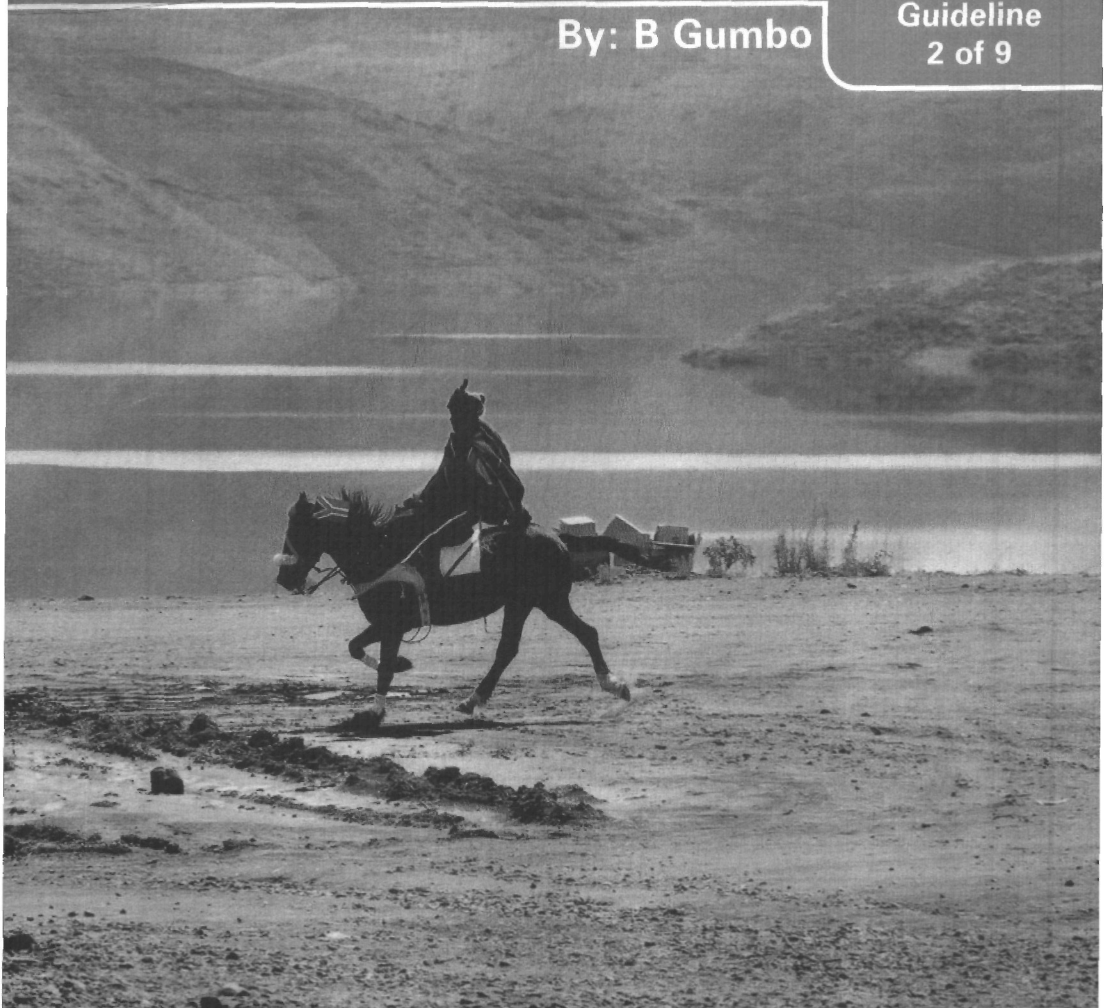
Implementation

BULK SUPPLIERS OF UNTREATED WATER

By: B Gumbo

Guideline 2 of 9



Building Awareness and Overcoming Obstacles to Water Demand Management

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WATER DEMAND MANAGEMENT

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Preface

The IUCN-RoSA (World Conservation Union-Region of Southern Africa office) managed a Water Demand Management (WDM) programme between 1997 and 2002 to study WDM practices and applications within the SADC member states. These studies indicated the urgent need for improved water resource and supply management in much of the region and the broad potential of WDM to be an important tool in achieving this aim.

Currently, IUCN-RoSA is committed to sharing the knowledge gathered in the studies to promote the adoption of sound WDM practices as a method of accelerating effective water resource and supply management throughout the region. These guidelines on Building awareness of and overcoming obstacles to Water Demand Management are a part of IUCN-RoSA's WDM sharing initiative. They have been written by a multi-disciplinary team assembled from several countries in the SADC region.

The guidelines comprise 9 separate booklets, aimed at all the people who can influence WDM outcomes or who should be responsible for actively promoting or implementing WDM, within different water management, supply, and user sectors. Since every water user and water resource or supply stakeholder can improve the quality of life for him/herself or others, by ensuring WDM plays an important role in his/her planning and actions, related to water management and usage, one or more of these *booklets has been written with you in mind.* The titles are listed on the inside of the back cover. Check the titles, see which apply to your situation, and obtain copies. They will help you to do your job better.

In these guidelines, WDM includes all actions that improve the efficiency and equity of water use. Efficient water usage includes using water in a manner that minimises pollution. Thus, WDM is not about getting poor people with insufficient water to use less, but about all users using water wisely so that everyone has sufficient water. In this context, WDM is seen as an integral part of Water Resource Management (WRM) and Water Supply Management (WSM).

When implemented effectively, WDM will:

- Reduce water supply costs per unit volume, whilst assisting to create more financially sound water supply institutions, through:
  - Postponing the development of new sources;
  - Reducing water wastage; and
  - Equitably reducing unpaid water bills;
- Ensure the delivery of sufficient water to meet the reasonable demands of all users, for domestic and productive water, at a reasonable cost in both water abundant and scarce areas, whilst assuring ecological sustainability, or, in the few situations where this is not practical, WDM will maximise equity and minimise deprivation;
- Improve the assurance of supply through ensuring that the demand does nor exceed the yield of the source;
- Prepare users and supply institutions to manage with less water as scarcity arises, through population increase, general development or climate change; and
- The prevention of all ongoing serious water pollution.

By definition, WDM, on balance, always produces positive outcomes. However, effective implementation requires:

- A good knowledge of current demands and usages;
- Planning and resources to introduce behavioural change within well-managed time frames; and
- Communication with other stakeholders upstream and downstream of your place in the water supply/usage chain.

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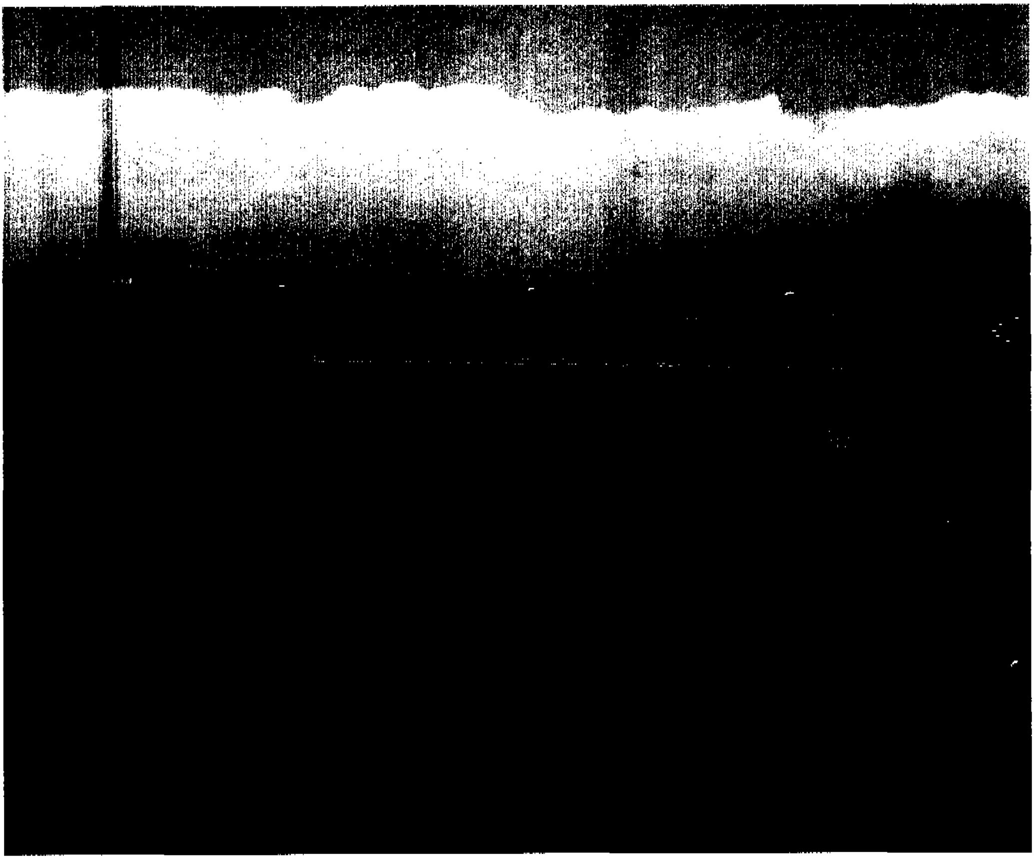
Abbreviations and Acronyms

BWS	Bulk Water Suppliers
DWAF	Department of Water Affairs and Forestry, South Africa
GDP	Gross Domestic Product
GIS	Geographic Information System
ICOLD	International Commission on Large Dams
IUCN	World Conservation Union
LA	Local Authority
LHDA	Lesotho Highlands Development Authority
LHWP	Lesotho Highlands Water Project
Mm^3/a	Million cubic metres per annum
NGO	Non Governmental Organisation
O&M	Operation and Maintenance
SADC	Southern African Development Community
UNEP	United Nations Environment Programme
US	United States
WDM	Water Demand Management
WRC	Water Research Commission, South Africa
WSM	Water Supply Management

Introduction



1.1 Target readership

This Guideline is intended for bulk suppliers of untreated water in southern Africa. These include all government, parastatal and non-governmental institutions and associations from national down to community level responsible for supplying bulk water for agricultural, industrial or communal use and/or for ongoing treatment for domestic use. The Guideline is also aimed at international water development institutions; watershed or catchment management agencies; and local municipalities.

