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DEVELOPMENT OF A RECONCILIATION STRATEGY FOR THE OLIFANTS RIVER WATER SUPPLY SYSTEM

WP10197

Report on Possible Water Conservation and Demand Management Measures

Original

FINAL REPORT
December 2011

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Report no.: P WMA 04/B50/00/8310/5

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Glossary of Terms

Allocatable Water
Water which is available to allocate for consumptive use.

Database
Accessible and internally consistent sets of data, either electronic or hard copy with spatial attributes wherever possible.

Environmental Water Requirement
The quantity, quality and seasonal patterns of water needed to maintain aquatic ecosystems within a particular ecological condition (management category), excluding operational and management considerations.

IWRM Objectives
The objectives and priorities for water resource management, for a given time frame, which have been agreed by the parties as those which will best support the agreed socio economic development plans for the basin.

IWRM Plans
A set of agreed activities with expected outcomes, time frames, responsibilities and resource requirements that underpin the objectives of IWRM.

Management Information System
Systems such as GIS which provide a user friendly interface between databases and information users.

Resource Classification
A process of determining the management class of resources by achieving a balance between the Reserve needs and the beneficial use of the resources.

Acid Mine Drainage
Decanting water from defunct mines which have become polluted and acidic and that reach the resource.

Level of Assurance
The probability that water will be supplied without any curtailments. The opposite of Level of Assurance is the risk of failure.

Internal Strategic Perspective
A DWA status quo report of the catchment outlining the current situation and how the catchment will be managed in the interim until a Catchment Management Strategy of a CMA is established.

List of Abbreviations & Acronyms

CMA	Catchment Management Agency
DWA	Department of Water Affairs
DWAF	Former Department of Water Affairs and Forestry
EMF	Environmental Management Framework
EWR	Ecological Water Requirements (Ecological Component of the Reserve)
GIS	Geographical Information System
IB	Irrigation Board
IDP	Integrated Development Plan
IWRM	Integrated Water Resources Management
IWRMP	Integrated Water Resources Management Plan
LNW	Lepelle Northern Water Board
OWAAS	Olifants Water Availability Assessment Study
ToR	Terms of Reference
WC/WDM	Water Conservation /Demand Management
WMA	Water Management Area
WRC	Water Research Commission
WRSM	Water Resource Simulation Model
WRYM	Water Resource Yield Model
WUA	Water User Association

EXECUTIVE SUMMARY

The Olifants River catchment is currently one of South Africa's most stressed catchments as far as water quantity and water quality is concerned. The main purpose of this study is to develop reconciliation strategies to resolve this water stressed situation, both in the short and long term. The strategies do not necessarily entail the augmentation of the water resource. Experience has shown that often the most cost effective option is to reduce the water demand, especially if the existing water use is inefficient.

The purpose of this report is to report on water use efficiency within the study area and suggest likely savings that can be made based on experience from other water conservation and demand management initiatives. This analysis of water use efficiency considers several water use sectors separately since each sector has its own characteristic or benchmark efficiency which should be achievable. The sectors considered in this report are:

- *Urban,*
- *Rural,*
- *Irrigation,*
- *Mining,*
- *Industrial, and*
- *Power generation.*

The urban sector is generally inefficient with its water use, with unaccounted for water use in Emalahleni being especially high. Of concern is the lack of reliable information of the water use efficiency in Polokwane.

Rural water use within the context of this report refers to water supply areas where there is a low level of service and often no, or limited payment for services. This is typical of rural areas where basic services are free. Although these schemes are not necessarily using water efficiently there is little scope for saving due to the low level of service.

The largest water user sector in the Olifants River catchment is by far the irrigation sector. Due to rapidly increasing pumping costs it is suggested that irrigators can no longer afford to be inefficient and that irrigators within the Olifants are becoming increasingly efficient with their water use. Nevertheless, there is still widespread use of irrigation techniques that are less than optimal and replacing sprinklers with drip irrigation could result in significant savings. However, in the past there has not been much success in saving water through WC/WDM in the irrigation sector because any water saved by irrigators through improved efficiency is used to expand the irrigated area. It is suggested in this report that real savings can be achieved through one of two mechanisms:

- *Trading of the saved water to other water use sectors. This would require willing sellers and willing buyers.*
- *Compulsory licencing to reduce allocations by the amount of water saved.*

The mining sector is already very efficient with its water use due to the very high value that mines (specifically the platinum mines) place on their water. However, the mining sector has indicated that technology is available to reduce their demands by up to 10% through improved recycling techniques. A possible area for reducing water allocations to the mining

sector is to evaluate the water use by the coal mines. There is an estimated allocation of 20 million m^3/annum to coal mines in the Upper Olifants, but as coal mines develop they generate surplus water. It seems likely that the original allocations are in most cases no longer required and a significant amount of water could be saved by withdrawing these allocations, either through compulsory licensing or by non-renewal when the licence expires. This would need to be done in close consultation with the coal mining sector.

The water use by the industrial sector within the study area is relatively small and hence the scope for water savings from this sector is very limited.

The second largest user of water in the study area is power generation and while their water use is efficient, there is nevertheless scope for improved efficiency and water savings. These savings would however necessitate very costly water reclamation works. It is also debatable whether water saved by the power generation activities within the study area would be reallocated to users in the Olifants River catchment, or be seen as a saving from the water source, which in this case is the Komati and Vaal river catchments.

The table below provides a summary of the estimated maximum reduction in water demand that could be achieved per water use sector.

Table 1: *Summary of possible water savings*

Sector	Current water requirement (million m^3/a)	Estimated saving (million m^3/a)	Comment
Urban	140.4	32.1	Achievable
Rural	29	0	Problematic due to existing low levels of service
Irrigation • Improved irrigation systems • Improved conveyances	486	 19 16	Requires willing buyer/willing seller Very costly
Power generation	228	27.3	Very costly to Eskom
Mining	86	5	
Industrial	9.0	~0	
Total	**978.4**	**99.4**	

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1. INTRODUCTION

1.1 PURPOSE OF THIS STUDY

The Olifants River catchment is currently one of South Africa's most stressed catchments as far as water quantity and water quality is concerned. The main purpose of this study is to develop reconciliation strategies to resolve this water stressed situation, both in the short and long term. The strategies do not necessarily entail the augmentation of the water resource. Experience has shown that often the most cost effective option is to reduce the water demand, especially if the existing water use is inefficient.

