

# COVER PAGE

**PROJECT NAME** : PREFEASIBILITY STUDY INTO MEASURES TO IMPROVE THE MANAGEMENT OF THE LOWER ORANGE RIVER AND TO PROVIDE FOR FUTURE DEVELOPMENTS ALONG THE BORDER BETWEEN NAMIBIA AND SOUTH AFRICA

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## LIST OF REPORTS

TITLE	REPORT NUMBER		
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Main Report	PB D000/00/4703	400/8/1/P-13	3749/97331
<b>Legal, Institutional, Water Sharing, Cost Sharing, Management and Dam Operation</b>	<b>PB D000/00/4603</b>	<b>400/8/1/P-10</b>	<b>3692/97331</b>
Specialist Report on the Environmental Flow Requirements - Riverine	PB D000/00/4503	400/8/1/P-07	3519/97331
Specialist Report on the Determination of the Preliminary Ecological Reserve on a Rapid Level for Orange River Estuary	PB D000/00/4503	400/8/1/P-08	3663/97331
Water Requirements	PB D000/00/4202	400/8/1/P-02	3486/97331
Hydrology, Water Quality and Systems Analysis (Volume A)	PB D000/00/4303	400/8/1/P-04	3736/97331
Hydrology, Water Quality and Systems Analysis (Volume B)	PB D000/00/4303	400/8/1/P-03	3485/97331
Water Conservation and Demand Management	PB D000/00/4903	400/8/1/P-12	3487/97331
Dam Development Options and Economic Analysis – Volume 1	PB D000/00/4403	400/8/1/P-05	3484/97331
Dam Development Options and Economic Analysis – Volume 2 (Appendices)	PB D000/00/4403	400/8/1/P-05	3484/97331
Environmental Assessment of the Proposed Dam Sites on the Orange River	PB D000/00/4503	400/8/1/P-06	3873/97331
Vioolsdrift/Noordoewer Joint Irrigation Scheme: Assessment of Viability	PB D000/00/4803	400/8/1/P-11	3525/97331
Public Consultation	PB D000/00/4503	400/8/1/P-09	3869/97331
Inception Report	PB D000/00/4102	400/8/1/P-01	3365/97331

## **EXECUTIVE SUMMARY**

### **BACKGROUND/INTRODUCTION**

*This Report provides an overview of the different options for co-operation in and sharing of, the development and management (operation and control) of different development and management options of the Lower Orange River (LOR). The overview is in the context of the Namibian/South African legal frameworks and applicable International Law and Protocols. The Report also provides water and cost sharing options for possible development scenarios. The Report forms part of the joint South African and Namibian Lower Orange River Management Study (LORMS).*

*The Orange River is an international Watercourse with an obligation for it to be managed and used in terms of the relevant International Law. The underlying principles thereof are to adopt a holistic approach, with respect to its use, protection and regulation. As such, the LORMS Study was commissioned in February 2002 and completed in March 2005, and had the objective to investigate measures to improve the availability of water along the Lower Orange River. The Study thus assessed the water resources and water use of the Orange River Basin downstream of the Vanderkloof Dam, specifically on the South African/Namibian common border area (CBA). The assessment reviewed both demand and supply measures with particular emphasis on the potential of water demand management (WDM) and ways to improve beneficial use of water. The Lower Orange serves a number of irrigation areas and urban/industrial water uses. The Study investigated ways to improve the management, development and operation of the Orange River to benefit both countries. The Vaal River System was not studied in any detail. However, the results of detailed studies recently completed on the Vaal River Basin by South Africa, were used in this Study.*

### **INSTITUTIONAL AND LEGAL BACKGROUND**

*The LORMS established that international legal frameworks, regional (SADC) protocols and local Namibian/South African instruments provide a background to the management of the Lower Orange River Basin. Important international frameworks include the RAMSAR convention, UN organs and the World Commission on Dams, while the Revised SADC Protocol on Shared Water Courses and bi-lateral water agreements between neighbouring States are of particular relevance at regional level.*

*The 1997 UN Convention on the Law of Navigational Uses of International Watercourses forms the appropriate legal instrument defining the status and governing the management of the Watercourse. The UN Convention is a framework containing general principles that may be tailored to specific requirements. Furthermore, the Revised SADC Protocol is a regionally accepted and up to date instrument, which should be employed as a basis for negotiating agreements on the Orange River. Considerations for National and International Law requirements on the protection of eco-systems will need more detailed study to establish effective agreements and implementation of ecological water requirements in the SADC Revised Protocol. In this instance, flow article 67 in the Berlin Rules (2004) is most applicable. The implication of the Berlin Rules should be considered in further studies.*

*The Revised SADC Protocol established comprehensive guidelines on water sharing principles and obligations, and was accepted as a baseline document for management of the Orange River Course. Furthermore, experience gained with bi-lateral water management institutions can be utilized in further developments on the Lower Orange River.*

*The national and institutional environment in Namibia and South Africa, that will have a bearing on the management of and further development of water resources along the Lower Orange River, are summarised in **Table 1** below:*

**Table 1: National and Institutional Environment in Namibia and South Africa**

Administration Level	State	
	South Africa	Namibia
National Government	DWAF International Commissions	DWA & DA International Commissions
Provincial Government	Liaison	DWRS
Local Authorities	(District and Local Municipality) Water supply and sanitation	Water supply and sanitation
Encompassing water course	Catchment Management Agencies (CMAs)	Basin Management Committees
Bulk water suppliers	DWAF & TCTA, Water Boards, WUAs, LAs, Private	DWRS, NamWater, LAs, Private

### ENVIRONMENTAL CARE

*Ecological Water Requirements (EWRs) of the Orange River and its estuary may significantly affect the management and the yield of the system. The Study established that an approach to determine the Ecological Water Requirements should be agreed upon between the Water States, firstly on the scientific methodology, then on how the information will be utilised. The agreement should consider the social and economic information to inform decisions as to the desired ecological condition. Further, adaptive management and environmental monitoring of the system is required and should involve stakeholders and be supported by policies and legislation. The monitoring programme should be based on joint strategy and programme. It is recommended that each country adapt its domestic policies/legislation to include challenges of international rivers. For the estuary, States bordering on the Lower Orange River should agree on how to implement Ecological Water Requirements and manage the estuary.*

*The present responsibilities for environmental management of Watercourses in Namibia and South Africa are divided between a number of organisations that include Environment Affairs, Water Affairs, Agriculture and Minerals and Energy. Authority and responsibility of these departments is made difficult due to the unclear border situation in the common border area. It is recommended that a Bi-national Forum for the coordinated management, planning and implementation of the ecological impacts be established. The Forum should involve the existing and possible future cross-border organisations in the Lower Orange River.*

## **WATER SUPPLY DEVELOPMENT FRAMEWORK**

*Under natural conditions, flow through the Orange River mouth was about 10 800 Million m<sup>3</sup>/a, but has reduced to about 3 670 Million m<sup>3</sup>/a due to developments and extensive water use in the Orange and Vaal River Watercourses. About 92% of the water from the Orange River is generated in the sub-catchments upstream of the confluence of the Orange and Vaal Rivers, i.e., from Lesotho, the Upper Caledon and Upper Orange. Inflows from the Vaal into the Orange, though still significant, are mainly a result of spills during periods of high flows. To be able to utilise some flows from the Vaal River, real time modelling and accurate gauging weirs at strategic points are needed, and a storage dam should be built in the Lower Orange.*

*A total of 5 485 Million m<sup>3</sup>/a was estimated as the consumptive water requirements from the Orange River for 2005 and distributed in the ratio of 98,2% to 1,4% to 0,4% among South Africa, Namibia and Lesotho, respectively. Of this requirement, 176 Million m<sup>3</sup>/a was required from the Lower Orange (common border area) in a ratio of 56,6% to 43,4% between South Africa and Namibia, respectively.*

*Two systems, the Integrated Vaal River System (IVRS) and the Orange River System are important in the management of the Lower Orange River. Although the Integrated Vaal River System is not used to support the Orange River System, it is operated to minimize spills into the Orange River. This is important, as large volumes of water are transferred into the Vaal River from neighbouring catchments (e.g., from Lesotho Highlands Water Project) at high cost.*

*The Gariep and Vanderkloof Dams, which are part of the Orange River System, are the only resources currently used to supply the Lower Orange and stabilise water requirements along the Orange River from the Gariep Dam to the Orange River Mouth. The two dams increased assurance of supply to water users in South Africa and are used to provide water requirements for irrigation, urban, mining, environmental needs, river evaporation and operational losses. The Gariep and Vanderkloof Dams are not supported by any upstream dams, but only receive the spills and environmental releases, mainly from Katse and Mohale Dams. Releases from Gariep and Vanderkloof Dams, to supply downstream users, are made directly into the Orange River, and are routed through turbines to generate hydropower.*

*Operating analyses for the Orange River Systems are done on an annual basis to determine available surplus or deficit in the system for the next year. Surpluses are allocated to generate additional hydropower over and above that is generated*

by normal releases for downstream users. It is proposed that when there is a deficit in the system, curtailments be imposed, beginning with low assurance (95% assurance of supply) component of demand, then the medium (99%) assurance of demand and finally, the high assurance (99,5%) of demand.

Minimum operating levels (m.o.l) for hydropower are currently being used as minimum operating levels in both dams. Storage control curves (SCCs) were produced for both Gariep and Vanderkloof Dams in order to minimise spilling from the dams, as well as to increase hydropower generation in wet periods. However, both storage control curves and hydropower generation were excluded from LORMS, as both will disappear over time as the system demand grows.

Yield analysis results from the Water Resources Planning Model (WRPM) analyses indicated that the Lower Orange River System is already being utilised close to its capacity and will only be sufficient to meet expected growth in demand until 2006. If the LORMS environmental water requirements for Category D estuary are met, then the Orange River System is virtually in balance at 2005-development level. Long-term stochastic yield analyses showed a small surplus of 40 Million  $m^3/a$  at 95% assurance, which is only 6% of total systems yield. Historic yield analysis, however, gave a 47 Million  $m^3/a$  at the 2005-development level. Measures to increase available surplus and or system yield will be required to supply environmental requirements or any further developments. Options to increase available surplus or system yield in the Lower Orange River include implementing water conservation and demand management (WC&DM) programmes, improved use of existing infrastructure and new infrastructure. However, demand management is not considered a secure source of additional water for new users.

Improved use of existing infrastructure will include utilising current surplus in the Vaal (94 Million  $m^3/a$ ) and utilisation of the Vanderkloof Lower storage that can provide additional 143 Million  $m^3/a$ . The Vaal surplus is, however, an expensive option with limited life span as it will reduce to zero in 2015. Construction of a re-regulating dam at Vioolsdrif site will reduce operating losses by 170 Million  $m^3/a$ . The Vioolsdrif site was also recommended as the best option for a larger storage dam, for a dam size varying from 500 to 2 400 Million  $m^3/a$  live capacity, providing additional yield of between 270 and 420 Million  $m^3/a$ .

The Study revealed that the Orange River System cannot be successfully managed with only Gariep and Vanderkloof Dams included, but requires modelling of the entire Watercourse as an integrated system. Annual operational analyses to determine surpluses or deficits in the Orange River System should be done on the



entire Orange River System. In effecting restrictions to users allocated, low assurance should be curtailed first. No changes in operating rules are required when using Lower Vanderkloof Storage. Operating rules applicable to the Orange River System are applicable with a Vioolsdrif re-regulating dam. The large Storage Vioolsdrif Dam will also be used for re-regulation and using the same operating rules as for the re-regulation dam.

### **OPTIONS FOR WATER SHARING, COST SHARING AND JOINT MANAGEMENT**

The management of upstream (of the Lower Orange River) systems and conditions are important when water sharing, cost sharing and joint management structures are considered. Upstream development has altered the natural flow patterns and reduced annual average flows in the Lower Orange. Equitable sharing of benefits of the system to achieve a win-win situation for all involved, including the eco-system, is therefore required. The sharing solutions should be such that vested interests and country sovereignty are not threatened.

In determining the practical sharing of allocable water, the following principles should be achieved:

- Water produced by an option should be able to be clearly defined with a known assurance and cost of supply, together with its point of delivery.
- Water provided should be available at the point of delivery as modelled in the analysis. Abstractions should be metered.
- The benefits of the development option should be achieved in practice, i.e., it should be ensured that water assessed to be available, should in practice, reach the consumers for whom it is meant.

Management issues that need to be considered include:

- Determining, managing and monitoring of Ecological Water Requirements and conservation responsibility.
- Management arrangements and operating rules of the current Orange River water resource, that may need to be adjusted or expanded, to include new developments.
- Other developments in the Orange River System that may influence the Lower Orange River need to be agreed upon.

*In addition to technical management issues, current and envisaged institutional arrangements in both Namibia and South Africa need to be considered. Each country is to take full responsibility of matters, like control of anthropogenic impacts on Lower Orange River, pollution control, water demand management (WDM) and monitoring and managing water quality in river courses upstream of jurisdiction of joint Lower Orange River area. It was proposed that a joint common border authority under the auspices of the Permanent Water Commission (PWC) could be made responsible for shared responsibilities, like instream water quality and anthropogenic activities that pose a threat to its own business.*

*Each of the development options have costs associated with making water available through investment of capital in further infrastructure development. The sharing of the costs between the countries should be in accordance with an agreement to be worked out between the two countries. At least four options for sharing the cost of joint yield-increasing measures exist in the Lower Orange River. The options include:*

- Cost is shared in relation to what each country would have paid, should each have independently improved its own yield.*
- Cost shared in relation to incremental benefit accrued from improvement measures.*
- Cost shared in relation to water use from the entire Orange River System, by combining the costs of new developments into the total system cost, including historic developments.*
- Limiting the system under consideration to the sub-system from Gariep Dam downstream.*

*Possible alternative joint development opportunities include:*

- Namibia and South Africa agree that either one of them make full improvements necessary in the Lower Orange River or water is sold by one country to the other.*
- Each country makes its own provisions independent of the other.*
- The countries jointly develop systems to their mutual benefit.*

*Opportunities for joint developments include infrastructure development on the common border area, infrastructure development upstream of the common border area and measures like river modelling and the Vaal surplus. Developing a dam along the common border area, particularly the re-regulating dam, is one of the selected options for further development. Joint management of the dam would require an institution that would manage releases from the dam, monitor water use by the Parties and ensure that environmental obligations are met. The institution*

would coordinate with the Catchment Management Agencies (CMAs) and Basin Management Committees (BMCs) in South Africa and Namibia respectively, particularly for operation and management of upstream structures. Developments upstream of common border area, which include use of the Vanderkloof lower level storage and construction of the Gariep Dam, will have different access control from a Vioolskloof Dam, as these are totally located in South Africa. Cost of Vanderkloof low level storage option should include quantification of the impact on hydropower supply by Eskom. Operating rules for the system need to be formalised in an agreement.

### **OPTIONS FOR COST SHARING**

The sharing of the cost between the countries should be in accordance with an agreement reached between the two countries. Some options are discussed below. These are options for agreeing the cost sharing between the countries. Thereafter, each country would have to decide how it wishes to recover, or absorb the costs and the water tariffs to be charged to various users on the river system.

The options for South Africa and Namibia to share the cost of implementing agreed measures include the following:

- **Option 1:** The cost is shared in relation to the benefit each country gains by developing a joint project compared with what each country would have paid, had each independently developed its own yield improvement measures.
- **Option 2:** The cost is shared in relation to the incremental water derived by each party from the improvement measures
- **Option 3:** The cost is shared in relation to water use from the entire Orange River System, by combining the cost of new developments into total system cost, including the cost of historic developments to get a total unit cost of water from the system. This is the approach commonly adopted by a country when developing the water resources of a basin within its borders. A current South African example is the Berg River Project. This option would not normally be pursued by two independent countries, but may be of relevance when considering that:
  - Namibia used to be part of the Republic of South Africa (RSA) when the existing water supply systems were developed.
  - Measures are sought to maximise overall benefits from the system and not only to meet the water requirements of the two countries.
- **Option 4:** The same as Option 3, but by limiting the system under consideration to the sub-system from Gariep Dam and downstream, excluding the Vaal System.

*Arguments for and against Options 3 and 4 should be pursued as a subsequent action, if so desired by the two countries.*

### **RESPONSIBILITIES FOR MEETING ECOLOGICAL WATER REQUIREMENTS**

*The sharing of this obligation should be in accordance with the utilization from the system. The sharing of this cost is based on the assumption that the upstream systems, such as the Upper Orange and Vaal both meet their obligations to the LOR System. That is a RSA responsibility and the sharing for the LORMS Ecological Water Requirements is thus independent of South Africa's arrangements with the upstream systems/countries.*

### **NEW INFRASTRUCTURE ALONG COMMON BORDER AREA (AT VIOOLSDRIF)**

*The option of developing a dam along the common border area has proved to be beneficial, in particular the re-regulating dam, and is one of the selected options for further development.*

*The capital cost of the re-regulating dam, at April 2004 prices, amounts to R 56 million. This re-regulating dam can add 170 Million m<sup>3</sup>/a to the yield of the system after provision for losses and Ecological Water Requirements.*

*The cost of the dam could be shared on any of the bases discussed earlier, after allowance for losses and Ecological Water Requirements are accounted for. The range of costs attributable to each country is shown in **Tables 2 - 5**.*

**Table 2: Option 1: Sharing of Benefits of Joint Development**

	Total	Namibia	South Africa
<b>Yield Requirement (in 2025)</b>			
- Million m <sup>3</sup> /a	374,8	198,9	175,9
- % of Total	100	53,1	46,9
<b>Estimated Development Cost of Independent Dams</b>			
- R Million	1 173	603	570
<b>Joint Dam Development</b>			
- Yield Million m <sup>3</sup> /a	374,8		
- Cost R Million	941*		
- Cost Saving = Total Benefit R Million	232		
<b>50/50 Share of Total Benefit</b>		116	116
<b>Contribution to Joint Development</b>		Own cost less benefit (603-116)	Own cost less benefit (570-116)
- R Million	941	487	454
- % Share of Cost		52%	48%

\* Note: This is the estimated cost of a storage to meet the total required yield of 374,8 Million m<sup>3</sup>/a.

