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Draft Botswana country water report

Prepared for UN ECA as part of the preparation of the African water Development Report

March 2005

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Acronyms

AMWOC	African Ministerial Conference on Water was established (AMCOW
AWV	African Water Vision
BDSAP	Biodiversity Strategy and Action Plan
BOBS	Botswana Bureau of Standards
CBNRM	Community-Based Natural Resource Management
CWP	Country Water Partnership
DC	District Council
EAA	Environmental Action Agenda (NEPAD)
EIA	Environmental Impact Assessment
FFA	Framework for Action
ECA	Economic Commission for Africa
IWRM	Integrated Water Resources Management
KCS	Kalahari Conservation Society
LRMC	Long Run Marginal Cost
MAR	Mean Annual Run-off
MDG	Millennium Development Goals
NAMPAADD	National Master Plan for Arable and Dairy Development
NCSA	National Conservation Strategy Ageny
NMPWWS	National Master Plan for WasteWater and Sanitation
NSWC	North South Water Carrier
NWMP	National Water Master Plan
ODA	Official Development Assistance
ORC	Okavango Research Centre
SACU	Southern African Customs Union
SADC	Southern African Development Community
NEPAD	New Economic Programme for African Development
RBO	River Basin Organisation
RSAP	Regional Strategy and Action Plan for IWRM (SADC)
RISDP	Regional Indicative Strategic Development Plan (SADC)
UAL	UnAccounted Losses
UN	United Nations
WA	Water Authority
WAB	Water Apportionment Board
WDM	Water Demand Management
WSSD	World Summit on Sustainable Development

Executive summary

Botswana has made substantial progress in the water sector since 1990. The major achievements include the following:

1. Rapid expansion of water supply systems for urban and rural settlements;
2. A growing number of individual yard or house water connections in urban and rural villages;
3. Construction of the North-South Water Carrier, several dams and well fields;
4. Rapid expansion of sanitary facilities in urban areas and the larger rural villages;
5. Establishment of modern wastewater treatment facilities (over 64);
6. Sustained financing of water development and sanitation through water tariffs etc.
7. Ratification and implementation of international and regional conventions.
8. Adoption and implementation of the 1991 National Water Master Plan NWMP (its review has started in 2004) and the National Master Plan for Wastewater and Sanitation (NMPWWS)

In addition, new units have been established for water conservation and for international water. Civil society starts to play a role in water management issues.

Good governance and sustained economic growth have been important conditions to achieve the above.

Despite the achievements, several major challenges remain, including the following ones:

- Development of a comprehensive water management policy, including a water management and planning institution. The policy needs to look at:
    - Water allocation;
    - Incorporation of the sector of self-providers;
    - Decentralised, catchment area management.
- Development of up-dated water legislation dealing with water allocations, catchment area management, and water quality aspects
- Implementation of water demand management and conservation

In terms of the four focal areas of the African water Vision, Botswana has performed very well on addressing water and sanitation needs and water funding. Its performance on water wisdom and governance has been satisfactory, but progress has been slower and there is room for improvement.

1 INTRODUCTION

1.1 Background

This is the draft Botswana Water Report, prepared for the UN-ECA in the period January-March 2005. Individual country reports such as this one for Botswana feed into the preparation of the African Water Development Report, which in turn will contribute towards the Global Water Development Report.

The Centre for Applied Research[1] (Dr.Jaap Arntzen with assistance from Ms. Kogomotso Molosiwa) prepared the draft report that benefited from assistance from people in Botswana and the UN ECA.

1.2 Botswana in brief

Botswana is a democracy with a strong tradition of development planning and good governance. Six year National Development Plans and District Development Plans guide the development process. In addition, a growing number of policies, strategies and programmes support the development process. Decentralisation and privatisation are stated government policies.

Botswana has sustained economic growth since the early 1970s, and has 'graduated' from a low-income to medium income country. This achievement has led to a decrease in donor assistance. Economic growth (in real terms) stood at 5.7% in 2003/04. The economy has transformed from a predominantly agricultural economy, based on livestock production, to a mining-driven economy, particularly diamond extraction. Arable production is decreasing, and the livestock sector has stagnated. Tourism is a growing industry, based on rich wildlife resources and unique ecosystems such as the Okavango delta. The industry is relatively small, and government large.

The per capita income was US$ 3080 in 2002 (US$ 8170 in purchasing power parity; UNDP, 2004). The Human Development Index is 0.589, and Botswana is ranked 128. The HID has decreased in the 1990s due to the reduced life expectancy and increased mortality associated with HIV/AIDS. Botswana scores high on the Environmental Sustainability Index (ESI): 55.9 and the country is ranked 34. The ESI is based on reducing stress, reducing human vulnerability, environmental systems, global stewardship and social and institutional capacity (Esti et al, 2005).

Unemployment remains a challenge with an unemployment rate of 23.4% in 2003/04.is a An estimated 23.1% of the population lives on less than 1$/day and half of the population has less than $2/day. According to the latest Household Income and Expenditure Survey, poverty has dropped from 47% in 1992/93 to 30% in 2002/03 (Budget Speech 2005/06).

[1] The assistance is acknowledged of Ms.D. Mello (Population Census office CSO) and Mr. Khupe, head international water division, DWA.

Botswana hosts the SADC secretariat and is a member of the Southern African Customs Union (SACU).

1.3 Water resources and regional initiatives

1.3.1 African Water Vision 2025

The Africa Water Vision for 2025 (ECA *et al*, 2000) was adopted in 2000 and envisages an Africa in 2025, where there is an equitable and sustainable use and management of water resources for poverty alleviation, socio-economic development, regional cooperation and the environment.

Probably more than any other continent, Africa needs to resolve the backlog in provision of access to safe drinking water and sanitation and at the same time ensure that sufficient water resources will be available to boost economic growth and reduce poverty (*productive water*). This backlog is the result of economic stagnation of the last decades. Meeting the domestic and productive resource needs will lead to a rapid increase in water consumption over the next decades, and therefore careful management of water resources will be needed.

The vision encompasses:

- Sustainable access to safe and adequate water supply and sanitation, especially covering the basic needs;
- Sufficient water for food and energy security;
- Sufficient water to maintain ecosystems and biodiversity;
- Reformed water resources institutions to facilitate effective and integrated water resource management of national and transboundary water basins;
- Water basins serving as a basis for regional cooperation and development;
- Sufficient, motivated and highly skilled water professionals;
- Effective and financially sustainable system for data collection, assessment and dissemination for national and trans-boundary water basins;
- Effective and sustainable strategies for addressing natural and man-made water resources problems;
- Water tariffs that promote equity, efficiency and resource sustainability; and
- Sufficient political will, public awareness and commitment for sustainable water resources management, including a mainstreaming of gender issues and youth concerns and the use of participatory approaches.

The Vision will be implemented through a framework for action (FFA) that focuses on four strategic areas:

1. *Governance*: strengthening governance of water resources.
2. *Wisdom*: Improving water wisdom, including public awareness, gender issues and youth concerns;
3. *Water needs*: meeting urgent water needs; and
4. *Water funding*: strengthening of the financial base for water management.

The Water Vision is important for the Africa-wide NEPAD process and the SADC regional strategy of regional cooperation, specialisation and growth for southern Africa.

Although as a continent Africa has abundant water resources, some resources are not efficiently used and part of the resources is underdeveloped. Some countries such as Botswana depend on groundwater and concerns exist about groundwater mining. The distribution of water resources does not correspond to the main demand centres, and therefore water transfer schemes are being constructed and water demand management measures are being considered to avoid water shortages.

Most surface water resources are shared between countries and their use is subject to international and/or regional Protocols such as the SADC Protocol for Shared River Courses). Other resource problems include inadequate funding and under-development of water infrastructure, high spatial and temporal variability of rainfall, inadequate data and human resources to support IWRM, and water wastage through high water leakages and inefficient production techniques.

Milestones and targets have been set for 2005, 2015, and 2025 for the key performance areas of governance, water wisdom, meeting urgent needs and financing of water development and management. The milestones and targets for Africa are summarised in Table 1 (at the back of this report).

In 2002, the Accra Declaration on Water resources was adopted and the African Ministerial Conference on Water was established (AMCOW) to further the Vision, to coordinate it with initiatives such as NEPAD, the Millennium Development Goals (MDG) project and progress made by regional groupings, and finally to make an African Water Input into the 2002 World Summit on Sustainable Development (WWSD).

At the 2003, Kyoto conference, AMCOW indicated that a NEPAD water agenda would be established based on the Water Vision and Framework for Action and that an African Water Facility would be established to pool funds for capacity building and water investments. Regional and sub-regional programmes of action for water will address key water-related concerns. Developed countries were called upon to meet the norm of 0.7% Official Development Assistance (ODA), to allocate more of the funds to the Water Facility and to provide additional support for the pursuit of MDG.

Table 2: Water-related goals of MDG and RSIDP

	MDG	**RSIDP**
Governance		Develop long term water policy and strategy by 2004 Establish at least 8 RBOs Make water planning more participatory and gender sensitive by 2005. Identify and strengthen centres of excellence in water research
Poverty reduction-economic growth	Eradicate absolute poverty by 2016 Reduce by 50% those who suffer from hunger and malnutrition by 2016	Achieve growth rate of at least 7% p.a. Half the proportion of the population living on less than 1$ /day between 1990-2015
Access to water: urgent needs	Reduce by 50% those who do not have access to sustainable	Reduce by 50% those who do not have access to sustainable safe drinking water

	safe drinking water supply in 2016	supply in 2016 Double the water irrigation infrastructure by 2015
Access to sanitation	Reduce by 50% the proportion of people without access to proper sanitation.	
Gender	Reduce gender disparity in access to and control of productive resources by 2016.	
Food security		Double cropland under irrigation from 3.5 to 7% by 2015 Increase use of fertilisers and yields to global average by 2015; Increase livestock production by at least 4% p.a. Double adoption rate of proven technologies
Info and data banks		Establish water data banks by 2007
Financing		Possible SADC Development Fund

1.3.2 NEPAD and water resources

Water resources are a key part of the Environmental Action Agenda (EAA) of NEPAD (2003). The EAA proposed water action in the following areas: pollution, physical changes in the water environment; water-related biodiversity, integrated management approaches, environmentally sustainable economic development in coastal areas, augmentation of water resources and climate change. Water demand management and water use efficiency are not listed as key areas, but most southern African governments have committed themselves at the 2002 WSSD to prepare water use efficiency plan by 2005. For each of the above-mentioned areas, proposals are available for implementation or proposals are being developed.

1.3.3 SADC and water resources

SADC's water efforts are based on the Shared Water Courses Protocol, Regional Strategy and Action Plan for IWRM (1998) and on the recent Regional Indicative Strategic Development Plan (2003).