Its aim is to assist and encourage agencies dealing with bulk untreated water to implement water demand management (WDM) as well as to help them motivate and encourage their customers to do the same. This Guideline also recognises the importance of international partners in the development of raw water sources, either as providers of capital, expertise, material or equipment, and as such can influence the adoption and implementation of WDM.

This Guideline will identify and illustrate opportunities where WDM techniques can be implemented and promoted, and identify applicable and feasible WDM options for its target readership. It also provides a step-by-step procedure for bulk suppliers to plan, promote and sustain the implementation of WDM projects.

Box 1: What do bulk suppliers of untreated water do?

- Implement national policy;
- Manage and regulate bulk water supplies, such as rivers and ground water;
- Develop and/or manage artificial or natural storage facilities;
- Manage the use of water by society;
- Allocate water between competing groups;
- Allocate water between water abundant and water scarce regions;
- Initiate and facilitate adoption and implementation of WDM;
- Or they advocate and promote these aspects of water management.

1.2 Why should bulk suppliers of untreated water implement and promote WDM?

Population growth, climate change and human interference in the water cycle are all causing the region's renewable freshwater resources to diminish. As the custodians and regulators of national and shared water resources, bulk suppliers of untreated water play a leading role in water resource development. They are also indirect custodians of other natural resources (forestry, fisheries and soil). This obliges them to adopt and promote WDM.

Bulk suppliers' main aim is to ensure that all consumers, at national, provincial and local level, have affordable access to sufficient water in the short and long term, assuming those consumers manage and use the water delivered to them wisely. This objective needs to be implemented within a framework that embraces good water management practices, including maintaining:

- A balance between ecological sustainability of supply systems, national economic growth and meeting basic human needs;
- An efficient and equitable allocation of water between different sectors; and
- Fair access for all user groups in and between water abundant and water scarce areas.

It is recognised that the environment in which bulk suppliers operate is both enabled and constrained by various factors, including resources (water, human, financial and material), *politics, institutional capacity and ethics, and the* amount of hydrological cycle they control.
As a result, many bulk suppliers have adopted a supply-side approach – trying to sell more water rather than preserve it to recover their capital investment, cover the operation and maintenance (O&M) costs and make a surplus.

Box 2 (see page 6) describes the operating environment of bulk suppliers of untreated water in the SADC region.

However, adopting a demand-side perspective can be even more beneficial, especially in the long run. Direct benefits include:

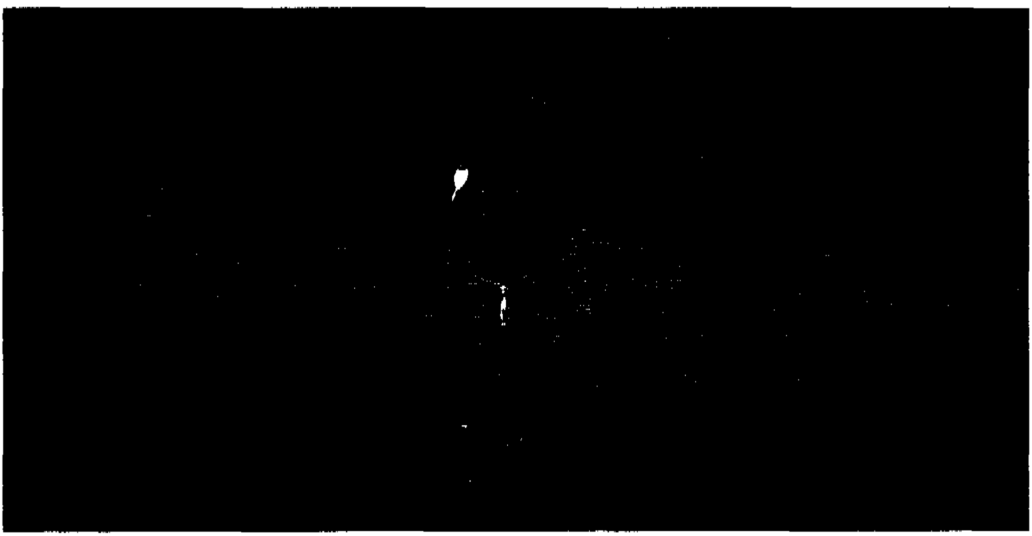
- Settlement of capital expenses for new water sources, thereby warding off increases in the price of water;
- Alignment with resource conservation and sustainability initiatives;
- Ability to balance water demands and use by various competing water users;
- Opportunity to introduce full water cycle management;
- Ability to identify inefficient end users and hence develop appropriate incentives for rectification;
- Increased availability of water for consumptive and non-consumptive uses;

- Application of convincing and transparent economic and financial principles in the evaluation or appraisal of new schemes e.g. long run marginal costing;
- Protection of water supply sources from pollution;
- Improved utilisation of land, forestry and fisheries;
- Ability to identify cost-effective local water recycle, reuse and harvesting schemes; and
- Ability to identify education and information requirements of stakeholders.

Indirect benefits (which are usually long term) include contribution to hydrological and ecological sustainability; ability to avoid the social and environmental impacts of large water schemes; and decreased impact on climatic variables leading to climate change.

Box 2: Operating environment of bulk suppliers of untreated water in SADC

- Resources vary greatly between countries and between tiers of government. The organisations can be highly resourced, e.g. DWAF in South Africa, or poorly resourced, e.g. the water departments in Mozambique, and Angola.
- They are obligated to supply adequate quantity and quality of water.
- They tend to be *de facto* custodians of national water resources even when officially this authority lies with a higher tier of government.
- Government policies direct their activities.
- They are under constant pressure to deliver water.
- They may be short on knowledge for decision-making.
- They need to maintain a long-term perspective of supply.
- There may be poor cooperative governance between different tiers of government and/or between different ministries.



1.3 Guideline content

The Guideline describes the potential for and the practicalities of WDM promotion and implementation for bulk suppliers of untreated water in a regional context. The potential for WDM is outlined in the form of opportunities and incentives that can arise as a result of:

- Diminishing renewable freshwater resources in a predominantly semi-arid region;
- Increased frequency of droughts and floods;
- Ensuring the equitable and efficient allocation at all times, but especially in times of shortages;
- Policy and regulatory changes;
- Ensuring environmental sustainability in the form of ecosystem functions and pollution control;
- Avoiding social and human health impacts related to the development of large water storage facilities;
- Increased transparency to allow all stakeholders to understand, consider and respond to the effects of developing an additional water source long before it is required, especially within trans-national shared water courses; and
- Ensuring full cost recovery and, perhaps, a small surplus.

2.1 Water sources and dams in SADC countries

WDM is extremely necessary in southern Africa, a region characterised by frequent droughts, floods and erratic seasonal and unevenly distributed rainfall (Ashton, 2001, Pallet, 1997; Chenje & Johnson, 1996).

Rainfall and other sources of freshwater, such as rivers, lakes, and ground water, are unevenly distributed throughout the region and are not always located where human water demand arises. Pollution threatens surface and ground water sources, and may make them unfit for many uses, or require expensive treatment to rehabilitate them and/or improve water quality.

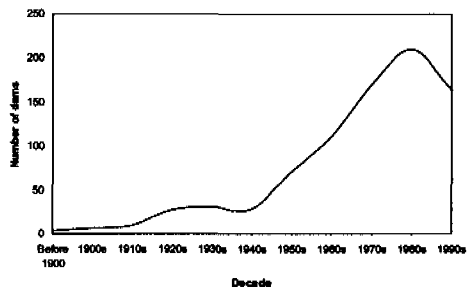
Climate change may also have affected the seasonal distribution of rains and water availability in the region. Evaporation averages 85%. In the Vaal Hartz irrigation scheme in South Africa, for example, rainfall is about 150 mm per year, while evaporation claims 3000 mm.

Unfortunately, the bias towards water supply management (WSM) has resulted in limited practical examples of WDM. Instead, dams, major pipelines and inter-basin water transfer schemes have been widely developed as an important means of meeting perceived needs for water and energy services as well as long-term, strategic investments. The benefits of these investments include regional development, food self-sufficiency, job creation and encouraging an industrial base with export capability. Moreover, until recently, dams and large water supply schemes have fit well within the model of foreign aid provided by the World Bank, International Monetary Fund and western world donor countries. Such schemes have been the first visible sign of donor presence in most countries in the region. This scenario has further boosted the environment for WSM.

Figure 1 illustrates the rise of number of dams commissioned per decade in southern Africa in the past century. It is not clear whether the construction rate has peaked yet after 1980s.

According to the ICOLD's World Register of Dams, of the over 1270 large dams in Africa, between 539 and 791 are in South Africa and between 213 and 233 are in Zimbabwe, which together account for more than 60% of all the dams on the continent.

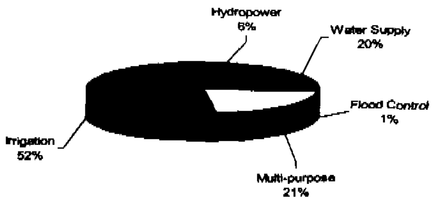
Figure 1: Large dams commissioned per decade in southern Africa



Data source: WCD (2000). (Note: Rates of dam commissioning in the 1990s are underreported)

In the northern and central lying parts of SADC, which is less arid, hydropower is the main reason for dam building. Countries that are much drier have tended to build dams with large storage capacity to match water demand with stored supply, and for security against the risk of drought. In South Africa, large dams have a capacity equivalent to 50% of mean annual river flow (WCD, 2000). Overall, however, irrigation remains the biggest single reason for building dams (see figure 2).

