CHAPTER 2: BROAD PERSPECTIVE REGARDING THE WATER SITUATION IN THE LOWER VAAL WMA

2.1 Introduction

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

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

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

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

In addition to the water resource system specific issues, listed in **Appendix A**, issues or strategies that were identified for consideration at national level are excluded from this document and will be dealt with through a separate document that will focus on all the National Issues. These items typically cover aspects that should be under the Minister's control, relate to national policy, or were identified in several other WMAs and therefore require a high level of co-ordination.

2.2 General Catchment Description

2.2.1 Overview

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

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

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

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

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

Figure 2.1: Layout and location of the Lower Vaal WMA

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

2.2.2 Topography

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

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

2.2.3 Geology and Soils

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

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

2.2.4 Climate

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

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

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

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

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

2.2.5 Environmentally Sensitive Areas

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

2.2.6 Demography, Land Use and Development

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

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

Table 2.2: Lower Vaal WMA : Population in 1995

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

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

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

2.2.7 Economic Characterisation of the WMA

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

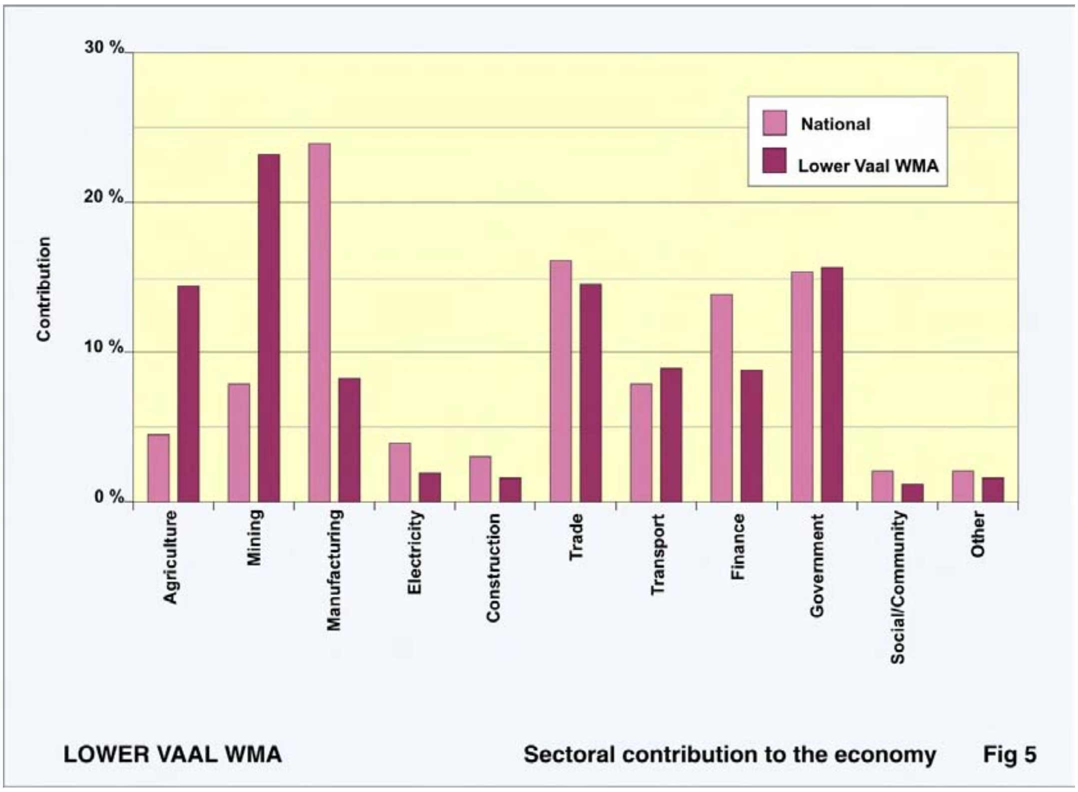
Kimberley	29,6%
Postmasburg	14,8%
Lichtenburg	9,6%
Kuruman	8,9%
Vryburg	8,3%.

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

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

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

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



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

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

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

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

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

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

2.3 Water Resource availability

2.3.1 Surface Water

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

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

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

Table 2.3: Natural Mean Annual Runoff and Ecological Reserve (million m^3/a)

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

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

(1) Quantities given are incremental, and refer to the sub-catchment under consideration only.

