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# ORANGE-SENQU RIVER COMMISSION (ORASECOM)

# ASSESSMENT OF POTENTIAL FOR THE DEVELOPMENT AND USE OF "MARGINAL WATERS"

## *Final Report*

**Version 2.0**

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# *EXECUTIVE SUMMARY*

## *INTRODUCTION*

*Scarcity of water in semi-arid regions of the world, similar to the Orange-Senqu River Basin, has necessitated the development of strategies to optimise the use of available water resources. One of the most widely adopted measures is the augmentation of the water supply through the use of unconventional or "marginal" water sources. Marginal water can be used to supplement intensively exploited conventional sources.*

*For the purpose of this study, "Marginal Waters" will be defined as:*

*"Water that can be recycled, reused or reclaimed, including naturally occurring non-potable water, such as sea water, brackish water, saline and sodic water, unpotable groundwater, rainwater and fog harvesting.*

*The following definitions for recycle, reuse and reclaim have been adopted for the purposes of this report:*

***Re-cycle** – When water is used in a process and then reused in the **same** process with or without any purification / treatment or improvement of the water quality.*

***Reuse** – When water is used and is then used again for **another** purpose with or without purification to some acceptable level (not yet potable).*

***Reclaim** – Water that was previously used for potable or any other purposes is treated up to potable quality standards so that it can again be used for potable purposes.*

## *SUMMARY OF THE STATUS QUO*

*Examples of the different types of marginal water have been obtained from within the Orange-Senqu River Basin. An indication of the different types of marginal water is shown in Table E1.*

*Table E1: Different types of marginal waters within the Orange-Senqu Basin*

| | ***Namibia*** | ***Botswana*** | ***Lesotho*** | ***South Africa*** |
|---|---|---|---|---|
| *1. Reclamation of waste water for potable use* | ● | | | |
| *2. Reuse for irrigation after treatment* | ● | | | ● |
| *3. Reuse and recycling of industrial water* | ● | ● | ● | ● |
| *4. Reuse of water in mining sector* | ● | ● | ● | ● |
| *5. Rainwater & fog harvesting* | ● | ● | ● | ● |
| *6. Fog harvesting* | ● | | | ● |
| *6. Rainfall Enhancement* | ● | | | ● |
| *7. Use of brackish groundwater* | ● | ● | ● | ● |
| *8. Sea water and desalinisation* | ● | | | ● |
| *9. Use of dual systems* | ● | ● | | |

*Examples from within the basin countries that are worth mentioning are:*

- *Botswana: Debswana mine. This mine is a good example in the sense that four types of marginal water are being exploited, i.e.:*
    - *Rainwater harvesting*
    - *Irrigation with treated effluent*
    - *Recycling of process water*
    - *Use of brackish water*
- *Namibia: Windhoek reclaiming water from sewage water to potable standards.*
- *Lesotho: Rainwater harvesting*
- *South Africa: Emalahleni plant in Witbank, where heavy metals are removed from acid mine water and where the water is treated to potable standards.*

*Two distinct examples in other countries of the world are:*

- *Australia: Irrigation of open spaces with water from package treatment plants plugged into sewers.*
- *Japan: Best example of dual systems for large scale buildings.*

***IMPORTANT ISSUES RELATING TO MARGINAL WATER USE***

*The following implications have been identified for marginal water use:*

- *Institutional: Different tiers of institutional structures do not cooperate to promote marginal water use to its optimum.*
- *Legislation: Regulation needed on water quality standards.*
- *Environment: Marginal water use can have both positive and negative impacts on the environment e.g. positive when water is released into the environment with improved water quality and negative when e.g. lime precipitates and blocks boreholes in limestone areas.*
- *Health: Faecal coliform guidelines must be met when irrigating with treated waste water in order to avoid helminth and bacterial infections.*
- *Cost trends of marginal water use are shown in Figure E1.*