Figure 2: Breakdown of purpose of dams in southern Africa

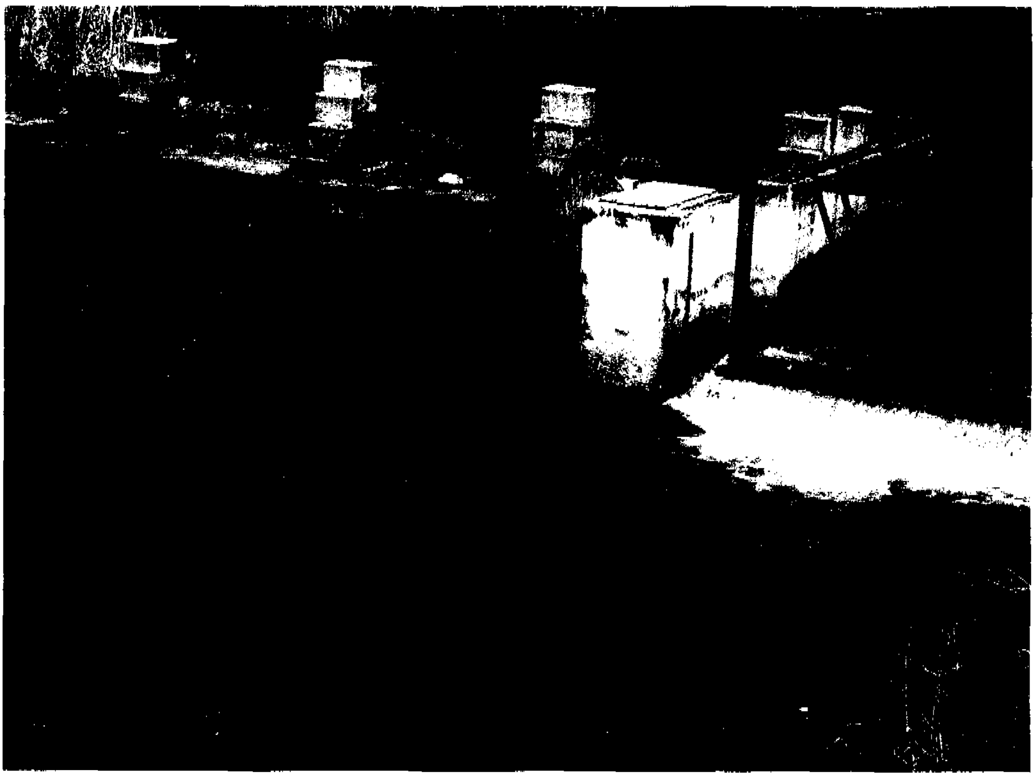


(Data source: WCD (2000))

Large dams and raw water inter-basin transfer schemes can have significant impacts on rivers, watersheds and aquatic ecosystems.

Historically, social and environmental impacts were left outside the assessment framework, and the role of impact assessments in project selection remained marginal, even into the 1990s. *In some cases, this has resulted in* severe damage of species and ecosystems through reduction in water quality due to pollution, sedimentation and eutrophication, among others.

Box 3 presents the case study of the failure to *implement WDM in the City of Mutare,* Zimbabwe in favour of a water supply option. The case study illustrates why the worlds of finance and engineering tend to ignore demand-side solutions, and convince local politicians of the superiority of grand supply solutions.



Box 3: Political constraints to WDM in Mutare

The 1992 water crisis fuelled local politicians, residents and the Department of Water Development to search for a new additional source of water for Mutare, the fourth-largest city in Zimbabwe. There was consensus that the capacity of the existing water system (20 Mm^3/a) had to be doubled to cater for the city's need up to the year 2010, when the population was projected to have surged to 300 000 people. The water requirement of 40 Mm^3/a of raw water for 300 000 residents was based on the unrestricted water consumption in the period prior to the great drought of 1992. No questions were raised regarding the demand side of Mutare's water problems in spite of the fact that the average gross loss (unaccounted-for-water) for the entire city network was estimated at 52%.

Three supply-side options were considered during 1994 – 95. The most expensive, and preferred option, involved taking water from the Pungwe River. Several disadvantages existed for this option:

1. Its secure yield (16 Mm^3/a) fell short in providing a supply solution for the projected demand;
2. It would be expensive to build (US$100 million; compared to US$37 million for the next most expensive option, which would have had a much higher yield);
3. It could create problems with Mozambique, as Beira entirely depends on Pungwe water; and
4. It could negatively impact on the pristine ecology of the Pungwe catchment.

Despite these disadvantages, construction of the Pungwe pipeline started in December 1996, was completed in December 1999 and officially opened by President Robert Mugabe in March 2000. The main stakeholders were satisfied:

- The **City** now had its own water system independent of central government with pure gravitating water hardly requiring any treatment and therefore low running costs.
- The **engineers** had added yet another engineering miracle to their portfolio.
- The **politicians** portrayed the Pungwe project as providing purity (pristine water), security (no more shortages) and prosperity (more business) to its residents.
- The **financiers**, viewed a monopolistic water supply system for a city as an attractive investment, since the city's residents will always need water.

However, the distribution pipe network did not perform: pipes kept on leaking and bursting, and more water meters mysteriously got stuck. It was now pure Pungwe water that disappeared. Few people wanted to know that half of the precious water remained unaccounted for.

Source: Gumbo & Van der Zaag (2002)

2.2 Bulk suppliers of untreated water

The institutional set-up relating to bulk water suppliers of untreated water in the region is diverse and complex. In almost all countries no single agency has the sole responsibility for bulk supplies of untreated water. Authority may also be divided among several ministries.

Table 1 lists examples of bulk water suppliers of untreated water in each of the SADC countries. Note that some suppliers are private entities, e.g. in farms and mines.

Table 1: Examples of bulk water suppliers of untreated water in SADC

Country	Institutions responsible for bulk supplies of untreated water
Angola	Department of Water Affairs (DWA)
	Department of Geological Survey (DGS)
Botswana	District Council (DC)
DRC	Department of Water Affairs (DWA)
Lesotho	Lesotho Highlands Development Authority (LHDA)
	Catchment Management Authority (CMA)
Malawi	Water Board (WB)
	Water Resources Unit (WRU)
	Central Water Authority (CWA)
	Irrigation Authority (IA)
Mauritius	Central Electricity Board (CEB)
	National Directorate of Water (DNA)
	National Directorate for Irrigation (DNHA)
Mozambique	Regional Water Authority (ARA)
Namibia	NamWater
South Africa	Department of Water Affairs and Forestry (DWAF)
	Water Board (WB)
	Department of Water Affairs and Forestry (DWAF)
	Water Users Association (WUA)
Swaziland	River Basin Authority (RBA)
Tanzania	Department of Water Affairs (DWA)
	Water Board (WB)
Zambia	Zambezi River Authority (ZRA)
Zimbabwe	Zimbabwe National Water Authority (ZINWA)
	Regional Water Authority (RWA)
	District Development Fund (DDF)
	Municipalities

Source: Various IUCN WDM Country Reports Phase I & II (1998; 2002)

Bulk suppliers of untreated water also act as national or regional custodians of water. They are, therefore, usually the entry point in the water management chain and, in some cases, also participate in the treatment, distribution and retailing of treated water.

Table 2 indicates the general institutional hierarchies in the provision of water, from bulk suppliers to water boards through to retail service providers.

Table 2: Range of water users and retailers supplied

Bulk treated water suppliers	The sole function of bulk treated water suppliers is to treat the purchased raw water and distribute it to municipalities in its service areas e.g. Rand Water in South Africa. They can be either public or private enterprises.
Local governments and municipalities	Some municipalities purchase raw water from a bulk supplier and then treat, distribute, and retail it to consumers in their areas of supply i.e. the municipality acts both as wholesaler and retailer.
Community water supplies	Bulk raw water suppliers can also treat the water and retail it directly to rural consumers as well as to other individual consumers e.g. Zimbabwe National Water Authority and Umgeni Water in South Africa.
Industry and mining	The bulk supplier of untreated water may also retail water directly to mines and industry e.g. Department of Water affairs in Botswana.
Irrigation	The bulk supplier of untreated water distributes water to a number of irrigation schemes e.g. the River Basin Authority in Swaziland.

3.1 Paradigm shift

WDM, recycling and end-use efficiency measures can all reduce pressure on water resources in the region. However, the benefits of WDM are often obscured by institutional, intellectual, financial and political barriers. For WDM to succeed there needs to a significant turn-around in approach from supply-side management to demand-side management.

The most significant way in which bulk suppliers can promote WDM is to make their customers aware of what effect failure to implement WDM could have on future water prices. Water made available through WDM measures can be 65% to 80% less expensive than water made available through new infrastructure, a significant reason for bulk suppliers to develop mechanisms, *in cooperation with their customers*, for financing WDM approaches. These could include traditional methods used by the dam building industry as well as new innovative mechanisms (Rothert 2000; WCD, 2000).

Customers of bulk suppliers might even find that, if they do not practice WDM, they will soon have no water at all. If the SADC governments adopt the Strategic Priorities spelt out in the 2000 report of the World Commission on Dams (WCD, 2000), which they should, no bulk supplier will be allowed to build a new dam without a comprehensive options assessment (strategic priority 2) or without optimising the benefits of supplies from existing dams (strategic priority 3). Thus, even if additional resources are available, customers may find that their local bulk supplier is prohibited by government policy from developing these sources and that they will undoubtedly be left short of water unless they practice WDM.

Promoting WDM

WDM not only has significant advantages for individual countries, but also for the region as a whole. There is a high level of dependence on trans-boundary shared rivers in southern Africa. With 15 international river basins in SADC regularly named as points of tension, second only to the Middle East, the region has more experience in negotiating water treaties and implementing joint management bodies than any other region on earth, except for the European Union. For bulk water suppliers, WDM can contribute to transparency, accountability, conflict prevention and resolution, all ensuring regional security.

Through the SADC Protocol on Shared Watercourses System, a good regional cooperation has already been established, and should improve with time. WDM should, therefore, be promoted not only in individual countries, but also at a regional scale through the established river basin organisations in the region. Since shared river basins are one entity, ignoring political boundaries, any WDM project in any of the sharing countries can contribute towards improved sustainability in other areas of the shared basin, and/or the delay of further use of such a resource.

Advantages of WDM on the environment also needs to be considered. Most existing impoundments in the SADC region do not have environmental water releases incorporated into their operation schedules. With WDM, there is scope to improve the operation of these impoundments to mitigate some of their effects on downstream ecosystems (Sherwill & Rogers, 2003; Brown & King, 2003). This can be done in four ways:

1. Redistributing releases for other purposes, such as downstream abstraction for agriculture;
2. Implementing a WDM programme followed by an environmental release strategy where this is absent;
3. Changing the dam or barrage design; and
4. Decommissioning the dam or barrage.