**Table 3: Option 2: Sharing of Costs on the Basis of Incremental Water Use – Starting Point: Equitable Share of Water Resource**

	Total	Namibia	RSA
2025 Incremental Water Use (Million m <sup>3</sup> /a)	374.8	224.4	150.4
Ratio	100%	59,8%	40,2%
Yield (million m <sup>3</sup> /a)	170		
Capital Cost (million)	R 561	R 335.5	R 225.5
O&M Cost (million/a)	R 2.1	R 1.26	R 0.84

(with adjustment of 25.5 mill m<sup>3</sup>/a "temporary" allocation)

**Table 4: Sharing of Costs on the basis of Incremental Water Use – Starting Point: Water Use in 2005**

	Total	Namibia	RSA
2025 Incremental Water Use (Million m <sup>3</sup> /a)	374.8	198.9	175.9
Ratio	100%	53,1%	46,9%
Yield (Million m <sup>3</sup> /a)	170		
Capital Cost (million)	R 561	R 297.9	R 263.1
O&M Cost (million/a)	R 2.1	R 1.1	R 1.0

(without adjustment of 25.5 mill m<sup>3</sup>/a “temporary” allocation)

**Table 5: Option 4: Sharing of Costs on the Basis of Share of System Water Use and Costs**

	Total	Namibia	RSA
2025 System Water Use (Million m <sup>3</sup> /a)	2 423.9	274.4	2 149.5
Ratio	100%	11,3 %	88,7%
Yield (Million m <sup>3</sup> /a)	170		
Capital Cost (R million)	561	63.4	497.6
O&M Cost (R million/a)	2.1	0.2	1.9
Historical Capital Expenditure Annuity (R million/a)	80.0	9.04	70.96
O&M Cost of Existing Works (R million/a)	9.13	1.03	8.10

The practical joint management of a dam at Violsdrif will require an institution (say, a Lower Orange River Authority –LORA) that will manage the releases from the dam, monitor the use of water by the Parties and ensure that the environmental protection goals and conservation obligations are met. The continued measurement and monitoring of the abstraction, flows, etc., will also be an important function of such an organisation. The coordination with equivalent bodies in South Africa and Namibia, the Catchment Management Agency and Basin Management Committee, will be of utmost importance, especially regarding the operating rules of and the management of upstream structures.

## **WATER SHARING AGREEMENT**

*The LORMS suggest that a project-driven approach to a water sharing agreement between South Africa and Namibia be followed whereby the two States agree on the project, environmental requirements, etc., and from that basis, expand the agreement towards systems management activities.*

## **OPTIONS FOR BI-NATIONAL DEVELOPMENT AND MANAGEMENT INSTITUTIONS**

*Various models exist for co-operative management, operation and maintenance of water schemes and the format mainly relates to the autonomy granted to such an institution. In the Lower Orange River, the core consideration will be whether Namibia and South Africa will need this institution to function on an independent budget and recover costs from consumers or countries and thus be able to raise own funding. As both Namibia and South Africa are in the process of revising or implementing new water and environmental legislation, consideration should be given of the evolving external institutional environment and the respective time scales. LORMS propose fairly simple arrangements for the initial stage, and limit the levels of the institutions to a minimum. Proposed institutional options can be divided into:*

- *Multi-National basin wide management;*
- *Bi-National management of a specific portion of the Basin;*
- *Water supply organisations (bi-national and national); and*
- *National institutions.*

*It was assumed that the Orange-Senqu River Basin Commission (ORASECOM) will be the umbrella coordinating body in the Orange River System and supplementary structures and authorities (e.g. a Watercourse Agency and a Multi-lateral Watercourse eco-system and freshwater research body) that will strengthen ORASECOM's executive powers, will be developed and given powers for effective management and operation of the system. Further, it was proposed that Lower Orange River system bi-national issues, like monitoring implementation agreements, determination of strategy and policy of the sub-system and exercising control over sub-system authorities will be managed by the Permanent Water Commission. A management authority for Lower Orange Sub-system, LORA, was proposed to assist with operation and water resource management (WRM) roles. LORA will be a key to communication and co-operation with existing and proposed national and bi-national organisations and its jurisdiction will either be the river reach along the common border area and the estuary/river mouth or the river reach downstream of Vanderkloof dam to the estuary. It is proposed that LORA receive funding from the two Governments. The Catchment Management Agencies (in RSA) and proposed Basin Management Committees (in Namibia) will assist the*

*bi-national and multi-national institutions with management, monitoring conservation and protection of water resources and implementation of catchment management strategies.*



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## ABBREVIATIONS

<b>BMC</b>	:	Basin Management Committee (in Namibia)
<b>BMP</b>	:	Best Management Practice
<b>CBA</b>	:	Common Border Area
<b>CMA</b>	:	Catchment Management Agency (in RSA)
<b>DA</b>	:	Directorate of Agriculture
<b>DRWS</b>	:	Directorate of Rural Water Supply
<b>DW</b>	:	Department of Works
<b>DWA</b>	:	Department of Water Affairs (NAM)
<b>DWAF</b>	:	Department of Water Affairs and Forestry (RSA)
<b>EWR</b>	:	Ecological Water Requirement
<b>FSL</b>	:	Full Supply Level
<b>IFR</b>	:	Instream Flow Requirement
<b>ILA</b>	:	International Law Association
<b>IVRS</b>	:	Integrated Vaal River System
<b>IWRM</b>	:	Integrated Water Resource Management
<b>JIA</b>	:	Joint Irrigation Authority
<b>JPTC</b>	:	Joint Permanent Technical Committee
<b>JWC</b>	:	Joint Water Commission
<b>KOBWA</b>	:	Komati Basin Water Authority
<b>LA</b>	:	Local Authority
<b>LHDA</b>	:	Lesotho Highlands Development Authority
<b>LHWC</b>	:	Lesotho Highlands Water Commission
<b>LHWP</b>	:	Lesotho Highlands Water Project
<b>LOR</b>	:	Lower Orange River
<b>LORA</b>	:	Lower Orange River Authority (hypothetical)
<b>LORMS</b>	:	Lower Orange River Management Study
<b>MAWRD</b>	:	Ministry of Agriculture, Water and Rural Development (Namibia)
<b>Million m<sup>3</sup>/a</b>	:	Million cubic meters per annum

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<b>m.o.l.</b>	:	Minimum Operating Levels
<b>MRLGH</b>	:	Ministry of Regional and Local Government and Housing (Namibia)
<b>MWTC</b>	:	Ministry of Works, Transport and Communication
<b>NAM</b>	:	Namibia
<b>NamWater</b>	:	Namibia Water Corporation Ltd
<b>NWA</b>	:	National Water Act (No 36 of 1998) (RSA)
<b>NWRS</b>	:	National Water Resource Strategy
<b>O&amp;M</b>	:	Operations and Maintenance
<b>ORASECOM</b>	:	Orange-Senqu River Basin Commission
<b>PWC</b>	:	Permanent Water Commission
<b>RSA</b>	:	Republic of South Africa
<b>SADC</b>	:	Southern African Development Community
<b>SCC</b>	:	Storage Control Curves
<b>TCTA</b>	:	Trans Caledon Tunnel Authority
<b>ToR</b>	:	Terms of Reference
<b>UNFCCC</b>	:	United Nations Framework Convention on Climate Change
<b>WC&amp;DM</b>	:	Water Conservation and Demand Management
<b>WDM</b>	:	Water Demand Management
<b>WMA</b>	:	Water Management Area
<b>WRM</b>	:	Water Resource Management
<b>WRPM</b>	:	Water Resources Planning Model
<b>WUA</b>	:	Water User Association

## 1. INTRODUCTION

### 1.1 Study Area

The Orange River has the largest river basin south of the Zambezi. It rises in the Drakensberg Mountains in Lesotho at an altitude of about 3 300 m, from where it flows to the west for 2 200 km to the sea. It has a total catchment area in excess of 1 million km<sup>2</sup>, 600 000 of which is located in South Africa and the rest in the three neighbouring States of Lesotho, Namibia and Botswana. From 20°E longitude westwards, it forms the nearly 600 km long international border between Namibia and South Africa. This Common Border Area (CBA) has an arid climate. Here the Orange River passes through some of the most rugged and isolated terrain, but with fertile soils in narrow corridors along its banks. A map of the Orange River Basin is included as shown in **Figure 1-1**. The study area encompasses the river reach downstream of the Vanderkloof Dam and specifically focuses on the CBA.

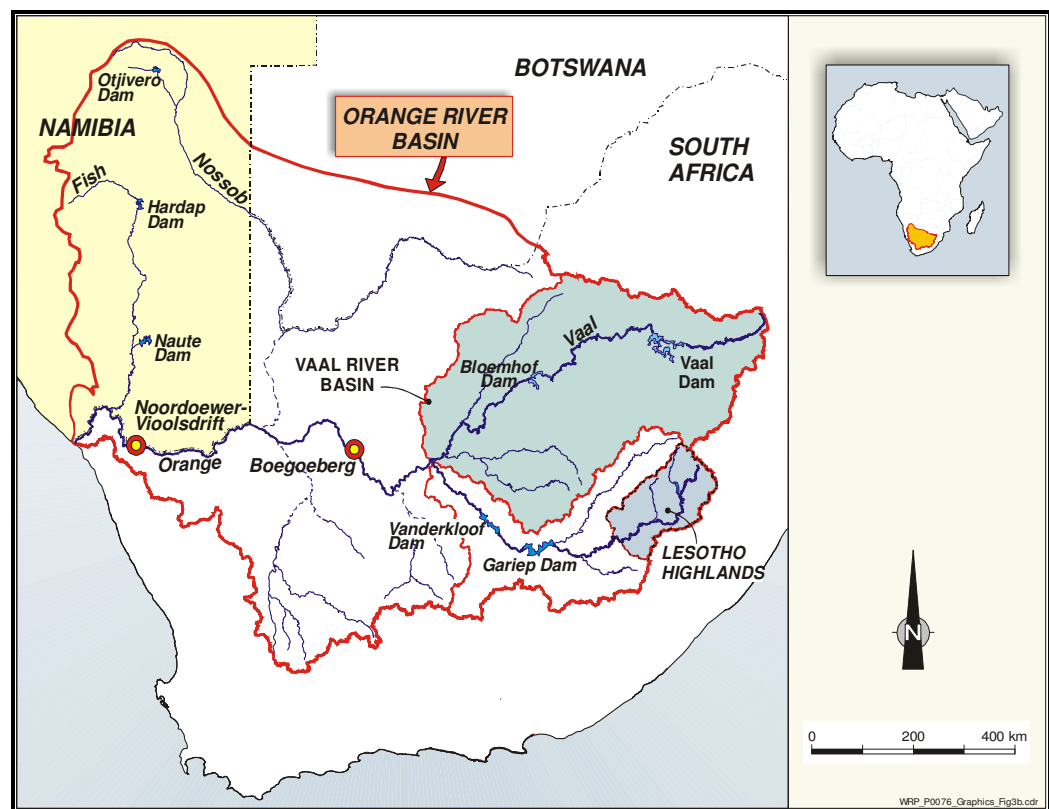


Figure 1-1: Orange River Basin



### 1.1.1 Topography and Climate

The CBA is sparsely populated and is not well served by infrastructure or supporting services.

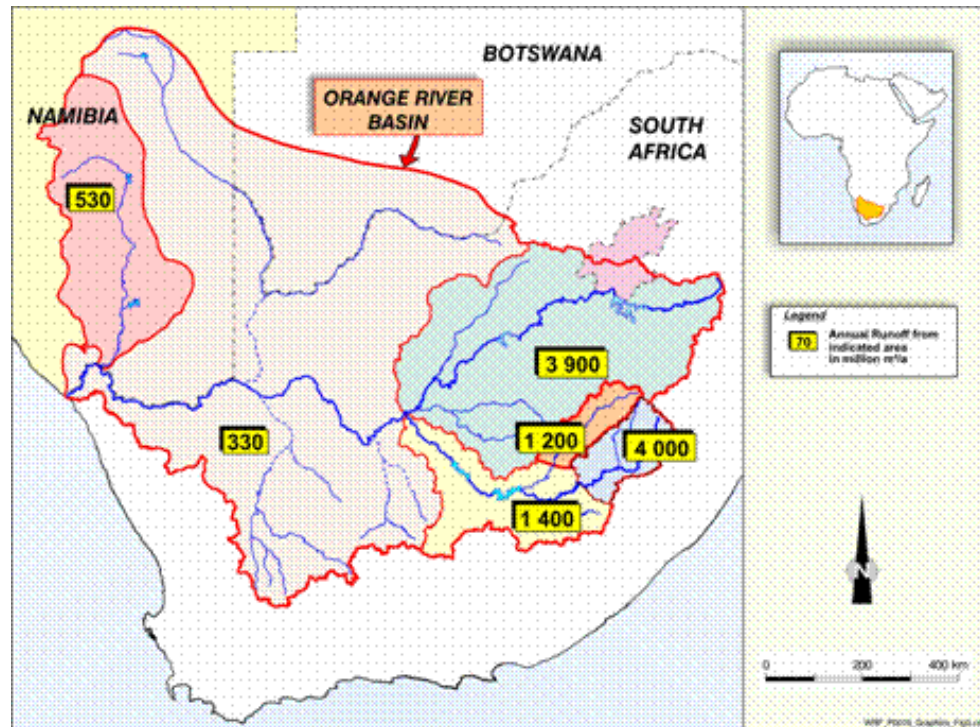
The intensive dissection of the landscape by the Orange River has resulted in the areas in the vicinity of the river being very mountainous and hilly. Combined with the arid climatic conditions, this dissection has resulted in a restricted flood plain. The potential useable soils are generally scarce and limited to strips of alluvium and terrace gravel alongside the river.

From Augrabies in the Republic of South Africa (RSA) to Vioolsdrif/Noordoewer, the geology consists mainly of gneisses and schists, as well as granite and pegmatite. In the region of Noordoewer and Kotzéshoop, shale, limestone, arcose and phillites of the Nama System are found. West of Kotzéshoop, the Orange River flows through the Richtersveld Igneous Complex. A variety of rocks, varying from the Swaziland System to the young tertiary river terrace-gravel, can be found in this area.

The CBA has an arid climate with an annual rainfall, which varies from about 400 mm in the east to less than 50 mm in the west. Mean maximum temperatures for the hottest month vary from 31°C at Oranjemund to more than 40°C at Goodhouse. The mean minimum daily temperature for the coldest month varies from 6.4°C at Goodhouse to 7.9°C at Oranjemund. The area has a very low frost risk. The average annual evaporation is estimated to be approximately 2 800 mm.

### 1.1.2 Runoff

It has been estimated that the natural runoff of the Orange River Basin is in the order of 11 300 million, of which approximately 4 000 Million m<sup>3</sup>/a originate in the Lesotho Highlands and approximately 800 million from the contributing catchment downstream of the Orange/Vaal confluence. The remaining 6 500 Million m<sup>3</sup>/a originate from the areas contributing to the Vaal, Caledon, Kraai and Middle Orange Rivers (See **Figure 1-2**). Much of the runoff originating from the Orange River downstream of the Orange Vaal confluence is highly erratic and cannot be relied upon to support the various downstream demands unless further storage is provided.



**Figure 1-2: Approximate Distribution of Natural Runoff in the Orange River Basin**

Three important strategies that could increase the available yield of the river system are:

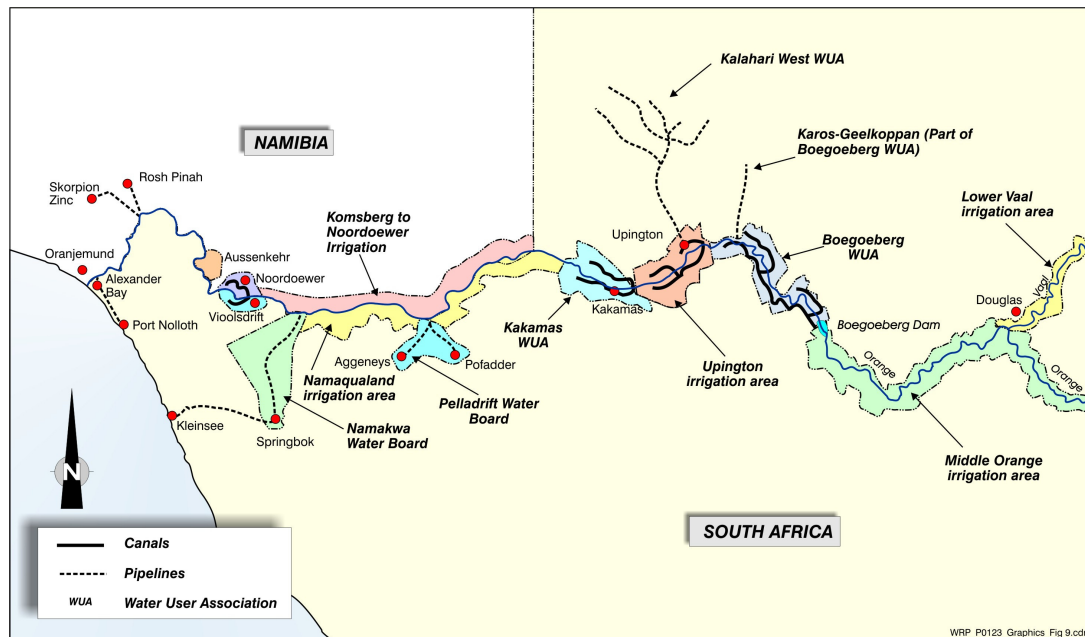
- Storage in the Lower Orange, which could capture some of the 800 Million m<sup>3</sup>/a contributed by the catchment, downstream of the Orange/Vaal confluence.
- Improve operating systems to reduce the operating losses.
- Water Demand Management (WDM) initiatives.

### 1.1.3 Sub-catchments supplied from the Orange River

The major demand sub-catchments supplied from the Orange River System are:

1. Vaal River System.
2. Upper Orange River (upstream of the Orange/Vaal confluence).
3. Eastern Cape (transfers through the Orange / Fish Tunnel).
4. Lower Orange River (LOR) (Orange/Vaal confluence to the river mouth), further divided into:
  - Upstream area (Orange/Vaal confluence to the Namibia/RSA border); and
  - The CBA – (Namibia/RSA border to the river mouth).

The Lower Orange serves a number of irrigation areas and urban/industrial water users are as indicated in **Figure 1-3**.



**Figure 1-3: Major Water Demand Areas along the Lower Orange River**

## 1.2 Objective of This Study

The objective of this study is to investigate measures to improve the availability of water along the LOR.

The options investigated include both demand and supply measures. In particular, the study investigated the potential of WDM along the LOR, together with ways to improve the beneficial use of water. It also investigated the need for, and feasibility of, constructing new storage reservoirs in the Lower Orange. Social and Environmental issues were assessed, accompanied by public involvement in the process.

The practical and financial viability of all the options to improve the water availability along the LOR were assessed and the options prioritised.

### **1.3 Objective of This Report**

The objective of this Report is to describe different options for co-operation in and sharing of, the development and management (operation and control) of the different development and management options. This is done in the context of the legal framework in the countries, as well as the applicable international law and protocols.