1.2 PURPOSE OF THIS REPORT

The purpose of this report is to report on water use efficiency within the study area and suggest likely savings that can be made based on experience from other water conservation and demand management (WC/WDM) initiatives. This analysis of water use efficiency considers several water use sectors separately, since each sector has its own characteristic or benchmark efficiency which should be achievable. The sectors considered in this report are:

- Urban
- Rural
- Irrigation
- Mining
- Industrial
- Power generation

1.3 REPORT STRUCTURE

The report has been structured to disseminate the information within each water use sector. The efficiency of each sector is described followed by an analysis of possible savings within each.

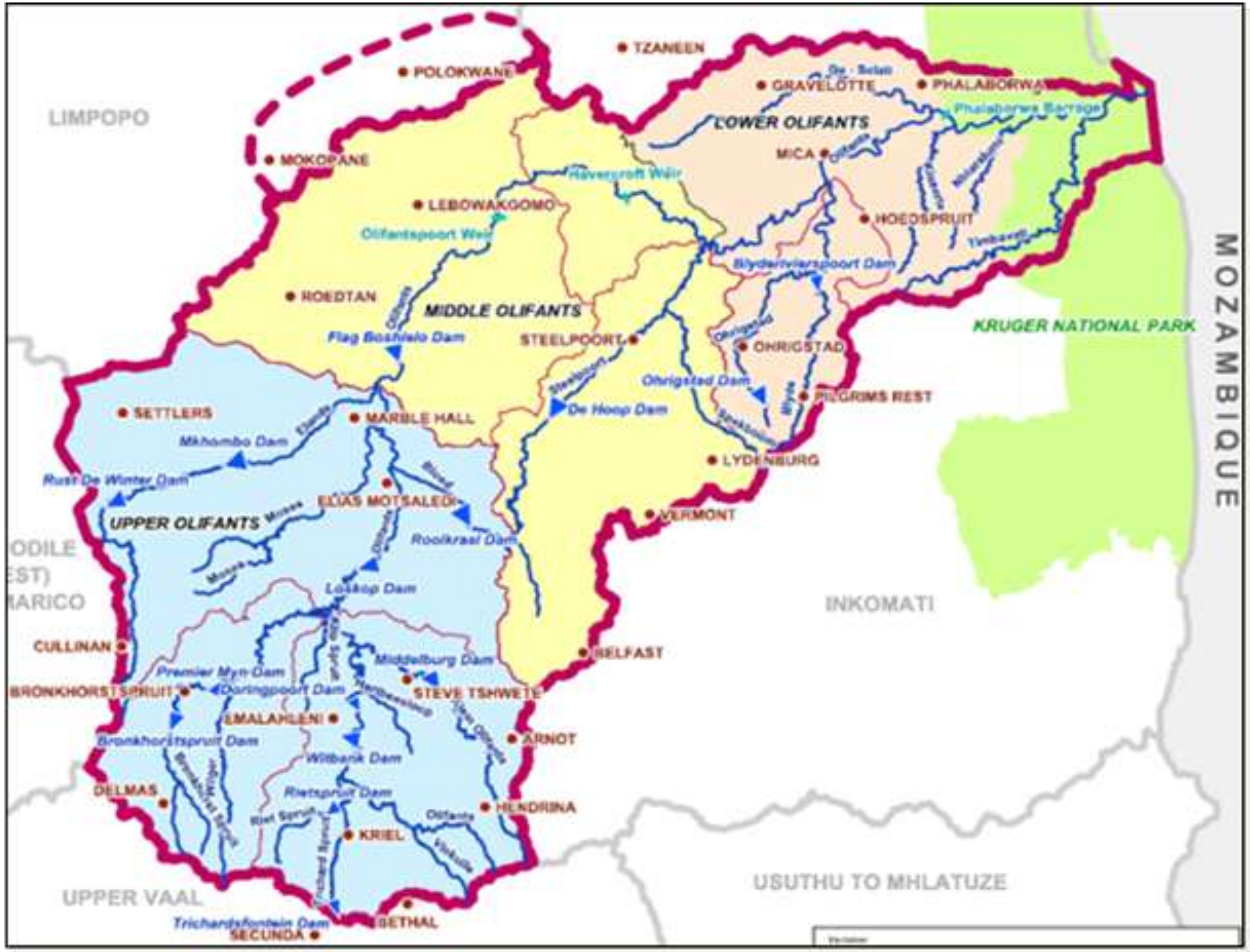

Figure 1.1: Study Area with Sub-Catchments

2. SOURCE OF INFORMATION

The Terms of Reference (ToR) for this study referred to the following previous studies from which to obtain water use and water resources information:

- Upper and Middle Olifants River Catchment: The Development of an Integrated Water Resources Management Plan (**Study 1**),
- Assessment of Water Availability in the Olifants Water Management Area by Means of Water Resource Related Models (**Study 2**),
- Development of Operating Rules for the Olifants River System (**Study 3**), conducted by Water Resources Planning Systems Directorate; and
- Development of Reconciliation Strategies for All Towns in the Northern Region (**Study 4**), conducted by NWRP Directorate.

In addition to the above reports, the Directorate: Water Use Efficiency, commissioned a study on WC/WDM in the Olifants Water Management Area (WMA) in 2006 and it was anticipated that all the necessary information on WC/WDM would be available from these reports. However, it was found that many of the reports on the Urban and Rural sector were never completed and attempts to obtain the information from the relevant Professional Service Provider proved unsuccessful within the timeframe of the project deliverables. The following completed reports from the aforementioned study were used as input to this study:

- WC/WDM report on Emalahleni
- WC/WDM report on Lebowakgoma
- WC/WDM report on Eskom
- WC/WDM report on the irrigation sector

In November 2010, certain draft reports from the All Towns Study became available, and although reports for every town had not been completed, those received added considerably to the WC/WDM information within the Urban and Rural sectors. In addition, limited field visits were made to several of the larger towns to confirm water use efficiency estimates and obtain new estimates where necessary.