Lastly, WDM offers the potential to revisit water use allocative efficiency between the environmental, economic and social requirements. The South African National Water Act (NWA) (Act no 36 of 1998), for example, gives highest priority to water for the Reserve which includes water for basic human needs and for the environment (see Box 4).

Box 4: Priorities for allocating water in South Africa

To facilitate the most beneficial utilisation of water, a general guide on priorities for the use of water is given below. Priorities are stated in descending order of importance, although it is acknowledged that these may vary under particular circumstances.

- Provision for the Reserve.
- International agreements and obligations.
- Water for social needs (such as poverty eradication).
- Water for key economic sectors and employment creation (such as power generation and commerce).
- Water for general economic uses, where allocation should best be dictated by the economic efficiency of water use.
- With trading of water, this will automatically adjust over time according to the value of water in particular uses.
- Uses of water not measurable in economic terms (including convenience uses and some private water use for recreational purposes).

Additional factors to be considered in assessing priorities for the allocation of water are the level of assurance of supply required, the consumptiveness of use and the quality of return flows.

Source: NWRS (2002)

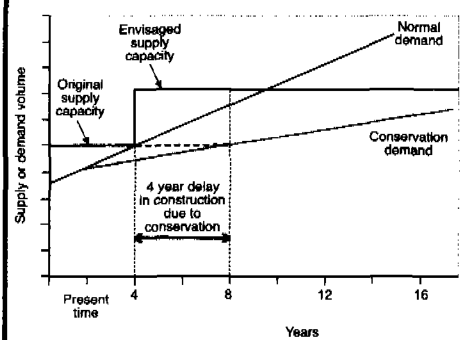
3.2 Financial and economic incentives for implementing WDM

There are various incentives for bulk water suppliers to implement WDM options. These may include:

- Fulfilling government policies, including constitutional rights/obligations;
- Fulfilling mandate to voters;
- Providing least cost delivery of services to citizens;
- Meeting job performance criteria;
- Enabling job promotion with increased financial benefits;
- Delivering the maximum water with the least cost, to maximise company profits; and
- Satisfying both consumptive or non-consumptive uses and environmental flow requirements.

The benefits of WDM in general may not be readily apparent. Figure 3 illustrates cost savings from delayed construction of a new water supply reservoir if water is conserved.

Figure 3: Cost savings from delayed construction of bulk water schemes



Source: Macy, (1999)

The wider the angle between unmanaged demand and managed demand, the more effective the WDM is in delaying the need to construct facilities to sustain increased demand (Macy, 1999). This delay can bring significant cost savings, especially if the construction costs are constant in real terms over time. This is due to the associated savings achieved from the delay in capital repayments and the savings from four years without having to pay the operating costs for the new reservoir and other items such as chemicals, pumping and labour. Box 5 further illustrates the way in which WDM could be implemented to delay the construction of a major water supply scheme, the Lesotho Highlands Water Project (LHWP) Phase II.

3.3 Broad WDM options for bulk water suppliers

There are a number of actions which can be undertaken immediately within the existing WDM strategy that will pay sustainability dividends in both the short and long term.

These broad WDM options for the bulk water supply sector include the:

- Promotion of water cycle management;
- Efficient capture and storage of water;
- Efficient allocation of water between users;
- Promotion of efficient water use within society;
- Promotion or implementation of the efficient reuse of water;
- Promoting efficient land use and economic activities within a watershed;

- Efficient water distribution systems from storage to wholesaler; and
- Generation of greater knowledge of demand management.

Descriptions of some of these options are given in greater detail by other Guidelines in this series.

> **Box 5: Potential impact of WDM on construction of LHWP Phase II**
>
> When the LHWP was planned in the 1980s to meet the water demands of Gauteng, in South Africa, the five dams in the project were scheduled to meet demand projections developed without considering the potential of WDM. Effective WDM measures would extend greatly the number of years to reach what would be considered the trigger demand, i.e., the level of demand at which project developers would have to set in motion the next dam in order to complete the project before demand exceeds supply.
>
> In 2000, Gauteng's water consumption was about 3 Mm^3/day, (1 077 Mm^3/year). Assuming a steady growth in demand of 3% annually, and assuming the 50% losses that the region experiences due to inefficiency, leaks and illegal connections could be reduced to 20% over five years, current water supplies could last at least 12 additional years, until 2029. This means that if Phase II of the LHWP, which is now being considered, is constructed according to the original schedule established in 1986, it would be constructed 12 years too early.
>
> *Source: Rothert (2000).*

3.3.1 Water cycle management

The bulk supplier's first step to implementing water cycle management is realigning its institutional behaviour from that of supplier to that of water cycle manager.

Set new demand management standards for suppliers. Then identify objectives, tasks, resources, monitoring needs and the process for implementation.

After determining the feasibility of water cycle management implementation, develop a practical implementation strategy. Bulk suppliers also need to develop and promote institutions for water management that include legal and regulatory, gender and racially-balanced representation.

3.3.2 Efficient capture and storage of water

Efficient water capture mechanisms include dams, aquifers, rivers, weirs, wetlands, grasslands, and mountain watersheds.

Bulk suppliers have to ensure that their artificial and natural reservoirs store water efficiently. For artificial reservoirs dam design, location, depth to surface area ratio; water storage capacity to water consumption ratio, maintenance programme, abstraction and recharge strategy, the sedimentation management programme (in the dam and in the watershed), and the evaporation limiting strategy have to considered. In turn, the efficiency of natural reservoirs depends on their size, location, conditions, maintenance programme, abstraction and recharge strategy.

Other efficiency strategies can also be implemented. These include:

- Controlling evaporation losses from reservoirs, leaks from canals and conduits, spills from canals and other hydraulic infrastructures;
- Gathering sufficient information to understand the supply and demand inter-relationships, e.g. from meteorological and hydrological information networks in support of planning and real-time operation and management of reservoirs and water supply systems;

- Applying optimisation, risk, and decision models to reservoir operation to define optimised system management rules and to decide the allocation of water resources among the different users; and
- Controlling groundwater withdrawals, recharge and contamination.

3.3.3 Efficient allocation of water between users

Bulk suppliers have to allocate water efficiently within catchments. This may entail deciding whether to supply to the highest bidder, or to the most productive economic sectors using water, or the economic activities that produce the greatest value per litre used.

Water also has to be allocated efficiently between water abundant and water scarce catchments, supplying areas that are most productive in the use of water.

Changing from a supply-oriented to demand-oriented delivery schedule is the desirable orientation of system management when regulation and control are reliable. Demand-oriented delivery schedules assume that managers give priority to satisfy the demand rather than optimising the supply service, making it that e.g. farmers apply improved irrigation schedules to save water and increase water productivity. It requires that regulation and control be modernised and some kind of communication between farmers and managers adopted.

Lastly, bulk suppliers need to maintain required discharges for ecological purposes in natural streams and water bodies. All these initiatives need to balance equity, ecological and political imperatives.

3.3.4 Efficient water use within society

Water saving achievement standards can be set for suppliers and consumers involving their choice of fittings such as toilets, showerheads, irrigation mechanisms, and scheduling of water use times.

Enhance public awareness of the economic, social and environmental value of water, and educate society with regard to efficient water use.

Provide incentives for suppliers to meet standards using strategies such as regulations with penalties, implementation resources, subsidies for infrastructure change, resources for education, and water efficient product branding.

Behavioural changes in water consumption can be generated through the introduction of effective water tariff structuring, using variable tariffs to direct consumption patterns in various consumer sectors.

Establish an effective water charge administration by devising effective money collection systems and financial administration systems. This allows for the withholding of water supply and prosecution for non-payment of water services.

Implement effective water-use monitoring systems for sectors and individual consumers for self-assessment and billing purposes, and promote efficient water management through knowledge development.

3.3.5 Efficient reuse of water

Available water resources can be augmented through the reuse of treated wastewaters, drainage and low-quality waters. There are a number of ways to increase the reuse of water:

- Educate society with regard to efficient water reuse;
- Set standards for water reuse by various sectors and enforce water quality management measures and practices;
- Provide incentives for sectors to meet standards through regulations with penalties, implementation resources, subsidies for infrastructure change, and resources for education;
- Apply water pricing and financial incentives that favour efficient water uses, as well as treatment, reuse and recycling of water; and
- Develop technology to support reuse of water.

Bulk suppliers can also explore non-conventional water sources for households, farmers, industry and water supply bodies.

3.3.6 Efficient land use and economic activities within a watershed

Bulk suppliers can collaborate with various government departments to promote water-efficient economic, land and water use planning and management. They can assist in developing the most appropriate economic activities for the available water resources. This is a particular issue in southern Africa where agriculture is considered the only economic driver in most rural areas, and is extremely wasteful of water resources. This also means removing perverse incentives that encourage water-inefficient economic activities, while adopting penalties for water wasting and misuse, and degradation of the environment.

WDM can also be promoted through integrating economic development with water supply realities, and using full costs accounting to assess economic development options.

3.3.7 Efficient water distribution systems from storage to wholesaler

Ensuring the effectiveness of distribution systems can go a long way in preserving water. Ensure the use of efficient water carriers, including appropriate pipes, canals and rivers, for particular environmental conditions or economic circumstances.

Lined canals will reduce loss through seepage. It must be noted, however, that a canal lining is only fully effective when canal management is improved, maintenance is performed continuously, and other canal structures are also improved. Environmental impacts of canalisation and large pipelines also need to be mitigated.

