as Nitrogen (mg/l) Free Chlorine (mg/l) Suspended Solids (mg/l) Ortho-Phosphate as Phosphorous (mg/l)

(c) the quality of industrial wastewater discharges must be monitored weekly by grab sampling-

(i) for all substances which have been added to the water through any industrial activity;

(ii) for all substances which have been concentrated in the water through any industrial activity;

(iii) for all substances which may be harmful or potentially harmful to human health or to the water resource quality; and

(iv) as set out in paragraph 3.9(1)(b) above, if the wastewater contains any domestic wastewater.

(d) The methods for the measurement of specific substances and parameters in any wastewater must be carried out-

(i) by a laboratory that has been accredited under the South African National Accreditation System (SANAS) in terms of SABS Code 0259 for that method; or

(ii) as approved in writing by the responsible authority .

(2) Upon the written request of the responsible authority the registered user must-

(a) ensure the establishment of any additional monitoring programmes; and

(b) appoint a competent person to assess the water use measurements made in terms of this authorisation and submit the findings to the responsible authority for evaluation.

(3) Subject to paragraph 3.9. (2) above, the water user must submit the following information on a monthly basis to the responsible authority -

(a) the quantity of wastewater discharged;
(b) the quality of wastewater discharged;
(c) details of the monitoring programme/s;
(d) details of failures and malfunctions in the discharge system and details of measures taken, and

such information must be made available upon written request to the responsible authority.

(4) Any information on the occurrence of any incident that has or is likely to have a detrimental impact on the water resource quality must be reported to the responsible authority.

Precautionary practices

3.10. (1) The water user must follow acceptable construction, maintenance and operational practices to ensure the consistent, effective and safe performance of the discharge.

(2) All reasonable measures must be taken to provide for mechanical, electrical, operational, or process failures and malfunctions of the discharge system.

Inspections

3.11. Any property or land in respect of which a water use has been authorised in terms of this notice must be made available for inspection by an authorised person in terms of section 125 of the National Water Act.

Offences

3.12. A person who contravenes any provision of this authorisation is guilty of an offence and is subject to the penalty set out in section 151(2) of the National Water Act.

TABLE 3.3: Listed Water Resources

	WATER RESOURCE
1	Hout Bay River to tidal water
2	Palmiet River from Kogelberg Dam to its estuary
3	Lourens River to tidal water
4	Steenbras River to tidal water
5	Berg and Dwars Rivers to their confluence
6	Little Berg River to Vogelvlei weir
7	Sonderend, Du Toits and Elandskloof Rivers upstream and inclusive of Thee Waterskloof Dam
8	Witte River to confluence with Breede River
9	Dwars River to Ceres divisional boundary
10	Olifants River to the Ceres divisional boundary
11	Hlsloot and Smalblaar (or Molenaars) Rivers to their confluence with Breede River
12	Hex River to its confluence with Breede River
13	Van Stadens River to tidal water
14	Buffalo River from its source to where it enters the King Williams Town limits
15	Klipplaat River from its source to Waterdown Dam
16	Swart Kei River to its confluence with the Klipplaat River
17	Great Brak River
18	Bongola River to Bongola Dam
19	Kubusi River to the Stutterheim limitsy
20	Langkloof River from its source to Barkly East limits
21	Kraai River to its confluence with the Langkloof River
22	Little Tsomo River
23	Xuka River to the Elliot limits
24	Tsitsa and Inxu Rivers to their confluence
25	Mvenyane and Mzimvubu Rivers from sources to their confluence
26	Mzintlava River to its confluence with the Mvalweni River
27	Ingwangwana River to its confluence with Umzimkulu River
28	Umzimkulu and Polela Rivers to their confluence
29	Elands River to the Pietermaritzburg-Bulwer main road
30	Umtamvuma and Weza Rivers to their confluence
31	Umkomaas and Isinga Rivers to their confluence
32	Lurane River to its confluence with the Umkomaas River
33	Sitnundjwana Spruit to its confluence with the Umkomaas River
34	Inudwini River to the Polela district boundary
35	Inkonza River to the bridge on the Donnybrook-Creighton road
36	Umlaas to the bridge on District Road 334 on the farm Maybole
37	Umgeni and Lions River to their confluence
38	Mooi River to the road bridge at Rosetta
39	Little Mooi and Hlatikula Rivers to their confluence
40	Bushmans River to Wagendrift Dam
41	Little Tugela River and Sterkspruit to their confluence