In addition, Integrated Development Plans (IDPs) were also referred to for information on water use efficiency. While these plans should contain comprehensive situation assessments of the water services aspects, only the IDP for the Phalaborwa area (Ba-Phalaborwa Municipality, 2010), commented on the water use efficiency.

It was stated in the ToR of this study that the All Towns study would provide water requirement projections for domestic and other users up to year 2030, as well as first order reconciliation strategies, taking into account the available water resource. Hence only limited field work to collect primary data has been undertaken as part of this Reconciliation Strategy Study.

Other valuable sources of information used were:

- The Lepelle Northern Water Board Business Plan, and
- Personal consultation with chairpersons of several irrigation boards.

3. METHODOLOGY

The overall approach taken in reporting on water use efficiency is to express efficiency (or water loss) as a percentage of the total consumptive use. Possible savings were then determined by means of benchmarking that is, applying generally acceptable losses for each sector. These norms are as follows:

- Urban water use: 15% loss
- Rural water use: 20% loss
- Irrigation:
  - Commercial farmers: 15% (90% irrigation efficiency and 5% transmission losses)
  - Emerging farmers: 25% (85% efficiency and 10% transmission losses)
- Mining: 5%
- Industry: 5%
- Eskom: 5%

Although emerging farmers should ultimately not be measured against a different benchmark from established commercial farmers, it is well known that new upcoming emerging farmers, who have to do their beyond-field-edge-irrigation-system development themselves and at their own cost, start modestly, with less sophisticated conveyance and irrigation systems, such as unlined canals and use of a flood irrigation respectively. As they progress and become more established, they upgrade their systems until they attain the same efficiencies as the established commercial farmers. In order to allow for the progressive development of efficiency by emerging farmers, two different benchmarks for these two respective groups have been allowed for.

4. URBAN SECTOR

Based on the limited urban WC/WDM investigation carried out as part of the Olifants WC/WDM study (DWAF, 2007), it appears as if losses in the Urban and Rural sectors are very high. This was confirmed by the All Towns Study as well as personal interviews carried out as part of this reconciliation strategy study. **Table 4.1** summarises the total water consumption and unaccounted for water (or loss) for each town for which data was available.

Table 4.1: Water use and loss of the Urban Sector

Town	Total consumptive water use (million m^3/annum)	Water loss (%)	Primary source of information
Emalahleni	35.8	50	All Towns
Middelburg	12.6	20	All Towns
Groblersdal/Marble Hall	2.0	Unknown	
Bronkhorstspruit	3.4	Unknown	
Western Highveld	35	50	All Towns
Polokwane	7.0[1]	Unknown	
Lebowakgoma	8.3	30	Comprehensive study
Burgersfort	1.5	15	All Towns
Lydenburg	3.2	75	All Towns
Belfast	0.9	Unknown	
Phalaborwa	24.5	Low, probably meeting the benchmark of 15%	Lepelle Northern Water
Hoedspruit	2.3	Unknown	

Notes: 1. The consumptive water use for Polokwane related only to that supplied from the Olifants River catchment and not the town's total water use.

Emalahleni was noted in the Comprehensive WC/WDM Study (DWAF, 2007a) as having very high losses and this was confirmed by the All Towns Study (DWA, 2010) and through personal communication with municipal officials. It needs to be taken into consideration that about 8 million m^3/annum of the raw water abstracted from Witbank Dam is supplied to Highveld Steel while the loss in the treatment and reticulation process is stated as being a loss of 17.9 million m^3/annum. The implication of this is that the loss is mostly within the Municipal distribution network and is not due to losses within the industrial use.

Middelburg has a loss of only 20% which is close to the accepted benchmark of 15%.

Phalaborwa was not dealt with by either the Comprehensive WC/WDM study or the All Towns study. The Lepelle Northern Water (LNW) Business Plan (2009) does not state the loss but indicates that 5Ml/day could be saved through implementation of WC/WDM. This equates to about 8% of the water supplied. However, LNW also supplies the mines in the area, and this saving does not relate only to the urban sector. The Integrated Development Plan for the Phalaborwa Municipality (Ba-Phalaborwa Municipality, 2010) indicates a loss of 10Ml/day, relating only to the urban sector. This equates to an efficiency of about 15% which meets the benchmark.

Water use in **Lebowakgomo** is inefficient with losses in the order of 30% (DWAF, 2007). Considering that there are no WC/WDM measures in place, these losses are not as severe as might be expected. The Comprehensive WC/WDM assessment (DWAF, 2009) does however recommend various measures that could be implemented to reduce these losses down to acceptable limits.

No quantitative information on water use efficiency within **Polokwane** could be obtained. It seems as if metering within this town is not sufficiently accurate to determine losses. An interview with officials did however confirm that losses were a serious problem. No measures were in place nor are any yet planned to quantify or alleviate the problem.

The water supply to the town of **Burgersfort** is efficient with a loss of only 15% (DWA, 2010g).

According to the All Towns Study (DWA, 2010b), **Lydenburg** experiences a loss of 2.4 million m^3/annum. This implies a loss of 75% which seems unlikely. A possible reason for this apparent anomaly could be the town's water balance calculation. This may be affected by discrepancies between the bulk metering and distribution metering / water sales record. A loss of 50% has been assumed.

The **Western Highveld** is well known for its high losses and numerous studies and infrastructure improvements have been undertaken to improve the situation but with limited success. The main problem seems to be the large number of illegal connections and lack of payment for services. It is interesting to note that in the IWRMP report (DWAF, 2008), the projected water demands for the northern parts of the Western Highveld indicated a reduction in water use from 19 million m^3/annum in 2005 to 11 million m^3/annum in 2010, based on successful implementation of water conservation measures. In reality what has happened is that actual water consumption has in fact increased to 22 million m^3/annum, resulting in a 100% increase from what was estimated. This serves as an example of how uncertain projections of water use can be, especially when recommended actions (in this case water conservation measures) are not followed through on an on-going and committed basis after initially being implemented.