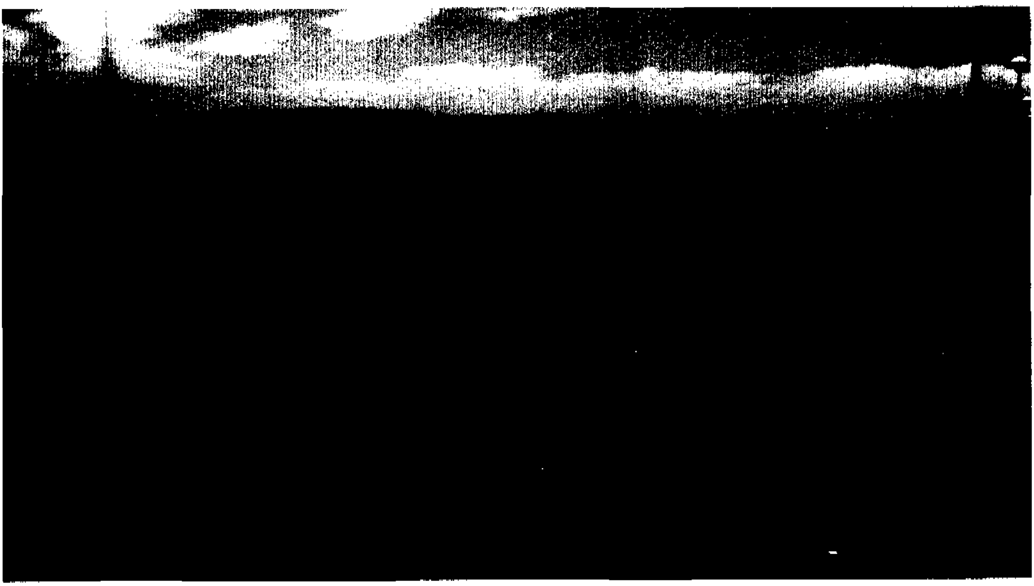
Establish efficient monitoring and maintenance strategies, such as regular leak detection and repairs, with an associated resource budget.

Importantly, train personnel in operation, maintenance and management. This will enhance the quality of service, for technological upgrading of the systems and to carry out water saving programmes. Training is also crucial to develop the skills required to liase with the public and users.

3.3.8 Generate greater knowledge of demand management

Knowledge of WDM can be enhanced by supporting technology innovation through focused research funding, and bursary allocations, competitions for school science projects, bursaries to foreign universities with global centres of WDM excellence, and the establishment of a national centre of WDM excellence.

By establishing information management systems and WDM auditing systems, and developing information feedback systems for education programmes, supply and demand trends can be monitored. Remote sensing, GIS and models, which provide information on the reserves in storage and to the uses and demand, are some of the tools that can be applied.



Examples of WDM measures

4.1 Introduction

This section describes selected WDM options available to bulk suppliers of untreated water and provides some case studies as examples. While these provide a sample of good practice, it is by no means an exhaustive or exclusive range of options. Each particular challenge of bulk raw water supply is unique and, therefore, a range of WDM options need to be investigated before adoption and implementation.

4.2 Applying least cost planning techniques

Least cost planning means that if one person with perfect knowledge and negotiation skills had sole decision making powers on the supply of water to consumers, the decision would be made taking into account the lowest cost implications throughout the water cycle, keeping the cost to the consumer as low as possible while remaining within the consumers quality, reliability and level of service demands (White & Fane, 2001). In reality, bulk water suppliers rarely have such sole decision making powers. Nonetheless they need to implement practical strategies to maximise the impact they have in ensuring that WDM is successfully implemented throughout the water cycle.

The fact that WDM is mainly driven by sound financial and economic policies makes decision makers and consumers more aware of the value of water. The implementation of WDM strategies should be subjected to the same appraisal as any other investment in water supply to ensure that good economic practices prevail.

There are many agents affected by the implementation of WDM in the water management chain. They include the:

- Bulk water supply agency (raw or potable water);
- Water retailer, distributor or service provider;
- End users (farmer, domestic consumer, industrialist); and
- Recipients of return flows (sewage treatment agencies, downstream farmers, reused and recycled water).

Each agent or end user affected by the WDM policy can be assessed and a measure of the net economic effect (costs or benefits) to each should be appraised. The results of these economic assessments can be useful in explaining why WDM does or does not happen spontaneously, and where intervention on behalf of the government may be necessary. The effect on the revenues of different stakeholders and on the cost of water will depend on the type of WDM strategy used and the timing of implementation (refer to the Guideline on Municipal Water Supply Agencies).

4.3 Applying the revenue impact test

There are various economic tests that can be applied to ensure that WDM in the bulk water supply sector will be both economically desirable and politically acceptable. Bulk suppliers of untreated water can use the so-called Revenue Impact Test defined in Box 6.

Box 6: The Revenue Impact Test

Revenue Impact = Reduction in Operating Costs + Reduction in Capital Costs – Programme Costs – Reduced Revenues.

Source: Van der Merwe et al., (1998).

Tests such as these are exemplified in the case of NamWater in Namibia (see Box 7) and can be implemented to discover whether or not it is worthwhile for bulk water suppliers to promote and invest in WDM strategies.

Box 7: Revenue Impact Test application, City of Windhoek and NamWater

Windhoek, Namibia, started implementing WDM in 1995. In the case of capital costs, the extension of the Goreangab Water Reclamation Works is taken into account as a deferred investment at a nominal rate of 3% a year. The saving in water consumption was 3,2 Mm³ (15%) on the unrestricted demand. The saving in bulk supply cost payable to the Department of Water Affairs (now NamWater) amounted to N$5,28 million. Of this amount, the net saving can only be taken as N$1,6 million because the actual saving for NamWater on the production cost of water can only be taken as N$0,50/m³ i.e. 30% of the bulk supply price.

The estimated benefit due to deferred investment amounted to N$2,4 million.

The cost for the implementation of the WDM programme was N$0,60 million. No reduction in revenue was experienced in 1996.

The net Revenue Impact in 1996 was an estimated saving of N$3,38 million for the Municipality of Windhoek and NamWater.

Source: van der Merwe et al, (1998).

4.4 Water cycle management

Water cycle management is a strategic approach for the equitable, efficient and sustainable management of water resources and services. It expresses the idea that water resources must be managed holistically, coordinating and integrating all aspects and functions of water resource management, water containment, abstraction, control and related service delivery so as to bring sustainable and equitable benefits to all those dependent on the resource.

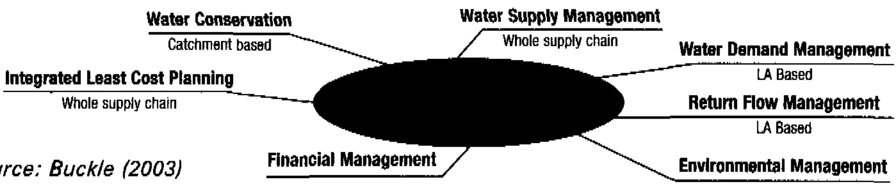
A bulk supplier of untreated water undertakes WDM measures more as a service to its customers than to itself, like a municipality would direct WDM intervention in awareness and customer service to its consumers. The difference is, however, that the bulk supplier needs to facilitate WDM interventions throughout its supply area. It also needs to integrate these efforts with any external agency (public or private) that may be responsible for augmenting or diminishing available supply to its area.

To manage the water cycle, a number of strategies need to be adopted and implemented (see Figure 4). However, the prevailing circumstances in the region may require a greater emphasis on some of the components to correct prevailing imbalances.

As part of water cycle management bulk suppliers of untreated water need to:

- Monitor and evaluate their performance and lead by example;
- Ensure that bulk suppliers of treated water, water utilities and retailers implement national policy, legislation and regulations related to WDM;
- Take a leading role in formulation WDM guidelines and strategies at local, national and regional levels;

Figure 4: Components of Water Cycle Management



Source: Buckle (2003)

Examples of WDM measures

- Promote education and awareness on national and regional level; and
- Play a leading role in initiating and implementing advocacy programmes and the awareness and lobbying component of WDM.

Box 8 describes the role of the South African DWAF in the development of policies, strategies and implementation frameworks for WDM.

In turn, the Botswana government has developed a National Water Conservation Policy and Strategy Framework to facilitate the introduction of widespread water conservation and demand management measures at local and national levels. Box 9 illustrates the activities of Botswana's DWA in water cycle management.

Box 8: Bulk water supplier taking a leading role in WDM, DWAF in South Africa

The Directorate: Water Conservation, of DWAF in South Africa was created during 1998 with a mandate to develop appropriate policies and strategies that will result in the efficient and sustainable use of water by all the country's water users.

As a first step, the Draft Water Conservation and Demand Management National Strategy Framework was produced, and is being circulated for critique and comment. This document lays out the key principles, and the legislative, economic and social frameworks that will guide the national water conservation and demand management strategy.

The Directorate is also in the process of implementing various sectoral WDM strategies that have been developed to assist in achieving this mandate. These include an integrated communication and marketing strategy. Implementation guidelines for water conservation and demand management for various sectors, including agriculture, industry, forestry and the water services sector, have been released and are available on the DWAF website for comments.

Source: DWAF website: http://www.dwaf.gov.za/WaterConservation/

Box 9: Water cycle management by DWA in Botswana

The Water Conservation Unit within the DWA has embarked on a number of WDM projects, including:

- **Ramotswa Water Loss Control Project:** Water loss control is being piloted at Ramotswa village, 35 km east of Gaborone. It is estimated that unaccounted-for-water (UAW) is in excess of 50% of the water purchased. An aggressive leak detection and repair programme aims to reduce UAW to below 20% within a year.
- **DWA Headquarters Building Complex:** The project aims to establish an accurate water balance for the DWA Headquarters campus and construct a wetland system to collect and treat grey water from all ablutions on the campus and rainwater from the roofs of the major buildings. Treated water and harvested rainwater will be used for irrigation.
- **Education and Awareness:** A coordinated plan of action for education and awareness has been formulated by DWA in collaboration with Water Utilities Cooperation (a bulk supplier of treated water) and the Ministry of Education. A WDM Schools Programme and celebration is conducted annually to coincide with World Water Day.

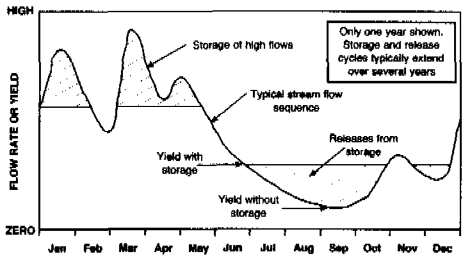
Source: Mathangwane (2003)

4.5 Control of evaporation in surface water reservoirs

Most water supply schemes incorporate storage reservoirs. These may be surface storage or sub-surface aquifers. These reservoirs allow the supplier to retain a surplus of water that can be released when required to smooth out the natural variability of the hydrological system.