The Protocol (1995 and amended in 1998) is entirely based on the IWRM, and seeks to facilitate the establishment of shared watercourse agreements through river basin commissions, advance sustainable, equitable and reasonable use of shared water, promote integrated, coordinated and environmentally sound development and management of shared watercourses, harmonise legislation and policies for management of shared watercourses, promote research, technology development, and information exchange on shared water courses.
The use of shared water should balance water development and conservation of the environment, and cooperation should be established for all projects with an impact on shared watercourses. Moreover, the use should be equitable and reasonable, and international laws should be respected. Environmental water needs have been explicitly recognised. Use entitlement depend on biophysical and environmental factors, the social, economic and environmental needs of states, the population size dependent on the share watercourse, existing and potential uses, conservation and economic use of

water and finally the availability of alternative of comparable value to a particular planned or existing use (art. 3.8). Shared water courses are systems of surface and ground water flowing into a common point and passing or bordering two or more SADC countries. The implementation of the SADC Protocol is currently restricted to river basins, but it is important to note that the Protocol covers aquifers too.

The RSAP (SADC, 1998) has adopted a holistic approach towards water development and management. Seven strategic objectives are distinguished:

1. Improve legal and regulatory framework at the national and regional level;
2. Improve national and trans-boundary river basin management and planning;
3. Strengthen linkages among macro-economic, social and environmental policies;
4. Improve information acquisition, management and dissemination;
5. Support awareness building, education and training;
6. Promote public participation; and
7. Invest in infrastructure.

2 BACKGROUND INFORMATION OF BOTSWANA[2]

2.1 Geography

Botswana is a landlocked, semi-arid country with an approximate area of 582 000 km^2 and population of 1 680 863 million people in 2001 (Latest population census). It is landlocked and located in the centre of southern Africa. The population density in Botswana is 2.9 person/km^2.

Botswana is bordered to the north by Zambia, to the northwest by Namibia, to the northeast by Zimbabwe and to the east and southeast by South Africa. The country is an almost uniform plateau with an average altitude of 1 000m; elevation ranges between 700m and 1 300m. The lowest parts of the plateau surface are the Ngami area and swamps of the Okavango River in the northwest, the salty pans of the Makgadikgadi in the northeast and the area between the Shashe and the Limpopo Rivers in the east.

Because of the semi-arid climate, most rivers and streams are ephemeral. The Okavango and Chobe Rivers are the only perennial rivers with their sources outside the country. Because most of the rivers are ephemeral, most valleys are usually dry except after the rains. In the central parts of Kgalagadi, there are several fossil valleys, created during periods of higher rainfall in the past. There is no surface water in the western part of Botswana.

Around 80% of the country has an underlying geological foundation of predominantly Aeolian Kalahari sand and is known as the sandveld. The major soil group of the sandveld is the arenosols, generally deep, fine textured sands with little structure and very low water and nutrient holding capacity. The remaining part, a narrow strip along the eastern side, has a more diverse and harder geological base, and is known as the hardveld. As for the hardveld, a number of soil groups intermix but luvisols predominate.

[2] The background information is derived from a wide range of literature, but in particular from the National Development Plan (NDP).

Over 80% of the population live in the eastern hardveld. The boundary between the sandveld and the hardveld coincides approximately with the divide between Limpopo and Makgadikgadi drainage basins (SMEC *et al*, 1991).

2.2 Climate

The climate of Botswana is semi-arid. Because of the country's location in the sub-tropical high pressure belt of Southern hemisphere in the interior of Southern Africa, far away from the oceanic influences, rainfall is low and seasonal, and diurnal ranges of temperature are high. The mean annual rainfall in Botswana varies from less than 250mm in the extreme southwestern part of the country to over 650mm in Kasane in the extreme north. The rains fall mostly in summer months between November and March. Very little if any, falls between May and September. Inter annual variability in rainfall is high and drought is a recurrent element of Botswana's climate. Drought adversely affects food production and livestock and seriously impairs the rural economy.

Mean annual temperature range from 20^{o}C in the southwest to 23^{o}C in the north. Mean monthly temperatures show greater geographical variations especially for winter season. In July the mean daily temperature ranges from below 12^{o}C in the southwest to over 18^{o}C in the extreme north. Frost occurs in most parts of Botswana during the winter season. The frequency of occurrence of frost generally decreases northwards and eastwards from 72 days of ground frost per annum the southwest to only 3 days per annum in the extreme north.

2.3 Population

The country is characterised by a small population, slow-down in population growth, urbanisation and low population densities.

Population size and growth
According to the 2001 Population Census, the de-facto population was 1 680 863, compared with the 1991 figure of 1 326 796. The average annual growth rate was 2.4% between 1991 and 2001, and is declining (1971-81: 4.5%; 1981-1991: 3.5%). Annual growth rates between 1971 and 1981 and between 1981 and 1991 were 4.5 and 3.5 percent respectively. The population growth accounts for a high proportion of children and young people.

The decline in population growth is due to declining fertility rates, increased women participation in economic activities, increased literacy rates, access to better health and the HIV/AIDS pandemic.

There has been a decline in child mortality due to the Child Survival Programme. Recently, HIV/AIDS-related mortality among infants, children and prime-aged adults could increase. The life expectancy at birth has dropped to 41.2 years in 2002 (UNDP, 2004).

Urbanisation
Botswana has experienced rapid urbanisation due to the concentration of formal employment in urban areas. In 2002, the urban population was estimated to be 51.5% (UNDP, 2004).

Population density
The average population density (the overall spatial distribution of the population) of Botswana was 2.9 persons/km^2 in 2001. However, variations from this norm do exist. In general, population density increases as one moves from the west to the east. The lowest population densities recorded, of less than 0.5 person/ km^2 occur in western and northern Botswana.

3 THE CURRENT STATE OF FRESHWATER RESOURCES

3.1 The state of the resource

3.1.1 Hydrology and catchment basins

The hydrology of Botswana is shaped by the following climatic factors:

- *Low rainfall*. Botswana experiences generally low rainfall. The mean annual rainfall varies from a maximum of over 650mm in the extreme of north-eastern area of Chobe District to a minimum of less than 250mm in the extreme south-western parts of Kgalagadi District. As a result, no significant river takes its source from within the country;
- *High rainfall intensities*. Even though Botswana is classified as a semi-arid to arid country, it experiences very high intensity rainfalls;
- *Rainfall seasonality*. The seasonal nature of the rainfall is responsible for the fact that most rivers are seasonal or ephemeral;
- *High temporal variability* of rainfall. Rainfall in Botswana is highly variable overtime. This temporal variability of rainfall is mirrored in the time distribution of run-off and river flow.
- *High spatial variability of rainfall*. There is high variation of rainfall from one area to another. Even over the same catchment area, rainfall can vary highly from one part to another. As a result, runoff from areas with high rainfall may be absorbed in areas without rain before it reaches dams.

The high evaporation rates have led to unfavourable ratios of dams between volumes of water stored and impounded water surface area. This poor ratio basically leads to evaporation ponds from which most of the water impounded is pumped back into the atmosphere by evaporation (Department of Surveys and Lands, 2002)

Botswana can be divided into six drainage basins or catchments. These are the:

1. The *Molopo/Nossop River*, which forms the southern border between Botswana and South Africa. The river drains in a generally westerly direction, and ends up in Orange River. Due to the low rainfall in the basin the river has negligible flows for most of the time, so it is not gauged;
2. *Limpopo River basin* in the eastern part of the country. The Limpopo River forms the eastern border between Botswana and South Africa. Most rivers in eastern Botswana drain into the Limpopo River. The major rivers in this drainage basin are the Ngotwane, the Bonwapitse, the Mahalapye, the Lotsane, the Motloutse and the Shashe rivers. The basin constitutes a drainage area of some 80 000km^2.
3. *Makgadikgadi drainage basin* to the west of the Limpopo basin. On the eastern side of the pans, the Mosope, Mosetse and the Nata Rivers all drain into the

Makgadikgadi pans. The Boteti River feeds the western side of the wetland, which is part of the Okavango wetland system. The Nata River is the largest of the rivers draining into the Makgadikgadi pans. It drains a total area of 21 216 km^2, most of it in Zimbabwe.

4. *Kwando/Linyanti/Chobe Rivers* in the north of the country. The Kwando originates in Angola and enters Botswana after crossing through the Caprivi Strip in Namibia. In Botswana, it spreads out into the Linyanti swamps, which drains into the Savuti and Linyanti Rivers, eventually reaching the Chobe River.
5. *Okavango River drainage* and basin and Delta system in the northwest. This comprises the Okavango River, the Okavango Delta, and the outlets from the delta, the major ones of which are the Thaoge, the Kunyere, the Shashe, the Boro and the Ngogha Rivers. The system also extends down the Boteti River to the Makgadikgadi pans. The river and delta provides sustenance in a generally arid region, and is one of Botswana's major tourist attractions.
6. *Internal drainage system*. The remaining part of the country is the uncoordinated internal drainage system. All runoff is lost through evaporation and seepage. In the central Kgalagadi, there are some fossil river channels, which run in an easterly direction. These rarely ever carry any significant runoff.

The location and size of the drainage basins is summarised in Table 3.

Table 3: Location and size of the main drainage basins of Botswana

Drainage Basin	**Region**	**Area (km^2)**
Limpopo	East	80 000
Makgadikgadi	North	30 000
Okavango	North-West	97 000
Kwando/Linyanti/Chobe North	North	26 000
Molopo/Nossop	South	71000
Uncoordinated	Central	259 000

Source: Dep. of Surveys and Mapping, 2001.

3.2.2 Surface water resources

The available surface water resources available can be classified as domestic origin and shared. The first one is related to rainfall in Botswana. This consists of rivers, areas of wetland notably the Okavango Delta and the various salt pans, notably the Makgadikgadi salt pans. Most of the rivers are ephemeral and are concentrated in the eastern parts of the country. The shared component is composed of runoff in international river systems, which have the whole or major proportion of their catchments outside the country. This component includes perennial rivers such as the Okavango, Kwando/Linyanti/Chobe, Limpopo and Molopo/Nossop Rivers, of which their use is subject to international agreements. The Okavango and Chobe rivers in the northwestern and north constitute 95% of the total surface water of Botswana. The ephemeral rivers which are in the eastern parts of the country have an estimated yield of 1 200 million m^3 per year (Khupe, 1994).

Estimated long-term run-off of the major rivers in Botswana excluding the Okavango and Chobe River systems whose catchments are outside the country are shown in table 3.

The average annual runoff is 1.2mm, and ranges from zero in western and central Botswana to over 50mm per annum in the north. The total mean annual surface runoff from catchments within Botswana is estimated at about 700 million m^3. About 85% of this runoff is contributed by catchments within the Limpopo river basin. The remainder is accounted for by flows into Makgadikgadi Pans (SMEC *et al*, 1991). Most of the run-off cannot be captured due to lack of suitable dam sites and high variability of run-off in time (Arntzen et al., 2003).