5. RURAL SECTOR

The distinction between urban and rural areas used in this WC/WDM analysis is based on level of service as defined in DWA's Water Services Database. Any water user with a level of service less that 'B' is considered to be rural. Rural water use is generally associated with low per capita water use and while it is accepted that there are water losses in the rural water supply schemes, reducing the supply to users who are already receiving low per capita service is not recommended and it is not anticipated that significant savings from this sector can be realised. Nevertheless, increased levels of service to rural communities should not proceed without an evaluation of the losses associated with existing rural water supply schemes and action to reduce these losses to within acceptable norms where necessary.

6. IRRIGATION SECTOR

6.1 SOURCE OF INFORMATION

The Comprehensive WC/WDM study carried out by D: Water Use Efficiency also considered water use by the irrigation sector, and a separate report on this sector was produced (DWAF, 2007b). That report focused on the potential for WC/WDM in the irrigation sector in the Olifants and Inkomati Water Management Areas (WMAs). The goal of that study was to collect data from Water User Associations (WUAs) and Irrigation Boards (IBs) in the catchments, in order to develop a water management plan that would identify ways and means for improving water use efficiency in the irrigation sector in the Olifants and Inkomati WMAs, so as to quantify the water savings that could potentially be achieved. That study did not consider all irrigators in the Olifants but only selected a few representative IBs. The main gap in that study was therefore that it did not consider any of the irrigators lying outside of IBs or WUAs, referred to hereafter as uncontrolled irrigation.

Another important source of information used is the report on 'Standards and Guidelines for Improved Efficiency of Irrigation Water Use from Dam Wall Release to Root Zone Application' (Agricultural Research Council, 2010).

6.2 EFFICIENCY WITHIN THE IRRIGATION SECTOR

There are three main factors affecting the efficiency of water use within the irrigation sector. These are:

- losses in the conveyance system (river or dam to field edge),
- losses relating to the type of application method (e.g., flood irrigation, sprinkler etc.), and
- the scheduling of the irrigation. With the aid of potentiometers (which measure the soil moisture), the right amount of water can be applied at the right time, substantially reducing losses.

Losses occurring in closed conveyance systems vary from as low as 1 to 2% where pipelines are used and where the distance from the source of water to field edge is short, to as high as 30% where unlined canals are used to transport water over long distances.

According to numerous sources, (Koegelenberg, 2002 and Loxton Venn, 1995), typical losses relating to the type of irrigation system are given in Error! Reference source not ound.. However, recent work completed by the Agricultural Research Council (ARC) under the auspices of the Water Research Commission (Agricultural Research Council, 2010) indicates much greater efficiency than previous estimates. These newly recommended 'design norms' are also indicated in Error! Reference source not found. or comparison purposes. It is noted that these new design norms deviate considerably from conventional wisdom and it is suggested that DWA need to make a policy decision as to whether to accept these drastically improved efficiencies or not since it affects DWA's WC/WDM strategies. If irrigation is really as efficient as suggested in the ARC report then DWA should rather concentrate their WC/WDM measures on local municipalities where the losses are often very high.

Table 6.1: Typical Losses associated with irrigation systems

Irrigation system	Loss (% of total river abstraction)	
	Conventional	ARC, 2010
Flood	40	2 to 14
Sprinklers (permanent)	25	10
Sprinklers (quick coupling)	30	17
Sprinklers (Micro systems)	20	15
Centre Pivot	15	10
Drip systems	10	5

Source: 1. Koegelenberg, F.H. 2002, DWAF, 200b
2. Loxton Venn, 1995 cited on Pitman et al, 2008.
3. Agricultural Research Council, 2010

The efficiency related to applying rigorous irrigation scheduling based on soil moisture as opposed to a simple (often constant) application rate is very site specific and hence difficult to generalise. However, almost all irrigators within irrigation boards are already applying sophisticated scheduling techniques and any further significant savings are not possible through improvements in scheduling.

6.3 CONTROLLED IRRIGATION

The irrigation boards that were analysed as part of the Comprehensive WC/WDM study (DWAF, 2007b) are shown in **Table 6.2** and findings from that study summarised in the sections below.

Table 6.2: Irrigation schemes analysed as part of the Comprehensive WC/WDM study (DWAF, 2007b)

Irrigation Board	Scheduled Area (ha)	Application Rate (m^3/ha/annum)	Allocated Volume (million m^3/annum)
Loskop	16 117	7 700	124.1
Blydepoort	8 978	9 900	88.9
Central Steelpoort	350	7 700	2.7
Ohrigstad GWS (incl Kaspersnek-Vyehoek IB)	1 857	7 000	13.0
Lower Spekboom	750	5 000	3.8
Great Dwars	41	6 700	0.3

6.3.1 Loskop Irrigation Scheme

The Loskop Irrigation Board has a total of 16 117ha of scheduled area of irrigation land (according to DWAF, 2007b) with a full quota of 7 700 m³ per hectare per annum. This equates to a full allocation of 124 million m³/annum.

The main source of water provision to this scheme is Loskop Dam. The scheme consists of a network of concrete lined canals and seven balancing dams. Irrigation systems used include centre pivot, drag lines, micro, drip, and travelling gun.

Existing water management problems are primarily quality related and include algae and water grass. Years of historical data on water releases into their canal network are available. Water orders from farmers are the main data input which is captured in the Water Allocation System (WAS) database and used to calculate water releases from the Loskop Dam. Weather data is also published on their website for use by farmers or consultants that provide irrigation scheduling services.

During the course of this Reconciliation Study, DWA requested that the losses associated with the Loskop Irrigation Board canals be investigated in more detail, specifically to ascertain the following:

- What are the losses from the canals?
- What assumptions are made regarding these losses? Do they return to the river or are they lost through evaporation?
- How much of this loss can be reduced by repairing leaks from the canals?

The above questions were addressed through new information obtained from a WRC research project (Agricultural Research Council, 2010) as well as correspondence with members of the Loskop Irrigation Board (van Stryp, 2011). The losses published in the afore-mentioned publication are shown in **Table 6.3** and graphically in **Figure 6.1.**

Table 6.3: Loskop Irrigation Board % loss summary period 2000 to 2005

Loskop Irrigation Board					
Year	**Quota (m³/yr)**	**Ordered (m³)**	**Released (m³)**	**Difference (m³)**	**% Loss**
2000/2001	123 346 303	120 066 103	150 635 473	30 569 370	20.3
2001/2002	123 346 303	118 108 993	130 889 884	12 780 891	9.8
2002/2003	124 047 003	126 200 417	160 757 342	34 556 925	21.5
2003/2004	62 122 447	59 307 750	86 055 269	26 747 519	31.1
2004/2005	124 244 893	97 613 397	118 532 099	20 918 702	17.6

Source: Agricultural Research Council, 2010.