The report also puts forward some water and cost sharing options for possible development scenarios.

Discussions and recommendations in this report are based on the recognition of the interdependence of the countries, and the alignment of the strategic objectives of the countries for the LOR Basin and the CBA. It also builds on the expectation that mutual trust exists between the Governments and that information will be shared as envisaged in the Southern African Development Community (SADC) Revised Protocol. It is expected that the development of the water resources in the CBA will follow natural progression from being signatories to the SADC Revised Protocol to more specific agreements on the management of the LOR.

The proposals have been prepared to support the common objective of achieving equitable sharing of the benefits of regional development that is supported by the water resource.

Agreements reached between countries may result in the need for each country to adapt its domestic legislation and regulations although no specific changes have been identified at present.

## 2. INSTITUTIONAL AND LEGAL BACKGROUND

### 2.1 Existing International Water Management Environment

#### 2.1.1 International Community

Instruments of and stakeholding by the broader international community, which provide background, include the following:

- (a) International Law.
- (b) The RAMSAR convention: both Namibia and South Africa are signatories to the RAMSAR convention and the Orange River Estuary is a declared RAMSAR conservation site.
- (c) United Nations organs, with particular mention of:
  - (i) The United Nations Framework Convention on Climate Change (UNFCCC)
  - (ii) United Nations Convention on the Law of the Non-Navigational Uses of International Watercourses
  - (iii) UNDP
- (d) World Commission on Dams.
- (e) Civil society organisations, including environmental conservation organisations.
- (f) Donors that could fund environmental protection programmes, social-economic betterment programmes and infrastructure development programmes.

#### 2.1.2 Southern African Development Community (SADC)

Interstate matters are to an increasing degree being addressed at the SADC level and the following SADC executive directorates play a direct role in International Watercourse matters:

- (a) Directorate of Food, Agriculture and Natural Resources.
- (b) Directorate of Infrastructure and Services (which includes the SADC Water Unit).

The SADC Revised Protocol on Shared Watercourses (2000) is of particular relevance, and is discussed in later sections. It is and should continue to progressively be given effect by its signatories.

### **2.1.3 Southern Africa**

South Africa and Namibia also have other bi-lateral water management institutions relating to common Watercourses and schemes shared with other neighbouring countries. The experience gained with these institutions can be utilized in the further development on the LOR.

Within the Orange-Senqu Basin, the Lesotho Highlands Water Project (LHWP) is managed on the basis of a Treaty between RSA and Lesotho. The Bi-lateral Lesotho Highlands Water Commission (LHWC) has an overall supervision responsibility, whilst the Trans Caledon Tunnel Authority (TCTA) and the Lesotho Highlands Development Authority (LHDA) develop, finance and manage the infrastructure in the respective countries.

On the Komati River, RSA and Swaziland manage the common watercourse(s) and joint project. This also happens on the basis of two Treaties that define the specific functions of the Parties, the Joint Water Commission (JWC) and the Komati Basin Water Authority (KOBWA) utility institution. The KOBWA utility has responsibilities regarding the infrastructure development, financing and management, river management and monitoring aspects. The KOBWA utility is headed by a Board of Directors appointed by the respective Governments and report to the JWC.

The Limpopo Watercourse Commission between South Africa, Botswana, Zimbabwe and Mozambique was formed in July 2004.

## **2.2 The Orange River Watercourse and Watercourse States**

Botswana, Lesotho, Namibia and South Africa are the Watercourse States to the Orange River System, which has been accepted by all as an international Watercourse. The relationship between them regarding the research, protection, development and management of the system is still under consideration and the Lower Orange River Management Study (LORMS) is also structured to provide inputs to the debate. The following Multi-national and Bi-national Treaties and Commissions for the Orange River are in existence.

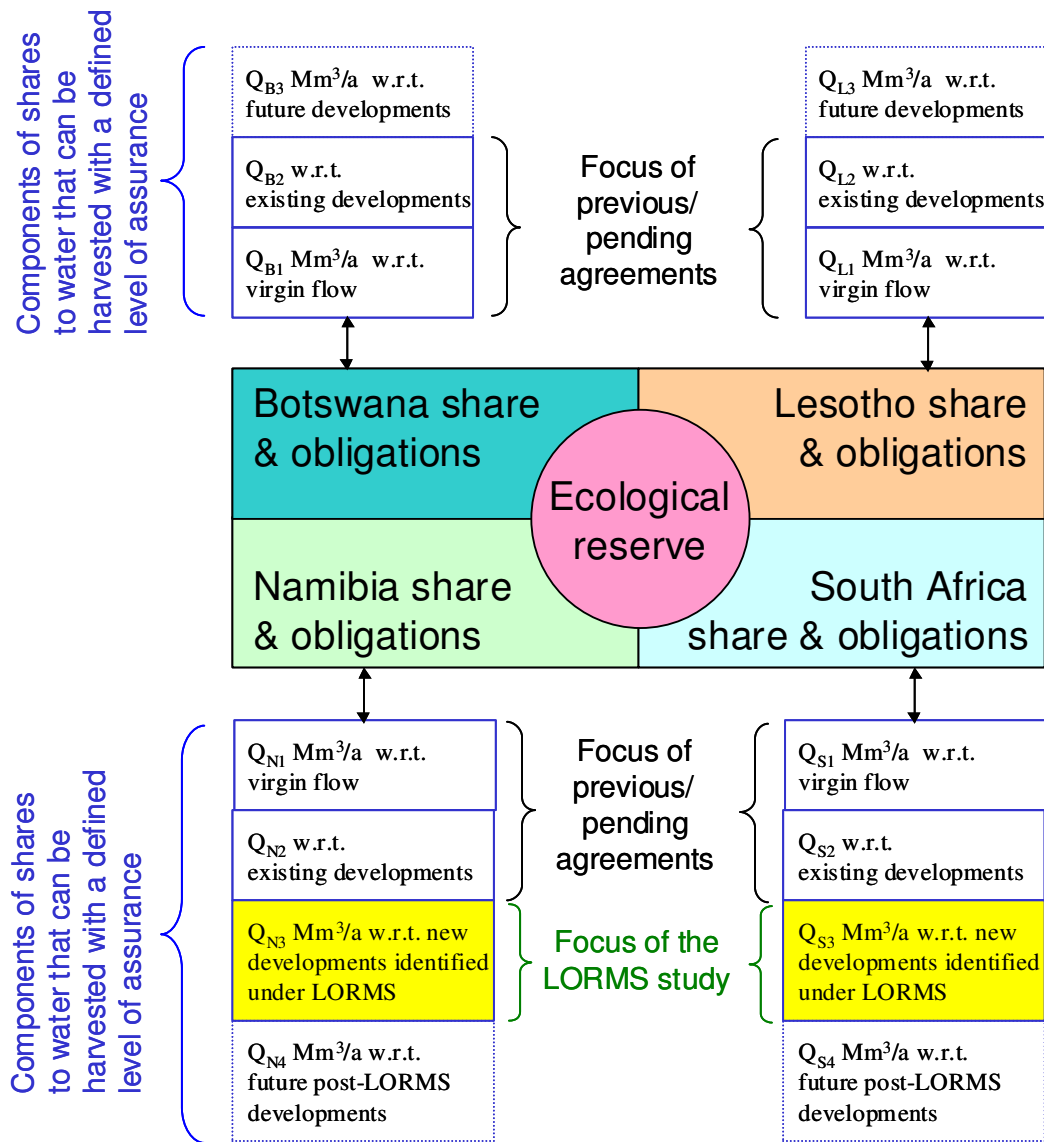
- Orange-Senqu River Basin Commission (ORASECOM) (Lesotho, South Africa, Botswana and Namibia);
- Permanent Water Commission (PWC) (South Africa and Namibia). This is a Commission that deals with all matters related to common Watercourses and also supervises the Vioolsdrift/Noordoewer Joint Irrigation Authority (JIA).
- LHWC (Lesotho and South Africa). LHWC only has jurisdiction over the Lesotho Highlands Water for transfer to RSA. It is not a body like the JWC (RSA/Swaziland) or PWC (RSA/Namibia), which deal with all common watercourses between the countries. LHWC has no jurisdiction over Lesotho Lowlands.
- LHWP Treaty (South Africa and Lesotho); and
- JPTC (South Africa and Botswana). Deals with all matters relating to common Watercourses.

A brief overview is given below of their composition, status, role and responsibilities.

There are also Inter-basin Water Transfers in South Africa, which must be considered within the context of the Orange River Watercourse.

- Inter-basin transfers into the Upper Vaal; and
- Water transfers out of the Orange River system to the Eastern Cape

The LORMS focuses on the Orange River downstream of Vanderkloof Dam and in particular on the CBA between Namibia and South Africa, with specific reference to the effective management of the system and the requirements for further infrastructure development. The management of this section of the river, however, needs to take place within the wider context of both the entire Watercourse and developments that have taken place to date. The LORMS focus and its context to entire system is graphically illustrated in **Figure 2.1**.



**Figure 2-1: Contextual Diagram: Major Stakeholding in the Orange River Watercourse**



### 2.3 Applicable International Watercourse Conventions and Protocols

A discussion on the international status of the Orange River with regard to existing law and protocols is presented in a separate report. This report was drafted by the legal experts appointed for this purpose and is attached hereto as **Annexure A**. Selected themes from this report are summarised below.

The Orange River is an International Watercourse with an obligation for it to be managed and used in terms of the relevant rules of International Law. The underlying principles thereof are to adopt a holistic approach, with respect to its use, protection and regulation.

The 1997 UN Convention on the Law of the Non-navigational Uses of International Watercourses forms the appropriate legal instrument defining the status and governing the management of the Watercourse.

The UN Convention is a framework convention containing general principles that may be tailored to specific requirements. Many of the provisions also reflect Customary International Law.

Commentaries on the Convention divide its content into “substantive” and “procedural” obligations, with both categories being equally binding. The substantive obligations are to utilise an International Watercourse in an equitable and reasonable manner, not to cause significant harm to other States using the same Watercourse and to protect the Watercourse and its eco-systems. The procedural obligations deal with the duties to consult and co-operate, and to share and exchange data.

The UN Convention was ratified by South Africa on 26 October 1998 and by Namibia on 29 August 2001.

The UN Convention also gained acceptance as a doctrinal basis for the revision of the first SADC Protocol on Shared Watercourse Systems. The initial Protocol was adopted in 1995 and came into force in September 1998. The need for a revision soon became apparent, not only to align it with the UN Convention, but also to pay more specific attention to the environmental protection of the water resources and ecological concerns, whilst at the same time ensuring that it remains a genuine SADC instrument which articulates and serves the needs of the region. The Revised Protocol was negotiated over a number of years, and

eventually adopted at a SADC Ministers Summit on 7 August 2000. It has since then been ratified by both Namibia and South Africa.

The Revised SADC Protocol is a regionally accepted and up to date instrument, which should be employed as a basis for negotiating agreements on the Orange River.

A summary of relevant existing agreements related to the Orange River Watercourse and a summary of associated provisions are given in the Legal Report.

It is recommended that further legal studies be undertaken as part of the Feasibility Phase to include a review of all recent agreements and relevant legislation changes in any of the countries, e.g., the new Water Act in Namibia.

The process in implementing the Revised SADC Protocol will also have to be pursued to follow the development of instruments, which give effect to its provisions. The requirements of the respective National and International Law on the protection of ecosystems will also need more detailed study for the effective agreement and implementation of ecological flow requirements in the SADC Revised Protocol. The most applicable article in the recently published "Berlin Rules (2004)" is Article 67 given below. They supersede the Helsinki Rules, but were not available at the time of this study. Their implications should be considered in any further studies.

**"Article 67 : Sharing Expenses":**

1. Expenses for the collection and exchange of relevant information and other joint activities, including the establishment and operation of a basin wide management mechanism, shall be allocated among the Basin States based upon:
  - (a) Receipt of economic benefits;
  - (b) Receipt of environmental benefits; and
  - (c) Ability to pay.
  
2. Expenses for special works undertaken by agreement in the territory of one State at the request of another State shall be borne by the requesting State, unless otherwise agreed.

This Article reflects the standards that are emerging in many environmental and resource agreements regarding the sharing of the expenses of various measures to protect the environment, and in agreements relating to the management of waters generally. The provision in this Article provides a

more nuanced and flexible approach to the sharing of costs than the comparable provisions of the *Flood Control Rules*, art. 6, and the *Belgrade Rules*, arts. 4 and 5. The principles set forth in this Article were endorsed in the *New Delhi Declaration*, pr. 3.2. Often States will agree to pay equal shares, but this is not required by customary International Law.

It appears that receipt of economic benefit can be derived from the pro rata share of water as both countries will use it for irrigation in similar conditions. The above conclusion by the International Law Association (ILA) was based on the various sources of ILA Rules on Water Resources given below for this Article. The conclusion is drawn that the overriding international approach is to share cost on the basis of benefit. The “ability to pay” approach is not really illustrated by examples. In many respects, this could rather be approached on the basis that a poor country could attract donor funds, and also concessionary finance.

## 2.4 The Revised SADC Protocol

The Revised SADC Protocol established comprehensive guidelines on water sharing principles and obligations and has been accepted as a baseline document for the management of the Orange River Watercourse within the region.

The Revised Protocol comprises 16 Articles of which are summarised below.

**Article 1** covers the definitions.

**Article 2** defines the objectives of the Protocol to “foster closer cooperation for the judicious, sustainable and co-ordinated management, protection and utilisation of shared watercourses and advance the SADC agenda of regional integration and poverty alleviation.” To achieve this the Protocol **seeks to promote and facilitate the establishment of shared watercourse agreements**, to advance the sustainable, equitable and reasonable utilisation thereof, to promote environmentally sound development and management, to promote the harmonisation of legislation and policies for planning, development, conservation and the allocation of resources therefore, and to promote research, information exchange and capacity-building.

**Article 3** covers the general principles of the Protocol being that of the unity and coherence of each shared Watercourse, to undertake to harmonise water uses, socio-economic policies and plans, to respect existing rules of customary or general international law, to seek balance between resource development for a higher standard of living and conservation, to pursue cooperation with regard to

all projects likely to have an effect on the regime of the shared Watercourse, and to exchange information and data. The Article furthermore **obliges the Watercourse States to utilise a shared watercourse in an equitable and reasonable manner** and describes the relevant factors to be taken into account in this regard. The matter of avoiding the causing of “significant harm” is also covered.

**Article 4** deals with specific provisions and arranges for planned measures, environmental protection and preservation, and the prevention and mitigation of harmful conditions. It furthermore addresses the management of shared Watercourses, stipulating that Watercourse States shall at the request of any of them, enter into consultations concerning the management of a shared watercourse, which may include **the establishment of a joint management mechanism**, co-operate to respond to needs or opportunities for regulation and **participate on an equitable basis in the construction and maintenance or defrayal of the costs of such regulation works as they may have agreed to undertake.**

The institutional framework for implementation is covered under **Article 5**. It arranges for both the SADC water sector organs and what is termed as Shared Watercourse Institutions. The latter **require Watercourse States to establish appropriate institutions, such as Authorities or Boards, whose responsibilities are to be determined by the nature of their objectives**, which in turn, must be in conformity with the principles of the Protocol.

**Article 6** deals with Shared Watercourse Agreements. **It allows Watercourse States to enter into agreements on the characteristics and uses of a particular Watercourse or a part thereof.** Such an agreement is required to define the waters to which it applies and is thus **allowed to entered into with respect to** an entire shared Watercourse or **any part thereof, or a particular project, or programme or use.** An exception being where such an agreement will adversely affect, to a significant extent, the use by one or more of the other Watercourse States without an expressed consent.

The further Articles arranges for administrative matters related to the Protocol itself, such as the entry into force, accession, amendments, withdrawal, settlement of disputes, etc., and is of no substance matter to this discussion.

From the above analysis of the Revised Protocol, it can be derived that the Protocol provides for a solid base of principles and prescriptions, which should form the foundation of any agreement to be sought between Namibia and South Africa. In fact, it specifically allows for such bilateral negotiations on only a part

of the Watercourse or project and even defines the overall obligations of the two parties in this regard. There can be no doubt as to the legal provision of such an action and then only for the modalities to be worked out to the mutual acceptance of the Parties.

## **2.5 Current Bi-National Situation**

### *2.5.1 Permanent Water Commission (PWC)*

A PWC between Namibia and South Africa was established in the 1980s to attend to the mutual interests of the two countries concerning water matters. Since then, a number of studies have been carried out on the potential of and demand on the system. The Commission operates at the advisory, policy-making and supervisory level, but does not have the capacity or the authority to regulate or manage water resource structures and systems.

### *2.5.2 Water Sharing Agreement*

A baseline agreement on the management, utilisation and conservation of the Watercourse has yet not been concluded. However, an agreement to address the present operation of the Watercourse and to agree on the water available to each country from the LOR, has been under negotiation for some time and there is Version 12 of a Draft Agreement.

In terms of the present draft of the baseline agreement, Namibia would receive a specified quantity of water from existing infrastructure in the Orange River. This quantity was agreed to as being the highest usage that farmers on the Namibian side of the Orange River had been using prior to independence of Namibia, namely 50 Million m<sup>3</sup>/a. This quantity is referred to, and considered as Namibia's "agreed share" in the existing Orange River developments.

Apart from the said "agreed share", Namibia was also granted a temporary use of a further 60 Million m<sup>3</sup>/a until the year 2007, which is a temporary surplus that South Africa had available in the system at the time.

The baseline agreement has not yet been signed, mainly because the financial implications of the operations and maintenance cost of this "agreed share" could not yet be agreed upon.

A final "baseline agreement" could also:

- address any other so-called historic claims that the two countries may have to the source;

- arrange for the present abstraction and usage of water from the river;
- set out the basic management and operation of the Watercourse to meet environmental obligations; and
- establish a baseline understanding that the Parties would agree upon, which could then form a foundation for further agreements.

At the commencement of the LORMS, it was anticipated that the Agreement would have been concluded and recommendations on how to share and manage new development would then be additions. However, a baseline agreement is unlikely to be concluded before the end of the study and the outcome of the LORMS may have to be directed towards a “first agreement”.

Nevertheless, the point of departure in this study is that 50 Million m<sup>3</sup>/a of the Namibian water demand would be met from existing infrastructure, and all other demand would have to be met from new measures that are to be taken.

### *2.5.3 Border Demarcation*

The Orange River west of the 20° longitude forms the international border between Namibia and South Africa. There is, however, uncertainty as to the exact location of the borderline in the direction of the river and it has to date neither been agreed upon nor been demarcated. Although the sharing of water should not be directly dependent on the resolution of the dispute, the complete application of the Revised SADC Protocol may require more detailed forms of co-operation on matters, such as environmental responsibilities and the private use of the river and river shoreline. Certainty regarding the border then becomes a more pertinent issue.