Rivers with their catchments within Botswana have low and erratic flows. Coupled with high rates of evaporation and the lack of suitable dam sites this account for low sustainable yields of most reservoirs (usually below 40% of the mean annual flows) For example, the Gaborone dam has a sustainable yield of only 32% of the mean annual runoff.

More dams are being developed, mostly on river systems originating in the country. Plans for surface water development of the last NDPs are summarised in Table 4. Four new dams will be constructed, and studies for several others, including the lower Shashe dam as the second phase of the NSWC are carried out.

Table 4: Activities for surface water development in NDP 8 and NDP 9

National Development Plan 8	**National Development Plan 9**
Dam development	**Dam development**
Studies for dam sites done on Mosetse River	Construction of four surface water dam Dikgatlhong,Lotsane,Thune,Ntimbale
Studies for dam sites done on Tati River near Masunga	
Detailed design of Lotsane dam completed	
Detailed design of Ntimbale dam completed	
Detailed design of Lower Shashe dam (Dikgatlhong dam) completed	
Preliminary design of a dam on the Thune River	
Possible Dam sites	
Thune,Ntshe,Tati	

Sources: Government of Botswana, 1997 and 2003.

Letsibogo represents the largest dam in Botswana in terms of mean annual reservoir yield. Its whole catchment is within Botswana and has an area of around 5 700 km^2 with an estimated mean annual of 57 M m^3. The dam has a capacity of 104 M m^3 and an annual yield of 24 M m^3. The development of Letsibogo dam and the proposed Lower Shashe dam form part of the largest engineering project ever undertaken in Botswana, namely the North South Water Carrier project.

Major dams are used to supply urban and peri-urban centres, and small dams are used mainly for agricultural purposes, notably horticulture and livestock watering.

Table 5: The storage capacity of large dams in Botswana

Dam	**Capacity (M m^3)**
Gaborone dam	144.15
Letsibogo dam	104
Nywane dam	2.28
Bokaa dam	18.5
Shashe dam	87.9

Source: WUC.

According to Breen *et al*, (1997), Botswana has over 28 000 km of wetlands, mostly swamps (Okavango and Linyanti-Chobe) and pans (Makgadikgadi and Nxai). In addition, Lake Ngami and Lake Liambezi are shallow lakes, which have virtually dried up. All wetlands are located in northern Botswana.

3.2.3 Groundwater resources

The geology and climate, past and present, are important factors that influence the groundwater resources of Botswana (Dep. of Surveys and Mapping, 2001). Groundwater in Botswana is limited, both in quantity and quality and is unevenly distributed over the country. Groundwater collects in aquifers and is abstracted through well fields. Only a small part of the groundwater resources can be economically abstracted due to high abstraction costs, low yields, poor water quality and remoteness of aquifers in relation to consumers centres (SMEC *et al,* 1991, Masedi *et al*, 1999). The estimated mean annual recharge is 2.7mm being zero in western Botswana to 40mm in the north.

Any large scale of extraction of groundwater in Botswana (e.g. for mines of Orapa and Jwaneng), constitute mining of a non-renewable resource. The extractable volume of groundwater in Botswana is estimated to be about 100 000 M m^3 (Khupe, 1994). But only 1% of this amount is rechargeable by rainfall because of the semi-arid climate characterised by low rainfall amount and high rates of evaporation as well as the nature of geology of aquifers (Ayoade, 2001)

According to Ayoade (2001) four types of aquifers are found in Botswana

i) *Fractured aquifers,* which cover 27% of the country, are found in the crystalline bedrocks of the Archaen Basement in the east and in the karoo basalt. These have low yields with the median yield ranging between 2 and 10 m^3 per hour.
ii) *Fractured porous aquifers*, which cover 37% of the country, are found in Ntane and Ecca sandstones as well as in arkoses in the karoo formation. These aquifers have the highest yields.
iii) *Porous aquifers*, which cover 35% of Botswana, occur in sand rivers, alluvium and the Kalahari beds. These are usually high yielding and have a median yield ranging between 10 and 300 m^3 per hour.
iv) *Karstified aquifers* occur in the dolomite areas in southwestern parts of Botswana as well as in other areas in Lobatse, Ramotswa and Kanye. Karstified aquifers account for only 1% of the land area of Botswana. These aquifers have a median yield of 4-20 m^3 per hour.

Groundwater is the major source of water supply in rural Botswana (people and livestock). In 1990, groundwater accounted for around 64% of the 1990 total water consumption in Botswana, but the share is expected to decline to around 40% in 2020.

Recharge in western sandveld is in the order of 1mm/yr or less. The low recharge is related to the surface sand cover, from which most moisture is lost through evapotranspiration by plants and trees. In eastern and northern Botswana (the hardveld) recharge increases to between 4 and 20mm/yr, depending on local geology and geomorphology.

Groundwater is located at great depth except in a few areas receiving regular floods or with permanent water bodies. The depth varies over the country from less than 40m in the north and east to well over 60m in the drier central and south-western parts. The borehole technology has opened up very deep groundwater deposits. According to the Botswana National Borehole Registry, there are around 17700 registered boreholes drilled for domestic and livestock watering purposes.

There are at least 38 major well fields and several new ones are being developed or studied. Most are used to supply villages, but a few supply mines and the power plant. Two well fields are being rested and one is no longer used due to nitrate pollution. According to NDP 8, many groundwater projects have been completed such as the Kanye, Ramonnedi and Moshaneng areas ground water resource evaluation projects.

Water yields from successful boreholes vary widely over the country. Over a large part of Botswana, borehole yields are poor to fair with average yields being less than $4m^3$ per hour. In only a few areas are the average borehole yields in excess of $8m^3$ per hour.

Resource concerns include the following:

- Water salinity in central and western Botswana. Some resources are unfit for human and even livestock consumption. Progress with desalination technology would open new user opportunities.
- Low recoverable water proportion due to relatively poor water transmitting properties;
- Groundwater mining, i.e. abstraction exceeds recharge, around large villages and mines (Masedi *et al*, 1999);
- Groundwater pollution.

Table 6: Estimated long-term run-off potential of major rivers in Botswana

River	Area km^3	Runoff mm	Long-term runoff potential $10^6 m^3$
LIMPOPO RIVER BASIN			
1.Notwane river at Gaborone Dam	3983	7.6	30
2. Metsimotlhabe River at Morwa	3570	2.7	10
3. Mahalapswe River at Madiba	754	11.2	9
4. Lotsane river at Maunatlala	6385	5.8	40
5.Motloutse River at Tobane	7930	12.0	95
6. Shashe River at Shashe dam	3650	25.1	92
7. Shashe river at lower Shashe (excluding area of Shashe Dam catchment)	4160	30.0	125
8. Ramokgwebana River (Catchment area within Botswana only)	2310	18.0	42
Subtotal	**32740**	**14.1**	**460**
B.MAKGADIKGADI	**BASIN**		
Mosope and Mosetse river	9500	6.0	57
Nata River at Old Nata bridge	6500	6.9	45
Subtotal	**1600**	**6.4**	**102**
LIMPOPO RIVER	**CONFLUENCE**		
Notwane river	17620	4.7	83
Bonwapitse River	11000	1.3	14
Mahalapye River	5740	7.0	40
Lotsane River	15790	4.3	69
Motloutse River	18310	6.9	127
Shashe River	11340	23.7	269
Subtotal	**79800**	**7.5**	**602**
TOTAL (B+C)	**95800**	**7.3**	**704**

Source: Ayoade, 2001, p. 89.

4 WATER DEMANDS AND NEEDS

Water demand has increased as a result of the growth in population, economy and welfare levels. The aggregate water demand is not exactly known, as there are many water providers and there is no central consumption record. Only, Water Utilities Corporation (WUC; urban areas), the department of Water Affairs (DWA; large villages) and some mines keep consumption records. The District Councils (rural villages) and most self-providers such as livestock farmers do not record consumption.

This section is based on the water demand forecasts of the National Water Master Plan NWMP (SMEC *et al,* 1991) and two water accounting studies that have estimated water consumption for the period 1990-2001 (NCSA/CSO, 2000 and Arntzen *et al*, 2003).

In this report, water demand and consumption are used interchangeably, and refer to the amount of water used by end-users. Water consumption plus unaccounted losses UAL (leakages and non-payment/ illegal use) together constitute the water production. The *basic water needs* are the water needs of households for washing, food preparation etc. Government policy emphasises meeting basic needs through the construction of water reticulation systems in all villages (more than 500 inhabitants) and settlements (250-500 persons) and through the provision of free or subsidised water for the so-called lifeline band (up to 5 m^3 per month). The water from standpipes is free, but due to wastage and escalating costs government is in the process of terminating standpipes in favour of yard connections.

4.1 Demand forecasts

In 1991, the NWMP forecasted a rapid growth in water consumption, especially for domestic use, in urban areas and in large rural villages (Table 7). The demand, including UAL, was expected to rise more than fivefold in urban areas and major villages. This demand is mostly domestic use, industry and government, based in urban areas.

Table 7: Water demand forecasts (in M m^3)

	1990	**2000**	**2010**	**2020**
Urban areas	20.9	45.0	72.0	103.1
Major villages	8.2	21.5	35.4	51.9
Rural villages	5.3	9.2	12.7	16.5
Other settlements	1.9	2.3	2.7	3.0
Mining	22.5	35.7	56.5	63.7
Livestock	35.3	44.8	34.3	44.1
Irrigation, forestry	18.9	28.9	38.5	46.9
Wildlife	6.0	6.0	6.0	6.0
Total	**119.0**	**193.4**	**258.1**	**335.2**

Source: SMEC *et al*, 1991 vol. 1.

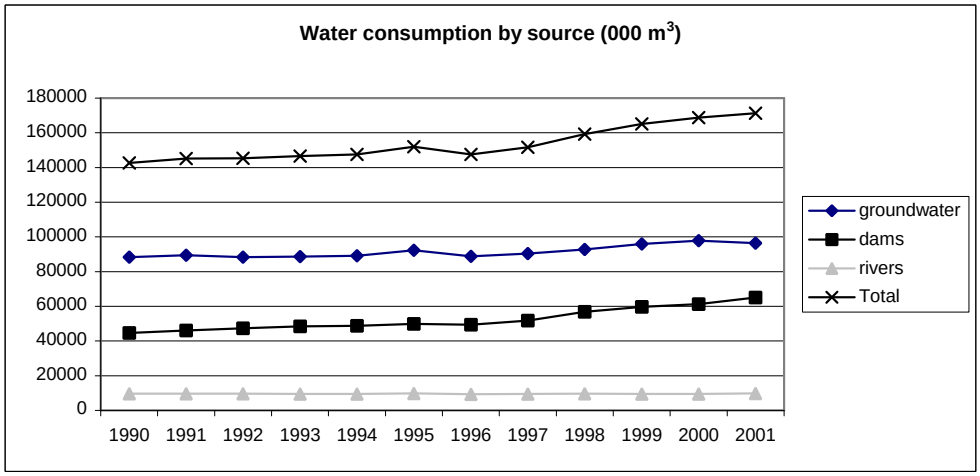
The scenarios predicted that the demand would rise fastest in southeastern Botswana where there were limited opportunities for expansion of surface water and groundwater. Therefore, the NWMP recommended that a North-South Water Carrier NSWC be built to transfer water from Letsibogo dam in northern Botswana to supply southeastern Botswana. The dam and pipeline have been built in the 1990s.