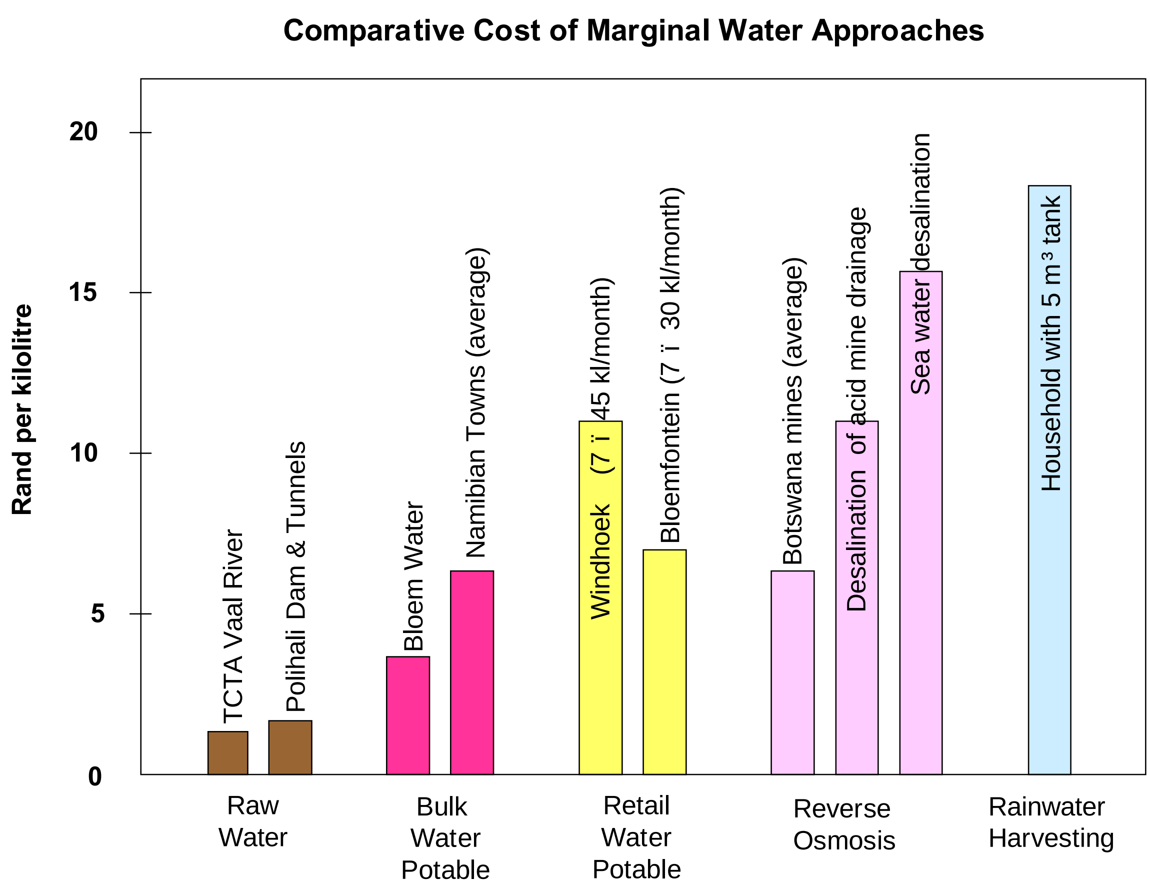


***Figure E1: Comparative cost of Marginal Water Approaches***

***TRENDS AND FUTURE POTENTIAL OF MARGINAL WATER***

*Trends in marginal water use and future potential are shown in Table E2.*

***Table E2:*** *Marginal Water Use Trends and Potential within the Orange-Senqu Basin*

| Type of Marginal Water use | Namibia | | Botswana | | Lesotho | | South Africa | |
|---|---|---|---|---|---|---|---|---|
| | Current | Future Potential | Current | Future Potential | Current | Future Potential | Current | Future Potential |
| Reuse water for irrigation of recreational facilities and agricultural crops with treated waste water. | Mines within basin use effluent for irrigation of sport fields and golf courses. So does Windhoek (outside basin) | Apart from current use by mines, ± 2 mill m³ domestic sewage effluent in the larger towns can become available for reuse. | Treated effluent sold for use in gardens. Sport field irrigation e.g. by Debswana mine and Maru-A-Pula school. | Sway public perception and use treated effluent water from Gabarone works for irrigation of food crops. | No information found. | Treated waste water could be used for irrigation of Maseru's sport fields and golf course. | General practice in SA. Treated waste water is discharged in river and abstracted downstream by irrigators. Some industries reuse process water for irrigation, including crop irrigation. | Current practice to be continued, however discharging institutions must ensure that they comply to quality standards. |
| Recycle and/or reuse for industrial and mining purposes with treated or untreated water. | Rössing Uranium Mine recycles ± 62% of their water purchased from NamWater. | Continuation of present use. | Localised examples, e.g. Debswana mines. | Continuation of present use. | Recycling of water e.g. in textile industry and reusing process water by e.g. SAB Miller in Maseru. Recycling at diamond mines. | Continuation of present use. | Some industries reuse their water e.g. SAB Miller. | More industries could be encouraged. There should be a financial incentive. |
| Reclamation of waste water for potable use | 24% of total water consumption of Windhoek is reclaimed water from sewage effluent (outside basin). | ± 2 mill m³ sewage effluent available from larger towns but reusing rather than reclaiming is more attractive. | Not practised in Botswana as yet. | If public perception can be swayed, waste water of Gaborone could possibly be reclaimed for potable purposes. | Not practised in Lesotho as yet. | Maseru has limited water source and should look at this option. | Not practised in South Africa as yet. (Direct reclamation). | Limited potential in basin. Other water users currently dependent on the discharged treated waste water. |
| Aquifer recharge | Aquifer recharge/banking successfully applied outside basin (Omaruru Delta Aquifer and Windhoek Aquifer). | Localised / limited opportunities. | Localised examples. | There is potential to recharge aquifers with surface water to reduce evaporation losses. Infiltration dams needed. | Not practised in Lesotho as yet. | Localised / limited opportunities. | Not practised within the basin in South Africa as yet. | Localised / limited opportunities. |