	WATER RESOURCE
42	M'Lambonjwa and Mhlawazeni Rivers to their confluence
43	Mnweni and Sandhlwana Rivers to their confluence
44	Tugela River to its confluence with the Kombe Spruit
45	Inyamvubu (or Mnyamvubu) River to Craigie Burn Dam
46	Umvoti River to the bridge on the Seven Oaks-Rietvlei road
47	Yarrow River to its confluence with the Karkloof River
48	Incandu and Ncibidwane Rivers to their confluence
49	Ingogo River to its confluence with the Harte River
50	Pivaan River to its confluence with Soetmelkspruit
51	Slang River and the Wakkerstroom to their confluence
52	Elands and Swartkoppie Spruit to their confluence
53	All tributaries of the Komati River between Nooitgedacht Dam and its confluence with and including Zevenfontein Spruit
54	Seekoeispruit to its confluence with Buffelspruit
55	Crocodile River and Buffelskloofspruit to their confluence
56	All tributaries of the Steelpoort River down to its confluence with and including the Dwars River
57	Potspruit to its confluence with the Waterval River
58	Dorps River (or Spekboom River) to its confluence with the Marambanspruit
59	Ohrigstad River to the Ohrigstad Dam
60	Klein-Spekboom River to its confluence with the Spekboom River
61	Blyde River to the Pilgrim's Rest municipal boundary
62	Sabie River to the Sabie municipal boundary .
63	Nels River to the Pilgrim's Rest district boundary
64	Houtbosloop River to the Lydenburg district boundary
65	Blinkwaterspruit to Longmere Dam
66	Assegaai River upstream and inclusive of the Heyshope Dam
67	Komati River upstream and inclusive of the Nooitgedacht Dam and the Vygeboom Dam
68	Ngwempisi River upstream and inclusive of Jericho Dam and Morgenstond Dam
69	Slang River upstream and inclusive of Zaaihoek Dam
70	All streams flowing into the Olifants River upstream and inclusive of Loskop Dam, Witbank Dam and Middelburg Dam
71	All streams flowing into Ebenezer Dam on the Great Letaba River
72	Dokolewa River to its confluence with the Politzi River
73	Ramadiepa River to the Merensky Dam on the farm Westfalia 223, Letaba
	LISTED WATER RESOURCES WHERE SPECIAL LIMIT FOR ORTHO-PHOSPHATE AS PHOSPHOROUS IS APPLICABLE (Crocodile (west) Marico Water Management Area)
74	Pienaars River and tributaries as far as Klipvoor Dam
75	Crocodile River and tributaries as far as Roodekopjies Dam
76	Elands and Hex River and trrbutaries as far as Vaalkop Dam
77	Molopo River and Tributaries as far as Madimola Dam

	RAMSAR LISTED WETLANDS:	**PROVINCE**	**LOCATION**
78	Barberspan	North-West	26°33' S 25°37' E
79	Blesbokspruit	Gauteng	26°17' S 28°30' E
80	De Hoop Vlei	Western Cape	34°27' S 20°20' E
81	De Mond (Heuningnes Estuary)	Western Cape	34°43' S 20°07' E
82	Kosi Bay	Kwazulu-Natal	27°01' S 32°48' E
83	Lake Sibaya	Kwazulu-Natal	27°20' S 32°38' E
84	Langebaan	Western Cape	33°06' S 18°01' E
85	Orange River Mouth	Northern Cape	28°40' S 16°30' E
86	St Lucia System	Kwazulu-Natal	28°00' S 32°28' E
87	Seekoeivlei Nature Reserve	Free State	27°34' S 29°35' E
88	Verlorevlei	Western Cape	32°24' S 18°26' E
89	Verloren Valei	Mpumalanga	25°14' S 30°4' E
90	Nylsvlei	Northern	24°39' S 28°42' E
91	Wilderness Lakes	Western Cape	33°59' S 22°39' E

4 DISPOSING OF WASTE IN A MANNER WHICH MAY DETRIMENTALLY IMPACT ON A WATER RESOURCE

[Section 21(g)]

Purpose of this authorisation

4.1. The authorisation permitted in terms of this Schedule replaces the need for a water user to apply for a licence in terms of the National Water Act for the disposal of waste, provided that the disposal is within the limits and conditions set out in this authorisation.

Exclusion

4.2. This authorisation does not apply to a person who is not the lawful occupier of the land or who does has lawful access to the land on which the disposal takes place.

Compliance with National Water Act and other laws

4.3 (1) This authorisation does not-

(a) replace any existing authorisation that is recognised under the National Water Act;

(b) exempt a person from compliance with section 7(2) of the Water Services Act, 1997 (Act No. 108 of 1997);

(c) exempt a person from compliance with the provisions of the National Building Regulations and Building Standards Act, 1977 (Act No. 103 of 1977) for construction, operation and maintenance of any structure used for the collection, treatment or disposal of waste; or

(d) exempt a person who uses water from compliance with any other provision of the National Water Act unless stated otherwise in this notice, or any other applicable law, regulation, ordinance or by-law.

(2) A person who uses water in terms of this authorisation is exempt from compliance with section 22(2)(e) of the National Water Act.

Area of applicability

4.4 This authorisation is applicable throughout the Republic of South Africa, except for those subterranean government water control areas set out in Table 4.1.

Duration of authorisation

4.5. This authorisation will be applicable for a period of five years from the date of publication of this notice, unless-

(a) it is amended at any review period, which period shall be at intervals of three years from the date of publication of this notice;

(b) the period is extended by a further notice in the *Gazette*;
(c) it is replaced with a General Authorisation in relation to a specific water resource or within a specific area; or
(d) the water user is required to apply for a licence in terms of the National Water Act.

Definitions

4.6. In this authorisation, unless the context otherwise indicates, any expression to which a meaning has been assigned in terms of the National Water Act shall have that meaning, and-

"biodegradable industrial wastewater" means wastewater that contains predominantly organic waste arising from industrial activities and premises, including-
(a) milk processing;
(b) manufacture of fruit and vegetable products;
(c) sugar mills;
(d) manufacture and bottling of soft drinks;
(e) water bottling;
(f) production of alcohol and alcoholic beverages in breweries, wineries or malt houses;
(g) manufacture of animal feed from plant or animal products;
(h) manufacture of gelatine and glue from hides, skin and bones;
(i) abattoirs;
(j) fish processing; and
(k) feedlots;

"**category A mine**" means-
(a) any gold or coal mine;
(b) any mine with an extractive metallurgical process, including heap leaching; or
(c) any mine where the mineral deposit contains sulphide or where acid-forming minerals occur in the mineral deposit;

"**complex industrial wastewater**" means wastewater arising from industrial activities and premises, that contains-
a) a complex mixture of substances that are difficult or impractical to chemically characterise and quantify; or
b) one or more substances, for which a wastewater limit value has not been specified, and which may be harmful or potentially harmful to human health, or to the water resource-
(identification of complex industrial wastewater will be provided by the Department upon written request);