4.2 Water consumption in the period 1990-2001

According to the water accounts, the water consumption grew at a slower path than predicted by the BNWMP. The aggregate flow accounts show that the total water production has increased from 144.5 million m^3 in 1992 to 171.3 million m^3 in 2001. This is a modest increase of 17.8% in ten years. Compared to the NWMP, the original consumption is higher than forecasted, but the consumption in 2000 is considerably lower (171 M m^3 compared to a forecast of 193 M m^3). The increase in consumption is below the population growth of 2.4% per annum.

The water account further showed that surface water, particularly through the new Letsibogo dam and the NSWC, met the bulk of the increase in demand. This has led to a better balance between groundwater and surface water supplies. In 1992, groundwater accounted for 61% of the country's consumption, but this figure dropped to 56% in 2001. Six large villages are connected to the NSWC, alleviating groundwater pressure. This provides the opportunity of resting some well fields.

Figure 1:



Source: Arntzen *et al*, 2003.

4.3 Amount and use opportunities of wastewater

The National Master Plan for Sanitation and Wastewater (NMPSWW) describes the prevailing attitude towards treated wastewater as '*dispose rather than re-use'*.

Due to the construction of more sewerage systems and increasing water consumption, the amount of wastewater has increased. Over 64 wastewater treatment works exist in the country with a total capacity of 90 974 m^3/day compared with a daily inflow of 61 045 m^3. Seventy percent use pond sanitation; the other treatment systems include wetlands, trickling filters and activated sludge). The Big Five plants (Gaborone, Francistown, Selebi Phikwe, Lobatse and Orapa) account for around 80% of the return flow. In 2002, the estimated return flow was estimated to be 24.5 M m^3 and the amount of 'new' water (outflow from treatment works) at 12.3 M m^3. This is 18.5% of the water demand of urban areas and large villages. Only 20% of the new water is re-used, mostly for watering of public gardens, golf courses and in one instance for crop production (Lucerne). Plans exist to increase re-use for irrigation around Gaborone and Francistown.

During the on-going water crisis in Gaborone, households are encouraged to re-use new water for their gardens and the construction sector is encouraged to re-use new water too. The water crisis would have lasting, beneficial, impacts if water consumers who do not require potable water, continue to use new water.

While currently wastewater is greatly underutilised, it is expected that re-use will increase in the near future, particularly for irrigation. The feasibility of recycling needs to be addressed during the current review of the NWMP.

4.4 Basic water needs

Basic water needs are being met through two interrelated policies. Firstly, reticulated water supply systems are constructed, maintained and -where necessary- up-graded in all settlements (with more than 250 inhabitants). The norm is that all persons should have access to a water point within 500 meters form their home. Secondly, water tariffs are set in such a way that basic water needs are affordable. For this reason, water from standpipes in rural villages is free, and in urban areas there is a nominal monthly fee (that also includes other services). In addition, water charges for the lifeline band (up to 5 m^3) are low and sub-economic (through cross subsidisation by large users, including government). As stated above, standpipes are being phased out to prevent water wastage, but care should be taken that those who cannot afford to pay for water retain access.

4.4.1 Access to sanitation and safe drinking water

The Water Utilities Corporation (WUC), the Department of Water Affairs (DWA) and District Councils (DCs) are responsible for reticulated water supply in urban areas (WUC), seventeen large villages (DWA) and rural areas (over 460 villages; DCs).

Water
The comparison of the Population Census 1991 and 2001 shows that the percentage of households with access to piped or tapped drinking water has increased significantly during the last decades: 1981: 56%; 1991: 77% and 2001 87.7% (Kelekwang and Gowera, 2003). The 2001 figures are as follows:

- Urban areas: 99.5% with access to safe piped and tap water;
- Large rural villages: 96.7% access with access to such water;
- Rural villages: 73.3% access.

Households without piped or tap water mostly rely on boreholes 5.1%, wells (1.8%), tankers (0.8%) or other water points (4.5%; Kelekwang and Gowera, 2003)). Particularly boreholes are considered safe and reliable water sources.

Access has also improved in qualitative terms. A growing proportion of households has water inside their yard and/or house, and no longer relies on public standpipes.

Sanitation
The proportion of households with access to sanitation facilities has more than doubled in the 1990s (Tiroyamodimo, 2003). Using the WHO definition of adequate sanitation[3], 77.4% of the households have access to adequate sanitation in 2001, compared to 35.9% in 1991. Virtually all urban households have now access to proper sanitation (95%) while just over half of the rural households have such access (51%).

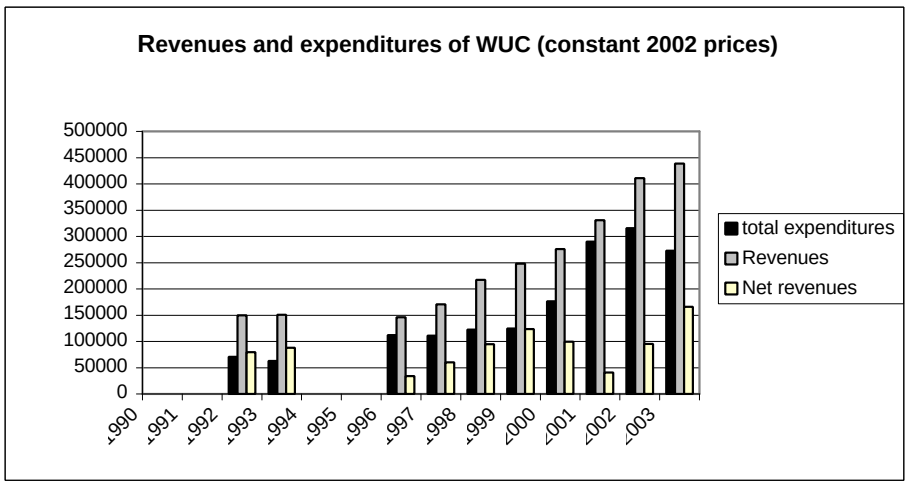
The Government of Botswana considers not-ventilated pit latrine to be inadequate sanitation. Therefore, according to government standards, fewer households have adequate sanitation: 53% and 18% of the urban and rural households respectively.

[3] Includes flush toilets, ventilated pit latrine and pit latrines.

4.2 Investments in drinking water supply and sanitation

Public water supply
WUC has invested in the NSWC in the 1990s for a total of P 1.6 billion. According to the WUC Annual Reports development expenditures peaked at P 1.6 billion in 2000, but the development expenditures dropped to Pula 3 million p.a. in 2003. The growth in expenditures has been accompanied by growing revenues. As a result, a positive financial result was recorded throughout the period (Figure 2). A growth in connections and substantial tariff increases are responsible for the revenue growth.

Figure 2:



Source: compiled from WUC Annual Reports

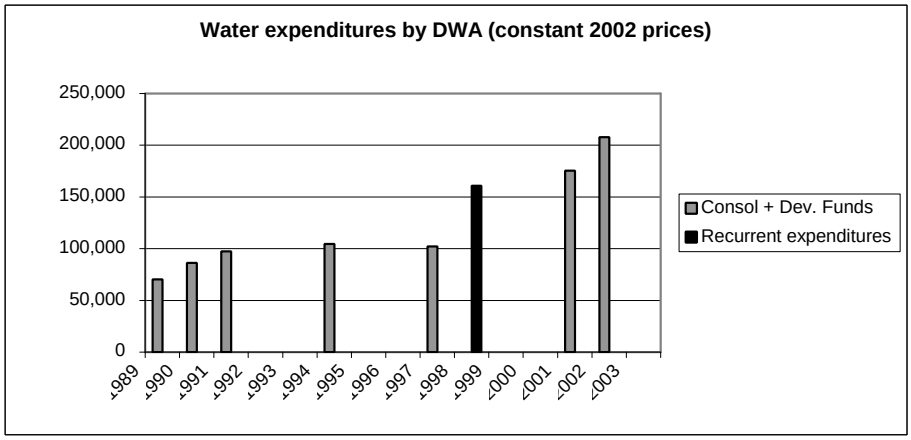
DWA 's expenditures have consistently grown during the period 1989-2002 in absolute and real terms (Figure 3). Real DWA expenditures from the Development and Consolidated Funds have triple in fourteen years. This has led to the establishment of water reticulation systems in most villages, and expansion and/or upgrading of older systems.

In brief, the water authorities have successfully invested in expansion of water supply systems during the 1990s: investments have increased dramatically in real terms. WUC has managed to combine this with its duty of full cost recovery.

Private water investments
The private sector does not participate in public water supply systems. However, the private sector invests in the supply of mines[4] and the livestock sector. Especially, the latter is important for drinking water supply for those who live outside villages. They often get or purchase water from livestock boreholes. Government provide subsidies for livestock water development under its SLOCA and LWDP programmes. The subsidies range up to 60% of the boreholes costs (for groups of livestock owners).

[4] No figures are available for water investments of the mining sector. However, investments are substantial as the watering costs are sometimes very high, as is evident from the fact that virtually no water leaves the mining operations.

Figure 3:



Source: compiled form Annual Reports on Government Expenditures

Sanitation

Sewerage systems have been constructed in all urban centres. Presently, government is constructing sewerage systems for all large villages. The required investments are substantial and affordability is one of the concerns raised in the 2003 NMPWWS. According to SMEC and Shandan (2003) investments of Pula 3.2 billion are needed in the next NDP to meet the policy objectives. The NMPWWS recommends an average household charge of P 290 per annum and institutions would pay P 2.08/m^3 used. Such rates would only cover the estimated operational costs.

Increased water consumption of end-users and/or the need to regularly flush the sewerage systems due to under-utilisation of the sewerage system also cause water resource concerns.