The yield of a water resource system is the volume of water that can be abstracted at a certain rate over a specified period of time. Figure 5 demonstrates the typically large fluctuations in stream-flow or mean annual runoff that occur in southern African water resource systems. Due to these fluctuations, the highest yield that can be abstracted at a constant rate from an unregulated river is equal to the lowest flow in the river.

Figure 5: Diagrammatic representation of typical stream-flow and storage in southern Africa



Source: Adapted from NWRS (2002)

In a regulated river, where dams or other storage structures have been built, water can be retained during periods of high flow for release during periods of low flow, as shown by the shaded areas in Figure 6. This extends the time over which water can be abstracted from the system, and therefore increases the yield. The greater the storage capacity, the greater the yield that can be abstracted within the limits that are defined by the risk factor and co-efficient of Variation of the stream-flow.

Evaporation losses from the surface area of reservoirs constitute the major deduction from the total surface water potential. The average evaporation from open water-bodies ranges from 1,5 to 2,0 m/year depending on the reservoir characteristics. If evaporation could be reduced by just 25%, the Yield of reservoirs in the region could be doubled (Kabell, 1984; Pallet, 1997).

There is no effective, practical, and economically viable way to reduce evaporation from large water bodies. Reservoir locations need to be chosen to minimise evaporation at the planning stage, by ensuring the volume to surface area ratio for the reservoir is maximised.

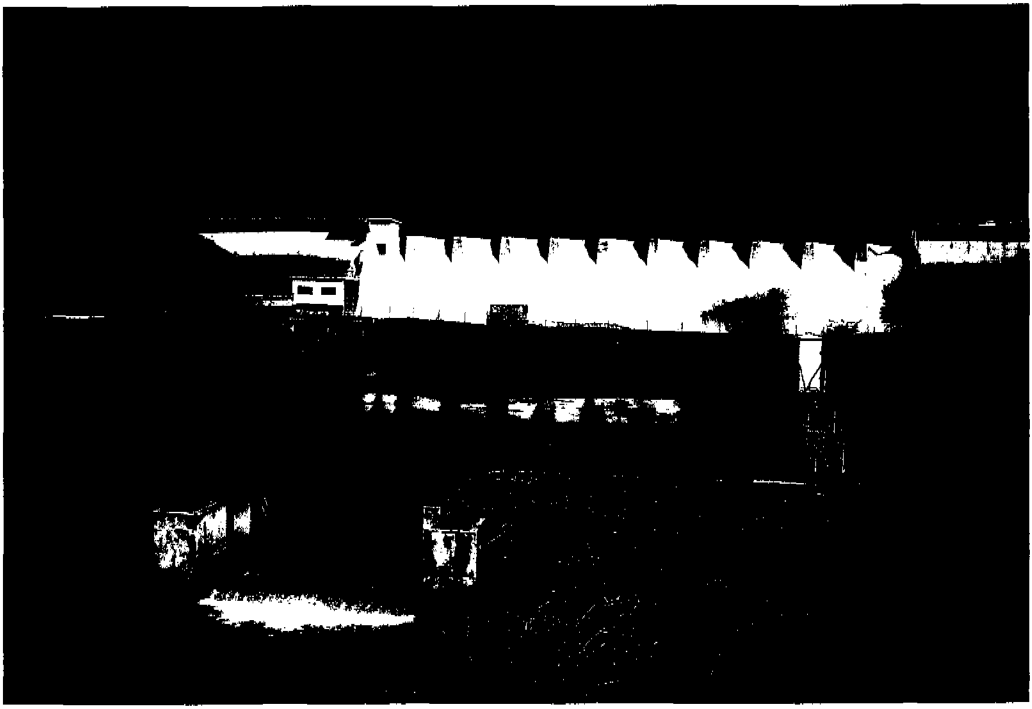
Several methods of reducing evaporation have been attempted in the region, without real success, including the use of monomolecular layers, or films, of long chain alcohols and oils. Apart from being costly, and often difficult to maintain, many of these methods are ecologically questionable.

Evaporation can be reduced from small, vertically-sided reservoirs by roofing them to shield the reservoir from solar radiation, or by covering the water surface with light-coloured floating blocks. However, floating covers are only effective if they are not porous and if their upper surface can be kept dry.

4.6 Subsurface storage

In ground water recharge areas, small dams and even low embankments across flood ways can be used to increase aquifer recharge.

Ground water storage offers several advantages. It may be found in areas where surface water is absent or difficult to transfer, for example. In the case of temporal or seasonal



scarcity of water, ground water can be tapped during the dry season and recharged during the rainy season. Ground water can be blended with non-conventional sources, and aquifers can be used for storage and additional treatment of recycled water (Pereira et al., 2002).

Ground water is the largest source of stored freshwater, and is often the only source of water in arid and semi-arid areas of southern Africa. Technological developments and an improved understanding of ground water hydraulics and the hydrogeology of aquifers have led to the large-scale exploitation of ground water. This, however, has resulted in severe problems with the availability of water and the quality of ground water when natural recharge rates are less than the growing water demand, or where the use of ground water is the main method for coping with drought. Artificial recharge of ground water aquifers offers a possible solution to the constant mining of the resource.

By 'banking' excess surface water underground, Windhoek, in Namibia, is greatly reducing water loss through evaporation (See Box 10).

Box 10: Banking water in Windhoek

The main surface reservoirs (Von Bach, Swakoppoort and Omatako) of Windhoek, Namibia, experience high evaporation rates. During 1997 the production of water from the three-dam system was 15,7 Mm^3 while evaporation losses were 35,5 Mm^3.

As a result, underground storage of water is viewed as beneficial to the long-term security of supply.

A municipal water source since 1920s, the natural recovery period for recharge of the Windhoek Aquifer after high abstraction during periods of drought, is five years. However, the City has adopted a novel method of shortening this to two or three years by recharging the aquifer with excess water that would otherwise evaporate from the surface sources.

Water from the dams is filtered through activated carbon and is chlorinated before being injected into the boreholes. This prevents particulate matter from entering the aquifer, and ensures that the injected water is chemically compatible with the natural ground water, reducing the risk of negative hydro-chemical reactions with natural ground water or the surrounding rock.

Since the 1950s, more than 100 Mm^3 has been pumped from the aquifer. This abstraction rate has clearly been over and above the sustainable yield and exceeds the natural recharge rate. Ground water levels have declined drastically, resulting in a cone of depression in the southern well fields. The over-utilisation is believed to have caused water to be drawn from natural storage in the Auas Mountains. At the same time, however, the lowered water level has created ample space for artificial recharge.

If the safe yield can only be increased by 2 Mm^3/annum the estimated savings amount to N$3,8 million per annum. It is estimated that underground storage capacity of at least 15 to 25 Mm^3 exists and that a minimum annual recharge at a rate of 6 to 10 Mm^3 will be possible.

The water for artificial recharge is provided by NamWater at production cost (i.e. the cost of chemicals and electricity to pump it to Windhoek) plus a 15% mark up for overhead costs. The price, of N$0,76/$m^3$, compares very favourably with the normal bulk supply price of N$2,40/$m^3$.

Source: Matthews (2003); Murray & Tredoux (2002); Van der Merwe (1998)

4.7 Non-conventional sources of water

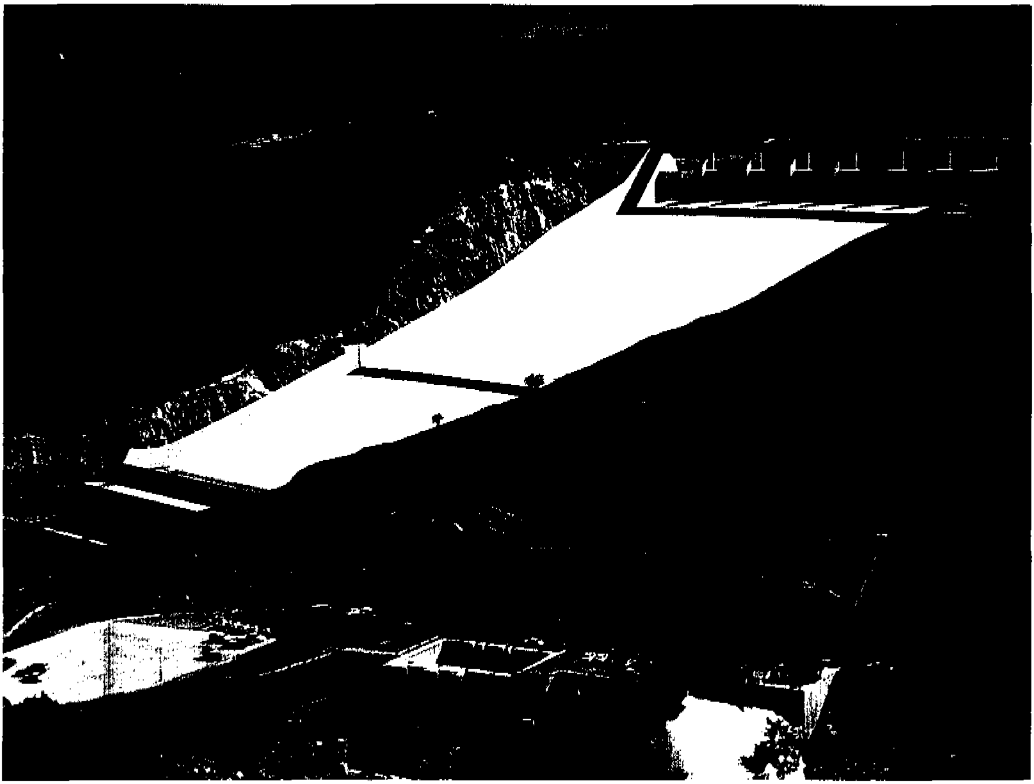
Whenever good quality water is scarce, water of inferior quality must be considered for agricultural use, domestic garden irrigation, pavement washing, and other uses not requiring high-quality water. Inferior quality water is also designated as non-conventional water or marginal quality water. Examples include saline water, agricultural drainage water, treated or untreated wastewater effluents, and water containing toxic elements and sediments. Desalinated seawater, and water obtained by fog capturing, weather modification, and rain-water harvesting, are also considered non-conventional waters.

Expanding urban populations and the growing percentage of people receiving water and sewerage services result in increased municipal wastewater. With the current emphasis on environmental health and water pollution issues, there is an increasing awareness of the need to dispose of these wastewaters safely and beneficially (Pereira et al, 2002). As a result, the use of wastewater in agriculture is already expanding in the region.