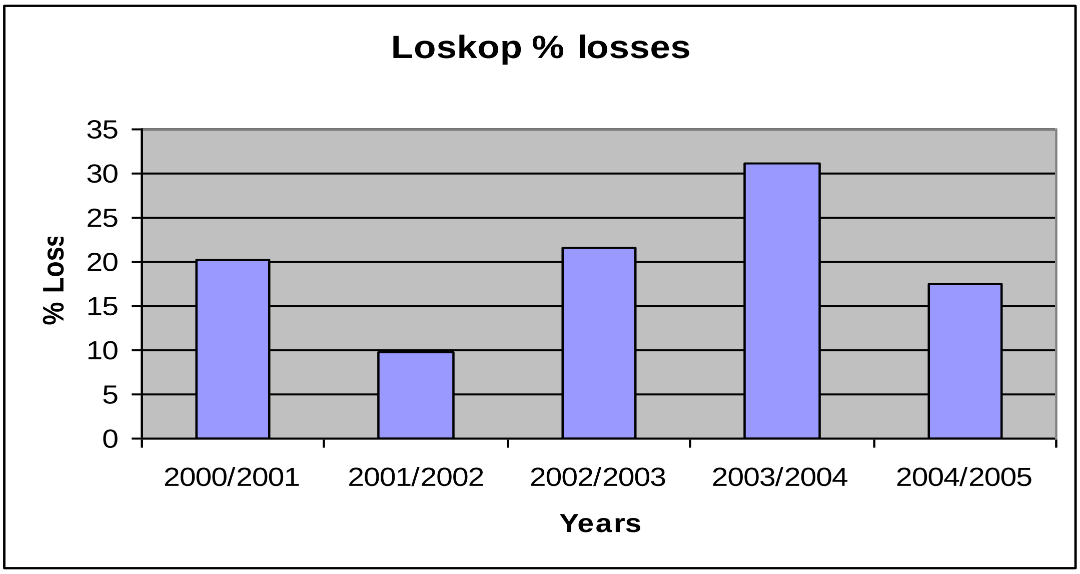

Figure 6.1: Loskop % loss graph for period 2000 to 2005
Source: Agricultural Research Council, 2010.

It is clear from the above information that the losses are highly variable ranging from a maximum of 31% to a minimum of just under 10%. Of more importance from a WC/WDM perspective is what is defined as a loss and how much of this loss can be saved. After consultation with Mr Johan van Stryp (Loskop Irrigation Board), the following breakdown of the losses was made, based on an average annual loss:

- Evaporation from the canal surface: 5 to 7%
- Leakage through canal joints: 5%
- Water released from the dam but not abstracted: 10%

From a water resources perspective the quoted loss of 20% is in fact only half of this since about half of the stated loss is an operational one. An operational loss in this context is water ordered by irrigators and released from the dam into the canal but which is not fully abstracted from the canal for whatever reason. This water returns to the river and becomes available to downstream users.

From a WC/WDM perspective, only the estimated 5% loss from the canal joints can be reduced by improved canal maintenance. The evaporation loss could only be reduced by replacing the canals with pipelines as has been done at the Blyderivierpoort Irrigation scheme. This would however be extremely costly.

6.3.2 Lower Blyde River WUA

The main crops cultivated in this area are citrus and mangoes for the export market. All inflows and outflows are measured with accurate meters, and data is collected via telemetry. Existing lawful water use entitlements are 8 978.1 hectares with a full allocation of 9 900 m^3/ha/annum. Hence the total allocation in terms of annual water requirement is 88.9 million m^3/annum.

Most of the irrigation systems are micro or drip irrigation with only the sweet corn being grown under centre pivot and sprinkler irrigation. The scheme is well organised and managed, data collected monthly, fitted with telemetry for remote control and monitoring.

An interesting aspect of the Blyde River scheme is that in the 1990s the canals (mostly unlined) were replaced with a gravity pipeline with a design capacity of 4,6 m^3/s. As a result, losses were substantially reduced.

6.3.3 Great Dwars River Irrigation Board

An increase in mining activity in the area has led to trade in water use licences from irrigation to mining and as a result there is no longer much irrigation taking place within the great Dwars River Irrigation Board. In 1936 the IB had 1202 ha of water rights allocated at a quota of 6700 m^3/ha/annum, but most have been converted to mining water with only 41ha remaining under irrigation.

6.3.4 The Lower Spekboom River Irrigation Board

The Lower Spekboom scheme originally supplied water to 51 farms and 1 037 ha were listed. Irrigation was by means of flood irrigation and was applied directly from an unlined canal. The canal is however constructed in soils with very high clay content and hence losses from the canal are thought to be low.

More recently, many of the smaller properties merged to create larger units and now only 10 active irrigation farmers remain. The actual irrigated area is estimated at 750ha. Most of the flood irrigation systems have been converted to centre pivot irrigation, with a few quick coupling sprinkler and micro irrigation systems. In its early days, the scheme was planted with mostly tobacco and wheat but the cropping patterns have changed to maize, soya and wheat with a few nurseries producing flowers.

The application rate within the Lower Spekboom IB is 5 000 m^3/ha/annum resulting in a current water requirement of 3.75 million m^3/annum.

6.3.5 Ohrigstad Irrigation Scheme

The Ohrigstad Irrigation scheme receives water from the Ohrigstad Dam to supplement rainfall and run-of-river abstractions. The scheme currently consists of approximately 3 000ha although only 1 857ha of this appears to be scheduled. At an application rate of 7 000 m^3/ha/year this implies a current demand of 13 million m^3/annum. The crops irrigated are citrus, lucerne, wheat and vegetables. The citrus is irrigated efficiently with drip and micro sprinklers while the other crops are irrigated less efficiently with centre pivots.