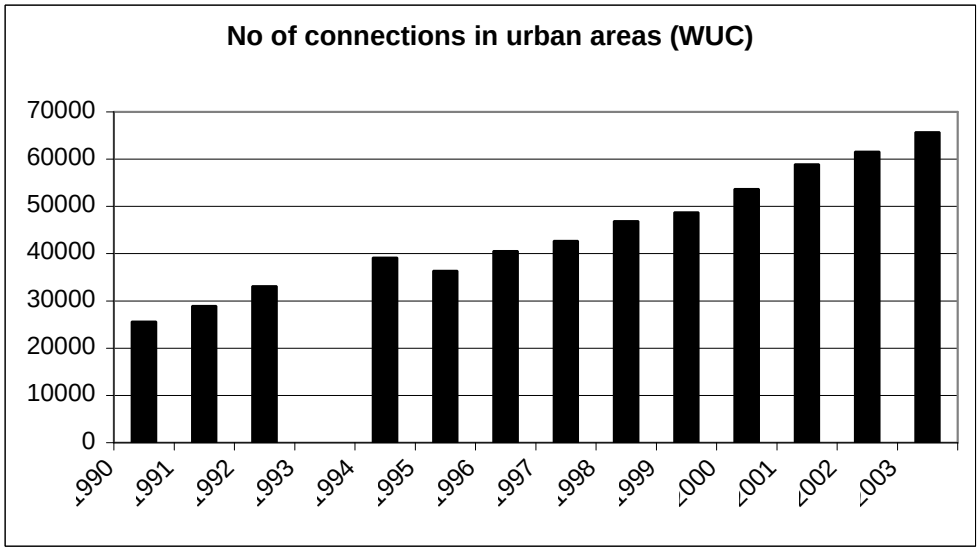
5 WATER FOR CITIES

The country has two cities (Gaborone and Francistown) that are small by international standards (a population of 186 007 and 83 023 respectively).

However, urbanisation is high and a large part of the population now lives around both cities. The number of water connections has grown almost threefold since 1990 (Figure 4).

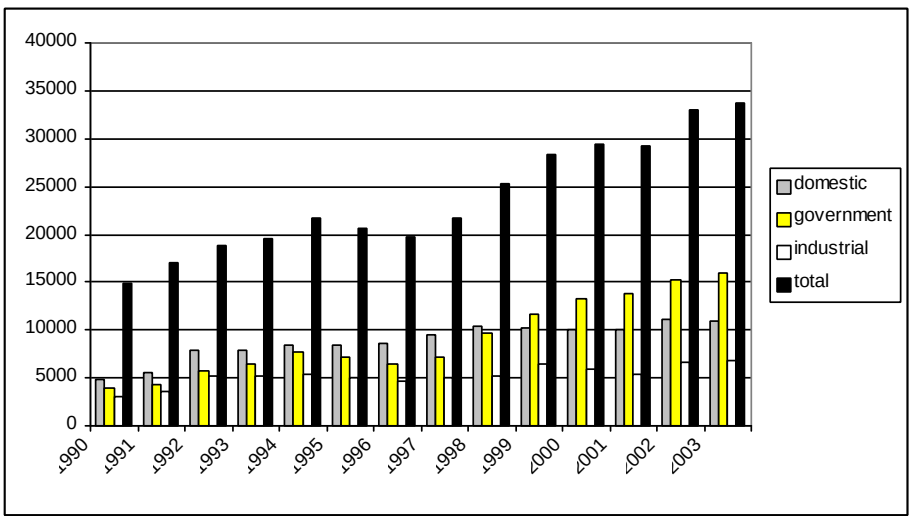
Both cities depend entirely on surface water from a series of dams (Gaborone, Shashe dam, Bokaa dam and Letsibogo dam). The water consumption for both cities has been estimated from WUC annual reports (Figure 5). Domestic use is the highest followed by government and business/ industry.

Figure 4:



Source: WUC annual reports.

Figure 6: Water consumption in Gaborone and Francistown by activity (1990-2003; in 000 m^3).



Source: WUC Annual Reports.

The average per capita consumption for domestic use is 120/L/day/ person in Gaborone and a low of 62.5 L/day/person in Francistown.

Daily use by government and industry is estimated to be 28 099 m^3 and 11529 m^3 in Gaborone. Comparable figures for Francistown are 9542 m^3 and 3167 m^3.

Through water management measures, WUC has reduced its unaccounted water losses (UAL), which represent leakages, non-payment and illegal abstractions. The losses are estimated to be 12% compared with over 20% before. DWA estimate the average UAL of large villages at 30% with losses in excess of 40% in some villages (Mathangwane and Molale, 2004).

6 FOOD SECURITY

Surface water is used for irrigation and for around three months of the wet season for livestock. Otherwise, groundwater supplies the livestock sector during the dry periods.

Cereals
As a semi-arid country, Botswana produces only a fraction of the food consumption. Rainfed crop production is common and the irrigation sector is very small, covering an estimated 1200 hectares. Rained crop production is stagnating due, as the risks are high, yields uncertain and non-agricultural development and employment is more attractive. Average yields are less than 250/kg ha and the cultivated area fluctuates between 100 000 to 300 000 ha, depending on the rainfall conditions. The cultivated area per capita has declined from 0.22 ha in 1981 to 0.06 ha. in 2001. Few youths are interested in traditional rain fed crop production. Commercial rain fed crop production is restricted to Pandamatenga area, which contributes around 20% of the country's grain requirements. Irrigated horticulture is limited to around 1200 ha and produces around 25% of the national requirements (Kapele, 2004).

The National Master Plan for Arable and Dairy Development (NAMPAADD; Tahal, 2000) recommends that the irrigation sector (mostly fruits and vegetables) be expanded, where water resources are available and irrigation is economically viable. It is anticipated that in 2010 over 5 000 hectares will be irrigated with a total *fresh* water requirement of 15 to 17 M m^3/year and 36 M m^3/year of *wastewater,* mostly from urban areas. Fresh water will be obtained from:

- Spare water abstraction capacity from livestock boreholes (6.6-8.2 M m3/yr). This can only be done where suitable land is available and transport costs are not prohibitive;
- Existing dams (2.3-2.5 M m^3) and existing ephemeral rivers (3.5 M m^3); and
- New groundwater abstraction (2.9-3.3 M m^3/ yr).

Two resource concerns exist. Firstly, the supply costs of irrigation water appear to be under estimated. Most water costs are estimated to be less than P 1/m^3 and the maximum cost is P 2.80/m^3. Presumably these are the costs to farmers too, but this means that there are likely to be substantial opportunity costs of water use in irrigation. Secondly, spare borehole capacity may not be available at the right place for irrigation,

putting more pressure on other fresh water sources. New irrigation schemes are planned to re-use treated wastewater from Gaborone (203 ha.) and Francistown (60 ha).

In the past, irrigation plans for the Okavango delta surfaced regularly, but at present only small-scale irrigation (totalling 132 ha) occurs around the delta, and no plans exist for substantial expansion.

As far as in the late 1980s, the government has shifted its food policies from food self-reliance to food security, accepting that it would be too costly to become self sufficient. This policy shift has been a wise move, but the subsequent collapse of the arable sector needs to be addressed, taking into account the semi-arid realities of the country. The NAMPAADD initiative towards larger scale mechanised dry land farming fits is a useful attempt, which needs to be supplemented by other creative initiatives.

Livestock
While the agricultural sector uses little surface and groundwater, the livestock sector is a major water consumer. The estimated herd of 2.2 million cattle and 2.6 million goats and sheep consumes 112 000 m^3 per day or 40.9 Mm^3 per annum (2002 figures).

Fisheries
Fisheries are confined to the northern parts of the country (Okavango and Chobe) and the surface dams. However, fisheries are very limited. The fisheries sector around the Okavango is small and under-developed. Most fishing is for subsistence purposes, and less than 100 commercial fishermen operate in the area. Table 8 shows the yields around the Okavango.

Table 8: Fish catch in and around the delta (tonnes).

Species	**2000**	**2001**	**2002**	**2003**
bream	87.2	85	89.8	61.1
barbel	51.6	18.2	19.1	23.7
s barbel	1.7	1.6	0.9	1
tiger fish	9.4	5.4	3.8	4.2
others	2.1	0.9	0.8	1.8
total catch	**152**	**111.1**	**114.4**	**91.8**

Source: Fisheries unit data.

7 WATER AND ECOSYSTEMS

The 1968 Water Act stipulates that as much water should be returned to the environment as possible, and that pollution should be minimised. This is useful for environmental conservation and maintenance. The merits of a formal reservation or prioritisation of ecological water requirements are currently evaluated as part of the NWMP review.

No general water quality standards exist. The Botswana Bureau of Standards (BOBS) has recently produced unified potable drinking water standards, ending a situation where DWA and WUC used different standards. DWA has standards for effluent discharges in rivers and for re-use for irrigation. BOBS expects to finalise unified standards in this area

later this year. Commercial discharges of effluent in sewerage systems are in principle subject to wastewater discharge agreements with the Councils. However, in reality few of such agreements exist, and monitoring is problematic.

Formal progress has been made in the areas of wetland management and biodiversity utilisation and conservation. This is briefly reported below.

Wetlands
Botswana host several wetlands of regional and global importance. The Katanga, Chobe/ Lynianti and the Makgadikgadi Pans are the largest and most important wetlands. Government has developed a National Wetland Strategy and Policy (2002) and is currently completing the Biodiversity Strategy and Action Plan (BDSAP).

The Okavango delta is the largest RAMSAR site. The preparation of the Okavango Development and Management Plan is on going, and the project formulation phase for the Integrated Management Plan for the Makgadikgadi Palustrine Wetlands was completed in 2004. The preparation of the Plan is expected to start in 2005. The threats to the wetlands include the following:

- Water abstraction (domestic and external);
- Human activities such as livestock, tourism and mining, causing disturbance, and pollution;
- Invasive alien species such as salvinia;
- Inadequately coordinated sectoral planning, in particular lack of integrated land and water use planning

The wetland strategy and the BDSAP still need formal government approval. It is expected that both strategies will ensure that sufficient water is reserved for the maintenance of wetland ecosystems.

8 WATER AND INDUSTRY

Botswana's industry is relatively small, and industrial water consumption is also small in comparison to that of agriculture, mining, government and domestic consumption. Industries are concentrated in urban areas, and their needs are met by WUC.

It is important that future industrial developments are water efficient, and minimise water consumption.

It is possible to turn water shortages into an advantage by the development of a water conservation technology industry. This requires a concerted Research and Development effort as well as the development of a domestic market that could be led by government as the largest consumer. SACU and SADC can be used to develop markets inside southern Africa.

9 WATER AND ENERGY

Botswana Power Corporation supplies the bulk of the country's electricity from its coal-fired power plant and through imports from South Africa through the SADC power grid.

Solar power is used on a small scale. A feasibility study has been conducted into the expansion of the current power plant.

The power plant uses groundwater from a nearby well field. Dry cooling methods are used to reduce water consumption (Arntzen *et al*, 1999).

The energy sector could in future indirectly influence water resources through hydroelectric power schemes in Angola and Namibia that could affect share water sources.