The demarcation of the boundary will involve practical and legal consequences such as territorial jurisdiction affecting aspects of statehood such as criminal, civil and administrative arrangements. It will also bring certainty about other related issues such as environmental management, access to and on the river and mining and maritime rights. The implications of all of these will have to be looked closer at during the next phase of the study.

#### 2.5.4 Joint Management Organisations on the Lower Orange River

A number of other cross-border organisations between Namibia and South Africa with defined areas of interest have been established along the LOR. These include:

- (a) Joint Irrigation Authority (JIA);
- (b) Joint Management Board for the Ai-Ais – Richtersveldt Transfrontier Conservation Park;
- (c) Orange River Mouth Interim Management Committee;
- (d) Lower Orange Remediation Forum; and
- (e) Augrabies Falls National Park.

## 2.6 Legal and Institutional Environments in the Water Sector in Namibia and South Africa

### 2.6.1 Namibia

According to the Namibian constitution, all water in Namibia belongs to the State, which regulates and permits its use. Relevant Acts in the water sector are:

- **Water Act 1956 (Act No. 54 of 1956) as amended**

Namibia's present Water Act is an older version of the South African Water Act and is being administered by the Department of Water Affairs (DWA) - Namibia, of the Ministry of Agriculture, Water and Rural Development (MAWRD) - Namibia. This Act provides mechanisms whereby International Treaties can be complied with, but it needs updating. Amongst its deficiencies count provisions for private ownership of groundwater where it is linked to the ownership of land, and it grants riparian landowners of surface water the right to a share of such water. These stipulations are in conflict with the constitution of Namibia and are to be rectified. A new Water Act is presently being developed to be specifically aligned with the requirements of the Namibian Constitution and International Treaties and Agreements. In terms of this draft legislation, River Basin Management Committees will also be set up to support Central Government with resource management.

- **Namibia Water Corporation Act (Act No. 12 of 1997)**

The Namibia Water Corporation Act establishes the Namibia Water Corporation (NamWater) and regulates its powers, duties and functions. NamWater has taken over the bulk water supply function of the DWA.

NamWater may also render water-related services to customers upon request.

- **Local Authorities Act (Act 23 of 1992)**

The Local Authorities (LAs) Act spells out the functions and duties of local authorities in rendering water supply and wastewater disposal services in its areas of jurisdiction.

- **Other Acts that have a bearing on the water sector include:**

- The Health Act of 1920 in terms of which regulations have been promulgated in 1969, and which has the purpose of regulating the health aspects of water use.
- A proposed Environmental Management Act, which is under preparation.
- A proposed Pollution Control Act, which is under preparation.

Since the Water Act makes the DWA the custodian of the country's water resources, other ministries have to co-ordinate with the DWA where their line functions have an impact on the water resources.

The Water Act also enacts an Advisory Water Board, which advises the Minister on matters concerning the protection and utilisation of water resources, and is responsible for the equitable allocation of and distribution of water between different consumer groups. The duties of the Advisory Board are, in view of the preparation of the new Water Act, for the time being been performed by the Permanent Secretary of the MAWRD.

The Directorate of Agriculture (DA) in the MAWRD is responsible for irrigation planning and development on Government land, as well as the necessary extension services. It operates in accordance with the National Agricultural Policy of 1995.

NamWater generally renders bulk water supply in Namibia. In some instances, however, LAs, Government departments and the private sector construct, operate and maintain their own water supply systems.

The Directorate of Rural Water Supply (DRWS) in the DWA is responsible for facilitating, co-ordinating and supporting rural communities, for them to secure, operate and maintain their own water supply in the rural areas.



Responsibilities for water distribution and sanitation are:

- in proclaimed towns: the local municipality (LA);
- in villages: the Ministry of Regional and Local Government and Housing (MRLGH); and
- at Government centres: Department of Works (DW) of the Ministry of Works, Transport and Communication (MWTC).

### 2.6.2 South Africa

- **The Constitution**

The **South African Constitution** is clear. It is supreme law of the land. In Sections 231 – 233 the adoption, approval, incorporation and interpretation of legislation related to international agreements are dealt with in considerable detail. There are no technical ditches in this regard. It must, however, be pointed out that Section 231 provides for five types of international agreements. Their passage through Parliament, and how the executive deals with them, differs. This particular matter will have to be considered if and when an agreement to establish an institution for the Lower Orange River Basin is negotiated and concluded. It is suggested that such an important agreement should be viewed as the type of instrument that needs parliamentary approval. The South African Department of Water Affairs and Forestry (DWAFF) will play an important role in deciding what avenue to opt for.

- **The South African National Water Act of 1998**

The DWAFF is mandated by the National Water Act (NWA) (No 36 of 1998): to ensure that South Africa's water resources are protected, used, developed, conserved, managed and controlled in a sustainable and equitable manner, for the benefit of all persons. The Act establishes the National Government, acting through the Minister of Water Affairs and Forestry, as the public trustee of the nation's water resources, with power to regulate the use, flow and control of all water in the Republic.

The National Water Resource Strategy (NWRS), which is required in terms of the Act, is based on Integrated Water Resources Management (IWRM), taking into account the availability of surface and groundwater, water use, ground- and surface water quality, and environmental and social considerations. Surface and groundwater are viewed as an integrated whole, as are aspects of water quantity and quality.

This Act incorporates important references to the International Law principles dealing with international watercourses. Chapter I of the Act contains basic principles under the heading “Interpretation and Fundamental Principles” that refer, amongst other things, to sharing of “some water resources with other countries.” In Section 1 there is a definition of “water management institution” which includes a body “responsible for international water management”. Section 2 states that one of the purposes of the Act is to “ensure that the nation’s water resources are protected, used, developed, conserved, managed and controlled” by taking several factors (such as the public interest) into account. Another objective is to meet “international obligations”.

Chapter 10 of the South African Act deals with “International Water Management”. The Minister of Water Affairs “may establish bodies to implement international agreements in respect of the management and development of water resources shared with neighbouring countries and on regional co-operation over water resources.” These bodies may perform their functions also outside South Africa (Section 103(3), National Water Act).

- **The Water Services Act, 108 of 1997**

This Act is of less direct significance for the purposes of the present study. It deals with the domestic regulatory framework with regard to basic water supply and sanitation, standards and norms for tariffs and governmental issues in the relationships between the Central, Provincial and Local Governments. It remains important, however, that these two Acts should be implemented in terms of the same vision; including the recognition of those implications that flow from regional and international agreements.

- **Environmental Acts**

- Environment Conservation Act. Act 73 of 1989.
- National Environmental Management Act. Act 107 of 1998.

- **Other Legislation**

- South Africa also has legislation on **administrative justice** and **access to information**.

These have implications for how all governmental structures have to function.

- **Current Institutional Arrangements**

The National Water Act requires the establishment of **Catchment Management Agencies** (CMAs) to undertake regional water resource planning and management to ensure that water users become part of the process. This could have important implications for negotiating any new agreement on the

Lower Orange River. Public participation through these existing bodies should be planned for. If the objectives of providing water to South African communities neglected in the past are to be met from sources of a regional character, the exercise cannot be done from a national viewpoint only.

The National Water Act also requires the preparation of a **National Water Resource Strategy** (NWRS) with reviews at periods not exceeding five years. A draft strategy was produced in 2002 (LIA 46) and after updating in the light of comments received during an extensive public participation consultation, a final version was completed in September 2004.

There is also a **Water Services Strategic Framework**, approved by Cabinet<sup>1</sup> in 2003. That provides for regulating and supporting the water services sector and support for municipalities.

Through **Water User Associations** (WUAs), the Department hopes to ensure that irrigation schemes once exclusively for white commercial farmers, are now shared more equitably by all users and communities; contributing to local economic development.

### 2.6.3 Institutional Framework

Comparative institutional frameworks in the two countries are shown in **Table 2.1** below. It can be seen that the two systems are very similar.

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<sup>1</sup> See in this regard the budget speech by Ms BP Sonjica, MP, Minister of Water Affairs and Forestry, in the National Assembly on 17 June 2004, <http://www.pmg.org.za/briefings/040617water.htm>.

**Table 2.1: Existing National and Institutional Environment**

<b>South Africa</b>	<b>Namibia</b>
<ul style="list-style-type: none"> <li>• <b>National Government</b> <ul style="list-style-type: none"> <li>- DWAF (National &amp; Provincial)</li> <li>- International Commissions</li> </ul> </li> <li>• <b>Provincial Governments</b> <ul style="list-style-type: none"> <li>- Liaison</li> <li>- Co-ordination of planning</li> </ul> </li> <li>• <b>Local Authorities</b> (At District and Local Municipality Level) <ul style="list-style-type: none"> <li>- Water supply &amp; sanitation</li> </ul> </li> <li>• <b>At the encompassing watercourse level:</b> <ul style="list-style-type: none"> <li>- CMAs</li> </ul> </li> <li>• <b>Bulk water suppliers:</b> <ul style="list-style-type: none"> <li>- DWAF &amp; TCTA (raw water)</li> <li>- Water Boards</li> <li>- Water User Associations (Irrigation Boards)</li> <li>- Some LAs</li> <li>- Private</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• <b>National Government</b> <ul style="list-style-type: none"> <li>- DWA &amp; DA (National)</li> <li>- International Commissions</li> </ul> </li> <li>• <b>Regional Governments</b> <ul style="list-style-type: none"> <li>- DRWS: decentralizing responsibilities</li> </ul> </li> <li>• <b>Local Authorities</b> <ul style="list-style-type: none"> <li>- Water supply &amp; sanitation</li> </ul> </li> <li>• <b>At the encompassing watercourse level</b> <ul style="list-style-type: none"> <li>- River Basin Management Committees (foreseen)</li> </ul> </li> <li>• <b>Bulk water suppliers:</b> <ul style="list-style-type: none"> <li>- DRWS (small scale rural)</li> <li>- NamWater (i.t.o. NamWater Act)</li> <li>- Some LAs</li> <li>- Private</li> </ul> </li> </ul>

### **3. ENVIRONMENTAL CARE**

#### **3.1 Ecological Water Requirements**

##### *3.1.1 Agreeing Methodologies*

The ecological water requirements (EWRs) of the Orange River and its estuary are likely to be significant informants affecting the management and in particular the yield of the system. Consequently, it is vital that the approach to the determination of the EWRs is agreed upon at least in principle between all the Watercourse States.

Agreement needs to be reached firstly on the scientific methodology. As the river is an international river, consideration should be given to all possible methodologies. Thereafter, and possibly more importantly, agreement needs to be reached on how the scientific information is utilised, together with the social and economic information, to inform a decision as to the desired ecological condition. Lastly, adaptive management and monitoring of the system is required. In order to achieve this, each country may need to adapt its domestic policies/legislation to take cognisance of the unique challenges of international rivers.

In the case of LOR and specifically the requirements related to the estuary, it is of key importance that the states bordering on the LOR agree how to implement EWRs and manage the estuary. In the case that Namibia and RSA agree and the obligations of all the Watercourse States towards the system are met, the conservation obligations will be fully covered.

The particular concerns regarding the health of the estuary may require RSA and Namibia to take the lead in the four Watercourse States, reaching agreement on methodologies and possible research into the further development of methodologies.

### 3.1.2 *Studies to Determine Requirements*

Once a scientific methodology has been agreed, it is essential that in order for any high confidence assessment of the ecological flows to be determined, adequate baseline data is collected and efforts to improve understanding of the functioning of the ecosystem are made. In this regard, it is vital that a comprehensive yet focussed “baseline” data collection and monitoring programme be implemented with immediate effect in order to be able to feed into the EWRs.

### 3.1.3 *Environmental Monitoring and Control*

A thorough and informed biological, chemical and physical monitoring programme is essential in order to manage a highly utilised and regulated system such as the Orange River. This monitoring should include stakeholder engagement and involvement and must be supported by policies and legislation to ensure corrective steps.

In order to be successful, such a monitoring programme should be based on a joint strategy and programme. This approach should build on existing monitoring programmes within each country such that each country’s efforts in this regard compliment those of the other country. It is vital that information be shared and that periodic meetings take place to discuss trends and future actions that may be required.

## 3.2 **Sharing of Costs**

The basis on which each country’s responsibility for sharing in the cost of protecting the environment, remedying the current impacts, sustaining environmental flows and monitoring the river system are discussed in **Chapters 5 and 9**. It is important to recognise that maintaining the ecological condition of the river and estuary cannot be achieved solely by managing flows. Responsibilities for and costs of management of the land-use and the myriad of other activities that affect the aquatic ecosystem require consideration.

### **3.3 Management of the Ecological System**

The present responsibilities for environmental management of Watercourses in Namibia and South Africa are divided between a number of organisations. This is particularly so when the sub-national responsibilities for land-use (catchment management) are considered together with the responsibilities of the respective Departments of Environment Affairs, Water Affairs, Agriculture and Mining or Minerals and Energy. The current situation regarding the border issue also compounds the question of authority and responsibility of the above Departments.

While these responsibilities are unlikely to change, it is essential that a suitable Bi-national Forum for the coordinated management, planning and implementation of the management of the ecological impacts be established. This Forum should take cognisance of and involve the existing and possible future cross-border organisations on the LOR, such as those mentioned in **Paragraph 2.5.4**.

## 4. WATER RESOURCES DEVELOPMENT AND OPERATIONS

### 4.1 Catchment Run-off

Under natural conditions the average flow through the Orange River mouth was estimated to be approximately 10 800 Million m<sup>3</sup>/a. As a result of the extensive developments and water use in the Orange- and Vaal River Watercourses, the average flow through the Orange River mouth has reduced considerably to approximately 3 670 Million m<sup>3</sup>/a. The natural flow generated in the main sub-catchments of the Orange River is compared with the flow as available at 2005-development level in **Table 4.1**. The location of the study area and sub-catchments are shown in **Figure 4-1**.

**Table 4.1: Run-off Contribution from Orange River Sub-catchments (1920 - 1987)**

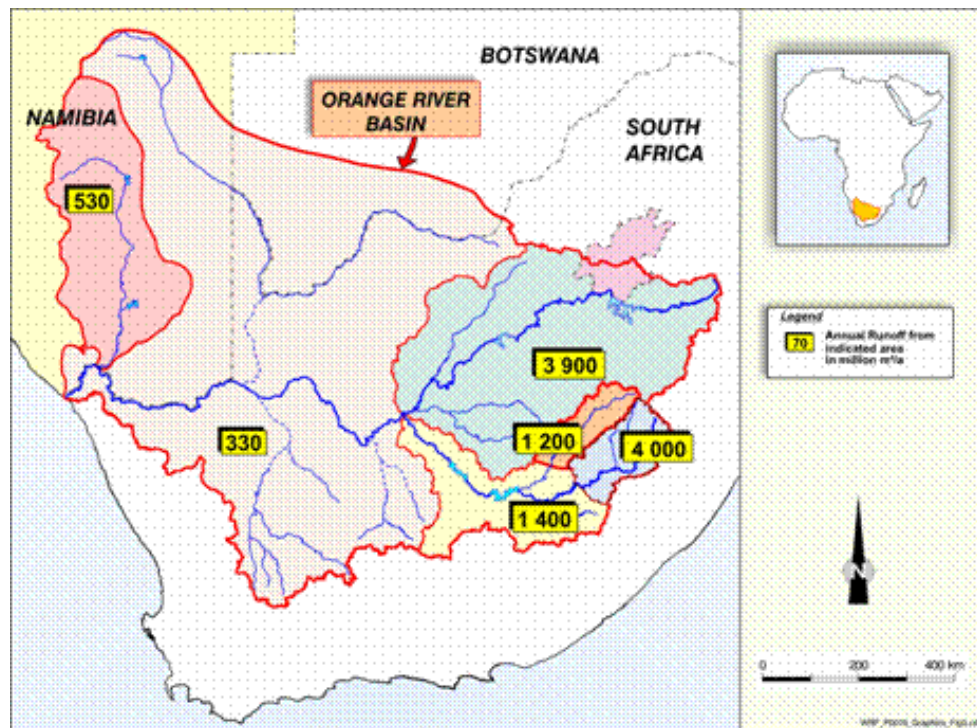
Sub-catchment	Run-off Generated under Natural Conditions		Run-off Contribution at 2005 Development level	
	(Million m <sup>3</sup> /a)	Percentage	(Million m <sup>3</sup> /a)	Percentage
Lesotho	4 000	35	3 240	73 (41)#
Vaal River	3 900	34	1 760	40 (22)#
Caledon	1 200	11	1 010	23 (13)#
Upper Orange	1 400	12	-890 (1 200)*	-20 (15)#
Lower Orange	330	3	-1 150 (220)*	-26 (3)#
Fish River (Namibia)	530	5	460	10 (6)#
<b>Total</b>	<b>11 360</b>	<b>100</b>	<b>4 430 (7 890)*</b>	<b>100 (100)#</b>
<b>River Mouth flow</b>	<b>10 800</b>	<b>95</b>	<b>4 430</b>	<b>100</b>

Notes: \* - The value in brackets represents the local run-off from the given sub-catchment that enters the main Orange River. As soon as the effect of all the abstractions from the main Orange River is taken into account, the balance for the sub-catchment is negative as indicated.

# - The percentage given in brackets is based on the total run-off contribution before the effect of abstractions from the main Orange River in the Upper and Lower Orange is taken into account.



From **Table 4.1**, it is clear that under natural conditions 92% of the water from the Orange River is generated in the sub-catchments (Vaal included) upstream of the confluence of the Orange and Vaal Rivers. The flow at the river mouth is lower than the sum of the natural flow from the different sub-catchments because of the river evaporation and seepage losses along the LOR, which exceeds the runoff generated in the Lower Orange. The effect of the river losses for the flows given at 2005-development level was already taken into account in the balance given for each sub-catchment and the total and river mouth flows are therefore the same.



**Figure 4-1: Approximate Distribution of Natural Runoff in the Orange River Basin**

The average flows given for the 2005-development level clearly shows that the bulk of the water that can be utilised in the Orange River System is coming from Lesotho, the Upper Caledon and the Upper Orange, although large volumes are already abstracted from the Upper Orange. The average inflows from the Vaal into the Orange River are still significant, but are mainly as a result of spills during periods of high flows. To be able to utilise some of these flows from the Vaal River, real time modelling in combination with accurate gauging weirs at strategic points are required and a dam should be built for storage purposes in the Lower Orange.

## 4.2 Water Requirements of each Country

The estimated consumptive water requirements from the Orange River by main consumer, by river stretch and by country is summarised in **Table 4.2**.