| Dual systems | Dual systems used at the mines and in Windhoek (outside basin), i.e. separate pipe systems for drinking and gardening. | Separate networks for irrigation of parks and sport fields of towns. | Car washing stations in Gaborone use treated effluent water. | Continuation of present use. | Not practised in Lesotho as yet. | Could possibly be considered for Maseru. | Not practised within the basin in South Africa as yet. | Use of dual systems including Japanese hand washing/ flushing system for toilet flushing could be introduced for Gauteng Region. |
| Use of brackish Ground water | Brackish water from Kahn River used for dust suppression at Rössing Uranium Mine. | Continuation of present use. | Used for stock drinking and wild life drinking. | Continuation and new copper mines at Ghanzi could use saline ground water as process water. | Not practised in Lesotho as yet. | Localised / limited opportunities. | Private boreholes used for stock drinking. | Current practice to be continued. Limited potential for expansion. |
| Seawater and Groundwater desalinisation | Two farms use desalinated water. Thermal distillation plant at Lüderitz (outside basin) today redundant. | Seawater: Only coastal town gets water from Orange. Brackish GW: Not regarded attractive enough. | Locked in land – no access to sea. Several GW desalination plants in operation in Botswana. E.g. Debswana mines. | Continuation and possible expansion of desalination plants for utilising saline ground water. | Not applicable for Lesotho. | Not applicable for Lesotho. | Only coastal town is Alexander Bay which does not need seawater desalinisation. No info on GW desalinisation. | Limited scope within the basin for major GW desalinisation project. |
| Rainwater & Fog harvesting | Schools harvest rainwater from roofs for drinking purposes. Some house-holds harvest rainwater for swimming pools. Fog harvesting unfeasible. | Annual rainfall very low (250 mm/a). Not seen as viable option, in many places for crop production but good for drinking where other water is too saline or has a bad taste. | Harvested rainwater used for gardening and car washing e.g. at Maru-A-Pula school. 3.5 mill m³/a harvested by Debswana. | Continuation and possible expansion. | Harvested rainwater used for gardening. | Option for Maseru from rooftops of public buildings. | Individual household rainwater tanks for gardening purposes. | Better utilisation of DWAF's subsidy scheme for resource poor farmers. Rainwater tanks are being subsidised. |
| Reclaim mine drainage water | Localised / limited mine drainage. | Localised / limited opportunities. | Localised / limited mine drainage. | Localised / limited opportunities. | Localised / limited mine drainage. | Localised / limited opportunities. | Some mine GW water is currently used for mining. | Huge potential. ± 150 mill m³/a available. Currently being investigated by W.U.C. (see para.4.1.5) |