10 SHARING WATER RESOURCES

All perennial surface water sources and most ephemeral rivers are shared watercourses. Most large dam sites, which have been constructed in ephemeral rivers in eastern Botswana, are part of the Limpopo River Basin. The Okavango delta is part of the Okavango River Basin, which also covers the Makgadikgadi Wetlands (with other major inflow from the Nata River originating from Zimbabwe) and the Chobe River is part of the Zambezi River Basin. Botswana also has a stake in the Orange River Basin through the ephemeral, but mostly dry, Molopo River.

Table 9: Shared watercourses and interdependency in SADC countries

Shared watercourse (MAR in Mm^3)	Countries	Key interdependency issues
Limpopo (5 500)	Botswana, Mozambique, South Africa, Zimbabwe	Over-use, allocations, ecosystems, urban use, industrial use, irrigation, afforestation, quality and flooding.
Okavango (11 000)	Angola, Botswana, Namibia,	Okavango Swamps ecosystem and competing urban, irrigation and hydropower demands.
Orange – Senqu (11 500)	Botswana, Lesotho, Namibia, South Africa	Export between South Africa and Lesotho from Senqu, quantity and allocations in Lower Orange River, estuary and ecosystem requirements.
Zambezi (94 000)	Angola, Botswana, Malawi, Namibia, Mozambique, Tanzania, Zambia and Zimbabwe	Hydropower, tourism, fishing, irrigation, water quality, flooding, wetlands protection and water allocation.

Source: Eberhard *et al*, 2003.

Botswana has ratified the SADC protocol on Shared Water Courses and actively participates in the management of four shared river basins (Okavango, Zambezi/ Chobe, Limpopo and Orange).

11 MANAGING RISKS

As a semi-arid country, droughts and water shortages poses the largest risks.

Floods occur sometimes, but their impacts are localised, for example to floodplains of the Okavango and major rivers. Due to poor settlement planning, residential and

industrial plots may encroach into the floodplains, increasing the risks of adverse impacts of floods.

Droughts are endemic, and have serious impacts on people's livelihoods and water supply. Arable farming is most vulnerable to droughts and to poor rainfall distribution. The livestock sector experiences declines during a period of drought such as the 1980s drought. The national herd shrank, and especially small herds were decimated.

Government has a drought monitoring system and provides drought relief support to mitigate adverse drought impacts and to stimulate the recovery process. Support measures include: assistance with seeds and ploughing, food provision (schools, vulnerable groups), labour-based drought relief projects.

Drought relief measures have generally succeeded in prevention malnutrition and starvation. However, concerns have grown about the government dependency of people.

Water shortages have so far been primarily managed through expansion of water supplies and water restrictions during droughts. More and more water supply systems are interlinked, reducing the risk of acute water shortages and opening opportunities for conjunctive use of ground and surface water. Water shortages have been mostly overcome but at escalating costs. There is need for water risk management within the broader IWRM framework. This would require greater attention for water demand management and for water allocation mechanisms.

12 VALUING WATER

12.1 Water tariffs

Resource pricing is firmly established through successive National Development Plans. Government fully controls water tariffs in urban and rural areas. In urban areas, the parastatal WUC proposes water tariffs, but the Minister of Minerals, Energy and Water Affairs has to approve. In rural areas, the Minister determines the prices through DWA. Urban water tariffs are the highest in southern Africa.

Water supply costs have been escalating in recent years, as shown in the high supply costs of the NSWC. The water tariff principles, described below, are generally sound and generate substantial revenues to cover mounting expenditures and to encourage resource conservation. However, full implementation of the cost recovery principles remains a challenge and the tariff gap for self-providers needs to be filled, particularly in areas of water scarcity and competition.

Urban water tariffs
WUC operates several large dams (Gaborone, Bokaa, Letsibogo and Shashe dams) and the NSWC to supply urban areas; it also imports water from South Africa (Molatedi dam), as compensation of the dams on the South African side of the Notwana and Limpopo catchments (WUC pays the transport costs only).

WUC has to recover its full supply costs, and this is reflected in the prices. Cross-subsidisation between end-users takes place to ensure affordability for all. According to

the 8th National Development Plan *(*Government of Botswana, 1997), urban water pricing is based on the principles of:

- *equity and affordability*. All citizens should have access to safe water to meet their basic needs. Government uses the affordability norm that people should not spend more than 5% of their disposable income on water. Water from standpipes is free in rural areas, and subject to a minimal monthly flat rate in urban areas;
- *efficiency*. The water supply should be cost effective and consumers should not waste water (Government of Botswana, 1997). Pricing is not used to promote allocative efficiency.

Water pricing does not formally consider sustainability. In practice, environmental concerns are addressed through block tariffs and measures such as environmental impact assessments, as well as water conservation.

Botswana's water pricing has several distinct features, the main one being the increasing block tariff structure. Unit charges of this tariff structure differ by use band; the higher the use band, the higher the unit charges. There is a lifeline charge at band of 0-5 m^3. Through cross-subsidisation of the small users by large users, low-income groups are partly shielded against the impacts of rising water tariffs. Urban tariffs aim to reflect the long run marginal production costs (LRMC). These include production, transport, and distribution costs. Urban water tariffs vary in different arts of the country, mostly due to differences in transport costs. Gaborone has the highest tariffs due to the high transport costs. Two forms of cross-subsidisation occur to ensure access and affordability. Firstly, all users subsidise the lifeline consumption band with a tariff below the supply costs. Secondly, government pays a super tariff, and thus indirectly subsidises domestic and other productive users.

Rural water prices (DWA and DCs)

Rural water tariffs are lower than the urban ones, as they primarily aim to recover the operational costs. The 8th National Development Plan (Government of Botswana, 1997) recommends that attempts should be made to recover part of the capital costs. Rural water charges are uniform throughout the country irrespective of the local supply costs. The price of water is higher, however, in villages supplied by the NSWC, due to the high costs of this supply source.

The water supply costs are high, and therefore villages that receive NSWC water have to pay higher water tariffs. The average unit payment for two monthly consumption levels (20 and 40 m^3) is given In Table 10. The table shows that higher water consumption leads to much higher unit costs and water bills. Moreover, rural villages that receive NSWC water have a much higher water tariff than other rural villages. Finally, government pays a super tariff that is roughly double that of other consumers. This super tariff is an implicit water subsidy to other consumers.

Table 10: Average unit tariff for two monthly consumption levels (Pula/m^3; 2004 tariffs).

	Domestic-business 20m^3	**Domestic-business 40m^3**	**Government 20m^3**	**Government 40 m^3**
Gaborone	4.69	7.60	9.59	15.38
Rural villages	4.04	6.92	12.26	21.03

NSWC supplied				
Rural villages	2.71	4.66	12.05	12.05

Sources: calculated from DW and WUC data.

A household with a monthly consumption of 20 m^3 pays an average unit price of P 4.69/ m^3, in Gabonore, P 4.04/ m^3 in a village supplied by the NSWC and P 2.71/ m^3 in other rural villages. The average unit rate is more than 50% higher if the monthly consumption doubles (except in rural villages). The current tariffs are summarised in Appendix 1.

Self-providers
No policy exists for water tariffs among self-providers. Most self-providers pay the full supply costs, and it is apparently assumed that this reflect the resource value. The opportunity costs and cost of depletion costs are not yet considered. Discussions have started about an additional water charge related to the abstracted volume. Livestock farmers are willing to pay a charge on top of the supply costs (Oageng, 1999).

12.2 Value added

Studies on water accounts (NCSA/CSO, 2000 and Arntzen et al, 2003) have calculated the value added per m^3 by different sectors. The results are presented in table 11. The value added realised by different sectors varies enormously. The agricultural sector generates the lowest value added, and yet receives a large proportion of the water. Not surprisingly, the service sector generates the highest value added per m^3. Water efficiency has increased in time, as reflected in the rising value added per m^3. Combining the value added and the share in water consumption, it becomes clear that the allocation of productive water is inefficient, especially in terms of the agricultural sector. While there is need to extend the analysis to other efficiency criteria (e.g. employment creation/ m^3), there can be no doubt that the allocation of productive water needs to receive much more policy attention, for example through the water efficiency plans.

Table 11: Value added by water unit by economic sector (constant 1993/94 prices; P/m^3).

Sector	**1993**	**1997**	**2001**
Agriculture	6.50	7.05	6.08
Mining	220.97	213.97	232.17
Manufacturing	194.27	250.60	162.81
Water + electricity	190.07	409.44	895.79
Construction	2294.25	2766.54	2596.33
Trade	1116.19	1631.08	1570.70
Hotels and restaurants	275.65	380.04	303.24
Transport + communication	2447.82	2971.32	2853.47
Insurance, banking, business	2421.34	2901.15	2807.68
Social and personal services	381.65	511.82	1708.88
Government	236.34	261.76	261.69
Grand total	74.00	89.42	99.45

Source: Arntzen *et al*, 2003.

An increase in water scarcity will necessitate an increase in overall water efficiency, i.e. creating more value added per average m^3. This will be challenging, as Botswana's water efficiency is already higher than that of Namibia and South Africa.

13 GOVERNING WATER

Botswana does not possess a comprehensive water management policy. Policy statements are scattered over the National Development Plans (Government of Botswana, 1998 and 2003) and the Botswana National Water Master Plan (SMEC et al, 1991). In addition, a draft Water Conservation Strategy has been prepared, but it has not been formally adopted. Finally, Botswana is signatory to the SADC Protocol on Shared Water Courses, and actively participates in trans-boundary river basin management (Okavango, Limpopo, Orange and Zambezi/Chobe).

The on-going review of the BNWMP is expected to lead to a comprehensive and unified policy based on the notion of integrated water resources management (IWRM). The element of water policies and strategies are rooted in out-dated laws such as the 1962 Waterworks Act and the 1968 Water Act. A 1991 revision of the old Water Act, developed as part of BNWMP, has never been approved. Botswana dos not have a Water Pollution Control or Water Quality Act.

The current review of the NWMP needs to address the policy gaps, particularly with respect to water demand management, water allocation, productive water provision outside urban areas, re-use and recycling of wastewater.

13.1 Legislation

According to the 1968 water Act, the State owns all water resources. The State has delegated water user and development rights to various stakeholders:

- The Water Utilities Corporation (WUC) has the duty to provide safe drinking water to urban areas in so-called *water work areas*. WUC has a monopoly in these areas; others are, for example, not allowed to drill boreholes in these areas. The WUC has to break even, i.e. charge the full resource costs to end-users. Since the late 1990s, WUC has assumed responsibility for the operation of the NSWC, which supplies urban areas and some large villages;
- The Department of Water Affairs (DWA) is charged with the establishment of reticulated water supply systems in rural villages. In addition, it operates and maintains the systems in seventeen large villages. Where these villages are supplied by the NSWC, DWA purchases the water from WUC;
- The District Councils (DCs) operate and maintain the water supply systems in all other rural villages, usually through the Water and Sanitation Division;
- *Self-providers*, including livestock owners, arable farmers and mining companies that operate outside villages and settlements. Self-providers apply for surface or groundwater rights to the Water Apportionment Board. The WAB grant such rights with an abstraction ceiling and the duty to return as much water as possible of the original quality. Details of boreholes (e.g. yields, depth, water quality etc.) are recorded in the National Borehole Registry. Monitoring of abstraction of the self-providers is difficult and in practice inadequate. This is a

major gap in the country's water management system, as self-providers account for the bulk of the abstraction.