The water requirements for Namibia from the system supplied by Gariiep and Vanderkloof at 2005, is estimated to be 75.5 Million m<sup>3</sup>/a. Similarly for RSA, it is 1973.6 Million m<sup>3</sup>/a. This comprises irrigation and other users supplied from the system in the Eastern Cape and the LOR. This total of 1973,6 Million m<sup>3</sup>/a comprises irrigation from Gariiep and Vanderkloof Dams, plus irrigation in the Eastern Cape and the CBA in the amount of 1201.1 + 617.5 + 81.7, respectively, plus the respective urban use of 27.7, 20 and 16.6 Million m<sup>3</sup>/a.

For 2025, the requirements are 274.4 Million m<sup>3</sup>/a for Namibia and 2149 Million m<sup>3</sup>/a for RSA, respectively. **Table 4.2** shows aggregated figures that include the figures as indicated here. Also, see **Annexure A** for a more detailed table of the demand figures.

**Table 4.2: Summary of the Probable Water Demands on the Orange River System**

Category	Expected water demand (Mm <sup>3</sup> /a)												
	RSA						NAMIBIA						
	2002	2005	2010	2015	2020	2025	2002	2005	2010	2015	2020	2025	
<b>Irrigation</b>													
Vaal <sup>1</sup>	796	796	796	796	796	796							
Upper & Middle Orange <sup>2</sup>	1 371	1 381.2	1 398.1	1 415	1 415	1 415							
Eastern Cape <sup>3</sup>	607	617.5	634.4	651	651	651							
Diffuse Irrigation <sup>4</sup>	397	397	397	397	397	397							
Lower Orange <sup>5</sup>	62	82	102	122	122	122	41	60	103	150	197	227	
<b>Subtotal Irrigation</b>	<b>3 233</b>	<b>3 273</b>	<b>3 328</b>	<b>3 381</b>	<b>3 381</b>	<b>3 381</b>	<b>41</b>	<b>60</b>	<b>103</b>	<b>150</b>	<b>197</b>	<b>227</b>	
<b>Urban, Industrial &amp; Mining</b>													
Vaal <sup>6</sup>	1 840	1 968	2 039	2 088	2 163	2 270							
Upper & Middle Orange	101	110	122	134	143	153							
Eastern Cape	19	20	20	20	20	41							
Lower Orange <sup>5</sup>	15	17	23	24	22	23	9	16	31	47	47	48	
<b>Subtotal Urban, Industrial, Mining</b>	<b>1 975</b>	<b>2 115</b>	<b>2 204</b>	<b>2 266</b>	<b>2 348</b>	<b>2 487</b>	<b>9</b>	<b>16</b>	<b>31</b>	<b>47</b>	<b>47</b>	<b>48</b>	
<b>TOTAL</b>	<b>5 208</b>	<b>5 389</b>	<b>5 531</b>	<b>5 647</b>	<b>5 729</b>	<b>5 868</b>	<b>50</b>	<b>76</b>	<b>134</b>	<b>197</b>	<b>244</b>	<b>274</b>	
<b>Lesotho</b>													
Irrigation		9	9	9	9	9							
Urban		11	12	14	15	17							
<b>Subtotal</b>		<b>20</b>	<b>21</b>	<b>23</b>	<b>24</b>	<b>26</b>							
<b>TOTAL (RSA, Namibia &amp; Lesotho)</b>		<b>5 485</b>	<b>5 687</b>	<b>5 867</b>	<b>5 997</b>	<b>6 168</b>							

Notes:

1. The irrigation figures used for the Vaal are those used in the yield modelling and estimated by Loxton Venn.
2. Upper Orange Irrigation allows for 4000 ha development from present to 2010 @ 11 000 m<sup>3</sup>/ha/a.
3. Eastern Cape irrigation allows for 4000 ha development from present to 2010 @ 11 000 m<sup>3</sup>/ha/a.
4. The Diffuse Irrigation refers to irrigation from farm dams and from tributaries of the Orange. There are no irrigation allocations for these irrigators.  
The hectares under irrigation vary annually and are not known. Only the irrigation consumption has been estimated.
5. Lower Orange refers to the Common Border Area and RSA Irrigation allows for 4000 ha development @ 15 000 m<sup>3</sup>/ha/a by 2015.
6. 2025 Urban, industrial, mining demand of Vaal is an extrapolated figure.

## 4.3 Current Operation of the System

### 4.3.1 Integrated Vaal River System

The Integrated Vaal River System (IVRS) is not used to support the Orange River System, but is rather operated to minimize spills into the Orange River. It is important to minimize the spills from the Vaal System, as large volumes of water are transferred into the Vaal River System from neighbouring catchments at high cost to augment the growing demand in the Vaal System. This mode of operation may, however, be questioned as it is not clear as to what extent the Vaal System is being operated to meet with its environmental obligations downstream which include a contribution to the instream flow requirements (IFRs) of the LOR.

The bulk of the transfers into the Vaal River System are coming from the LHWP and the Tugela-Vaal Transfer Scheme. The transfers from the LHWP are flowing into Vaal Dam at a fixed flow rate regardless of the storage levels in the Vaal System or in Katse and Mohale Dams. Transfers from the Tugela to the Vaal will only take place until Sterkfontein Dam, located in the upper reaches of the Wilge River, is full. Water from Sterkfontein Dam will only be released to support the Vaal Dam when Vaal Dam is at a fairly low level. Releases from Vaal Dam, to support Bloemhof Dam, are only made when Bloemhof Dam is at a low level.

Grootdraai Dam is generally not used to support Vaal Dam, although it might be used in cases of emergency. Grootdraai Dam is mainly used to support Sasol and Eskom power stations in the Upper Olifants catchment with water. Grootdraai Dam is, however, supported with transfers from Heyshope Dam in the Assegai River, and from Zaaihoek Dam in the Slang River, a tributary of the Buffels River.

This operating rule will therefore result in lower storage levels in Bloemhof and Vaal Dams and will consequently reduce evaporation and spillage from the two dams, as well as increase the possibility of the dams to capture local runoff.

Operational analyses are carried out for the Integrated Vaal River System on an annual basis. These analyses are used to determine possible shortages and surpluses in the system and to advise the operators to make adjustments in transfers or impose curtailments in advance, in order to prevent failures in water supply. This is also used to save unnecessary pumping cost - according to the required assurance levels applicable to the various users in the system. It thus remains apparent that the system is principally being operated to secure the demand for water from its consumers.

#### *4.3.2 Orange River System*

Gariep and Vanderkloof Dams are the two largest reservoirs in South Africa and used to stabilise the water requirements along the Orange River from the Gariep Dam to the Orange River Mouth. Since the completion of these two dams, the assurance of supply to the users in South Africa was significantly increased. The demands supplied from the two reservoirs include irrigation, urban, mining, environmental requirements, river evaporation and operational losses. Large volumes of water are also transferred to other neighbouring catchments in South Africa.

Gariep and Vanderkloof Dams are not supported by any of the upstream dams and it is only spills from these dams (Katse, Mohale, Welbedacht, Knellpoort and a few small dams), as well as environmental releases from mainly Katse and Mohale Dams that will enter the Gariep and Vanderkloof Dams.

Except for the releases through the Orange-Fish tunnel and those into the Vanderkloof Canals, all the releases from the Gariep and Vanderkloof Dams, to supply downstream users, are made directly into the Orange River. These river releases are routed through turbines to generate hydropower. Any spills from the Vaal or Fish Rivers (Namibia) or any local runoff generated in the Lower Orange is not taken into account when releases are made from the Vanderkloof Dam to supply the downstream users. It is extremely difficult to compensate for the Vaal, Fish or any other inflows into the Lower Orange by means of reduced releases from Vanderkloof Dam, as releases take approximately one month to reach the river mouth and the existing flow gauging structures in the Orange and Lower Vaal Rivers are inaccurate for measuring low flows.

Operating analyses are carried out on an annual basis for the Orange River System in order to determine the available surplus or deficit in the system for the next year. If there is a surplus available in the system, the surplus is allocated to

Eskom to generate additional hydropower over and above that generated by means of the normal releases for downstream users. Eskom utilises this surplus mainly during the winter months when the peak power demand is high. However, if there is a deficit in the system, curtailments are imposed - first on the low assurance (95% assurance of supply) component of the demand. Only when the low assurance demand component has been curtailed fully, will curtailments be imposed on the medium assurance (99% assurance of supply) demand component, and thereafter on the high assurance (99,5% assurance of supply) demand component. For the purpose of the LORMS Study, it was agreed that the different user groups should be supplied at the assurances as indicated in **Table 4.3**.

**Table 4.3: User Categories and Priority Classifications Suggested for the LORMS**

User Category	Priority Classification & Assurance of Supply		
	Low 1 in 20 year	Medium 1 in 100 year	High 1 in 200 year
Urban/mining	20%	30%	50%
Irrigation	60%	30%	10%
Losses	0%	0%	100%

From **Table 4.3**, it can be seen that 20% of the urban and mining requirements are supplied at a low assurance of 95% (or 1 in 20-year possibility of a failure), 30% at a medium assurance of 99% (or 1 in 100-year possibility of a failure), and the remaining 50% at a high assurance of 99,5% (or 1 in 200-year possibility of a failure). Losses such as river evaporation losses, operating losses, etc. are almost impossible to curtail and need to be supplied at a high assurance to ensure water reaches end users and the estuary.

Should there be any requirement that other assurances of supply be applied when a dam is finally sized, or more user categories be added, such changes should be decided on early in the proposed feasibility study. The two countries need not to fully agree on the levels of assurance, as long as the one country that needs a higher level of assurance in a certain category is prepared to pay for the cost associated with providing such additional assurance. This can be given effect to by creating an additional country-specific category in **Table 4.3** and calculating the size and costs related to the incremental measures that have to be taken to provide the additional water.

The minimum operating levels (m.o.l.) for hydropower generation are currently being used as the m.o.l. in both dams and it is only in severe droughts that the dams will be drawn below these levels. Storage control curves (SCCs) were produced for both the Gariep and Vanderkloof Dams. These SCCs are relatively close to the full supply levels (FSLs) of the dams and are at higher levels in the winter and lower levels in the summer. The purpose of these SCCs is to minimise spilling from the dams and to increase hydropower generation during wet periods. Limited volumes of water can be routed through the turbines and it is therefore not possible to route large floods through the turbines. As soon as the water spills over the crest of the dam wall, the water will be lost for power generation purposes. The SCCs allow the operator freedom to operate the turbines at maximum capacity as soon as the water level in the dam rises above the SCCs level for a specific month. When the level drops below the SCCs, the hydropower releases will again be reduced to be equal to the releases required by the downstream users.

As both the SSCs and hydropower generation with surplus water will disappear over time as the system demand grow, leaving very little or no surplus in the system, both components (SCCs and surplus used for hydropower generation) were excluded from the operating rules used in the LORMS. It was further decided and agreed upon by both Clients, for purposes of analysis, to use the Orange Fish tunnel outlet as the m.o.l. for Gariep Dam, and the Vanderkloof canal outlets as the m.o.l. for Vanderkloof Dam. In both dams, these m.o.l.'s are lower than the hydropower m.o.l.'s.

#### **4.4 Available Yield from and Existing Demand on the System**

Yield analyses were done to determine the yield from the Orange River System (Gariep and Vanderkloof Dams) as they are currently the only resource used to supply the Lower Orange. Although the available surplus/deficits vary according to the different approaches followed, they all indicate very clearly that the system is already being utilized close to its capacity. For this particular study, the results as obtained from the WRPM analyses were regarded as the most appropriate for planning purposes.

The analysis indicated that if the LORMS environmental flow requirements for a Category D Estuary are met, then the Orange River System is virtually in balance at the 2005-development level. With all the demands supplied at the agreed assurances of supply (see **Table 4.4**), the long-term stochastic yield analyses, using the Water Resources Planning Model (WRPM), showed that there is only a relatively small surplus of 40 Million m<sup>3</sup>/a WRPM available at a low assurance of

95% (1 in 20-years). This surplus represents only approximately 6% of the total system yield.

**Table 4.4: Water Use as per User Category and Priority Classification as suggested for the LORMS**

User Category	Priority Classification & Assurance of Supply (million m <sup>3</sup> /a)			Total (Million m <sup>3</sup> /a)
	Low 1 in 20 year	Medium 1 in 100 year	High 1 in 200 year	
Urban & mining	12	18	30	60
Losses	0	0	947	947
Irrigation	1 062	531	177	1 770
<b>Total</b>	<b>1 074</b>	<b>549</b>	<b>1154</b>	<b>2 777</b>

Historic firm yield analyses showed a deficit of 47 Million m<sup>3</sup>/a at the 2005-development level. The reason why the historic firm yield shows a deficit and not a surplus, is due to the fact that it represents an assurance of 99% (1 in 100-years), which means that all the demands are supplied at this relatively high assurance.

## 4.5 Options that may be Developed

### 4.5.1 Introduction

The WRPM analyses indicated that, with the environmental water requirements recommended in the LORMS to maintain the estuary in a Category D, the existing surplus in the system will only be sufficient to meet the expected growth in demand until 2006. Additional measures to increase the available surplus and/or system yield will then be required to be able to supply the agreed environmental requirements, and future developments. The effect of real time modelling to utilise Vaal spills and to improve the operational management of the system, was already included in the WRPM analyses.

While the implementation of Water Conservation and Demand Management (WC&DM) programmes is possible, it is not considered as a secure source of water for new users.



Possible other options that were identified and analysed to increase the system yield and to provide additional water, are the following:

- (i) Improved use of existing infrastructure:
  - Utilising the current surplus in the Vaal.
  - Vanderkloof Lower Level Storage utilization.
- (ii) New infrastructure:
  - Reduce river operating losses by means of a re-regulating dam on the Lower Orange.
  - Increase the system yield by means of one or more additional storage dams on the Orange River System.

#### 4.5.2 Improved Use of Existing Infrastructure

The Vaal surplus of 94 Million m<sup>3</sup>/a at 2005 will reduce to almost zero in 2015. It would thus only be available over the short-term, and then mainly as an emergency resource.

It is an expensive option, as the water needs to be pumped from the Tugela River and it is recommended that it be kept in reserve to be used in emergencies.

Vanderkloof Lower Level Storage can provide an additional 143 Million m<sup>3</sup>/a to the system yield at a relatively low cost, but this option will have a negative effect on hydropower generation. A separate study was carried out in parallel to determine this impact. The incremental yield benefit as established in that study is 240 Million m<sup>3</sup>/a. The reasons for the difference in this incremental yield benefit compared to the LORMS finding of 143 Million m<sup>3</sup>/a, are the fact that LORMS accepted a lower m.o.l. for the reference scenario, and used different EWRs. The figure of 143 Million m<sup>3</sup>/a is the agreed figure to be used in further analyses.

Due to the uncertain negative economic impacts on hydropower generation and the time required to fully assess and implement the option, it is not recommended as a reliable option to be included in the system planning.

#### 4.5.3 New Infrastructure

From an evaluation of alternative sites for a re-regulating dam, the Vioolsdrif site was recommended as a most appropriate site, which can reduce operating losses by approximately 170 Million m<sup>3</sup>/a.

For a large storage dam, the Vioolsdrif site was also identified as the best option on the Lower Orange with an incremental yield of between 270 and 420 Million m<sup>3</sup>/a over and above the 170 Million m<sup>3</sup>/a reduction in operating losses. The yield will depend on the size of the dam (500 to 2 400 Million m<sup>3</sup> live storage). Although this site could be used for a bigger dam, this would provide an incremental yield in excess of the foreseen future demands downstream of the dam, and has thus not been considered at this stage.

The development of a storage dam at Vioolsdrif should, however, be compared with the development of a large storage dam upstream of Gariep Dam. These options were not considered in this study, but some preliminary comparisons indicate that it will be necessary to compare all the options in more depth.

#### 4.5.4 *A Development Scenario*

The probable infrastructural requirements, to reliably meet the expected water demands of each country by 2025, as well as the agreed environmental water requirements, which have still to be determined are:

- The Vioolsdrif re-regulating dam;
- Sufficient storage at Vioolsdrif to increase the system yield, through raising a re-regulating dam or constructing a storage dam as the first phase of the development; or
- Additional storage provided upstream from the Gariep Dam.

At the time that the infrastructure is developed, the river modelling would also be implemented.

#### 4.5.5 *Costs*

The estimated capital and operating costs of the different development options, including Vanderkloof low level storage, are summarised in **Table 4.5**. These costs are based on April 2004 prices and include 14% VAT. The detailed breakdown of the costs are covered in the Dam Development Options Report and summarised in **Table 4.5**.

The capital costs include the design and supervision. The operation and maintenance costs are based on 4% of capital on electrical and mechanical work and 0,25% on civil and other works.

Provision should also be made for a Feasibility Study in the order of about R16 million.

**Table 4.5: Costing of the Different Development Options**

Development Option	Capital Costs	Yield	Operation & Maintenance
	R million	Million m <sup>3</sup> /annum	R million/annum
Vanderkloof Low Level Storage	97	143	2.9
Vioolsdrif Re-regulating Dam (150+110) million m <sup>3</sup>	561	170	2.1
Vioolsdrif Storage Dam (210+110+280) million m <sup>3</sup>	722	170 + 110	2.6
Vioolsdrif Storage Dam (360+110+830) million m <sup>3</sup>	941	170 + 248	3.3

#### 4.6 Proposed Operating Rules

The Orange River System's current operating rules have been described in **Section 4.2.2**.

An important finding of the LORMS is that it will not be possible to successfully manage the Orange River System as a stand-alone system with only the Gariep and Vanderkloof Dams included. The entire Watercourse should be modelled and analysed as an integrated system, which includes the Vaal River System for the purpose of the operating rules. Although Gariep and Vanderkloof Dams are not directly supported from any other dam, they and the Orange River System downstream from these dams, are directly affected by the operations and developments in the Larger Orange River and the Vaal Systems.

The most recent methodology developed in the RSA to determine environmental needs was used as the basis for the modelling of the environmental requirements for LORMS. To achieve this it also requires the low flow monitoring and the system operation management to be significantly improved. Improvements are also needed to the existing flow-monitoring network and real time modelling of the Orange River. It should also be done in conjunction with better flow monitoring of the Vaal River to be able to reduce operating losses and to utilise inflows from the

Vaal. These enhancements also need to be in place to be able to utilise any support from the Vaal System that might be required over the short-term.