***ASSESSMENT OF KEY PROJECTS***

*The following projects have been identified in the four basin countries.*

*Lesotho*

- *Irrigation of sport fields, the golf courses and suitable food crops in Maseru with treated sewage effluent.*
- *Reclamation of Maseru's sewage water for potable use.*
- *Rainwater harvesting from rooftops of large buildings in Maseru.*

*Botswana*

- *Irrigation of food crops with treated sewage effluent.*
- *Reclaiming Botswana's treated sewage effluent to potable standards.*
- *Recharge aquifers with treated sewage effluent.*
- *Better utilisation of Botswana's saline groundwater.*
- *Public awareness strategy for reclaiming sewage water to potable standards (directly or by means of aquifer recharge) and irrigating food crops with treated waste water.*

*Namibia*

- *Irrigation of sport fields and suitable food crops with treated sewage effluent.*

*South Africa*

- *Installation of dual systems for new developments in Gauteng*
- *Rainwater harvesting for food security.*
- *Reclaiming mine water to potabl e standards in Gauteng.*
- *Developing guidelines for the installation of dual reticulation systems in Gauteng.*

*Transboundary*

- *Review of institution, policy, legislation, and guidelines in the four countries.*
- *Development of guidelines for marginal water use by the industry sector.*

***SELECTION CRITERIA***

*The following eleven criteria were used for selecting between the list of projects.*

i. *The extent to which the project will combat poverty, the greater the better.*
ii. *Water stressed areas should receive preference.*
iii. *Does it provide an opportunity to test new technology?*
iv. *Will the public perception towards the possible project be positive?*

*v. The beneficial impact of the project on the basin as a whole.*
*vi. The extent to which the project will alleviate environmental problems.*
*vii. The management intensity of the project, the lower the better.*
*viii. The ability to duplicate (i.e. ease of adding modules and in so doing, expanding the project) or to copy project in other areas, the easier the better.*
*ix. Will the project leave other water users downstream in a weaker position? E.g. Water quality in the Orange River to the detriment of export grape farmers.*
*x. To what extent will the project lead to institutional growth?*
*xi. Will the project defer other projects (e.g. future augmentation projects which will be more expensive) in the basin state (locally or regionally)?*

*A condition with which it was recommended, all projects should be in place where a "marginal waters" project is to be implemented was that all possible water conservation and water demand management (WC/WDM) measures should already be being implemented. Normally WC/WDM is the cheapest and most efficient way of making the most use of the available water. However in cases where the usage of any marginal water option would be cheaper, the latter could be pursued as long as the WC/WDM had been considered.*

*Apart from the above 11 criteria, a separate objective was set, namely to get an even spread of projects in the four basin countries.*

***SELECTED PROJECTS***
*Six projects have been selected for further study, i.e.:*

*i. **Botswana:** Awareness campaign to promote indirect potable water reuse and irrigation of food crops with treated sewage effluent.*
*ii. **South Africa:** Dual reticulation system guidelines for Gauteng*
*iii. **Lesotho:** Irrigation of sport fields, the golf course and suitable food crops in Maseru with treated wastewater*
*iv. **Namibia:** Irrigation of sport fields and suitable food crops in larger Namibian towns*
*v. **Transboundary:** Institutional, Policy, Legislative and Guidelines Review*
*vi. **Transboundary:** Guidelines for marginal water use for the industrial sector*

*Scopes of Works have been drafted for each of the above six projects and are bound in this report as Appendix C.*

***COLOUR BROCHURE***
*A colour brochure has been prepared to promote the use of marginal waters and is included in this report in Appendix B.*