"**domestic wastewater**" means wastewater arising from domestic and commercial activities and premises, and may contain sewage;

"**evaporation pond**" means a dam designed to collect and dispose of wastewater through evaporation, from which any concentrated waste or sludge must be removed and disposed of according to the requirements of any relevant laws and regulations;

"**grey water**" refers to wastewater generated through domestic activities and premises, including washing, bathing and food preparation, but does not contain sewage;

"**monitoring programme**" means a programme for taking regular measurements of the quantity and/or quality of a water resource, waste or wastewater discharge at specified intervals and at specific locations to determine the chemical, physical and biological nature of the water resource, waste or wastewater discharge;

"**organic waste**" means waste of non-anthropogenic origin that is readily biodegradable in the environment and does not contain any substances that may accumulate in the environment;

"**on-site disposal**" refers to the disposal of wastewater on individual properties not permanently linked to a central waste collection, treatment and disposal system, such as septic tank systems, conservancy tank systems, soakaway systems, french drains and pit latrines;

"**primary treatment**" means the treatment of wastewater by a physical process, which may involve maceration, sedimentation, screening and grit removal;

"**secondary treatment**" means the treatment of wastewater by a biological process, through solar energy, bacteria, algae and a variety of aquatic biota, to remove organic matter;

"**wastewater**" means water containing waste, or water that has been in contact with waste material;

"**wastewater pond system**" means a dam or system of dams designed to collect wastewater and to conduct primary and secondary treatment, from which treated wastewater is disposed of.

Storage of domestic and/or biodegradable industrial wastewater for the purpose of re-use

4.7. A person who-

(a) owns or lawfully occupies property registered in the Deeds Office as at the date of this notice;

(b) lawfully occupies or uses land that is not registered or surveyed, or

(c) lawfully has access to land on which the use of water takes place,

may on that property or land outside of the areas set out in Table 4.1-

(i) store up to 5 000 cubic metres of domestic and/or biodegradable industrial wastewater for the purpose of re-use,

if the storing of the wastewater-

(aa) does not impact on a water resource or on any other person's water use, property or land; and

(bb) is not detrimental to the health and safety of the public in the vicinity of the activity.

Storage of domestic and/or biodegradable industrial wastewater for the purpose of disposal

4.8. A person who-

(a) owns or lawfully occupies property registered in the Deeds Office as at the date of this notice;

(b) lawfully occupies or uses land that is not registered or surveyed, or

(c) lawfully has access to land on which the use of water takes place,

may on that property or land outside of the areas set out in Table 4.1-

(i) store domestic and/or biodegradable industrial wastewater for the purpose of disposal of-

(aa) up to 10 000 cubic metres per property or land; or

(bb) up to 50 000 cubic metres in a wastewater pond system per property or land,

if the storing of the wastewater-

(aA) does not impact on a water resource or on any other person's water use, property or land; and

(aB) is not detrimental to the health and safety of the public in the vicinity of the activity;

Disposal of domestic and/or biodegradable industrial wastewater

4.9. A person who-

(a) owns or lawfully occupies property registered in the Deeds Office as at the date of this notice;

(b) lawfully occupies or uses land that is not registered or surveyed, or

(c) lawfully has access to land on which the use of water takes place, may on that property or land, outside of the areas set out in Table 4.1, dispose of -

(i) up to 1 000 cubic metres of domestic and/or biodegradable industrial wastewater, on any given day-

(aa) into a wastewater pond system; or

(bb) into an evaporation pond system;

(ii) domestic wastewater or biodegradable wastewater into a wastewater irrigation system as set out under General Authorisation 2 above;

(iii) wastewater to an on-site disposal facility -

(aa) for grey water generated by a single household;

(bb) up to one cubic metre of biodegradable industrial wastewater on any given day; or

(cc) domestic wastewater to a communal conservancy tank serving no more than 50 households;

(iv) domestic wastewater generated by a single household not permanently linked to a central waste collection, treatment and disposal system to an on-site disposal facility; and

(v) stormwater runoff from any premises not containing waste or wastewater from industrial activities and premises,

if the disposing of wastewater-

(aA) does not impact on a water resource or on any other person's water use, property or land; and

(bB) is not detrimental to the health and safety of the public in the vicinity of the activity.

Disposal of mine waste or residue

4.10. A person may dispose of mine residue into mine residue deposits provided that-

(a) the mine residue is not from a Category A mine;

(b) the disposal is in accordance with Government Notice No. 704, dated 4 June 1999; and

(c) the disposal is in accordance with SABS Code 0286, as amended from time to time.

Registration of wastewater storage

4.11.(1) A person who stores wastewater in terms of this authorisation must submit a registration form for registration of the water use before commencement of storage if more than 1 000 cubic metres are stored for disposal or if more than 500 cubic metres are stored for re-use.

(2) On written receipt of a registration certificate form the Department, the person will be regarded as a registered water user.

(3) All forms for registration of water use are obtainable from the Regional offices of the Department as well as from the Departmental web-site at http:\\www.dwaf.gov.za

Registration of wastewater disposal

4.12(1) A person who disposes of wastewater in terms of this authorisation must submit a registration form for registration of the water use before the commencement of the disposal if more than 50 cubic metres of domestic wastewater or biodegradable industrial wastewater is disposed of on any given day.

(2) The responsible local authority must submit a registration form obtained from the Department, to register the water use for disposal of domestic wastewater in-

(a) areas where more than 5 000 households are served by on-site disposal sites;

(b) areas where the density of on-site disposal sites exceeds 10 per hectare; or

(c) areas served by communal septic tanks.