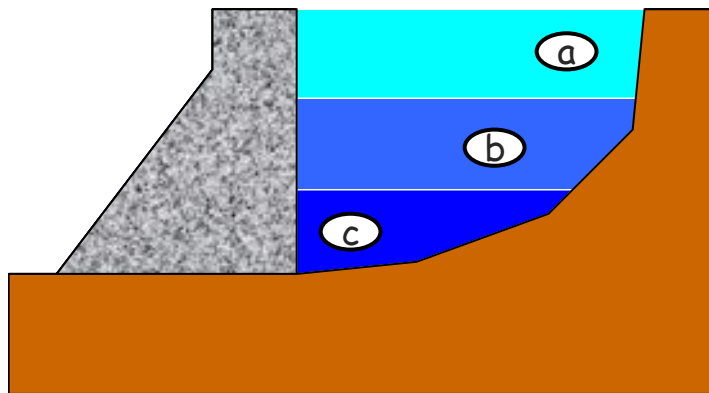
Operational analyses, which are carried out on an annual basis to determine the possible surplus or deficit in the Orange River System should therefore be done for the entire Orange River System. The WRPM is ideally suited for this purpose and should be used for the annual operational analyses.

When restrictions are required all the users in the entire System, allocated or partly allocated to the low assurance of 95%, should be curtailed first until the demands allowed under this assurance level have been fully curtailed. This means that 20% of the urban/mining demand and 60% of the irrigation demand would be curtailed as per **Table 4.3**. To be able to impose these restrictions effectively, it will be necessary to improve on the current flow measurement, monitoring and abstraction control. It also applies to the monitoring of operating and other losses to ensure that targets set for the reduction of these losses are met on a continuous basis.

No significant changes in the operating rules are required, should Vanderkloof Lower Level Storage be utilised as an option. It is, however, recommended that the lower level storage zone in the Vanderkloof Dam be used as a last resort to minimise periods of no hydropower generation at Vanderkloof. A safety zone should also be determined in the Gariiep Dam to ensure that sufficient water is available to supply the requirements for the Eastern Cape through the Orange/Fish tunnel. Some modelling also needs to be done to optimise the generation of hydropower, without affecting the assurance of supply to the other users.

With a Vioolsdrif re-regulating dam in place the basic operating rules as described for the Orange River System will still apply. Some additions to those rules will however be needed which are in a simplistic way described by means of **Figure 4-2** showing a cross-section zoning of the dam. For this purpose, Zone 'a' represents a volume of water above the dead storage level that will enable the dam to supply in the downstream requirements until such time that replenishment releases from the Vanderkloof Dam will reach it. Zone 'b' represents the replenishment volume required, whilst Zone 'c' depicts a safe operating volume that will enable the re-regulating dam to sustain the downstream supply on its own until replenishment is once again required. Operating rules should thus be as follows:

- All downstream requirements, including the so-called operating losses, should be released from Vanderkloof Dam to sustain the demand until Vioolsdrif Dam reaches the upper level of Zone 'b'.
- The releases from Vanderkloof Dam could then be reduced by the saving in operating losses (determined as 170 Million m<sup>3</sup>/a), as well as by the total demand downstream of Vioolsdrif Dam. The volume reserved in Zone 'a' should be sufficient to store the lag water of the higher releases from Vanderkloof for the period before the reduction of the releases from Vanderkloof.
- As soon as the lag water has all reached Vioolsdrif Dam, the outflow from Vioolsdrif Dam to supply downstream water requirements will be higher than the inflow to the dam, as a result of decrease in the releases from Vanderkloof Dam. Vioolsdrif will then be allowed to be drawn down slowly until the lower level of Zone 'b' has been reached.
- The releases from Vanderkloof Dam should now again be increased to include the operating losses, as well as the requirements of all the users downstream of Vioolsdrif Dam. The volume left in Zone 'c' will be sufficient to supply the requirements downstream of Vioolsdrif Dam until the increased releases from Vanderkloof Dam reached Vioolsdrif.



**Figure 4-2: Section through Re-regulating Dam showing Different Theoretical Storages**

- The releases from Vioolsdrif will always be equal to the total downstream needs, which include environmental requirements, urban, mining, irrigation, as well as river evaporation requirements.
- Real time modelling should also be utilised to as far as possible utilise spills from the Fish River, to partly supply in the environmental requirements of the estuary.

The levels between Zones 'a', 'b' and 'c' will be different for each month and can be obtained from the results of the hydraulic river-modelling task. These levels should, however, be refined and adjusted over time as more accurate flow data will become available, which will improve the estimations of the operating losses. Changes in the monthly flow release patterns will also affect the required levels and it will therefore be required to update the levels when changes in the monthly flow release patterns become apparent.

#### Large Storage Dam at Vioolsdrif

A large Vioolsdrif Dam will also be used for re-regulation purposes and the operating rules as given for the re-regulation dam will also apply. The levels between the storage zones will, however, differ although the volume required within each zone will be the same as for the re-regulation dam.

To reduce evaporation losses, Zone 'd' should rather be between 'a' and 'b' or above 'a'. An additional zone (Zone 'd') between Zones 'b' & 'c' need to be added as the storage zone which will be used to capture spills and local run-off.

Only when the additional volume stored in Zone 'd' has been used and the storage in Vioolsdrif Dam is moving into Zone 'c', will releases from Vanderkloof Dam be necessary to supply the demand downstream of Vioolsdrif Dam.

## **5. OPTIONS FOR WATER SHARING, COST SHARING AND JOINT MANAGEMENT**

### **5.1 Introduction**

This Study does not have the objective to resolve any outstanding issues regarding historical claims or rights or the current water usage and cost sharing.

Since both countries are signatories to the Revised SADC Protocol, a basis for co-operation and reaching agreement on the water and cost sharing already exists.

Useful international examples of development of shared Watercourses, which should be studied in future detailed studies, are those between America and Mexico, and America and Canada.

Regional examples, which can be drawn on, are those between Lesotho and South Africa, and South Africa and Swaziland.

The extent to which the middle and upper part of the Orange River has been developed, is such that the successful functioning of any water storage facility in the LOR will be dependent on the operating rules and management of the upstream developments. A dam on the LOR CBA, for example, cannot successfully function as a stand-alone entity and needs to be considered as a further addition to the entire suite of developments on the river system. The proposed operating rules governing that inter-dependence are described above. The management of upstream systems and conditions are important when water sharing, cost sharing and joint management structures are considered. The sharing of costs of the system, both the new infrastructure and the management functions to support it will have to be accommodated.

The development of infrastructure in the upper parts of the Orange River catchment has had positive and negative impacts on the downstream system and the users. Downstream users and the ecosystem have always had a stake in the system that many will argue should be maintained and equate to their equitable share.

Upstream development has altered the natural flow patterns and reduced the annual average flows in the Lower Orange. The ecological system can now only derive its benefit by direct release of water in the right quantity at the right time.

Downstream consumers benefit directly from the regulation of the river. For example, water is released at a known assurance of supply at times that the natural system would not have made it available. More reliable flood warnings are also possible.

The challenge is thus to approach the utilisation of the benefits of the system holistically in order to achieve win-win situations for all involved, including the ecosystem.

Aspects that complicate the derivation of an equitable sharing arrangement include the levels of control that each of the Parties will want to exercise over the system, limitations in funds and resources and differences in the priority and benefits of developments.

Sharing solutions should be such that vested interests and country sovereignty are not threatened.

## **5.2 Principles for Water Sharing**

In determining the practical sharing of allocable water, the following principles should be achieved:

- Water produced by an option should be able to be clearly defined with a known assurance and cost of supply, together with its point of delivery.
- Water provided should be available at the point of delivery as modelled in the analysis. Abstractions should be metered.
- The benefits of the development option should be achieved in practice, i.e., it should be ensured, that water assessed to be available, should in practice, reach the consumers for whom it is meant.



### 5.3 Management Considerations

Whilst recognising the sovereignty of states in the Basin, there are a number of planning and operational activities that require different levels of cooperation or joint management, ranging from interaction, through co-ordination and joint management to integrated management. The challenge is to determine the appropriate level of interaction for the different functions.

Although the considerations for the management of the system described here will focus more on the technical requirements, cognisance needs to be taken of the current and envisaged institutional arrangements in the countries. The relevant CMAs in the RSA and the envisaged Basin Management Committees (BMCs) of Namibia will have certain specific management functions regarding the shared River and these will need to be considered in any proposal. Likewise, the role of organisations with cross-border responsibilities, such as those mentioned in **Paragraph 2.5.4**, should be considered.

The different management issues that need to be considered, include:

- Determining, managing and monitoring of EWRs and the conservation responsibility. The cost incurred to make the water “allocated” to the ecological water requirements available, will need to be borne by the four Parties in some agreed ratio and is discussed later.
- The management arrangements and operating rules of the current Orange River water resource system that may need to be adjusted and/or expanded to include new developments.
- Other developments in the Orange River System that may influence the LOR and as such, need to be mutually agreed. In this regard, it is important that the obligations of the systems upstream of the LOR towards the LOR, such as the Vaal System and the LHWP System, are clearly defined, agreed and monitored.

The management of new infrastructure, hand in hand with the current system, will require mechanisms whereby matters of higher-level policy and approach need to be dealt with. It also requires co-operation in management at middle and lower levels to deal with matters such as strategic planning, and the setting of operating rules and implementation. Thirdly, mechanisms for the management of infrastructure are required at the day-to-day operational level, including operation and maintenance of works.

Proposed schemes on the CBA, also have other joint management matters such as the border, access to the works, utilisation of the dam basin and hydropower, etc., that need to be considered.

Different management arrangements are required on the full river system level, at the river sub-system level and at the local or scheme level. Options for such arrangements are presented in **Chapter 6**.

#### **5.4 Proposed Orange River Management Responsibilities**

In sharing responsibilities for environmental care and costs of improving the security of water supply there are measures to be taken and responsibilities to be assumed by:

- each country individually;
- bi-lateral organisations between Namibia and South Africa;
- multi-lateral organisations between all four Watercourse States; and
- the international community.

Each country should take full responsibility for a number of matters, the specifics of which are to be identified and agreed in accordance with international conventions and Treaties and included in new agreements. Matters, on which such full responsibility is suggested, include the following:

- Control over anthropogenic impacts on the LOR environment that occur within each territory;
- Pollution control within own territory;
- Enforcing limits of water abstraction by its users from the river and its contributing Watercourses;
- WDM within own territory;
- Ongoing monitoring and managing of water quality in river courses upstream of the jurisdiction area of a joint LOR Authority, with the aim to ensure that water entering the LOR is of agreed quality; and
- Controlling other activities in the catchment that may cause harm to the environment and downstream users.

A joint common border authority under auspices of the PWC could be made responsible for the following shared responsibilities:

- Monitoring and reporting with respect to the river section under its jurisdiction:
  - Anthropogenic activities that poses a threat to its own business;
  - Pollution activities that poses a threat to its own business;
  - Water abstraction from the river;
  - Incoming and outgoing water flows; and
  - Instream water quality.

Basin-wide responsibilities that could be shared between all Watercourse States may include:

- Development of scientific processes that are needed to characterise and classify the ecosystem and to facilitate the setting of standards and criteria that should be adhered to.
- Control monitoring of water quality and flow at strategic points in the river system.
- Determination and release monitoring of water required by the estuary from dams that are situated upstream of the LOR.
- Releasing environmental water from a new LOR dam, the environmental benefit of which is to be quantified and the cost thereof to be shared as agreed.

## **5.5 Options of Cost Sharing**

### *5.5.1 Overview of Alternatives*

The development options each have costs associated with making water available through the investment of capital in further infrastructure development. The sharing of the cost between the countries should be in accordance with an agreement to be worked out between the two countries. Some options are discussed below. These are options for agreeing the cost sharing between the countries. Thereafter, each country would have to decide how it wishes to recover, or absorb the costs and the water tariffs to be charged to various users on the river system.

The cost of joint yield-increasing measures in LOR, such as a dam and real time modelling etc., could be shared in relation to the agreed increases in allocatable water, i.e., after having subtracted the contribution that the measure makes towards the environmental water requirements.

The water demand in Namibia is expected to grow from 75.5 Million m<sup>3</sup>/a in 2005 to 274.4 Million m<sup>3</sup>/a in 2025 and the RSA demand on the Upper Middle and Lower Orange System, excluding the Vaal, to increase from 1 973.6 to 2 149.5 Million m<sup>3</sup>/a.

The options for South Africa and Namibia to share the cost of implementing agreed measures include the following:

- **Option 1:** The cost is shared in relation to the benefit each country gains by developing a joint project compared with what each country would have paid, had each independently developed its own yield improvement measures.

This approach is essentially the approach used for agreeing the cost sharing between South Africa and Lesotho for the LHWP.

- **Option 2:** The cost is shared in relation to the incremental water derived by each party from the improvement measures.
- **Option 3:** The cost is shared in relation to water use from the entire Orange River System, by combining the cost of new developments into total system cost, including the cost of historic developments to get a total unit cost of water from the system. This is the approach commonly adopted by a country when developing the water resources of a basin within its borders. A current South African example is the Berg River Project. This option would not normally be pursued by two independent countries, but may be of relevance when considering that:
  - Namibia used to be part of the RSA when the existing water supply systems were developed.
  - Measures are sought to maximise overall benefits from the system and not only to meet the water requirements of the two countries.
  - The inaffordability of any new development, such as a dam along the LOR, should either country expect only the new consumers to pay for it.
  - That all users in the system derive some benefit from the improved yield, arrangement and operation of the system. It may also be seen as to accommodating possible historic inequalities regarding development opportunities.

- **Option 4:** The same as Option 3, but by limiting the system under consideration to the sub-system from Gariep Dam and downstream, excluding the Vaal System.

Arguments for and against Options 3 and 4 are beyond the scope of this assignment and should be pursued as a subsequent action, if so desired by the two countries. In this report, emphasis is placed on the costs related to the incremental developments only.

### 5.5.2 *Indicative Values for Alternatives of Sharing Consumptive Water and Costs*

Amongst many considerations and options in the sharing of costs of further development of the LOR, the following discussion and values are provided as indicative of the implications of alternative sharing arrangements.

#### 5.5.2.1 Option 1

In this option, the benefits due to the cost saving of the joint development compared with the costs if each country were to develop another alternative scheme on its own are shared.

If it is accepted that either country could, on its own, develop a dam on the Orange River along the common border, then the following options exist. South Africa can construct a re-regulating and storage dam at either Vioolsdrif or Boegoeberg to provide its requirements. Namibia could potentially construct either the Vioolsdrif Dam or a dam on the Fish River to supply their demand.

However, this study has shown that:

- The Vioolsdrif Dam is better economically, than a dam at Boegoeberg; and
- That a dam on the Fish River in Namibia is not as economically attractive as Vioolsdrif and, because of its downstream location, cannot meet many of the demands.

It may thus be concluded that both countries would, independently select Vioolsdrif as their best stand-alone option. In this case, the benefit of a joint development is limited to the benefits of scale. This benefit would then be shared on a 50/50 basis. South Africa could also have a benefit of a delayed expenditure as it will require the infrastructure slightly later.

### 5.5.3 Option 2

#### 5.5.3.1 Starting Point : Equitable Share of Water Resources

At independence, it was agreed that Namibia's equitable share of the yield of the Orange River System was 50 Million m<sup>3</sup>/a.

The starting point for cost sharing would then be based on the agreed equitable share, i.e., 50 Million m<sup>3</sup>/a by Namibia and 1999.1 Million m<sup>3</sup>/a by South Africa, assuming an allocatable system yield of 2049.1 Million m<sup>3</sup>/a.

The combined incremental water requirements for cost sharing purposes is 374.8 Million m<sup>3</sup>/a. When incremental sharing uses the agreed equitable share as the starting point, the ratio is 224.4 Million m<sup>3</sup>/a to Namibia and 150.4 Million m<sup>3</sup>/a to South Africa, which results in a 59,8% and 40,2% share of water and hence, cost to Namibia and South Africa, respectively. (See **Table 5.2**).

#### 5.5.3.2 Starting Point : Water Use in 2005

The water utilization and water resources are expected to be approximately in balance at the 2005-demand level and with the LORMS EWR and the real time river modelling implemented. This means that Namibia and RSA could consider a year near to 2005 (or some other mutually agreed year) as the basis for considering the future development. In order to reach this basis, the sharing of cost of implementing the LOR environmental requirements, should be agreed separately.

In 2005, the RSA has a demand on the system of 1 973.6 Million m<sup>3</sup>/a and Namibia has a demand on the Upper, Middle and Lower Orange River System, excluding the Vaal of 75.5 Million m<sup>3</sup>/a in 2005. The 25,5 Million m<sup>3</sup>/a above the agreed current equitable share of 50 Million m<sup>3</sup>/a, that will be utilised by Namibia in 2005, is considered as a temporary arrangement.

This sharing according to the respective incremental demands of 198.9 Million m<sup>3</sup>/a in Namibia and 175.9 Million m<sup>3</sup>/a in South Africa, results in a 53,1% share of yield and costs to Namibia and a 46,9% share to South Africa. (This ratio is called sharing on the basis of incremental water use.) In this case, the sharing ratio can be adjusted to a common reference yield in order to account for the different assurances of supply. It was determined, however, that it does not make a

significant difference due to the similarities in the distribution of the yield to different user groups in Namibia and South Africa. (See **Table 5.3**).

#### 5.5.4 Options 3 & 4

In these options, the entire Orange River System is considered as an entity and the costs are shared in the same ratio as the respective predicted demands of 274.4 Million m<sup>3</sup>/a for Namibia and 2149.5 Million m<sup>3</sup>/a for South Africa for the Orange River sub-system.

In this case, the Namibian share would be 11,3% and that of the RSA 88,7%. However, the sharing of costs will not only apply to the incremental costs, but also to the cost of the existing infrastructure. The current cost of capital redemption and return on investment for Vanderkloof and Gariep Dams is R 80 million/a and the operating cost is R 9,13 million/a.

The implications of this approach are shown in **Table 5.4**.

### 5.6 Responsibilities for meeting Ecological Water Requirements

According to the principles already stated, the sharing of this obligation should logically be in accordance with the utilization from the system. Considering that LHWP meets its EWR obligations to the LOR System, the obligations from the Vaal System to LOR should also be met. Once that is quantified and achieved, the sharing of the obligation on LOR can be in accordance to the utilization or allocation from the LOR, i.e., the 2005 Namibian utilization of 75.5 Million m<sup>3</sup>/a in relation to the 1 973.6 Million m<sup>3</sup>/a demands of RSA. That boils down to a sharing of 96,3% and 3,7% for RSA and Namibia, respectively with respect to the internationally agreed environmental flows that should be forthcoming from the LOR resources. The sharing of this cost is based on the assumption that the upstream systems such as the Upper Orange and Vaal both meet their obligations to the LOR System. That is a RSA responsibility and the sharing for the LORMS EWRs is thus independent of RSA's arrangements with the upstream systems/countries.