(2) Total volume given, based on preliminary estimates. Impact on yield being a portion of this.

(3) Estimated runoff from catchment, which is lost through evaporation and infiltration before reaching the Orange River. This runoff therefore does not add to the total for the water management area.

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

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

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

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

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

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

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

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

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

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

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

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

2.3.2 Groundwater

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

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

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

Sishen Mine makes use of groundwater abstracted directly from the mining area although it can obtain water from the Vaal River via the 700mm diameter Vaal-Gamagara pipeline. Approximately 1.5 million m^3 of water is abstracted monthly from the mine and it is anticipated that the groundwater will gradually be depleted and that Sishen Mine will eventually have to import water.

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

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

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

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

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

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

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

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

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

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

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

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

2.3.3 Overall Water Availability

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

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

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

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

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

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

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

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

2.4 Water Requirements

Current requirements (year 2000)

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

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

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

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

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

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

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

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

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

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

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

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

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

Table 2.6: Year 2025 base scenario water requirements (million m^3/a)

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

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

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

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

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

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

(1) Includes component of Reserve for basic human needs at 25 ℓ/c/d.

(2) Mining and bulk industrial water uses which are not part of urban systems.

(3) Includes water for thermal power generation only. (Water for hydropower, which represents a small portion of power generation in South Africa, is generally available for other uses as well.)

(4) Quantities given refer to impact on yield only.

2.5 Water balance

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

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

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

(1) Brackets around numbers indicate negative balance. Surpluses are shown in the most upstream sub-catchment where they first become available.

(2) Transfers into and out of sub-catchments may include transfers between sub-catchments as well as transfers between WMAs. Addition of the transfers per sub-catchment therefore does not necessarily correspond to the total transfers into and out of the WMA. The same applies to Tables 2.5.2 and 2.5.3.

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

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

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

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

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

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

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

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

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

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

(3) Brackets around numbers indicate negative balance.

Changes made to the reconciliation balances for the year 2000

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

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

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

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

2.6 Water Reconciliation

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

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

2.6.1 Excess Supply in Harts sub-area

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

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

2.6.2 Allocation of Conditional Surplus

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

2.6.3 Intervention Measures

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

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

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

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

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

2.6.4 Necessity for Compulsory Licencing

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

2.6.5 Reserve Determination

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

2.7 Water Quality Management

The water quality situation of the Vaal River main stem and the tributaries are discussed below. The water quality of the main stem of the Vaal River is not only affected by the water quality of the flow from the tributaries within the WMA but also by the water quality of the water received from the upstream Upper and Middle Vaal WMAs. The water quality received from the Upper Vaal WMA is considered to be poor. Despite the blending practiced in the Upper Vaal WMA, with releases from Vaal Dam used to maintain the TDS concentration in the Vaal Barrage at 600 mg/L, salinity has been reported as a problem in the Vaal River main stem. Salinity levels in the Lower Vaal WMA have been increasing over the years as a result of high salinity inflows from upstream WMAs. This trend is expected to continue to increase in the future. However salinity levels are more acceptable downstream of Bloemhof Dam as a result of inflows from the Rhenoster, Vals, Sand and Vet sub-catchments.

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

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

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

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

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

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

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

2.8 Infrastructure System Management

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

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

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

2.9 Monitoring and Information Systems

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

2.10 Institutional Aspects

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

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

The role of the Lower Vaal WMA CMA will be:

- To manage the water quality by setting WQOs and developing CMS as per the Water Quality Management Strategy (A2.2) included in **Appendix A**. The setting of the WQOs will be within the framework of the Integrated Water Quality Management Plan for the Vaal River System.

- The monitoring of the system to provide management information for water quality management, abstraction control and input to the overarching operations and planning processes.

- Provide input into the supply of municipalities from local groundwater and surface water resources. This will be in the form of strategic level guidance as to where water can be obtained and the level of study needed to be submitted with the license application.

- A very important communication role between the Water Users and the utility.

- Promotion of WC&DM through the water service providers and local authorities/DWAF Head Office to achieve efficient use of water. Only once efficient use has been achieved can further transfers be considered.

- Management and control of water abstractions.

- Management of groundwater and local surface water resources.

- Management and Operation of Local dams, viz. Wentzel, Taung and Spitskop dams.

2.11 ISP Implementation Strategy

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

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

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