(3) On written receipt of a registration certificate from the Department, the person will be regarded as a water user.

(4) All forms for registration of water use are obtainable from the Regional offices of the Department as well as from the Departmental web-site at http:\\www.dwaf.gov.za

Location of wastewater storage dams and wastewater disposal sites

4.13. Wastewater storage dams and wastewater disposal sites must be located-

(a) outside of a watercourse;

(b) above the 100 year flood line, or alternatively, more than 100 metres from the edge of a water resource or a borehole which is utilised for drinking water or stock watering, which ever is further; and

(c) on land that is not, or does not, overlie, a Major Aquifer (identification of a Major Aquifer will be provided by the Department upon written request).

Record-keeping and disclosure of information

4.14.(1) The water user must ensure the establishment of monitoring programmes to monitor the quantity and quality of the wastewater prior to storage or disposal, as follows-

(a) for the storage of wastewater, the quantity must be recorded monthly; or

(b) for the disposal of wastewater, the quantity must be gauged or metered and recorded monthly.

(2) Upon the written request of the responsible authority, the water user must-

(a) ensure the establishment of any additional monitoring programmes; and

(b) appoint a competent person to assess the water use measurements made in terms of this authorisation, and to submit the findings to the responsible authority for evaluation.

(3) Subject to paragraph 4.14 (2) above, the water user keep a written record of the following wastewater storage or wastewater disposal and related activities-

(a) the location of the storage dam or wastewater disposal site;
(b) the quantity of wastewater stored or disposed of or re-used;
(c) the quality of wastewater stored or disposed of, where applicable;
(d) details of the monitoring programme;
(e) details of failures and malfunctions of any wastewater disposal system or wastewater storage dam that the registered user is responsible for, and

such information must be made available upon written request to the responsible authority.

(4) Any information on the occurrence of any incident that has or is likely to have a detrimental impact on the water resource quality must be reported to the responsible authority.

Precautionary practices

4.15.(1) The water user must follow acceptable construction, maintenance and operational practices to ensure the consistent, effective and safe performance of any wastewater disposal system or wastewater storage dam.

(2) All reasonable measures must be taken to prevent wastewater overflowing from any wastewater disposal system or wastewater storage dam.

(3) All reasonable measures must be taken to provide for mechanical, electrical or operational failures and malfunctions of any wastewater disposal system or wastewater storage dam.

(4) Sewage sludge must be removed from any wastewater and the resulting sludge disposed of according to the requirements of any relevant law and regulation, including-

(a) "Permissable utilisation and disposal of sewage sludge" Edition 1, 1997. Water Research Commission Report No TT 85/97and Addendum thereto Edition 1, July 2002, and as amended from time to time; and

(b) "Guide: Permissable utilisation and disposal of treated sewage effluent", 1978, Department of National Health and Population Development Report

No. 11/2/5/3, as amended from time to time (obtainable from the Department upon written request).

Inspections

4.16. Any property or land in respect of which a water use has been authorised in terms of this notice must be made available for inspection by an authorised person in terms of section 125 of the National Water Act.

Offences

4.17. A person who contravenes any provision of this authorisation is guilty of an offence and is subject to the penalty set out in section 151(2) of the National Water Act.

NOTE: Information regarding the drainage regions referred to in Table 4.1 can be obtained from the Department, upon written request.

TABLE 4.1: Subterranean government water control areas excluded from General Authorisation for disposal of waste

Primary drainage region	Tertiary/ Quaternary drainage region	Description of subterranean government water control area	Government Notice No.	Government Gazette Date
H	H30	Baden	136	1967-06-16
A	A30	Bo-Molopo	1324	1963-08-30
C	C30	Bo-Molopo	1993	1965-12-17
D	D41	Bo-Molopo	R634	1966-04-29
A	A24	Crocodile River Valley	208	1981-10-23
A	A21	Crocodile River Valley	18	1983-02-18
A	A21, A22	Kroondal-Marikana	180	1963-06-17
G	G10, G30	Lower Berg River Valley/Saldanha	185	1976-09-10
A, B	A60, B50, B31	Nyl River Valley	56	1971-03-26
G	G30	Strandfontein	2463	1988-12-09
M	M10, M20, M30	Uitenhage	260	1957-08-23
G	G30	Wadrif	992	1990-05-11
G	G20	Yzerfontein	27	1990-02-09
G	G30	Graafwater	1423	1990-06-29
A	A70	Dendron-Vivo	813	1994-04-29
A	A60	Dorps River	312	1990-02-16
C	C24	Ventersdorp	777	1995-06-02