### 5.7 Joint Management and Effective Sharing of Development Options

Within the continuum of possible development approaches in the LOR, the following alternatives for development and management of a joint scheme are possible:

- (a) Namibia and the RSA agree that either one of them makes all system improvements that are necessary in the LOR manages the system, and water is then sold by that country to the other country in terms of an agreement.
- (b) The countries jointly develop the system to their mutual benefit, establish a joint operating authority and thereby establish co-ownership, minimise total cost and minimise impingement on the natural environment.

Some opportunities and obligations that can be expected with respect to particular types of joint developments are discussed below under the following categories:

- Infrastructure development on the CBA, such as a storage dam or re-regulating dam at Vioolsdrif;
- Infrastructure development upstream of the CBA; and
- Other measures.

#### 5.7.1 *New Infrastructure along Common Border Area (at Vioolsdrif)*

The option of developing a dam along the CBA has proved to be beneficial, in particular the re-regulating dam, and is one of the selected options for further development. The creation of additional storage over and above the re-regulating requirement is an option that needs to be further investigated in more detail during the feasibility stage. On the basis of preliminary costing from other studies, it seems that it may be more cost-effective to construct the Vioolsdrif Dam to a capacity of about 600 Million m<sup>3</sup>/a to be operational in the year 2018.

The capital cost of the re-regulating dam, at April 2004 prices, amounts to R 561 million. This re-regulating dam can add 170 Million m<sup>3</sup>/a to the yield of the system after provision for losses and EWRs.

The cost of the dam could be shared on any of the bases discussed earlier, after allowance for losses and EWRs are accounted for. The range of costs attributable to each country is shown in **Table 5.1**, **Table 5.2**, **Table 5.3** and **Table 5.4**.

The sharing of cost of this option is based on the benefit of scale for a dam meeting the full requirements of South Africa and Namibia, and amounts to R 232 Million as indicated.

South Africa could benefit by a slight delay in an own development. A cursory sensitivity analysis indicates that this delayed expenditure can make a difference of R 30 to 60 Million that will make a difference of about 3% in the sharing ratios.



**Table 5.1: Option 1: Equal Sharing of Benefits of Joint Development**

	Total	Namibia	South Africa
<b>Yield Requirement (in 2025)</b>			
- Million m <sup>3</sup> /a	374,8	198,9	175,9
- % of Total	100	53,1	46,9
<b>Estimated Development Cost of Independent Dams</b>			
- R Million	1 173	603	570
<b>Joint Dam Development</b>			
- Yield Million m <sup>3</sup> /a	374,8		
- Cost R Million	941*		
- Cost Saving = Total Benefit R Million	232		
<b>50/50 Share of Total Benefit</b>		<b>116</b>	<b>116</b>
<b>Contribution to Joint Development</b>		Own cost less benefit (603-116)	Own cost less benefit (570-116)
- R Million	941	487	454
- % Share of Cost		52%	48%
<b>Re-regulating Dam</b>			
Capital Cost (R Million)	561	292	269
O&M Cost (R Million)	2.1	1.1	1.0

\* Note: This is the estimated cost of a storage to meet the total required yield of 374,8 Million m<sup>3</sup>/a.

**Table 5.2: Option 2: Sharing of Costs for a Re-regulating Dam along CBA on the Basis of Incremental Water Use – Starting Point: Equitable Share of Water Resource**

	Total	Namibia	RSA
2025 Water Use (Million m <sup>3</sup> /a)	374.8	224.4	150.4
Ratio	100%	59,8%	40,2%
Yield (Million m <sup>3</sup> /a)	170		
Capital Cost (million)	R 561	R 335.5	R 225.5
O&M Cost (million/a)	R 2.1	R 1.26	R 0.84

(with adjustment of 25.5 mill m<sup>3</sup>/a “temporary” allocation)

**Table 5.3: Sharing of Costs for a Re-regulating Dam along CBA on the basis of Incremental Water Use – Starting Point: Water Use in 2005**

	Total	Namibia	RSA
2025 Water Use (Million m <sup>3</sup> /a)	374.8	198.9	175.9
Ratio	100%	53,1%	46,9%
Yield (Million m <sup>3</sup> /a)	170		
Capital Cost (million)	R 561	R 297.9	R 263.1
O&M Cost (million/a)	R 2.1	R 1.1	R 1.0

(without adjustment of 25.5 mill m<sup>3</sup>/a “temporary” allocation)

**Table 5.4: Option 4: Sharing of Costs for a Re-regulating Dam along CBA on the Basis of Share of System Water Use and Costs**

	Total	Namibia	RSA
2025 Water Use (Million m <sup>3</sup> /a)	2423.9	274.4	2149.5
Ratio	100%	11,3 %	88,7%
Yield (Million m <sup>3</sup> /a)	170		
Capital Cost (R million)	561	63.4	497.6
O&M Cost (R million/a)	2.1	0.2	1.9
Historical Capital Expenditure Annuity (R million/a)	80.0	9.04	70.96
O&M Cost of Existing Works (R million/a)	9.13	1.03	8.10

The practical joint management of a dam at Vioolsdrif will require an institution (say, a Lower Orange River Authority - LORA) that will manage the releases from the dam, monitor the use of water by the Parties and ensure that the environmental protection goals and conservation obligations are met. The continued measurement and monitoring of the abstraction, flows, etc., will also be an important function of such an organisation. The coordination with equivalent bodies in RSA and Namibia, the Catchment Management Agency (CMA) and BMC, will be of utmost importance, especially regarding the operating rules of and the management of upstream structures.

The continued utilisation of modelling for the operation of the system will be an important focus area for the continued renewal and improvement of efficiency and should form part of the operation and maintenance (O&M) cost of the system.

The utilisation of the water body and the cost related thereto, can also be the responsibility of such an O&M institution, but may be outsourced to tourism operators. The border issue and immigration control of the public over the dam lake can be achieved by providing dedicated access routes to the water body. The alignment of policies by the countries regarding border control and tourism access will be important.

#### *5.7.2 Infrastructure Development Upstream of the CBA*

The utilisation of the Vanderkloof Dam lower level storage, as well as a possible dam upstream of Gariiep Dam will have similar considerations. Being totally located in RSA, these are not the same requirements regarding access control, etc., as is the case with Vioolsdrif. As the water is also in both instances made available to the system as a whole, the principles of cost sharing should in essence be the same.

The quantification of the cost of water supply from Vanderkloof low level storage is, however, more complex as the cost include the quantification of the impact on hydropower supply by Eskom. The cost also includes some redemption of contribution towards the capital cost of Vanderkloof Dam for the utilisation of the additional storage of 800 Million m<sup>3</sup>. The latter cost can be either be considered as the “averaged” cost that should be charged to all current consumers or pro-rata capital cost be calculated. The alternative approaches to sharing of the costs are shown in **Table 5.5**, **Table 5.6** and **Table 5.7**.

**Table 5.5: Option 2: Sharing of Costs for Infrastructure upstream of CBA on the Basis of Incremental Water Use – Starting Point: Equitable Share of Water Resource**

	Total	Namibia	RSA
2025 Water Use (Million m <sup>3</sup> /a)	374.8	224.4	150.4
Ratio	100%	59,8%	40,2%
Yield (Million m <sup>3</sup> /a)	140		
Capital Cost (R million)	R 97	R 58	R 39
O&M Cost (R million/a)	R 2.9	R 1.7	R 1.2

(with adjustment of 25.5 mill m<sup>3</sup>/a “temporary” allocation)

**Table 5.6: Sharing of Costs for Infrastructure upstream of CBA on the basis of Incremental Water Use – Starting Point: Water Use in 2005**

	Total	Namibia	RSA
2025 Water Use (Million m <sup>3</sup> /a)	374.8	198.9	175.9
Ratio	100%	53,1%	46,9%
Yield (Million m <sup>3</sup> /a)	140		
Capital Cost (R million)	R 97	R 297.9	R 263.1
O&M Cost (R million/a)	R 2.9	R 1.1	R1.0

(without adjustment of 25.5 mill m<sup>3</sup>/a “temporary” allocation)

**Table 5.7: Option 4: Sharing of Costs for Infrastructure upstream of CBA on the Basis of Share of System Water Use and Costs**

	Total	Namibia	RSA
2025 Water Use (Million m <sup>3</sup> /a)	2423.9	274.4	2149.5
Ratio	100%	11,3%	88,7%
Yield (Million m <sup>3</sup> /a)	140		
Capital Cost (R million)	97	10.9	85.6
O&M Cost (R million/a)	2.9	0.3	2.6
Historical Capital Expenditure Annuity (R million/a)	80	9.04	70.96
O&M Annual Cost of Existing Works (R million/a)	9.13	1.03	8.10

(with adjustment of 25.5 mill m<sup>3</sup>/a “temporary” allocation)

The operating rules for the system need to be formalised in an agreement and should also be subject to bi-lateral scrutiny. In the situation that no development takes place on the CBA, the functions of a bi-lateral institution need not include O&M responsibilities. One possibility is that there needs to be a joint regulatory institution that will monitor the O&M of the infrastructure and adherence to the operating rules, and also to coordinate the functions of the CMA and BMC. Another possibility is to expand the powers and responsibilities of the PWC to perform this additional function.

In the likely case where a Violsdrif Dam is to be managed, as well as some upstream works, then the situation will be very similar to what has been described in the above section. The co-ordination of functions between a possible LORA and the operations of the upstream system becomes more important. It is described in **Section 6**.

### 5.7.3 Other Measures

#### 5.7.3.1 River Modelling

This measure is a pre-requisite for the implementation of the LORMS EWRs and should be dealt with similarly. The cost could be shared according to the costing of the implementation of the LORMS EWRs. The management and control thereof, however, covers an area larger than the CBA and should be coordinated with the CMA, BMC and LORA. In the case that this system is not used for the implementation of the LORMS EWRs, the cost sharing should then revert to the proportions of allocated water.

As indicated in **Section 5.5** above these costs should be shared in a ratio of 96,3% and 3,7% to RSA and Namibia, respectively and is shown in **Table 5.8**.

**Table 5.8: Sharing of Costs for River Modelling and Implementation of EWRs**

	Total	Namibia	RSA
2005 Water Use (Million m <sup>3</sup> /a)	2049.1	75.5	1973.6
Ratio	100%	3,7%	96,3%
Capital Cost (R million)	R 29.0	R 1.1	R 27.9
O&M Cost (R million/a)	R 2.0	R 0.1	R 1.9

### 5.7.3.2 Vaal Surplus

This option is an interim measure that can be utilised for a short-term bridging facility or as an emergency measure. The cost sharing should be in accordance to allocation and costs charged as per actual costs.

## 6. A WATER SHARING AGREEMENT

### 6.1 Background

From research done on many international shared river systems, it was observed that in many cases agreements were indeed initially project-driven and then eventually expanded to include wider issues, such as general Watercourse system management activities, environmental matters and future planning actions. Many successes in co-operation could also be traced to practical activities such as physical projects, which benefited all participating states and encouraged them to work together in a pro-active way. A LORMS agreement by itself would thus not be an exception, provided both countries would stand to gain from it and be empowered, through the means of the project, to meet with the other general obligations prescribed by the Revised SADC Protocol. As such, it seems that a logical way forward would be that a project driven approach be followed for RSA and Namibia to agree on the project, environmental requirements, etc., and from that basis expand towards system management activities.

A typical agreement would comprise the following:

- a preamble providing the necessary background to the agreement and defining the general framework within which co-operation is sought;
- an acceptance of the principles as laid down by the UN Convention and Revised SADC Protocol;
- a statement on unresolved issues such as certain historical rights, the border issue, an agreement on water rights, etc.;
- an article on definitions;
- an article on the objectives of the agreement;
- a summary of the present state of affairs regarding the ability of the river to meet with the growing demand;
- an acceptance of the need for environmental care strategies, including the determination of and agreement on the environmental requirements of the river and estuary (this will probably require a separate and further agreement to be negotiated);
- an acceptance of the growth in the demand estimates and concurrent allocations (as per the feasibility findings);
- an acceptance of the basis of information and methodologies of analysis;
- an acceptance of the measures proposed (which may include an array of possibilities, including demand management actions and new infrastructure to be developed as per the feasibility findings) to meet with the demand;

- an acceptance of water quality management objectives and strategies;
- an acceptance of the establishment of a Bi-national Water Authority or similar structure that will be tasked to implement the stipulations of this agreement and a description of its terms of authority (guided by the feasibility recommendations);
- an acceptance of the costs sharing of the measures adopted (guided by the feasibility recommendations);
- an acceptance of the time scale for the implementation of this agreement;
- an article on public safety, including flood management and warnings;
- an article on the use of water during dry/drought periods;
- an article on the use of possible short-term augmentation measures;
- an article on the protection of the Watercourse;
- an article on monitoring and information sharing;
- an article on sharing secondary benefits, including hydropower and tourism;
- an article on general financial matters;
- an article on the competent authorities;
- an article on dispute settlement; and
- an article on entry into force, termination and amendments.

## **6.2 Water Allocations to Each Country**

In order to assist with the substance of such an agreement, the LORMS endeavoured to provide the required baseline information. This included an initial assessment of ecological requirements, a revision of the system yield and an analysis of growth in demand. This resulted in a projected demand in close to the available yield by about 2005, even with agreed restrictions during the drier years. This means that the current system can be considered as being more or less in balance. General principles to be adopted with regard to cost sharing for both the capital and running costs associated with new infrastructure are discussed. Suggestions are also made with regard to approaches for the joint operation and control of new infrastructure.



## 7. OPTIONS FOR BI-NATIONAL DEVELOPMENT AND MANAGEMENT INSTITUTIONS

### 7.1 Introduction

Various models exist for the co-operative management, operation and maintenance of particular water schemes. Internationally, establishment of such an institutional arrangement is accepted as good practice. The format of such arrangement can differ, depending on a number of factors, but mainly relates to the autonomy granted to such an institution. On the one end of the scale, such body can be granted extensive powers to determine the utilisation of works, obtain funding, set charges and recover costs from consumers. On the other end of the scale, the countries may delegate limited powers to such institution related only to the physical operation and maintenance of works. Examples in the SADC region are the TCTA and LHWP between RSA and Lesotho, as well as KOBWA between RSA and Swaziland, and the arrangement on the Kunene River between Namibia and Angola.

A core consideration will be whether RSA and Namibia will need this institution to function on an independent budget and recover costs from the consumers or countries and thus be able to raise own funding.

The existing institutional structures in the Orange River Basin are set out in **Chapter 2**. Both Namibia and South Africa are in the process of revising or implementation new water and environmental legislation. New institutional structures are being developed and it may take at least a decade or more for full implementation. The 2000 Revised SADC Protocol is also in its early stages of implementation. Therefore, when considering suitable institutional structures for the LOR, due cognisance must be taken of the evolving external institutional environment in both countries and the respective timescales.

The proposed structures must be practical and capable of implementation within the constraints of available human resource and institutional capacity, as well as financial constraints. The approach taken in this report has been to advocate for fairly simple arrangements for the initial stage, and limiting the levels of institutions to a minimum. As the various basin organisations develop in time, then organisations managing the LOR organisations can be adjusted, if necessary.

A key issue, which must be considered in the institutional assessment, is the boundary between national sovereignty and joint/co-operative management of a shared watercourse. Due to the limitations of skilled human resources in all the Southern African countries, it is essential that duplication of activities and overlap of functions of organisations be reduced to the absolute minimum. Important lessons can be learned from existing international water institutions in the Orange River Basin and elsewhere in Southern Africa.

The discussion below, which sets out institutional options, is divided into various categories as described below:

- Multi-National basin wide management.
- Bi-National management of a specific portion of the Basin.
- Water supply organisations (bi-national and national).
- National (country) institutions.

Outlines of possible international management structures are shown in **Figures 7-1** and **7-2**.

Recommendations on the proposed institutional arrangements are made at the end of the chapter.

## **7.2 Multi-National Basin-Wide Management**

There are multi-lateral issues that need to be discussed, co-ordinated and agreed multi-laterally with other Basin States as well. These actions will fall under the powers and functions of ORASECOM. ORASECOM is an advisory body to the Parties and it has no executive power except as conferred by the Parties.

The existing ORASECOM is currently expanding its organisation by the creation of a Secretariat, which will also have a limited technical capacity. One of its initial activities will be the gathering and collation of basin information from the four Parties. At this stage, ORASECOM has limited executive powers and reports to the respective Governments. It is therefore assumed that, for the immediate future, ORASECOM will be the umbrella coordinating body in the Orange River System and will not have an executive authority. The proposals and discussions on other institutions for the LOR are based on this assumption.

However, it is also possible that supplementary structures and authorities that would strengthen the executive powers for ORASECOM can be developed. Such authorities could be given powers for effective management and operation of the system and could include the following:

- (a) A Watercourse Agency or Authority reporting to ORASECOM, which is made responsible to manage the entire river system as an International Watercourse. Its responsibilities could include:
  - (i) Overall resource management; especially strategic management;
  - (ii) Policy formulation interactively with Watercourse States;
  - (iii) Ecosystem care and research as these impacts on all four Parties;
  - (iv) Equitable distribution of water: determining water transfer and release volumes according to agreed rules; and
  - (v) Sharing of information.
- (b) A Multi-lateral Watercourse eco-system and freshwater research body, to guide and direct research, with the purpose of providing information and management guidelines upon which sound management can be based (actual research can be contracted to established research organisations).

### 7.3 Bi-National Sub-System Management

There are also bi-national issues relating to the LOR system that falls in the ambit of the RSA/Namibia PWC. These issues need to be agreed on, and management mechanisms designed for the management of these by the PWC.

Article 1.4 of the Agreement (signed on 3 November 2000) on the Establishment of the ORASECOM reads:

*“Nothing in this Agreement shall affect the prerogative of any number of the Parties to establish among themselves river commissions with regard to any part of the River System. All such Commissions will be subordinate to this Commission and existing Commissions will liaise with this Commission in terms of this Agreement”.*

The existing PWC between Namibia and South Africa was formed in the 1980s and has therefore a liaison function with ORASECOM. The functions of the PWC are described in **Paragraph 2.5.1** and are somewhat limiting and will require a review and amendment in order for it to play a more meaningful role in Water Resource Management (WRM) in the LOR.

It may be appropriate to expand the powers and functions of the PWC to overseeing the joint development of future joint developments. The Swaziland/RSA JWC and the Lesotho/RSA LHWC can be considered as examples of such entities.

Matters that will typically be part of the functions and responsibility at this level will include water allocations, water rationing, and disaster management measures for droughts and floods, financial matters, policies and approaches, monitoring of lower level institutions, general overseeing and coordination functions, etc.