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## ABBREVIATIONS AND ACRONYMS

| | | |
|---|---|---|
| CSIR | - | Council for Scientific and Industrial Research |
| DEAT | - | Department of Environmental Affairs & Tourism |
| DME | - | Department of Mineral & Energy |
| DWAF | - | Department of Water Affairs and Forestry (South Africa) |
| EWR | - | Environmental Water Requirement |
| GAC | - | Granular Activated Carbon |
| Ha | - | Hectares |
| HDI | - | Historically Disadvantaged Individuals |
| IDP | - | Integrated Development Plan (South Africa) |
| IWRM | - | Integrated Water Resources Management |
| IWRMS | - | Integrated Water Resources Management Scenarios |
| NAFU | - | National African Farmers Union |
| LNDC | - | Lesotho National Development Corporation |
| NDA | - | National Department of Agriculture |
| MSF | - | Multi-Stage Filtration |
| NWMPR | - | National Water Master Plan Review |
| NAMPAAD | - | National Master Plan for Agricultural Development |
| PDO | - | Petroleum Development Oman |
| PIT | - | Project Implementation Team |
| PIU | - | Project Implementation Unit |
| PSC | - | Project Steering Committee |
| RSA | - | Republic of South Africa |
| SAAWU | - | South African Association of Water Utilities |
| SALGA | - | South African Local Government Association |
| SAR | - | Sodium Absorption Ratio |
| SoW | - | Scope of Works |
| STP | - | Sewage Treatment Plants |
| SWRO | - | Salt Water Reverse Osmosis |
| TDS | - | Total Dissolved Solids |
| ZSW | - | Centre for Solar Energy and Hydrogen Research (Namibia) *[Zentrum für Sonneregie – und Wasserstoff – Forschung* |
| USEPA | - | United States Environmental Protection Association |
| WC&DM | - | Water Conservation and Demand Management |
| WRC | - | Water Research Council |
| WRM | - | Water Resource Management |
| WRMD | - | Water Resource Management and Development |
| WWTWs | - | Waste Water Treatment Works |

# 1. INTRODUCTION

## 1.1 BACKGROUND TO THIS PROJECT

Scarcity of water in semi-arid regions of the world, similar to the Orange-Senqu River Basin shown in **Figure 1.1**, has necessitated the development of strategies to optimise the use of available water resources. One of the widely adopted measures is the augmentation of the water supply through the use of unconventional or ñmarginalò water sources. Marginal water can be used to improve the efficiency of water use and supplement intensively exploited conventional sources.


**Figure 1.1** Map of Orange-Senqu River Basin

The foremost objective of this project was to determine the *status quo* of the use of ñmarginal watersò within the Orange-Senqu River Basin, before identifying opportunities and key projects or areas to improve or increase the use of ñmarginal watersò, resulting in the *fuller use of the existing supplied and otherwise available water*.

In order to achieve the objectives, the Orangeï Senqu River Commission (ORASECOM) (Client) implemented this project for Consultancy Services for the Assessment of Potential for the Development and Use of ñMarginal Watersò.

## 1.2 DEFINITION OF MARGINAL WATERS

For the purpose of this study, ñMarginal Watersò were defined as:

ñWater that can be recycled, reused or reclaimed, including naturally occurring non-potable water, such as sea water, brackish water, saline and sodic water, unpotable groundwater, rainwater and fog harvesting.

The following definitions for recycle, reuse and reclaim have been adopted for the purposes of this study:

**Re-cycle** ï When water is used in a process and then reused in the **same** process with or without any purification / treatment or improvement of the water quality.

**Reuse** ï When water is used and is then used again for **another** purpose with or without purification to some acceptable level (not yet potable).

**Reclaim** ï Water that was previously used for potable or any other purposes is treated up to potable quality standards so that it can again be used for potable purposes.