Appendix 9

Potable water supply schemes

APPENDIX 9: POTABLE WATER SUPPLY SCHEMES IN THE OLIFANTS/ DORING WMA IN 1995

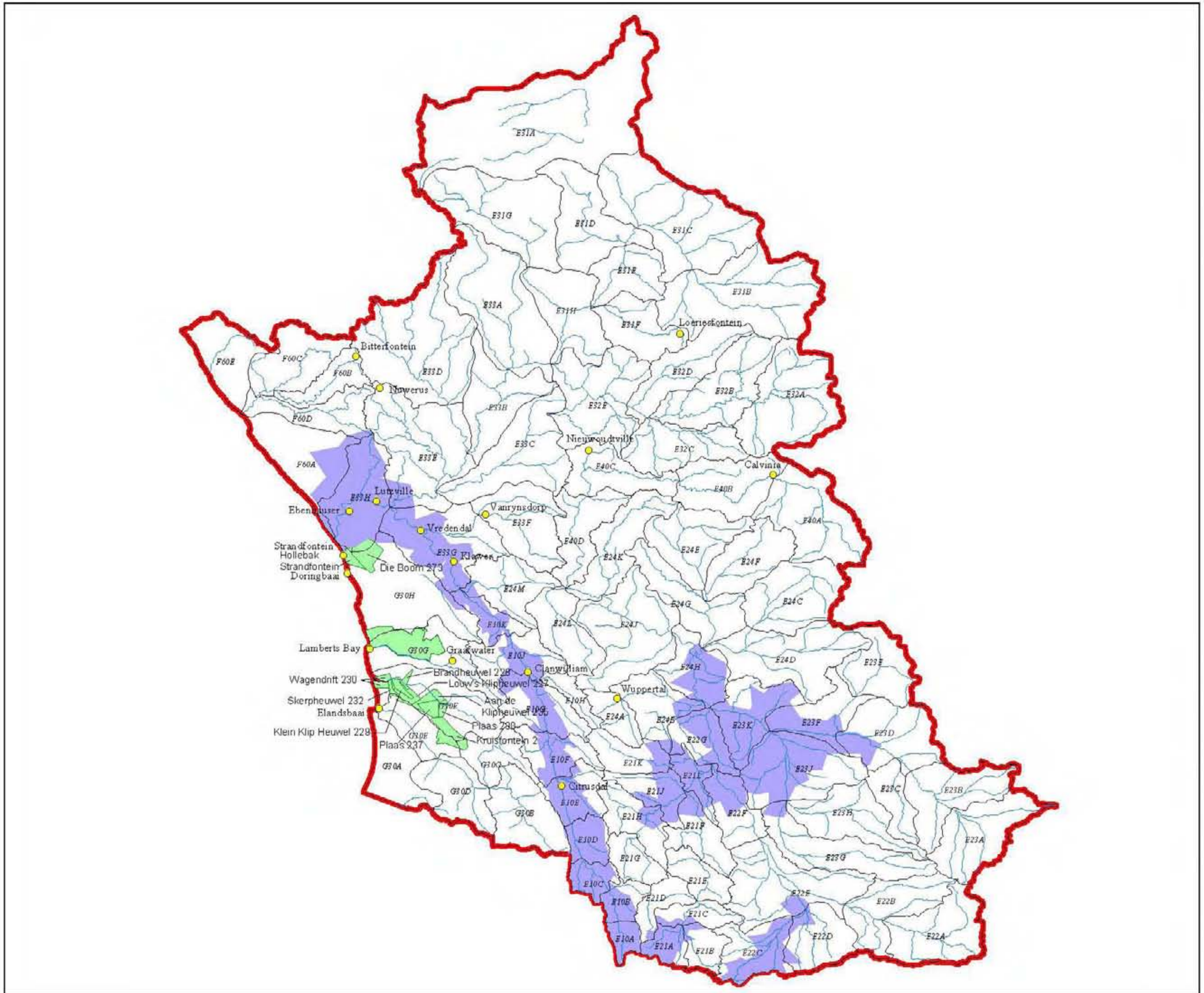
SCHEME NAME	RAW WATER SOURCE	POPULATION SUPPLIED	WATER REQUIRE-MENTS IN 1995 (million m^3/a)	SCHEME CAPACITY		
				million m^3/a	ℓ/c/d	LIMITING FACTOR
Klawer	Olifants River Govt Water Scheme Borehole	4 200	0,31	0,31	204	Raw water storage volume for use during canal maintenance
Vredendal and Vanrhynsdorp	Olifants River Govt Water Scheme	167 850	2,40	4,38	712	Treatment Works
Lutzville	Olifants River Govt Water Scheme	3 600	0,40	1,09	830	Canal capacity
Ebenhaezer, Strandfontein, Doringbaai	Olifants River Govt Water Scheme	5 000	0,40	1,05	575	Pump station, Treatment Works
Citrusdal	Olifants River	3 750	0,70	0,95	694	Treatment Works
Clanwilliam	Clanwilliam Dam, Jan Dissels River	4 400	0,83	1,5	934	Treatment Works
Graafwater	Boreholes	1 350	0,13	0,21	43	Number of bore-holes (more could be drilled)
Elandsbaai	2 boreholes	1 100	0,05	0,07	174	Borehole yield
Lambertsbaai	Groundwater (well)	4 100	0,80	at least 0,8	534	Pumps and pipelines
Bitterfontein and Nuwerus	7 boreholes	1 300	0,04	0,06	126	Number of bore-holes (more could be developed)
Rietpoort	2 boreholes	1 350	0,02	0,03	71	Availability of groundwater. Water quality
Loeriesfontein	6 boreholes	1 900	0,06	0,07	100	Groundwater quality
Nieuwoudtville	1 borehole	1 000	0,03	0,05	137	Borehole yield
Calvinia	Small dam and 3 boreholes	7 150	0,40	0,31	106	Pumps and pipelines
TOTALS FOR WMA		**57 050**	**6,57**	**10,88**	**522**	

(Source: Olifants Doring Situational Assessment, 2002)

Appendix 10

Controlled and Other Irrigation Schemes

LOCALITY MAP:



LEGEND:

- WMA Boundaries
- Towns
- Rivers
- Quaternary Catchment
- E24D Quaternary Number
- Surface Water Irrigation Scheme
- Ground Water Irrigation Scheme

PREPARED BY:

NINHAM SHAND
CONSULTING SERVICES

CLIENT:

Department: Water Affairs and Forestry
Directorate: Water Resources Planning

PROJECTION:

GEOGRAPHIC

SCALE : 1:2 100 000

10 0 10 20 30 40 Kilometers

N

TITLE:

OLIFANTS/DORING WMA

IRRIGATION SCHEMES

Prepared by:	A.Lawrence
Date:	07/2004
Data Type:	oli_irrigschemes.apr

Appendix 11

Major Dams, Infrastructure and Transfer Schemes

APPENDIX 11: MAJOR DAMS, INFRASTRUCTURE AND TRANSFER SCHEMES

SUB-AREA: Upper Olifants (E10A-H)

Supply to towns

LOCAL MUNICIPALITY	TOWNS	CURRENT SOURCES OF SUPPLY
Cederberg Municipality	Citrusdal	Olifants River

Major Dams

Dam Name	Quat	Live Storage (x $10^6 m^3$)	Yield (x $10^6 m^3/a$)				Use	Owner
			Domestic	Irrigation	Other	Total		
Clanwilliam Dam/ Bulshoek Weir combined	E10G	122 and 6	6	144	4	154	Irrigation, urban use and mining	DWAF

SUB-AREA: Lower Olifants (E33G, E33H, E24M, E10K, E10J)

Supply to towns

LOCAL MUNICIPALITY	TOWNS	CURRENT SOURCES OF SUPPLY
Matzikama Municipality	Lutzville	Olifants River Government Scheme
Matzikama Municipality	Ebenhaezer	Olifants River Government Scheme
Matzikama Municipality	Vredendal	Olifants River Government Scheme
Cederberg Municipality	Clanwilliam	Clanwilliam Dam and Jan Dissels River Weir

Major Dams

Dam Name	Quat	Live Storage (x $10^6 m^3$)	Yield (x $10^6 m^3/a$)				Use	Owner
			Domestic	Irrigation	Other	Total		
Bulshoek Weir/ Clanwilliam Dam combined	E10K	5.7	6	144	4	154	Irrigation, urban use and mining	DWAF

Transfer Schemes

Scheme Name	From	To	Transfer (x $10^6 m^3$)	Users
Namakwa Sands Mine	Olifants River Canal near Lutzville (E33H)	Namakwa Sands Mine (F60D)	2.4 (excluding losses)	Namakwa Sands Mine
Vanrhynsdorp water supply	Olifants River Canal near Vredendal (E33G)	Vanrhynsdorp (E33F)	1.16	Vanrhynsdorp for urban use
	Olifants River Canal near Ebenhaezer (E33H)	Strandfontein and Doringbaai (G30H) and to rural domestic users in the vicinity	0.4	Strandfontein, Doringbaai and rural domestic users in the vicinity
Irrigation Water Transfer	Olifants River Canal (E10K)	E24M	0.61	Irrigation in the vicinity of the confluence of the Olifants and Doring Rivers

<u>SUB-AREA: Doring (E24A-L, E40A-D, E22A-G, E23A-K)</u>

Supply to towns

LOCAL MUNICIPALITY	TOWNS	CURRENT SOURCES OF SUPPLY
Hantam Municipality	Calvinia	Small dam and 3 boreholes
	Niewoudtville	1 Borehole

Major Dams

Dam Name	Quat	Live Storage (x $10^6 m^3$)	Yield (x $10^6 m^3/a$)				Use	Owner
			Domestic	Irrigation	Other	Total		
Oudebaaskraal Dam	E23F	34.0	0	Not known	0	Not known	Opportunistic irrigation of 320 ha	Judge Burger

Transfer Schemes

Scheme Name	From	To	Transfer (x $10^6 m^3$)	Users
Inverdoon Canal	Lakenvallei Dam Catchment (H20C) in the Breede WMA	Upper Doring Catchment (E22C)	2.5	Irrigation

SUB-AREA: Knersvlakte (E31A-H, E32A-E, E33A-F, F60A-E)

Supply to towns

LOCAL MUNICIPALITY	TOWNS	CURRENT SOURCES OF SUPPLY
None – managed by West Coast District Municipality	Bitterfontein	7 Boreholes
	Nuwerus	7 Boreholes
Matzikama Municipality	Vanrhynsdorp	Olifants River Government Scheme
Hantam Municipality	Loeriesfontein	6 Boreholes

Major Dams

Dam Name	Quat	Live Storage (x $10^6 m^3$)	Yield (x $10^6 m^3/a$)				Use	Owner
			Domestic	Irrigation	Other	Total		
Driekop Dam	E32D							
Stofkraal Dam	E32E							

SUB-AREA: Kouebokkeveld (E21A-L)
None

SUB-AREA: Sandveld (G30A-H)

Supply to towns

LOCAL MUNICIPALITY	TOWNS	CURRENT SOURCES OF SUPPLY
Cederberg Municipality	Graafwater	Boreholes
	Lambertsbaai	Groundwater (well)
	Elandsbaai	2 Boreholes
Matzikama Municipality	Strandfontein and Doringbaai	Olifants River Government Scheme

Appendix 12

Equity Initiatives

APPENDIX 12: EQUITY INITIATIVES

This includes resource-poor farmers, land reform, poverty relief and capacity building.