6.3.6 Central Steelpoort Irrigation scheme

Most of the irrigation water allocation within the Central Steelpoort Irrigation scheme has been traded with mines and there are now only two active farmers left, who together irrigate approximately 350 ha. At an application rate of 7 156 m^3/ha/annum this equates to a current demand of 2.7 million m^3/annum. The system consists of unlined canals but pumping directly from the river also takes place. The main crops are lucerne, maize, wheat and vegetables. Irrigation is mostly by means of centre pivots and quick-coupling sprinkler systems with about 15% of the area still under flood irrigation. At the lower end of the Steelpoort River on the left bank there is another small scheme called "Praktiseer" or Tswelopele of 400 ha. This will require another 2.8 million m^3/ha/annum.

6.3.7 Other irrigation schemes

As part of this Reconciliation Strategy Study, several irrigation boards were contacted and the information obtained is included in **Appendix A.** This confirmed a trend noticeable in the Comprehensive WC/WDM study (DWAF, 2007c) that the irrigation board areas scheduled by DWA are seldom the same as those scheduled by the board itself. Hence the information on actual areas and hence water use are not accurate.

6.4 UNCONTROLLED IRRIGATION

According to the Olifants Water Availability Assessment Study (OWAAS) (DWA, 2010), there are large areas of uncontrolled irrigation within the Olifants River catchment, with a total estimated area of 46 721 ha. With the aid of an irrigation model, the estimated water use of this uncontrolled irrigation is 297 million m^3/annum. However, since much of this irrigation relies on run-of-river abstractions, the assurance of supply and actual use is much less than the requirements due to the limited water availability. In some areas, especially the Elands and Moses Rivers, irrigation seems to be practiced at very low levels of assurance. It is likely that these 'irrigators' only plant a single summer crop and supplement rainfall, when water is available in the river. With the aid of the WRYM model set up as part of the OWAAS (DWA, 2010), the actual supply to these uncontrolled irrigators was estimated to be 171 million m^3/annum. The assurance of supply to uncontrolled irrigation is high in the Upper Olifants and generally very low in the remainder of the Olifants River catchment.

7. MINING WATER REQUIREMENTS

Water use by the mining sector is generally very efficient for several reasons. Firstly, water is a crucial resource, especially on the platinum mines, and these mines use water very sparingly, recycling as much as possible. The mines also have the advantage over irrigators of having the relevant in-house expertise readily available on site, to ensure the efficient utilisation and management of their water supply. Another factor contributing to efficient use by the mining sector is that strict licence conditions are placed on the mines' water use licences relating to the discharge of effluent (and the cost thereof). It therefore pays a mine to recycle its water rather than discharge large volumes of it into the river after use.

Despite the high levels of water use efficiency already in place, representatives from the platinum mining sector have indicated the possibility to improve their efficiency by 10% but this would be relatively expensive.

A possible option for reducing water allocations to the mining sector is to evaluate the water use by the coal mines. There is an estimated allocation of 20 million m^3/annum to coal mines in the Upper Olifants, but as coal mines develop they generate surplus water from mining activities. It seems likely that the original allocations are in most cases no longer required, and a significant amount of water could be saved by withdrawing these allocations, either through compulsory licensing or by non-renewal when the licences expire. This would need to be done in close consultation with the coal mining sector.

8. INDUSTRIAL WATER REQUIREMENTS

The only two industries within the Upper Olifants sub-catchment with clearly defined water requirements are Highveld Steel, who obtains their water from Witbank Dam via the Emalahleni Municipality and Gouda/Festival Farms near Bronkhorstspruit. The largest of these users, Highveld Steel, was contacted with regard to their water use efficiency and it was ascertained that they recycle all their water use on site and that their operation is very efficient.

9. STRATEGIC WATER REQUIREMENTS

There are several large power stations located in the Upper Olifants sub-catchment which have large water requirements related to their cooling process. These power stations are Arnot, Duvha, Hendrina, Kriel, Matla and Kendal. Since all of these power stations are supplied from either the upper Komati or the Vaal Systems, any water savings made will not benefit the Olifants River catchment. The water efficiency of the power stations was nevertheless investigated as part of the Comprehensive WC/WDM study.

The conclusion of this report is that Eskom's wet-cooled stations do not meet international benchmarks but nevertheless perform at substantially better levels than European and American wet cooled power stations. The main reason for the power stations in the study area not meeting international best practice is the advanced age of these plants and hence the old technology used in their design.

The WC/WDM report (DWAF, 2007c), found that the efficiency of the five wet-cooled plants varies, implying that there is scope for improvement. Water use efficiency varied from 1.94 l/units generated at Matla to 2.3 l/units generated at Hendrina. The units referred to here is the amount of water required to generate a unit of power, in this a Kilowatt hour. The report concluded that Hendrina could improve its water use efficiency by improved ash dam seepage recovery rates, enhanced drift elimination and improvements in thermal efficiency. In addition, the report concluded that all of the wet-cooled stations would benefit from installation of a dry ash handling system, which would necessitate installation of desalination plants at each power station. These two investments would cost each station an average of R745 million. The water savings related to these enhanced processes are given in **Table 10.6.**

10. POTENTIAL SAVINGS THROUGH THE APPLICATION OF WC/WDM

10.1 GENERAL APPROACH

The general approach taken in estimating potential savings is to assume that the saving that can be achieved, as a percentage of current water use, is the difference between the current loss and the benchmark loss. The irrigation sector is, however, an exception in that increased efficiency merely leads to an increase in irrigated area and the water consumption saved is not made available to other users. There does not appear to be an easy way around this problem since irrigators are allocated a particular volume and they will generally utilise all this water. It is also argued that with the rapid increase in pumping costs, irrigators can no longer afford to operate inefficiently and that most irrigators are operating at their economic optimum with regard to efficiency. The implication of this is that there is no economic incentive for irrigators to become more efficient as they already are as efficient as they can within the scale of economic benefit.

One way of counteracting the horizontal expansion with saved water is to link the WC/WDM measures to compulsory licensing. In this manner irrigators are forced to relinquish a portion of their allocation and by applying WC/WDM they will be able to irrigate the same areas and maintain the same crop yields and associated incomes. It is, however, of utmost importance that the compulsory licensing and WC/WDM initiatives run concurrently, if compulsory licensing is ever implemented.