**Figure 1.2** illustrates the role of marginal waters in the hydrological cycle.

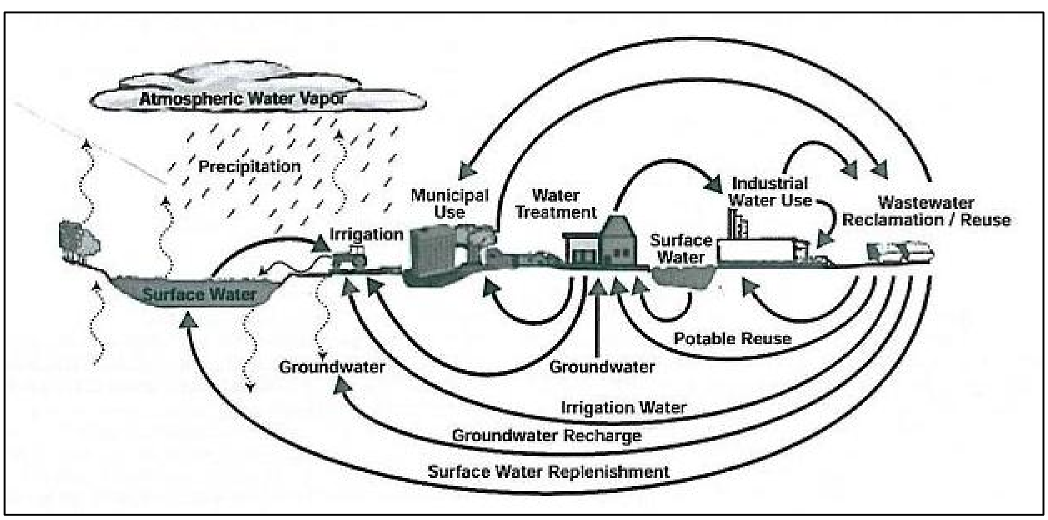


**Figure 1.2** The role of engineered treatment, reclamation, and reuse facilities in the multiple uses of water through the hydrological cycle. (Source: adapted from Asano, 1995).

## 1.3 THE SYSTEMS PERSPECTIVE OF MARGINAL WATER USE

When a catchment is viewed holistically, as a system, and acknowledging that all forms of water are part of the hydrological cycle, then water recycling, reuse and reclamation as well as rainwater and fog harvesting cannot create more water.

The objective of promoting use of marginal waters through this project is to use water more efficiently, to minimise water losses and wastage and to ensure that water, particularly potable water, is used for the most beneficial purposes.

The situation in a catchment might be that waste water discharges are already being used downstream (e.g. by irrigators) and that the resource is fully allocated or utilised and that no water is flowing out at the downstream end of the catchment. A decision by any up-stream water user to reuse/recycle/reclaim water or to intercept water by harvesting rainwater might therefore have a negative impact on downstream water users that rely on the discharges. This must always be taken into consideration when planning to use marginal waters.

However it may be that the recycling/reuse/reclaiming of water upstream is a more efficient or beneficial use and a countryõs best interest compared with the downstream use. These aspects must be factored into any decision making.

## 1.4 PROJECT PHASES AND PURPOSE OF THIS REPORT

The study was sub-divided into three phases, i.e. Inception Phase, Assessment Phase and Proposal Phase. The Inception Phase was completed and an Inception Report finalised and issued to the client. A comprehensive Bibliography was compiled using ñEndNoteò software which was delivered to the client and presented in Appendix A. The Assessment Phase comprised mainly an assessment of current marginal water use in the Orange-Senqu River Basin and of the future potential for use of marginal waters. That phase was completed in March 2009 and the Mid-Term report finalised and issued to the client. The third phase identified potential marginal water projects and Scopes of Work were drafted for them. This Final Report documents the findings of the Assessment Phase and presents the Scopes of Work for the selected priority projects. This report also displays the colour brochure which has been prepared about the project.

# 2. PROJECT SUMMARY

## 2.1 SUMMARY OF STATUS QUO

### 2.1.1 Lesotho

Extensive rain water harvesting projects funded through various donor agencies are currently in place in Lesotho. The harvested water is mainly used for watering private and community gardens. The mines in Lesotho also recycle water within their processes, for example the diamond mines and quarries. Within Maseru, the textile industry reuses their process water. The SAB Miller brewery in Maseru also reuses their industrial effluent for crate washing among other things.

### 2.1.2 Botswana

The Debswana mines in Botswana have set a precedent for mine water management. The mines are involved in rain water harvesting, approximately 3.5 million $m^3$ per annum (rainwater harvesting is also carried out in other locations such as at schools and government buildings). The rain water is used to water gardens. The process water from mining activities is reused within the processes. The sewage effluent gathered at the mines and mine villages is also treated and used to irrigate the sports fields and landscaped gardens at the mines. Botswana has also been busy with investigating the possibility of aquifer re-charge using treated effluent. However, the negative public perceptions have slowed progress on the reuse of treated sewage effluent. Car wash stations in Gabarone use treated effluent as their water supply. Another source of widely used marginal water in Botswana is saline groundwater. The saline groundwater is used extensively for stock drinking. Similarly, several desalination plants or in operation through out Botswana, utilising the widely available saline groundwater and further plants are being proposed.