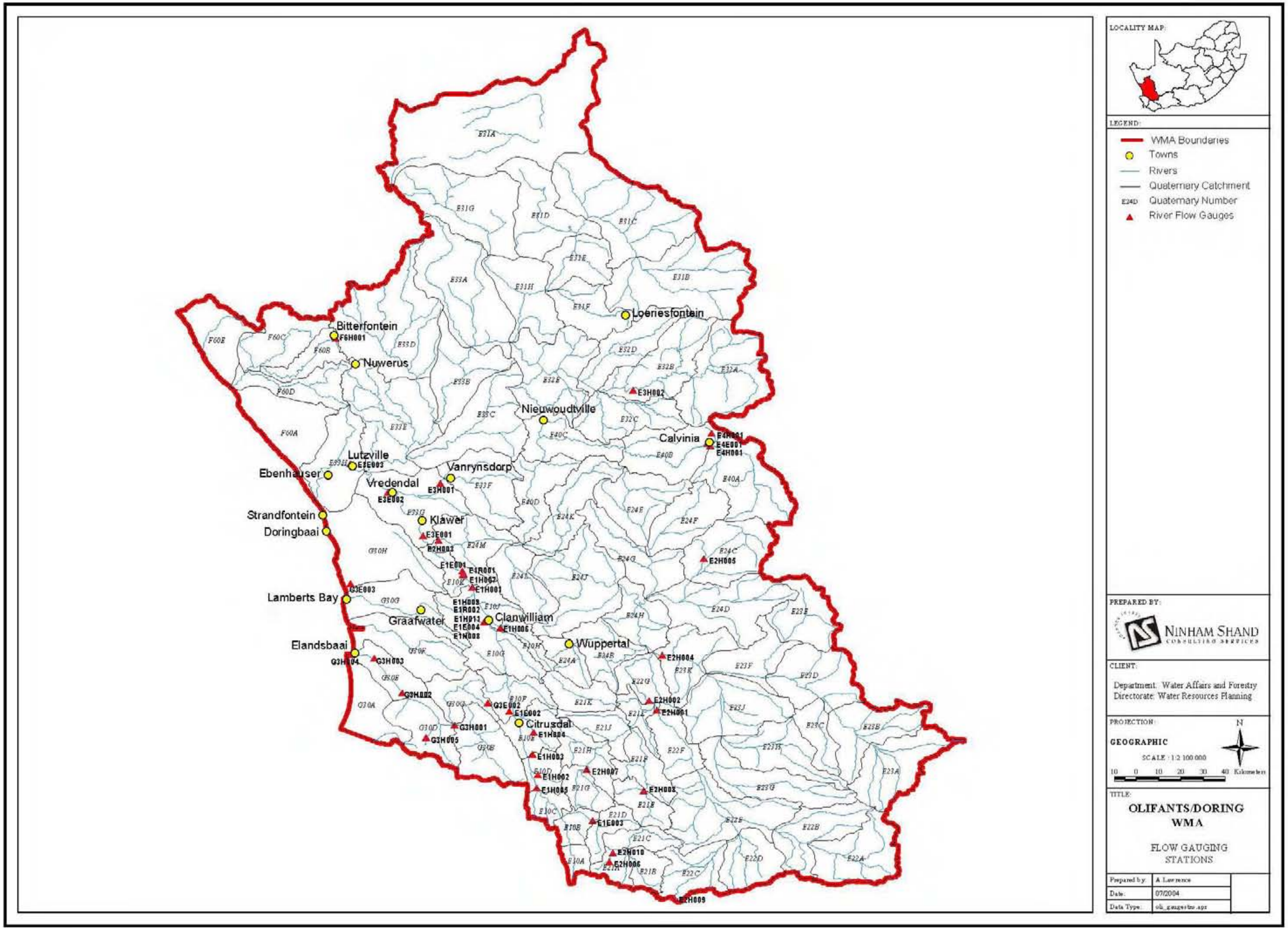
Towns/Suburbs	Project Name	Programme Type	Description
Witzenberg, Cederberg, Matzikama and Hantam	Programme to support emerging farmers accessing land, water, capacity and markets	PCM Capacity Building	Emerging Farmers
Upper Olifants (quats E10A – E10K)			
Witzenberg Valley	Caring for our valley - source of the Olifants River - schools awareness.	Champion Capacity Building	Water Awareness
Citrusdal	Elandskloof	Land Reform	
Citrusdal	Olifantstrust	Emerging Farmer	
Citrusdal	River Clean-up and Schools Awareness.	Champion Capacity Building	Water Awareness
Citrusdal	Water awareness cons. and leak repair	Champion Capacity Building	Water Conservation and Awareness – Urban
Citrusdal	Cedar Citrus / ALG Boerdery	Emerging Farmer	
Citrusdal	Spatial plan of Elandskloof for water resource management and land reform.	Champion Capacity Building	Water Conservation and Awareness – Agriculture
Vredendal	VSB (Vredendal)	Emerging Farmer	Vegetable and vine
Vredendal	Ebenhaezer Act 9	Land Reform	
Vredendal	Luiperdskop	Other	
Vredendal	Mount Pierre	Farm worker Equity Scheme	
Vredendal	Up-to-Date	Land Reform	
Vredendal	Vredendal Samewerk	Emerging Farmer	
Vredendal	Water-wise food garden for HIV / TB infected - Dorcas Care Group – Vredendal.	Champion Capacity Building	
Vredendal	Vredendal Opkomende Boere	Emerging Farmer	Chicken and Veg.
Klawer	Klawer Ontwikkeling Boerdery	Emerging Farmer	unknown
Klawer	Klawer Landbou	Emerging Farmer	unknown
Klawer	Klawer Kleinboere	Emerging Farmer	
Lutzville	Lutzville Kleinboere	Emerging Farmer	Cattle
	Olifantstrust SSF	Emerging Farmer	Initialising
Ebenhaezer	Urban WC Awareness	Champion Capacity Building	WC and Awareness
Ebenhaezer	Irrigation water use plan	Champion Capacity Building	WC and Awareness – Agriculture
Ebenhaezer	Water -wise community organic food garden	Champion Capacity Building	Water Awareness and Food Security
Ebenhaezer	Testing of micro-flood irrigation methods for water efficiency and effectivity – Ebenhaezer.	Champion Capacity Building	Water Conservation and Awareness – Agriculture
Ebenhaezer	Water conservation awareness – alien invasive vegetation removal	Champion Capacity Building	Water and Environmental Awareness
Ebenhaezer	Water Awareness Ebenhaezer Wetlands Project	Champion Capacity Building	Water and Environmental Awareness