Waterworks Act 1962
This Act is meant to encourage and protect public water supply systems. Waterworks areas need to be delineated and gazetted and a Water Authority appointed. The Water Authority receives the water development rights and has the duty to develop a water supply system. The Water Authority (WA) effectively the monopoly of water supply.

WUC is the WA in urban areas; DWA in large villages and DCs in rural villages.

This Act gives the Minister the right to approve tariffs, and prevent water wastage, for example through norms for unaccounted losses (UAL). The latter has not been done.

Water Act 1968
The Water Act controls access to and use of water resources. Water rights are needed to abstract, store, dam and divert water. Water rights are granted for a specific purpose (e.g. mining, forestry, industrial power generation and agriculture) of abstraction and indicate the maximum amount and period of abstraction. The abstraction ceiling varies according to the use but usually does not exceed 22.75 m^3 per day. Water rights may be cancelled if they are not used within three years or if there is too little water. The rights are conditional:

- Water should be returned (where reasonable) to the body from which it was abstracted;
- As much water as possible (given the type of use) should be returned;
- Water should not be polluted.

The Water Apportionment Board (WAB) grants the water rights and keeps a record of all water rights.

The penalties for non-compliance were high in 1968, but have not been adjusted and are now very low. Other deficiencies of the Act include:

- There is inadequate demand prioritisation and allocation;
- It does not provide for integrated water management approach, for example, catchment area management;
- The treatment of water pollution is inadequate;
- There is no provision for management of shared water courses, i.e. the Act is not in line with the SADC Protocol; and
- The monitoring and enforcement mechanisms are inadequate.

13.2 Institutions

In the absence of a comprehensive water policy, the institutional framework of water planning and management cannot be expected to be ideal. The institutional strength lies with water suppliers and authorities that have managed to improve access to potable and affordable water, and to adapt to droughts and growing water scarcity. This reflects the past bias towards water supply at the expense of a balanced IWRM approach.

Water resource planning and monitoring of use is not adequately institutionalised. No single institution is responsible for IWRM planning in the country, and no water planning and policy unit exists. While the Attorney General's Chambers is responsible for legislative developments, the absence of a policy and planning institution must have contributed towards the delay in water law reforms. Lack of such an institution has also contributed to fragmentation and gaps in water supply, use and management data.

The current institutions and their roles are summarised in Table 12.

Table 12: Key water institutions and their roles

Type of institution	**Responsibilities**
I. Supply agencies	
Water authorities (WUC, DWA and DCs)	Supply planning Duty to supply reticulated water in waterworks areas Right to propose water tariffs Right to supply other users, but not at lower charges than those for waterworks areas
Water exploration and supply companies	Groundwater explorations, Borehole drilling and well field development Desalination
II. Water management institutions	
Water Apportionment Board (national level)	Allocation of water rights Monitoring of the use of the water rights The Registrar is based in DWA
District Land Boards and sub-Land Boards	Allocate land use rights Allocate borehole drilling rights
National Conservation Coordinating Strategy Agency	Implementation of EIA legislation, including reviewing the EIAs Coordination of resource use and management (e.g. land and water)
III. Other stakeholders	
End users	Water consumption and conservation
Non-government organisations	Advocacy and Lobbying Implementation of research and CBO projects (e.g. Every River has its people)
IV. Water Research such as University of Botswana and Department of Geological Survey	Research on water issues

Recently, DWA has established two new units or divisions for shared watercourses and water conservation. These issues are important for IWRM, and can therefore been seen as steps towards IWRM planning. However, further reforms in water institutions are essential to strengthen water management. The BNWMP called for the replacement of the WAB by Water Council. Moreover, water policy-making and planning remain centralised, and there is need to develop catchment area management institutions (e.g. similar to Namibia and South Africa).

The Department of Water Affairs has established a separate unit dealing with shared watercourses. Botswana participates four river basin organisations (RBO):

- The OKACOM: established in 1994
- The Orange RBO, established in 2000;
- The Zambezi RBO, agreed upon in July 2004, but not yet in force;
- The Limpopo RBO, agreed upon in November 2003, but not yet ratified by all members;

The RBOs are guided by the revised SADC Protocol on shared Water Courses, that cam into force in September 2003 and the UN-Convention on Navigational waters.

Secretariats will soon be established for the Orange RBO in South Africa and for the Okavango in Botswana.[5]

Civil society is slowly becoming more involved in water management issues. Botswana now has a national chapter for the GWP that brings together stakeholders from the government and private sectors and civil society. Some NGOs engage in water related activities, but the sector is small and its input too. Somarelang Tikologo has been encouraging resource re use and recycling, including water and wastewater, for some time. The Kalahari Conservation Society (KCS) is the lead agency of the regional project Every River has its People with programmes in Angola, Botswana and Namibia. This programme aims to build stakeholder institutions and capacity in the three countries of the Okavango River Basin, to promote linkages between institutions of different countries, and to facilitate implementation of relevant community based initiatives. The project emphasise CBNRM activities, dealing with HIV/AIDS at the local level and gender issues. Botswana's CBNRM projects do not (yet?) cover local water supplies and management, as they do in Namibia.

The Country Water Partnership (CWP-Botswana) was established in October 2003 as a network of interested partners concerned with water and the environment (Jansen *et al*, 2004). A multi-sectoral National Steering Committee was established to move to CWP and the FFA process forward. The WCP-chair is from the University, and KCS holds the secretariat. DWA, WUC and for example mining corporations are actively involved. The CWP-Botswana is working on the national framework for action (FFA) and together with DWA it is developing a GEF proposal for an IWRM and water efficiency plan. Such a plan is due in 2005, as promised at the 2002 WSSD in Johannesburg. The Vision for Botswana centres on:

- Equitable access to water of acceptable amounts and quality of water assigned to DWA and WUC;
- Proper sanitation for all and safe wastewater disposal assigned to DSWM;
- Food security for all households assigned to DCPF;
- Sustainable environment assigned to the NCSA and HOORC;
- Security from national disasters assigned to the OoP and Vision 2016 Council;
- IWRM assigned to UB.

For each area, critical issues and action items were identified in group discussions. The workshop proceedings have been used as inputs into the regional FFA and the preliminary national FFA; the proceedings were expected to be used in the on-going Review of BNWMP. Botswana does not yet have a national FFA-Botswana.

13.3 Institutional and resource interconnectivity

The NWMP's main recommendation was to construct the NSWC. This is a pipeline that connects the newly constructed Letsibogo dam with the demand centre in southeastern Botswana. Since it started operating, several large villages (Palapye, Mahalapye, Mochudi, Tlokweng, Mogoditshane and Lobatse) have been connected to the pipeline and some well fields are being rested and benefit from recharge (e.g. Palla Road). The NSWC offers greater flexibility for water management in southeastern Botswana.

[5] RBO-secretariats will rotate among member countries. The up-date on RBOs is based on information provided by Mr. Khupe, head, department of international water, DWA.

The NSWC is managed by WUC, but in it requires integrated and strategic water management strategies to arrive at the optimal management decisions in terms of:

- Which consumption centres should be linked up and when? There should be prioritisation of demand centres based on the alternative supply sources and their costs. Because of current water shortages in Gaborone, most large villages have been disconnected from the NSWC and reconnected with the Shashe dam and/or old well fields;
- Which water resources should be abstracted from and when? This decision should take into account different inflow reliabilities and evaporation rates of dams, pumping costs, transfer capacity, losses and reliability and recharge of interconnected well fields along the NSWC;

13.5 Water quality standards

13.4.1 Drinking water standards

Until recently, Botswana had no uniform standards for potable water. WUC and DWA each employed their own standards. The Botswana Bureau of Standards has developed countrywide standards for drinking water (Table 13). Water providers, whose water falls in class 3, get a limited period of time to provide water of class 2 standards.

Table 13: Botswana drinking water standards

Variable	**Unit**			
Physical and aesthetic	**Unit**	**Class 1 (ideal)**	**Class 2 (acceptable)**	**Class 3 (max. allowable)**
Colour	TCU	15	20	50
Conductivity at 25 25 o C	S/cm	700	1 500	3 100
Dissolved solids	Mg/l	450	1 000	2 000
Odour		Not objectionable	Not objectionable	Not objectionable
PH value at 25 C		6.5- 8.5	5.5- 9.5	5.0 – 10.0
Taste	N/a	Not objectionable	Not objectionable	Not objectionable
Turbidity	NTU	0.5	5	10
Chemical requirements macro determinants	**Unit**	**Class 1 (ideal)**	**Class 2 (acceptable)**	**Class 3 (max. allowable**
Ammonia as N	mg/l	0.2	1.0	2.0
Calcium as Ca	mg/l	80	150	200
Chloride residual	mg/l	100	200	600
Fluoride as F	mg/l	0.7	1.0	1.5
Hardness as $CaCo_3$	mg/l	20	200	500
Magnesium as Mg	mg/l	30	70	100
Nitrate as NO_3	mg/l	45	45	45
Nitrate as NO_2	mg/l	3.0	3.0	3.0
Potassium as K	mg/l	25	50	100
Sodium as Na	mg/l	100	200	400
Sulfate as SO_4	mg/l	200	250	400
Zinc as Zn	mg/l	3.0	5.0	10.0
Chemical requirements- micro determinants	**Unit**	**Class 1 (ideal)**	**Class 2 (acceptable)**	**Class 3 (max. allowable**
Aluminium as Al	μg/l	100	200	200
Antimony as Sb	μg/l	5.0	5.0	5.0
Arsenic as As	μg/l	10	10	10
Cadmium	μg/l	3.0	3.0	3.0
Chromium as Cr (total)	μg/l	50	50	50
Cobalt as co	μg/l	250	500	1000
Copper as Cu	μg/l	1000	1000	1000

Cyanide (free as CN	µg/l	70	70	70
Cyanide (recoverable) as CN	µg/l	70	70	70
Iron as Fe	µg/l	30	300	2000
Lead as Pb	µg/l	10	10	10
Manganese as Mn	µg/l	50	50	50
Mercury as hg (total)	µg/l	1.0	1.0	1.0
Nickel as Ni	µg/l	20	20	20
Selenium as Se	µg/l	10	10	10

Source: Botswana Bureau of Standards BOS 32:2000.