### 7.3.1 *Permanent Water Commission (PWC)*

The PWC could be the formal communication mechanism between ORASECOM and the other institutional structures in the LOR System. The functions of the PWC could be modelled on that of the JWC between Swaziland and South Africa where a number of executive responsibilities are placed on it for the development and management of the shared water resources. The JWC is composed of three official delegates from each country and met monthly during the Joint Komati Project Development Phase. Subsequently, quarterly meetings are held during the operational/management phase. Occasional meetings between the Parties at Ministerial level are held. There is thus a limited resourcing requirement.

The proposed functions of the PWC would include:

- The monitoring of the implementation of agreements and reporting to the respective Principals.
- Communication with ORASECOM and with other institutions in the sub-system.
- Exercise control over sub-system authorities.
- Determination of strategy and policy for the sub-system.
- Undertake studies related to the sub-system.

These functions would require an amendment to the PWC Agreement and must be read in context with the further institutional proposals discussed below.

### 7.3.2 *A Management Authority for the Lower Orange Sub-System (LORA)*

A second tier River Sub-system Management Agency/Authority is proposed for the LOR sub-system. The Sub-system Agency/Authority would report to the PWC. The model is very similar to that in the Komati Basin and the equivalent institution is the bi-national KOBWA, which has performed exceedingly well in developing and financing two major dams. It has now transformed into an operating and WRM role. The responsibilities of the proposed LORA for the LOR could include:

- The management and control of the water resource, ecological care in its area of jurisdiction, and operation and maintenance of water resource infrastructure.
- Ensuring the agreed distribution of water to user groups.
- Implementation and financing of water resource development projects.
- Monitor of water resources information (in close co-operation with other agencies/authorities) and analysis of data to produce management reports.
- Co-ordination with other bi-national and national bodies, as well as users and stakeholders in both countries.

The proposed name for such an institution is the LORA. The area of jurisdiction of LORA needs to be considered in the context of other institutional structures and particularly the national BMCs in Namibia and the Upper and Lower Orange CMAs in South Africa. Reference is made to these national organisations in **Paragraphs 2.6.1, 2.6.2 and 6.5**. The jurisdiction of LORA could be either:

- The “river reach” along the CBA and the estuary/river mouth with a total river length of about 600 km. LORA would focus primarily on the river and the riparian zone, but in order to effect IWRM, it would have to be aware of land-use developments within the respective catchment, which could affect the water resources (quantity and quality). This type of spatial information is the primary responsibility of the respective national BMC/CMA and LORA would have to gain access to the relevant information by means of effective communication and co-operation with these bodies.

Or

- The whole “river reach” below the Vanderkloof Dam to the estuary is a second option which should be seriously considered. The distance from the Vanderkloof Dam, which is the last major impoundment on the Orange River, to the start of the CBA is some 700 km. The water flows through two South African CMAs (Upper (for 150 km) and LOR (for the remaining 550 km) to the beginning of the CBA. The information regarding the timing and volume of releases from the Vanderkloof Dam, as well as abstractions along the river and flow measurements to determine river losses are of major importance for the effective management of the LOR. The implications of this regarding issues of national sovereignty and communication with national bodies will have to be investigated.

The inclusion of this additional river reach from Vanderkloof Dam to the CBA would provide Namibia with valuable insights in the operation and planning of this South African portion of the Orange River System.

In this and other options, mechanisms whereby Namibia could participate in South African Water Resources Planning structures dealing with the Orange River, should be considered, as this will increase international co-operation and trust.

## **7.4 Water Supply Organisations**

The water supply organisations needed are of different types and can be subdivided into two major categories of:

- Organisations responsible for joint international water supply systems, which are herein referred to as bi-national water supply organisations; and
- Organisations responsible for water supply systems within a particular country, which are herein referred to as national water supply organisations.

Each of these is discussed below.

### *7.4.1 Bi-national Water Supply Organisations*

The JIA is an example of a Bi-national water utility or scheme management organisation responsible to operate and maintain a particular water supply scheme such as the current Violsdrif/Noordoewer Irrigation Scheme. The JIA currently reports to the PWC and investigations are underway to broaden the scope of the JIA in order to make it more effective in a sub-regional context or identify alternative mechanisms for integrated development planning and development. The JIA currently has a very limited mandate and any changes should be considered in the light of the total institutional structures for the LOR.

An institutional model, which should be considered is that the JIA in future, is accountable rather to LORA instead of the PWC and in turn LORA would provide the reporting route to the PWC. LORA would be able to provide the JIA with institutional support in areas such as financing, socio-economic issues, environmental and technical water resources matters. In turn, the JIA could probably provide LORA with services such as labour for the proposed Violsdrif Dam and its operation. Close collaboration will be achieved through these activities.

It could be considered to make the JIA also responsible for the development and/or operation of proposed water resources infrastructure such as the proposed Violsdrif Dam. This is, however, not considered to be advisable as the JIA serves a particular water use sector and may experience a conflict of interest when in dry periods water is also to be released for environmental use and for other users. Placing this development responsibility with LORA will ensure that all user sectors will be treated equitably and that care will be taken to ensure that ecological water requirements for the river and estuary are met.

While LORA would have the responsibility of developing and managing joint water schemes, it could outsource these functions to the private sector and/or to state-owned water utility companies. The existing water utility company in Namibia, namely NamWater, or a water utility company that is presently considered to be responsible for raw water supply systems in South Africa, or joint venture between these companies could be contracted to perform particular functions under the auspices of LORA.

#### 7.4.2 *National Water Supply Organisations*

There are a number of such organisations within the CBA, which receive water from the LOR. The construction of the proposed Violsdrif Dam would provide opportunities for improved water resources management and optimisation. LORA would therefore play a vital role in this regard and close liaison with the relevant water supply organisations is essential for both the reach upstream and downstream of the proposed dam. Examples of these national water supply organisations in the two countries are:

<b>Namibia</b>	<b>South Africa</b>
NamWater Rosh Pinah	Pelladrift Water Supply Scheme
Aussenkehr Irrigation	Springbok Regional Water Supply Scheme
Oranjemund	Alexcor

The metering of abstractions from the river by the water users and effective monitoring by LORA is an essential component of sound WRM and this would link up with billing systems. The payment for water usage in each country is probably an issue for the respective BMC/CMA and the abstraction information from LORA would serve this purpose. This again reinforces the close linkages between LORA and the BMC/CMA's.

### 7.4.3 Financing of LORA

LORA should receive payments from the two Governments, based on the Agreement and water allocations, and not be dependant on collecting charges from users, which is a sovereign responsibility. This type of model exists for the Komati System and has provided certainty of funding and repayment of infrastructure development and operating costs.

## 7.5 National Institutions

The two primary institutions in this category are:

- CMA (Catchment Management Agency in RSA); and
- BMC (Basin Management Committees in Namibia).

Both the Upper and Lower Orange River CMAs are relevant to LORA and the other LOR institutions. The Vanderkloof Dam is some 150 km upstream of the boundary with the LOR CMA. The NWRS (2004) of the DWAF provides an indicative programme for the formation of CMAs. These CMAs should be established during the period 2008 to 2011 and gradually achieve greater functionality. Full functioning of these organisations is expected by about 2016. In the interim period, DWAF acts as the *de facto* CMA.

The areas of jurisdiction and the program of implementation of BMCs in Namibia is currently under consideration. Once finalised, the impacts of their functions on LORA should be considered.

The powers and duties that can be assigned to a CMA in RSA (assumed to be fairly similar in Namibia in the near future), include the management, monitoring, conservation and protection of water resources, and the implementation of Catchment Management Strategies. In the case of the LOR, and more specific to the CBA, it would mean that consultation, coordination and a joint approach with the cross border institutions will be a pre-requisite for successful implementation. This interaction should not only be on horizontal level, but also vertically up to Government level and down to user and to stakeholder level. Mechanisms and structures for such interaction will need to be created and LORA will play an important role.



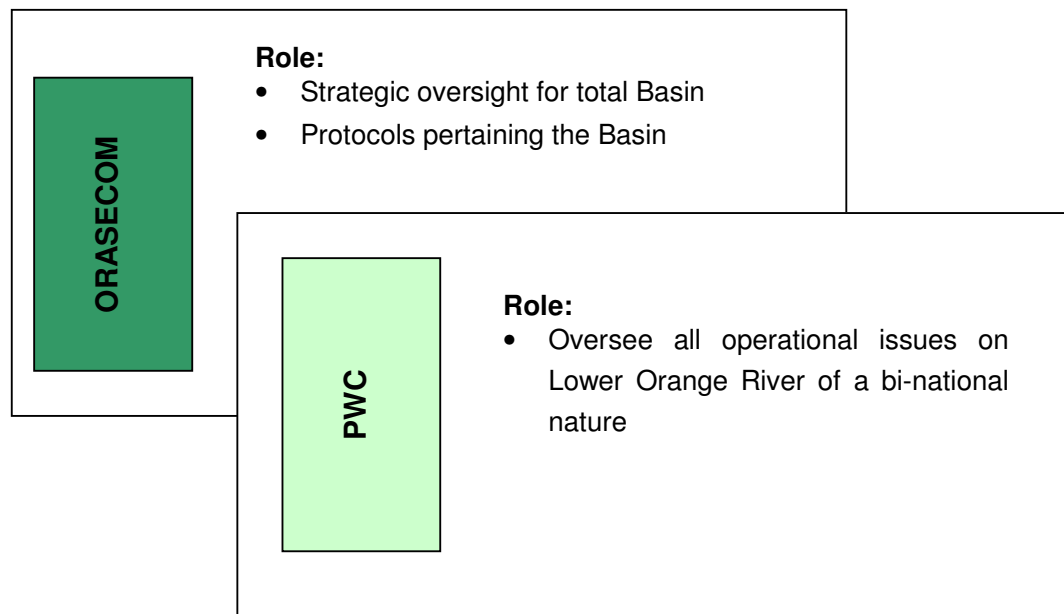
## 7.6 Summary and Recommendations: Institutional Options

The recommended institutional framework is shown in **Figure 7-1** and **Figure 7-2**. The existing institutional structures would be utilised, except that a new entity, the LORA would be created. The powers of the PWC and the JIA would require amendment to align them with the new structure and functions.

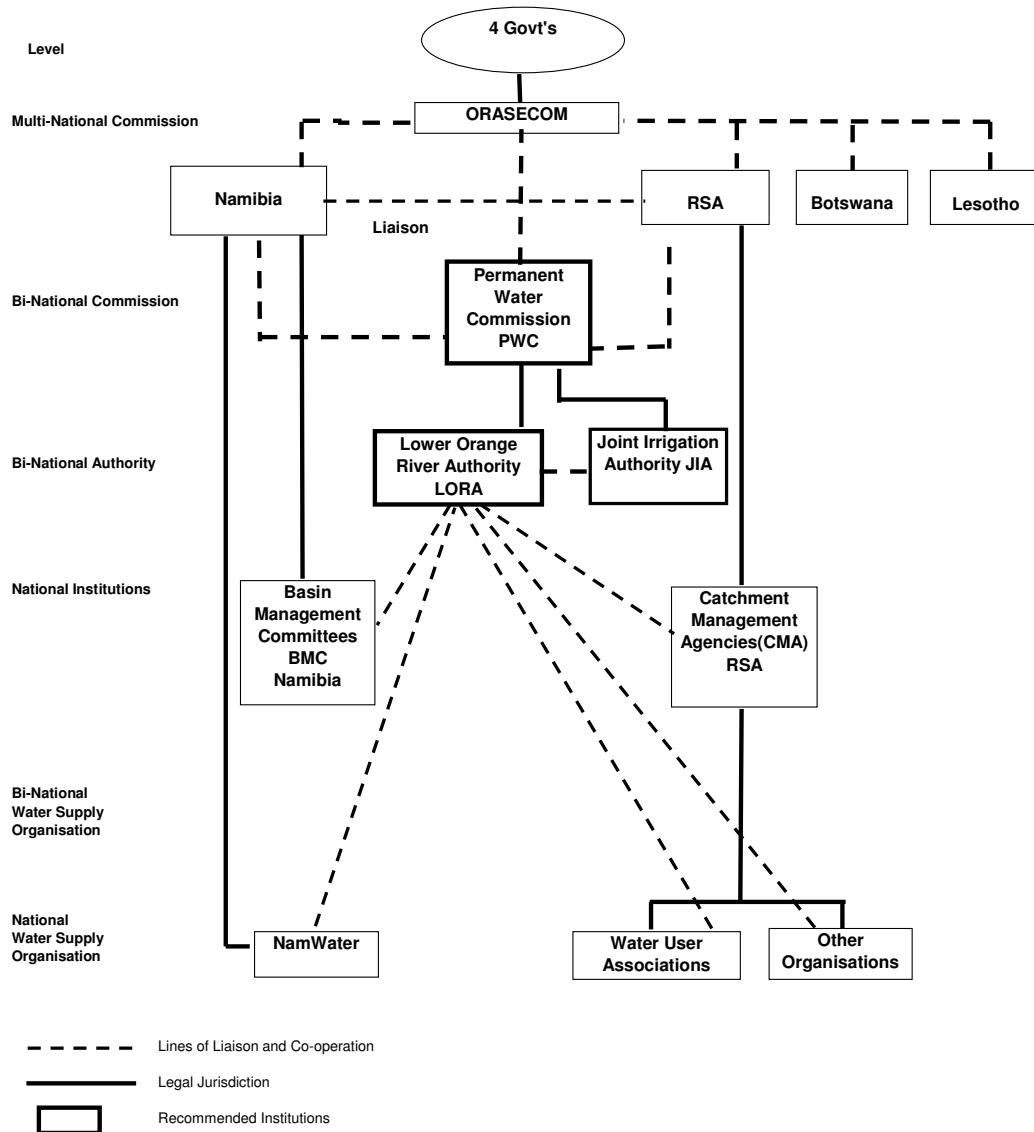
LORA is a key to communication and co-operation with existing and proposed national and bi-national organisations in its area of interest. The area of jurisdiction of LORA should preferably be from Vanderkloof Dam to the ocean, but could be along the CBA. The Parties will have to make a decision in this regard.

Broad functions of the different institutions are set out in the discussion above. It is recommended that the following be agreed on:

- The appropriate framework of institutions for the management of the Lower Orange and implementing the proposed new infrastructure.
- The roles and responsibilities of the institutions.
- The arrangements for sharing the costs and benefits of the management and development of the LOR.
- The appropriate sources of funding.



**Figure 7-1: River Basin Management Roles of PWC and ORASECOM**



**Figure 7-2: Recommended Institutions for the LOR in the Context of the Broader Institutional Framework**

## **8. SHARING OF NEW HYDRO-POWER POTENTIAL**

### **8.1 Hydropower at Vioolsdrif Re-regulating Dam**

The current results indicate that the economic viability of hydropower potential at Vioolsdrif Re-regulating Dam is marginal. The pre-conditions of generation according to required releases for other water demands may also require such generating capacity to be incorporated into a national / international grid, in order to be beneficial.

It may happen that one country may consider it worthwhile to proceed with such hydropower generation, whilst the other country does not support it. It may then be advantageous that the countries agree to allow such interested country to proceed. The necessary provisions should be included in the agreement, to be able to allow such development and should cover:

- Access to the facilities;
- Operating rules of the dam; and
- Contribution towards the capital costs of the dam.

The possible power generation at an internationally shared dam, such as Maguga Dam in Swaziland, can be used as an example of such a provision.

## **9. COST SHARING WITH RESPECT TO FURTHER JOINT STUDIES**

### **9.1 Ecological Water Requirements**

#### *9.1.1 Baseline Ecological Monitoring*

Baseline ecological information is required to enable a comprehensive study of EWRs for a river and estuary. This information is normally required for ecological studies and processes that include national and sub-national “state of the environment” assessments, the River Health Programme, and determination of the Reserve on national rivers in South Africa.

Collection and collation of the baseline information in the LORMS need to consider that:

- The Orange River is a shared Watercourse and its protection is the responsibility of all co-watercourse states. It could be an ORASECOM function to oversee the monitoring and implementation.
- Funding could be available, via ORASECOM, from international donors.
- Approach to monitoring should be consistent across the Watercourse and meet at least the minimum standards within each country.

It is therefore recommended that the Baseline Ecological Monitoring be undertaken under a framework agreed by ORASECOM. However, institutions such as the BMC and/or the CMA or Agency (ORASECOM) could act as an agency to secure funding and to implement the monitoring.

#### *9.1.2 Project Specific Monitoring*

In addition to the baseline information, further information related to environmental matters in the vicinity of and downstream of any development, will be required to identify and assess any impacts from the development. While this data will only be required during construction and, in particular, during operation of the proposed new water resource infrastructure, it is important that a number of years of baseline data are collected in advance before construction begins.

The development may not be able to proceed without this monitoring. Further, the locations of potential water resource developments should be considered when deciding on monitoring locations.

Considering that environmental impacts may result from water resources developments from both SA and Namibia, it is recommended that the project

monitoring be considered as a project cost and the inherent costs be shared accordingly.

### 9.1.3 *Studies into Ecological Water Requirements*

Studies to determine the EWRs of the river and estuary (specifically downstream of Vioolsdrif) will have to be undertaken to satisfy environmental legislation and international practice. It will also be a requirement for donors and international financial institutions. These further investigations should be integrated into the Feasibility Study.

The following points should be considered in agreeing on the cost sharing.

- The EWRs for the whole Watercourse should be undertaken in a consistent manner.
- The EWRs for the LHWP, covering the whole of the Senqu/Malibamutso, downstream of Mohale, were paid for as project costs.
- The EWRs for the estuary and river must be implemented simultaneously with the implementation of water resources development.
- The management of non-flow related, anthropogenic impacts at the estuary will be the responsibility of the South African and Namibian governments.

It is recommended that:

- Costs of studies for the whole Watercourse, including the estuary should be shared by the Watercourse States in proportion to their water allocation for consumptive use. This would be consistent with the principle that the user is responsible for the protection of the environment.
- Specific studies along the CBA required for the implementation of the proposed development, should be shared in proportion to the agreed cost sharing of the proposed project.

## 9.2 **Feasibility Study**

If the two countries agree to proceed with a detailed Feasibility Study, the cost of the Study should be considered as part of the project costs and shared accordingly.

Parallel studies by each country into the allocation and distribution of the water should be the responsibilities of the Parties.

## **ANNEXURE A**

### **Water Demand Summary of the Orange River System**

## **ANNEXURE B**

### **Report on Task 4.3: Water Sharing, Cost Sharing and Dam Operation – Contribution by Legal Specialists**