Towns/Suburbs	Project Name	Programme Type	Description
Ebenhaezer	Water Awareness – Assessing Water Quality at the Olifants River mouth.	Champion Capacity Building	Water and Environmental Awareness
Ebenhaezer	Ebenhaezer	Emerging Farmer	Cattle
Clanwilliam	Algeria	Land Reform	Water Awareness
Clanwilliam	Boontjies River	Farm worker Equity Scheme	
Clanwilliam	Ceder Estate	Emerging Farmer	
Clanwilliam	Eikevlei / Roomsekamp	Land Reform	
Clanwilliam	Karramelksvlei	Farm worker Equity Scheme	
Clanwilliam	Clanwilliam WC and Awareness	Champion Capacity Building	Water Awareness
Clanwilliam	Paleisheuwel	Land Reform	
Clanwilliam	Leipoltville	Land Reform	
Clanwilliam	Clanwilliam SSF	Emerging Farmer	Not yet decided
Doring (quats E24A – L, E40A – D, E22A – E22G, E23A – K)			
Wuppertal	Community water awareness programme – revitalisation of Ceder-Doorn Water Forum	Champion Capacity Building	Water Awareness
	Omsien Boerdery	Emerging Farmer	Vine
Knersvlakte (quats E31A – H, E32A – E, E33A – F, F60A – F60E)			
Nuwehoop	Nuwehoop Boerdery	Emerging Farmer	Not yet decided
Vanrhynsdorp	Goedemoed / Olifants Trust	Farm worker Equity Scheme	
Vanrhynsdorp	Rietpoort Act 9	Land Reform	
Vanrhynsdorp	Schools Awareness and Competitions.	Champion Capacity Building	Water Awareness
Vanrhynsdorp	Re-using wastewater to produce fodder for resource-poor farming.	Champion Capacity Building	Water Conservation and Awareness – Agriculture
Vanrhynsdorp	Re-using waste water to produce food for HIV and TB infected persons.	Champion Capacity Building	Water Awareness, Health and Food Security
Vanrhynsdorp	Vanrhynsdorp	Emerging Farmer	Vegetable
	Rooihoogte Farm workers	Emerging Farmer	Starting project
Bitterfontein	Groundwater awareness in Bitterfontein.	Champion Capacity Building	Groundwater Awareness
Rietpoort	Groundwater monitoring and awareness around the Rietpoort Water Supply Scheme.	Champion Capacity Building	Groundwater Awareness
Op-die-Berg	Water awareness conservation and leak repair – Op-die-Berg.	Champion Capacity Building	Water Conservation and Awareness – Urban
Op-die-Berg	Aksent Droogvoet Bridge – Environmental, Poverty Relief Project	Poverty Relief	Water and Environmental Awareness
Op-die-Berg	Wethu Experiences Community Based Tourism	Local Economic Development	Environmental Awareness
Op-die-Berg	Aksent Community Services – Bring Postal, Municipal and Government Services to the community	Local Economic Development	Poverty Relief
Op-die-Berg	Water-wise Organic Food	Poverty Relief	Water Awareness, Health

Towns/Suburbs	Project Name	Programme Type	Description
	Garden - Mooihawens Church and Aksent		and Food Security
Op-die-Berg	Aksent Project Auntie Vries – warming the hearts and minds of the Koue Bokkevelders.	Health and Social	Poverty Relief
	Harmonie Trust	Emerging Farmer	
Sandveld (quats G30A-G30H)			
Elandsbaai	Water-wise community food garden – Elands Bay.	Champion Capacity Building	Water Awareness and Food Security
Lambertsbaai	Lambertsbaai Vroue Groep	Emerging Farmer	Not yet decided
Doringbaai	Doringbaai Kleinboere	Emerging Farmer	unknown
Doringbaai	Doringbos	Emerging Farmer	Not yet decided

Appendix 13

Flow Gauging Stations



LOCALITY MAP:
LEGEND:
WMA Boundaries
Towns
Rivers
Quaternary Catchment
E24D Quaternary Number
River Flow Gauges
Bitterfontein
Nuwerus
Loeriesfontein
Nieuwoudtville
Calvinia
Lutzville
Ebenhauser
Vredendal
Vanrynsdorp
Strandfontein
Doringbaai
Klawer
Lamberts Bay
Graafwater
Clanwilliam
Wuppertal
Elandsbaai
Citrusdal
F6H001
E3H002
E4H001
E4E001
E3H001
E3E002
E3E001
E2H003
E1E001
E1R001
E1H001
E1H009
E1R002
E1H013
E1E004
E1H008
E1H006
G3E003
G3H003
G3H002
G3E002
E1E002
G3H001
G3H005
E1H004
E1H003
E1H002
E1H005
E2H007
E2H003
E1E003
E2H010
E2H006
E2H009
E2H004
E2H002
E2H001
E2H005
PREPARED BY:
NINHAM SHAND
CONSULTING SERVICES
CLIENT:
Department: Water Affairs and Forestry
Directorate: Water Resources Planning
PROJECTION:
GEOGRAPHIC
SCALE : 1:2 100 000
10 0 10 20 30 40 Kilometers
N
TITLE:
OLIFANTS/DORING
WMA
FLOW GAUGING
STATIONS
Prepared by: A Lawrence
Date: 07/2004
Data Type: oli_gaugestns.apr