13.4.2 Standards for re-use

At present, DWA has developed water quality standards for re-use. BOBS is preparing new uniform standards for re-use, which will be adopted later this year (2005).

Table 14: Water quality standards for re-use

Parameter	Irrigation of trees, cotton and other non-edible crops	Irrigation of citrus fruit trees, fodder crops and nuts	Irrigation of deciduous fruit trees, sugarcane, cooked vegetables and sports fields	Unrestricted crop irrigation for parks, lawns and uncooked vegetables	Livestock watering
pH (pH units)					
BOD (mg/l)	60	45	35	25	
COD (mg/l)					
Conductivity (mS/m)			550 (max)		1980 (max)
Suspended solids (mg/l)					
Temperature (^{o}C)					
Faecal coli forms (cfu/100ml)	50 000	10 000	1 000	100	
Coli forms, total /100ml					
Streptococci, faecal /100ml					40 median

Sources: SMEC et al, 2003; SPTC Effluent Quality Report (Nindi, 2002).

13.4.4 Guidelines for effluent entering sewerage system

The following standards are being used.

- PH: 6 to 9.5
- Ammonia not more than 100 mg/l
- TDS not more than 3000 mg/l
- Temperature not more than 43 ^{0}C.
- BOD as per effluent agreement in mg/l
- TSS No limit

13.4.4 Standards for discharge on perennial and ephemeral streams

By law, water resources need to be returned of a quality closest to the quality of the abstracted water. DWA has developed standards for the quality of the water discharged in streams (Table 15).

Table 15: Water quality standards for discharge into perennial and ephemeral streams

Physical and aesthetic variables	Unit	Perennial	Ephemeral
Temperature	0^0C	35	35
Colour	TCU	30	50
Conductivity at 25 25 o C	S/cm	700	1 500
Dissolved oxygen (% sat.)		75	75
pH		6.5-9.5	6.5-9.5
BOD		20	30
COD		30	75
Free and Saline Ammonia as (N)		1.0	10
Nitrate as (N)		2.0	-
Total Phosph. as (P)		-	1.5
Total Chloroforms/100ml		5000	20000
Faecal Chloroforms/100ml		100	500
Arsenic		1.0	0.5
Boron		-	0.5
Zinc		5.0	5.0
Copper		1.0	1.0
Phenols		0.005	0.01
Lead		0.001	0.05
Cyanide		0.01	0.1
Cadmium		1.0	0.05
Mercury		0.001	0.02
Selenium		0.01	0.05
Iron		1.0	1.0
Manganese		0.1	0.5
Sulphate		400	600
Chlorides		600	1000
Sodium		400	600
Fluorides		1.5	2.5
TDS		10000	2000
Turbidity	IUTU		
Oil and Scum		Nil	Nil
Chromium		0.05	0.5

Source: Department of Water Affairs

13.5 Managing water shortages

Water shortages occur regularly due to droughts and expanding water demands. Two types of water shortages can be distinguished. First, large scale threats of water shortages, mostly in southeastern Botswana. Secondly, water shortages in individual villages and town with mostly local impacts.

The capital Gaborone has twice experienced water shortages. The first crisis occurred in the early 1980s during the 1980-1987 drought, and was resolved through a combination of water restrictions, emergency well field drilling and raising the dam wall. Afterwards, an additional dam was built (Bokaa dam) and connected with the Gaborone dam and during the 1990s a long distance water transfer scheme was constructed (NSWC). The crisis was successfully handled, and a significant drop in consumption was realised during the restrictions. The well field supplied Gaborone until the Bokaa dam and the NSWC sufficiently augmented the water from the Gaborone dam[6]. The second crisis is

[6] This valuable well feld is now closed due to nitrate pollution from pit latrines.

on-going ad results from rainfall failure in the Gaborone dam catchment area. The Gaborone dam is currently 24%. While supplementary sources now exist, the situation is still alarming, and water restrictions were imposed in December 2004, aiming to reduce consumption by 25%. Water of all gardens with hosepipes or irrigation system is prohibited, water use in the construction sector and car washes are closely monitored as well as water use for swimming pools. In addition, households and appropriate private companies are encouraged to use treated where possible and health risks are minimal. More water of the NSWC has been earmarked for Gaborone. Consequently, some large villages (e.g. Mahalapye and Palapye) that received water from the NSWC have been reconnected to well fields that used to supply them.

Stricter measures may be taken as the wet season is ending and no significant rainfall has been recorded.

Water shortages also occur in other towns and villages, usually as a result of a drop in groundwater or capacity problems due to rapid consumption growth. The former are often seasonal; the latter require a structural solution. Increasingly, water reticulation systems of villages are linked. While the costs of pipelines are high, the flexibility and reliability of the systems are higher. Desalination plants have also been constructed in western and northern Botswana to make saline water suitable for consumption.

14 ENSURING THE KNOWLEDGE BASE

The government has invested heavily in education. As a result, illiteracy has dropped significantly, and most youth now attend school. While in 1981, 20 and 30% of the age groups 10-14 and 15-19 never attended school, the figures dropped to 3.1 and 3.3% in 2001 (Forceh, 2003). The percentage of 'never attending' is consistently higher for males. While a few still miss out from school, the vast majority is now enrolled. Moreover, remote districts in the west and north have higher non-attendance rates than the districts in eastern Botswana.

Several data basis exist for water management. Firstly, the National borehole Registry has information about all boreholes in the country. The information is provided when the boreholes become operational, but no up-dated information exists (e.g. still operational, yields, quality). Secondly, WELLMON is a computerised database for the major well in the country. The information is up-to-date, and combines abstraction, yields and other important characteristics. Thirdly, the WAB records all water rights that are allocated to self-providers. The information is not computerised, and is not easily accessible. Fifthly, the Okavango Research Station is a research and data base institution within the University, based in Maun. The ORC has assumed responsibility for the database on the Okavango Management Development Plan, and may play a similar role in the Makgadikgadi Management Plan in future. Finally, water accounts have been developed and have been regularly improved and up-dated. The water accounts provide insight into the accessible water resource stocks and their different uses (in m^3 and Pula). Water accounts are closely linked to the National Accounts and the macro economic planning process. The current accounts cover the period 1990-2002, and the value of the accounts increase with the length of the time series.

Knowledge gaps exist for water consumption in rural villages and for consumption of self-providers. Water quality is also an area of knowledge weakness. A pilot project dealing with water consumption in rural villages has not made much progress recently,

and needs to be re-activated. Regulations need to be developed to ensure that self-providers have the duty to regularly record and report their water consumption (e.g. to be incorporated in a new Water Act).

The 'Toti Campaign' has been developed to raise awareness about water scarcity in the country. The Toti Campaign focuses on schools and travels around the country. This year, World Water Day was celebrated in Ghanzi, western Botswana. The celebrations aimed to ensure that water resources are appreciated and not wasted.

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Appendix 1:

Table A1 : Water tariffs for Gaborone and rural villages by user band (1990-2004)

DWA tariffs rural villages with NSWC			
Monthly use band	**1990**	**2000**	**2004**
0 - 5 m^3	0.30	0.65	1.90
6-20 m^3	0.60	1.65	4.75
21-40 m^3	1.20	3.40	9.80
over 40 m^3	1.20	4.20	12.15
DWA tariffs in rural villages			
Monthly use band	**1990**	**2000**	**2004**
0 - 5 m^3	0.30	0.65	1.25
6-20 m^3	0.60	1.65	3.20
21-40 m^3	1.20	3.40	6.60
over 40 m^3	1.20	4.20	8.15
WUC tariffs in Gaborone			
Monthly use band	**1990**	**2000**	**2004**
0-10 m^3	0.65	1.45	2.10
11-15 m^3	0.65	4.40	6.40
16-25 m^3	2.60	5.60	8.15
26-40 m^3	2.60	7.75	11.30

Source: compiled from WUC data.

Table 1: Milestones and targets of the Africa Water Vision 2025.

Actions	**Targets**		
	2005	**2015**	
Improving Governance of Water Resources			
1. Comprehensive policies for Institutional Reform at national level			
? In process of development	100% of countries		
? Under implementation		100% of countries	100% of coun
2. Creating enabling environment for international cooperation			
? Under development in existing water basin organisations	100% of organisations		
? Under implementation in existing water basin organisations	50% of organisations	100% of organisations	
? Under development in new water basin organisations		100% of organisations	
? Under implementation in new water basin organisations		50% of organisations	100% of orga
Improving Water Wisdom			
1. Systems for information generation, assessment and dissemination			
? Established at national level	50% of countries	100% of countries	
? Establised at regional water basins	30% of basins	100% of countries	
? Established at Africa-wide level	100% complete		100% comple
2.Establishing sustainable financing for information gemeration & management			
? Review of global experience	100% complete		100% comple
? Implementation at national level	50% complete	100% complete	90% of countr
? Implementation at water basin level	30% complete		Three establis
? Implementation at Africa-wide level		30% complete	
3. Capacity building			
? Create public awareness and consensus	complete in all countries		
? Identify gaps in knowledge about IWRM through gap analysis	complete in 100% of countries		
? Develop partnerships to secure strategic assistance in IWRM	complete in 100% of countries		

? Establish research on water resources	One research institution established at Africa-wide level	Two research institutions established at Africa-w	
? Mainstreaming gender and youth concerns in water resources	305 complete at national level	100% complete at national and basin levels	
Meeteing Urgent Water Needs			
1. Proportion of people without access:			
? to safe and adequate water supply	Reduced by 25%	Reduced by 75%	Reduce by 95
? to safe and adequate sanitation	Reduced by 25%	Reduced by 75%	Reduce by 95
2. Extent of food security achievement	60%	80%	Increase by 6(
			Increase by 1(
3. Water for agricultural production, energy & hydropower production, industry, tourism & transpportation			
? Full cost recovery, subject to economic and environmental justification	Achieved in 30% of countries	Achieved in 70% of countries	25% of potent
4. Conservation & restoration of environment, biodiversity and life-supporting ecosystems			
? Sufficient water for environmental sustainability allocated through national policies	Implemented in 30% of countries	Implemented in 100% of countries	Implemented
5. Effective management of drought, floods and desertification	Under development	Operational in 50% of countries	Operational in
Strengthening Financial base for desired water future			
1. Financing for water supply sanitation			
? Mainstreaming full cost recovery, service differentiation and wider range of priced service options	Operational in 60% of countries	Operational in 100% of countries	
2. Securing sustainable financing for institutional reform	Secured in 100% of countries		
3. Securing sustainable financing for information generation and management	Secured for Africa-wide use		
4. Increasing private sector participation in financing	Operational in 30% of countries	Operational in 100% of countries	
5. Establishing mechanisms for sustainable financing of water resources management	Established in 50% of countries	established in 1005 of countries	