Other examples include the reuse of treated industrial effluents for low-quality uses in the same industrial plant, the reuse of treated municipal wastewater in aquaculture, for the irrigation of lawns and recreational areas, and for low-quality domestic water uses in dual municipal distribution systems, such as Bulawayo, Zimbabwe, and for potable reuse as in Windhoek, Namibia (Gumbo, 1997; Haarhoff, & Van der Merwe, 1996).

Despite it being a considerable water resource, roof water has not customarily been collected in many regions. This is because traditional roofing materials did not permit easy collection, and storage of collected water was difficult and expensive. However, in recent years, the availability of roof sheeting, combined with innovative water storage ideas, have changed the situation. There is a great need to encourage its use and to teach simple, low-cost means of collecting water from roofs, and of constructing suitable storage facilities.

Professional, expert help can be enlisted to develop better water-use and capture methods, but the local people need to be enlisted as the greatest source of ideas. There may be long-



established traditional practices of water use that may need to change. It will usually only be possible to effect such changes by first understanding the culture and traditions that surround them, and then developing a sensitive, locally adapted educational program. (Pereira et al.; 2002; Khouri et al., 1995).

4.8 Enhancing runoff by removal of alien invasive species

The Working for Water Project administered by the National Water Conservation Campaign in South Africa clears invasive alien vegetation in the catchment area of water resources. Clearing these invader plants allows the natural vegetation to return to the veldt, and the runoff to water sources increases substantially. Clearing invaders also improves the ecological functioning of rivers and lagoons, creates employment opportunities, and provides wood for furniture and fire.

The cost of clearing the dense stands of tall invader trees such as pines, eucalypti and acacias that occupy approximately 125 million hectares in South Africa and Lesotho is about R6 000 per hectare (US$600 per hectare).

These invaders have been identified as the country's major problem species, but applying these figures to all alien species countrywide suggests that the costs of mounting a one-year, "once-off" eradication campaign would be in the order of R7 billion (including follow-up costs) (Versveld et al, 1998). Although the high cost of the initial clearing and follow-ups would be spread over a period, the additional water that would become available for other uses would probably provide a sustainable supply of water to the catchment. It is estimated that the cost of the water saved during the 20-year period will amount to R0,45 per m^3 and an increase in mean annual runoff of almost 7% would be realised.

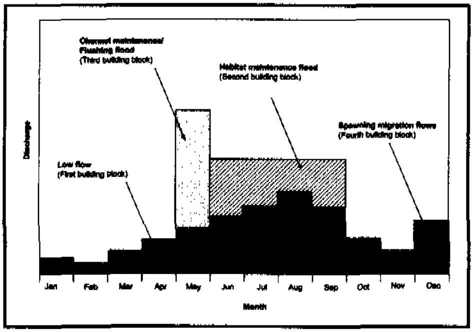
4.9 Managing environmental water demand

Ecological water requirements (EWRs) are the variable flows and quality of water needed to sustain the naturally occurring species (flora and fauna) in aquatic and related ecosystems. EWRs are very difficult to determine and quantify and are currently the subject of vigorous scientific and political debates. Post development flows are being set at about 25% of the pre-development situation, with similar seasonal variability, but this has no scientific basis.

There is a range of methods available for assessing ecological water requirements based on: simple hydrological indices; hydrological simulations; consensus and discussion based approaches; historical data analysis; and biological response simulation techniques often referred to as habitat simulation methods (Wallingford & DFID, 2002).

Few, if any, of the approaches available provide a complete solution and hence a wide range of approaches may be appropriate, especially for different levels of planning. An example is the Building Block Methodology which was developed in South Africa by the DWAF and various academic institutions (Hughes & Münster, 1999). The building block methodology requirements are summarised by Figure 6.

Figure 6: Examples of the flow building blocks used in the building block methodology



Source: Hughes & Münster (1999)

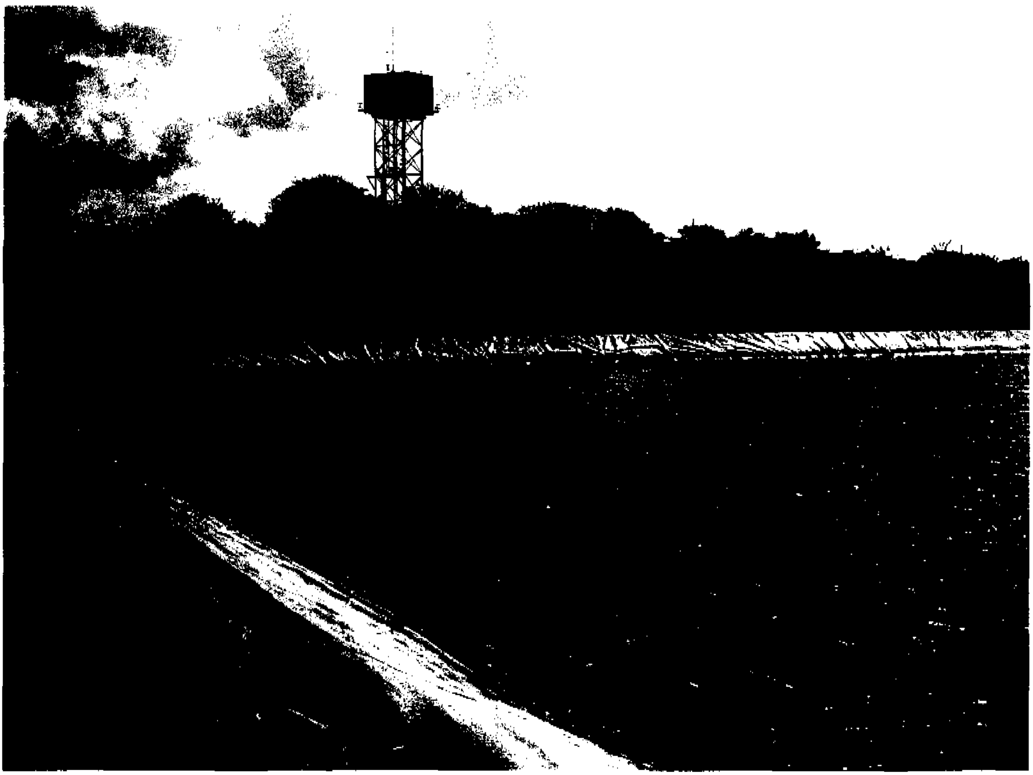
5.1 Contents of the section

The following section describes a self-contained scheme for establishing a WDM programme at a catchment scale for bulk water suppliers of untreated water. The procedure includes guidelines and recommendations for:

- Initiating a programme, including planning and organisation, beginning the process, establishing institutions, and identifying key WDM issues.
- Characterisation or assessment, involving assembling and analysing data, and determining the issues and requirements for WDM.
- Setting objectives, generating options and undertaking a feasibility analysis. This involves determining the outcomes required for satisfactory management, and identifying the actions needed to achieve them.
- Implementation, i.e. carrying out the identified actions in a coordinated way.
- Operating or maintaining a WDM programme. This process includes monitoring, reviewing and evaluating the success of the process, and amending where necessary.

5.2 The bulk supplier as the WDM facilitator

Setting up a WDM strategy is the first step in establishing a WDM programme. The strategy may be viewed as an overall plan (which looks at the current and the most desirable situation), or campaign, or course of action to make



custodian of a nation's water resources need to consider matters of national interest and coordinate the management of water resources throughout the water management chain (water cycle management). In WDM it is, therefore, their duty to encourage all water stakeholders, through early awareness creation to consider broad social, economic, and environmental issues involved management and use of water.

The roles of the bulk supplier in WDM is therefore that of a facilitator and motivator. Essential actions include: good example, knowledge transfer with respect to government policy and regulations and with respect to WDM implementation strategies and options; complete transparency with respect to its own

optimum use of existing resources (human and natural) to achieve specific objectives in the most efficient and productive way.

A hydrological catchment is the most logical basic planning unit for a WDM strategy. Bulk suppliers of untreated water as the trustee or

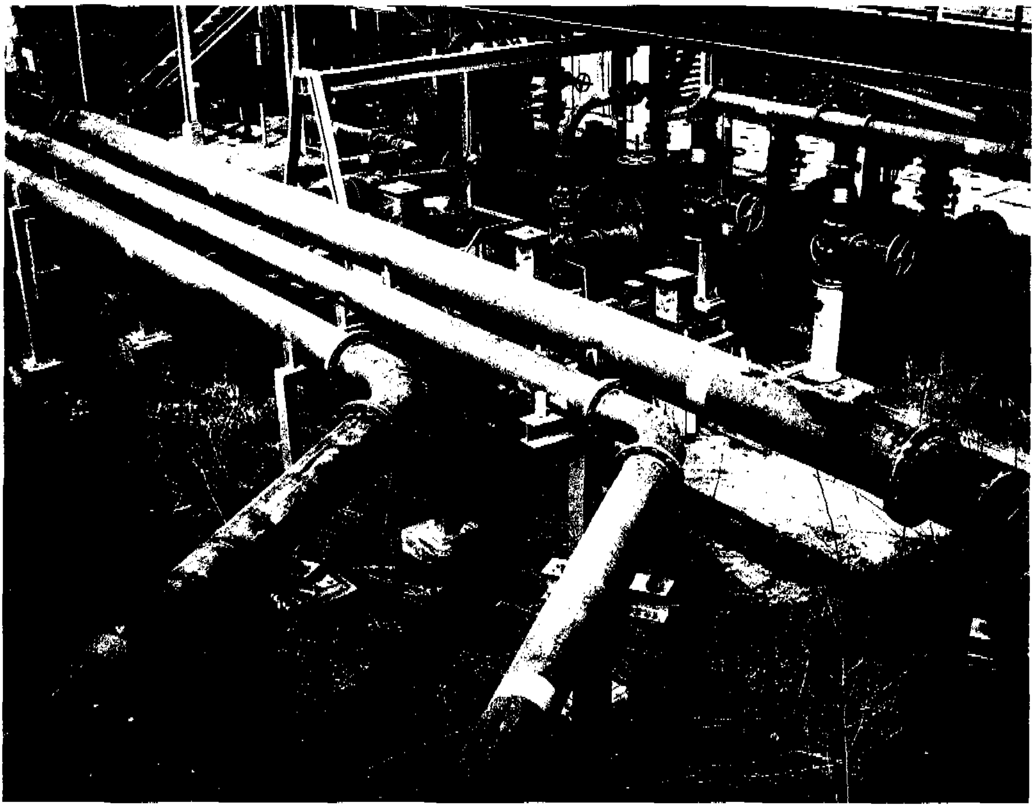
short- and long-term plans; and with respect to how these can be modified to everyone's advantage by stakeholders implementing WDM. Table 3 summarises the important action points in the setting-up and maintenance of a WDM programme facilitated by a bulk water supplier.