Another possibility that was proposed by the mining sector is for the mines to pay for the measures to improve the efficiency of irrigators (where these can be clearly identified) but the saved water then be allocated to the mines. Considering that the mines are prepared to pay between R5 and 10/m^3 for their water, this will result in much greater investment in WC/WDM than the irrigation sector can afford resulting in much greater savings overall and with the added benefit of having the technical resources to optimally implement WC/WDM.

10.2 SAVINGS WITHIN THE URBAN SECTOR

Based on estimated water losses within towns and targeting a maximum 15% loss, the saving within the urban sector can be calculated, or at least estimated with reasonable confidence. See **Table 10.1.**

Table 10.1: Targeted savings within the urban sector

Town	Current water use	Water loss (%)	Target Loss (%)	Water saved (million m^3/a)
Emalahleni	35.8	47	15	11.5
Middelburg	12.6	20	15	0.6
Groblersdal/Marble Hall	2.0	30	15	0.3
Bronkhorstspruit	3.4	30	15	0.5

Town	Current water use	Water loss (%)	Target Loss (%)	Water saved (million m^3/a)
Western Highveld	35.0	50%	15%	12.3
Cullinan	2.0	30	15	0.3
Delmas	1.8	30	15	0.3
Polokwane	7.0	30	15	1.1
Lebowakgoma	8.3	30	15	1.2
Burgersfort	1.5	15	15	0.0
Lydenburg	3.2	50	15	1.1
Belfast	0.9	30	15	0.1
Phalaborwa	24.5	25	15	2.5
Hoedspruit	2.4	30	15	0.4
Total	**140.4**			**32.1**

There is a recent initiative by Rand Water to address water losses in the whole of the Western Highveld area. This is a very comprehensive project which includes repairs and improvement to all infrastructures, the installation of additional flow meters where necessary and the retrofitting of plumbing. The project will include all towns and villages supplied from the Bronkhorstspruit and Weltevreden WTW. It is anticipated this project will result in substantial water savings.

As part of this Reconciliation study, the larger municipalities were visited and interviews conducted with appropriate municipal managers to ascertain what measures they were taking to reduce losses. The responses are summarised below:

Polokwane: There is no WC/WDM plan in place but the municipality are in the process of imposing water restrictions on users.

Emalahleni: There is no WC/WDM plan. The only initiative of consequence is that all new developments are required to install flow meters.

Steve Tshwete: There is no WC/WDM plan *per se* but there is an asset management plan which ensures that ageing infrastructure is replaced or refurbished timeously.

Lepelle North Water indicates in their Business Plan that Phalaborwa is using water efficiently but do not provide enough information to confirm this.

10.3 SAVINGS WITHIN THE RURAL SECTOR

It the short to medium term it seem unlikely that significant savings can be achieved from the rural sector.

10.4 SAVINGS WITHIN THE IRRIGATION SECTOR

Although it is accepted that the irrigation sector is efficient with their use of water, especially when compared to the large avoidable losses in Emalahleni and the Western Highveld, there are nevertheless several steps that can be taken to reduce the losses. Also, while it has been argued that it will be difficult to reallocate savings made within the irrigation sector to other sectors; this could be done through one of two mechanisms:

- Compulsory licencing can be implemented in conjunction with WC/WDM so that the water saved is reallocated to other users. In this manner the impact of compulsory licensing can be mitigated in the irrigation sector.
- Innovative solutions such as that suggested by the mining sector could be implemented. This would entail the mining sector funding the irrigation water conservation measures, and the savings (or at least a substantial proportion of them) being transferred to the mines. There does not seem to be any reason why the urban sector, or DWA, could not embark on similar initiatives.

The possible saving opportunities within the irrigation sector are:

- Improved irrigation systems,
- Improved conveyance of water from source to field edge,
- Improved scheduling.
- Change from high water use crops to more water efficient crops

Improved scheduling is not discussed further as an option since it appears as if most irrigators are already applying advanced scheduling techniques.

Elimination of unlawful water use would also reduce the water use by the irrigation sector but this is not seen as a WC/WDM measure but is addressed as a separate management scenario.

10.4.1 Improved irrigation systems

The irrigation systems utilised within the Olifants WMA are shown in **Table** 10.3.

Table 10.2: Irrigation systems in the Olifants WMA

Irrigation system	% of Irrigated area	Efficiency (%)	
		Loxton Venn, 1995	ARC, 2010
Centre Pivot	61%	85	90
Sprinkler	25%	70	90
Flood	8%	60	95
Micro systems (drip and micro-sprinklers)	7%	90	95

Source: DWAF, 2007b

Assuming a best case scenario in which all irrigation is converted to Micro systems (at an assumed efficiency of 90 to 95%) a saving of 50 million m^3/annum is theoretically possible if the lower efficiencies of Loxton Venn are accepted and only 25 million m^3/annum if the higher efficiencies of the ARC are accepted. This is a total saving of between 5 and 10%. It is accepted though that unless there is a willing buyer for the saved water, where water which can be re-allocated to other sectors, the saving will not be realised . A more realistic approach is therefore to consider only irrigation boards which are located in an area close enough to be of use to the mining sector. These are limited to the irrigation boards between Loskop and Flag Boshielo Dams, referred to further as the Loskop Area, and those located in the Steelpoort River catchment. The Blyde River IB has been excluded from consideration since it is already very efficient. However, through linking compulsory licencing with WC/WDM, even the Blyde river IB could become more efficient.

The type of irrigation systems used in the Loskop Area is not known in detail, but a similar distribution as to the whole WMA has been assumed, with the exception of flood irrigation which is not practiced within the irrigation boards. The areas and related efficiency of the irrigation within the Loskop Area is summarised in **Table** 10.4**.**

Table 10.3: Irrigated areas and efficiency within the Loskop Area

Irrigation system	Irrigated area (ha)	Efficiency (%)	
		Loxton Venn, 1995	ARC, 2010
Centre Pivot	16 082	85	90
Sprinkler	6 630	70	90
Flood	0	60	95
Micro systems (drip and micro-sprinklers)	1 780	90	95
Total	**24 492**		

Converting all centre pivot and sprinkler irrigation to Micro systems will make an estimated 17 million m^3/annum of water available within the Loskop Area if the efficiencies of Loxton Venn are accepted and only 9 million m^3/annum if the efficiencies of the ARC are accepted.