Table 3: Action points in developing a WDM programme for the sector

Action Point	Action	By whom
1	**Assessment** Check compliance with national WDM strategy. Check compliance with national and international water laws and treaties. Identify physical boundaries as dictated by catchments and catchment plans, existing land use and trends in land use patterns.	Bulk supplier with additional information from customers and other stakeholders. WDM in a catchment is a phased implementation of a dynamic, participative, integrated process that must be regularly reviewed, at least once every 5 years. The bulk water supplier needs to investigate, suggest and motivate WDM strategies for user sectors such as mining, urban, agriculture and environmental users.
2	**Broad plan** Draw up a broad WDM strategy *and motivate stakeholders to* develop the details. Evaluate the WDM options listed in section 3.3. Set up pricing strategy for raw water. Ensure compliance with water licensing and allocation rules and regulations. Ensure sufficient funding and political support.	Together with the local supplier or regulator, develop incentives and rewards to encourage customers to use water more effectively. The bulk supplier together with local *suppliers and retailers must* establish the costs of implementing WDM options, cost recovery options, debts and liabilities, incentives for reducing usage and pollution, credit options, loan facilities etc.
3	**Organisational arrangements**	Lead by bulk supplier throuhg a customer forum.

Action Point	Action	By whom
4	**WDM campaign** Develop strategies for focussed WDM education and capacity building where needed to promote a better public understanding of WDM so as to improve the level of participation.	Inclusion of key individuals and organisational stakeholders at both local and international levels is important. The bulk suppliers needs to investigate possible constraints to participation and find ways of addressing them if appropriate.
5	**Target setting** Develop a system of comparing recorded use with norms or best practice figures, to establish measure of efficiency. Set verifiable objective indicators and subjective indicators (refer to the Guideline series on Monitoring and Evaluation of WDM programmes).	Stakeholders interacting as a team. It is important that the bulk supplier leads the programme by example and transparency in its commitments to achieving stringent WDM targets set for itself.
6	**The bulk supplier, its customers and other stakeholders commit to targets.**	
7	**Monitoring overall outcomes** Establish regular auditing and review mechanisms. Construct detailed balances of water use, losses, sales and UAW.	Bulk supplier.

Action Point	Action	By whom
8	**Re-assesment:** Return to point 2, 3, 4, 5 or 6 depending on the results of the re-assesment. Reassess targets *occasionally.* Conduct periodic reviews of the programme.	Bulk supplier with additional information from customers. After the bulk supplier has monitored the overall outcomes, individual customers and other stakeholders will need to report on the performance of their individual organisations in achieving *their targets before a decision is made* collectively with respect to what action point to return to in this table.



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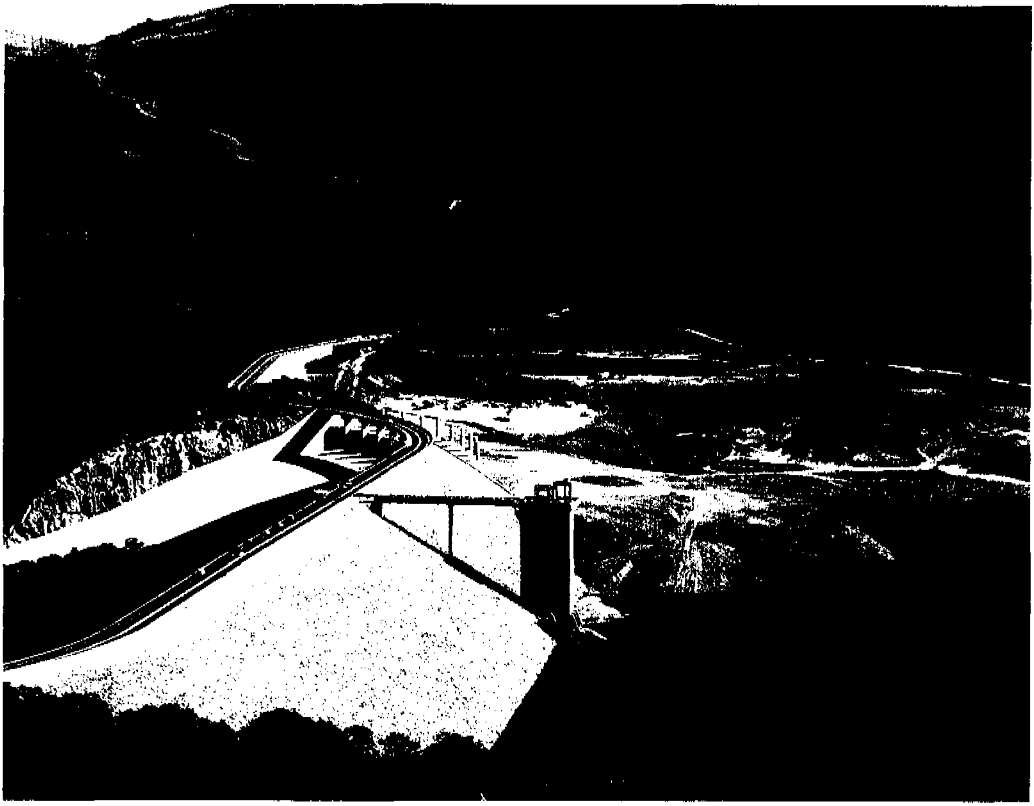

7 USEFUL ORGANISATIONS AND WEBSITES

1. Department of Water Affairs and Forestry, Private Bag X313, Pretoria, South Africa: URL: http://www-dwaf.pwv.gov.za/idwaf/index.html
2. Lesotho Highlands Water Authority (LHWA): URL: http://www.lhda.org.ls/
3. United States Environmental Protection Agency (USEPA), MC 7409, Washington, DC 20460: URL http://www.epa.gov
4. Water Research Commission, P O Box 824, Pretoria,0001, South Africa: URL: http://www.wrc.org.za
5. World Bank, URL: http:www.worldbank.org/
6. World Commission on Dams Knowledge Database, URL: http://www.damsreport.org/docs/kbase/
7. World Commission on Dams: URL: http://www.dams.org
8. Zambezi River Authority (ZRA): URL: http://www.zaraho.org.zm/

8 GLOSSARY

Catchment Area: This is the total water collecting area for any storage work. In a geographic context, a catchment is the area from which any rainfall will drain into the water-course(s) or part of a watercourse, through surface flow to a common point or points.

Co-efficient of Variation (Cv) of Run-off: The Cv is a measure of the variation in run-off from year to year. The Cv of run-off is greater than the Cv of rainfall. For a catchment where the variation is high (large value of Cv) there must be a greater carry-over of water stored in good years to balance out the low run-off in poor years. This longer period of retention results in a reduction of catchment yields, due to the water being subjected to evaporation losses for a greater length of time.

Evaporation: Evaporation from the surface area of reservoirs constitutes the major deduction from the total surface water potential. The magnitude of this deduction depends on the mean net evaporation for the appropriate climatic zone, but is also affected by other factors such as reservoir characteristics and the Cv of the mean annual run-off.

Mean Annual Run-off (MAR): This is the long-term average run-off and represents the total input to the surface water potential. It is primarily dependent on rainfall, both the gross precipitation and the intensity and distribution of falls having effect. To a lesser degree it is dependent on catchment characteristics such as soil type, vegetation and cover, land use and topographical features.

Reservoir Characteristics: The relationship between capacity and surface area of storage works will have a significant effect on evaporation losses, and hence on the potential yield. The reservoir characteristics are dependent on the topography of the storage basin; in general a large reservoir will be more favourable to maximum yield generation than a series of small reservoirs.

Storage Capacity: Sufficient storage capacity must be provided to generate the maximum yields within economic limits. Some water loss due to spillage in years of peak run-off is inevitable, but if the storage capacity were so great as to eliminate such losses, the increased evaporation losses from the greater surface area would offset the extra water saved.

Strategy: Derived from the Greek words "stratos" which is army, and "aegin" which means to lead, strategy literally means a piece of generalship (as in leading an army). More generally, a strategy is an overall plan or campaign to achieve a specific objective (such as to win a battle or war).

Glossary

Water Balance: The difference between the measured volume of water put into a water distribution system and the measured volume of water at any intermediate point in the water distribution system.

Water Demand Management (WDM): A management approach that aims to conserve water by influencing demand. It involves the application of selective incentives to promote efficient and equitable use of water. WDM has the potential to increase water availability through more efficient allocation and use. This is guided by economic efficiency; equity and access; environmental protection and sustainable ecosystems functioning; governance based on maximum participation, responsibility and accountability and political acceptability (IUCN, 2000).

Water Harvesting: Refers to methods used to collect water (1) from sources where the water is widely dispersed and quickly changes location or form and becomes unavailable or that is occurring in quantities and at locations where it is unusable unless some intervention is practiced to gather the water to locations where it can provide benefits.

Risk Factor: The acceptable risk of failure of an assured yield will have an effect on the potential water utilisation from a catchment. If the risk factor is low, a greater proportion of water must be held in storage over the years, with consequent increased evaporation losses. Conversely, if a higher risk factor can be tolerated, the reservoir can be drawn down to a lower level each year resulting in less evaporation and a greater yield. In Zimbabwe the accepted risk factors are 4% for urban and industrial supplies and 10% for agricultural use. For example, in South Africa a yield of 98 years out of 100 years on average is referred to as the yield at a 98% assurance of supply. Implicit to this is the acceptance that some degree of failure with respect to supplying of the full yield, will on average occur 2 years out of 100 years.