There is much less irrigation within the Steelpoort Area and the extent of possible water saving through improved irrigation techniques in this area is therefore limited. **Table 10.4** presents the areas within the Steelpoort catchment that lie within irrigation boards.

Table 10.4: Irrigated areas and efficiency within the Steelpoort Area

Irrigation system	Irrigated area (ha)
Centre Pivot	2 349
Sprinkler	968
Flood	0
Micro systems (drip and micro-sprinklers)	260
Total	**3 577**

Converting all centre pivot and sprinkler irrigation to Micro systems will make between 1 and 2 million m^3/annum of water available within the Steelpoort Area.

10.4.2 Improved conveyance of water from source to field edge

The biggest opportunity relating to reducing conveyance losses is generally considered to be to refurbish unlined canals and reduce seepage losses by lining the canals with concrete. However, very few such opportunities were found in the Olifants WMA. The canals that serve the Lower Spekboom irrigation scheme are unlined but seepage losses are limited due to the high clay content of the soil in the area. At best, 10% could be saved by lining these canals to achieve a saving of 0.4 million m^3/annum.

Another possibility is to follow the example of the Blyde River irrigation board which replaced all their canals with gravity-fed pipelines. A similar initiative on the Loskop scheme could save at least 10% of the evaporation and seepage losses from the extensive canal network associated with this scheme, resulting in a saving of approximately 16 million m^3/annum. The cost of this would however be exorbitantly high.

10.4.3 Current WC/WDM initiatives

There are no known activities (current or planned) to reduce water losses in the irrigation sector.

10.5 POWER GENERATION

The water saving that is possible at the six power stations located within the Olifants WMA are given in **Table 10.5.**

Table 10.5: Possible water saving at wet-cooled power stations

Power Station	Water Saving (Ml/day)
Matla	21.0
Duvha	17.2
Kriel	14.7
Hendrina	14.3
Arnot	7.3
Total	**74.8**

Source: DWAF, 2007c

Due to the very high cost of reducing water consumption of the power stations, Eskom is not planning to reduce their water consumption.

10.6 MINING

In Section 7 it was stated that mines could save up to 10% of their current water use through recycling. The water use to which this saving applies is the platinum, chrome and iron ore mines located in the Middle Olifants catchment and the mines locate in Phalaborwa. The estimate current total water use of this sector is estimated to be about 85 million m^3/annum from which a saving of about 5 million m^3/annum is possible. The mines do not have any one particular WC/WDM programme but the platinum mines are continuously striving to minimise their water use through innovative recycling technology.

10.7 SUMMARY OF POSSIBLE WATER SAVINGS

Table 10.6 summarises possible water savings through various WC/WDM measures within the study area.

Table 10.6: Summary of possible water savings

Sector	Current water requirement (million m^3/a)	Estimated saving (million m^3/a)	Comment
Urban	140.4	32.1	Achievable
Rural	29	0	Problematic due to low levels of service
Irrigation • Improved irrigation systems • Improved conveyances	486	 19 16	 Requires willing buyer/willing seller Very costly
Power generation	228	27.3	Very costly
Mining	86	5	
Industrial	9.0	~0	
Total	**978.4**	**99.4**	

11. CONCLUSIONS AND RECOMMENDATIONS

A desktop analysis of water use efficiency within the Olifants River catchment and Polokwane (which forms part of the study area) has shown that water use is generally inefficient by accepted benchmark efficiencies. The urban sector is especially inefficient with high to very high losses. Losses within the irrigation sector are generally acceptable, but water could be saved and freed up for other sectors to use through the improvement of the irrigation systems. The mining sector has expressed a willingness to fund such an initiative in return for obtaining an allocation from the water saved. Alternatively, compulsory licensing could be used as a mechanism to re-allocate water saved by the irrigation sector through WC/WDM to other users. The power generation sector, while efficient compared with similar power stations in Europe, makes use of high water-use technology which would be very expensive to replace with dry-cooling systems. Nevertheless, small improvements to the cooling process are possible with some savings in water use. The mining sector is generally very efficient with its water use, but the platinum mine have indicated that they believe a 10% reduction in water demand on all existing operations is possible.

The total saving, per sector, within the study area is indicated in **Table 10.6**. Based on this, savings could range from as little as 20 million m^3/annum if the large water losses in the urban sector are addressed to as much as 99 million m^3/annum if all options are implemented. However, the cost of all these options need to be weighed up in terms of cost-benefit and compared with cost-benefit estimates of other reconciliation options.

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APPENDIX A

Irrigation Board	Scheduled Area (ha)	Actual Area (ha) (if different from scheduled)	Application rate (m^3/ha/annum)	Allocated volume (million m3/a)
BLOEMPOORT (Moos River, Loskopdam)	684		6 200	4.2
BLYDE RIVER (Blyde dam, Driehoek/Moriah/ Jongmanspruit & river abstr.	8 978		9 900	88.9
GOUSBERG (Wilge River)	1 325		7 700	10.2
GROOT DWARSRIVER (Der Brochen Dam)	1 202	41	6 700	5.1
HEREFORD (Olifants River, Loskopdam)	4 466		6 200	27.7
KASPERNEK-VYEHOEK	514		9 200	4.7
KLASERIE RIVER	786		9900	7.8
LAER SPEKBOOM RIVER (Steelpoort River)	1 037	750	5 000	13.2
LOSKOP	16 117		7 700	161.3
METZIRR SCHEME (Moetladimo Dam)	82		7 700	0.6
OLIFANTS RIVER (Loskopdam)	1 732		7 600	13.2
SELONS RIVER (Selons Dam)	777		6 200	4.8
CENTRAL STEELPOORT RIVER	549	350	7 700	4.2
TRANS ELANDS (Elands River)	716		7 700	5.5
UPPER SELATI RIVER	722		9 900	7.1
WATERVALS RIVER (Buffelskloof Dam)	2 436		7 000	17.1
CENTRAL OLIFANTS (LEBOWA)	2 338		7 700	18.0
ORIGSTAD RIVIER	1 857		7 000	13.0
CATCHMENT TOTAL	46 318			406.6