### 2.1.3 Namibia

In Windhoek Namibia, 24% of the total water consumption is from reclaimed sewage effluent. Although this example falls outside the Orange-Senqu basin, it is an important example for this project. The reclaimed water is also used for irrigation purposes. The mines in Namibia provide good examples of using marginal waters both in the basin, and in the country as a whole. Many of the mines in Namibia reuse effluent for irrigation of their facilities and golf courses. Rössing Uranium Mine recycles approximately 62% of their water purchased from NamWater. Rössing also use brackish water from the Kahn River for dust suppression. Some of the mines make use of dual reticulation systems. Within Windhoek, the industrial area also has a dual reticulation system installed and operating. Many schools in Namibia conduct rainwater harvesting projects. The water collected is then used for drinking purposes. Most of the rainwater harvesting projects are individual initiatives, for example, using harvesting rainwater for swimming pools. Although not in the basin, but still in Namibia, Omaruru Delta Aquifer and Windhoek Aquifer have been successfully recharged through water banking projects. A thermal distillation plant was installed at Lüderitz, however it is currently out of action.

### 2.1.4 South Africa

In South Africa there are currently a few examples of marginal waters in use. Many of the examples are by individual companies rather than sector driven, or government driven. Treated effluent is indirectly used in the basin for potable purposes. Effluent released back into the river is then later abstracted further down stream for purification for potable use. The Northern Waste Water Treatment Works, in Johannesburg, pumps treated sewage effluent directly to the Kelvin Power Station for cooling of the stacks. Within the Durban region, treated effluent is used both in the Paper and Pulp industry, as well as Shell SAPREF Refinery. The treated effluent, collected from households and treated, is then piped to the industries where it is used for various industrial processes including cooling processes. SAB Miller plants throughout the country also practice various techniques of water recycling and reusing, including for crate washing.

In eMalahleni, in Witbank, Acid Mine Drainage is reclaimed to potable standards to augment the local drinking water supplies. A similar project is currently being researched, within the basin area, where acid mine drainage will be collected and treated and pumped to the drinking water reservoirs. The treating of the acid mine drainage provides a positive environmental impact, as better quality water is released to the rivers.

Brackish groundwater is used for stock drinking in water-scarce areas of the country. Similarly in high rainfall areas, rain water harvesting is conducted on a small and private scale. The water is then utilised for garden watering, dust suppression, and drinking purposes. Sea water desalination is being done by the Albany Water Board in the Eastern Cape.

The responses received from the questionnaires indicated that so long as water was coming from the tap, the majority of respondents weren't concerned about using marginal water, or investigating alternative sources of water.

### 2.1.5 In the rest of the world

Australia

Throughout Australia there are examples of reusing treated effluent as well as other marginal water sources. One example is the latest water recycling development in Melbourne, of a portable ósewer miningô plant, **Figure 2.1**. The plant uses membrane technologies (ultra filtration and reverse osmosis) producing Class A reclaimed water from Melbourneõs sewage mains. The unit, is mounted in a 12 metre shipping container, and connects directly into the sewage mains via available manholes. The treated water is used to irrigate Melbourneõs parklands and waste products are returned to the sewage mains.

**Figure 2.1**: Portable WWTW in 12 metre shipping container used for ósewer-miningô, Melbourne, Australia. (Mallia, 2003).

Japan

Approximately 150 million $m^3$ of water is recycled annually. Since 1997, 163 publicly owned Waste Water Treatment Works (WWTW) provide water recycling in 192 use areas, and 1475 on-site individual and block-wide water recycling systems provide toilet flushing water in commercial buildings and apartments as well as water for landscaping. The Tokyo Metropolitan Government produced a set of guidelines for the reuse of treated ómiscellaneous-useô water in 1984. Based on these guidelines, Tokyo directs the operators of large-scale buildings with a floor area of more than 30 000$m^2$ or that use a daily total volume of 100$m^3$ of water for non-drinking water purposes to reuse water.

California

In the United States, California residents reuse on average 656 million $m^3$ of municipal waste water annually, the majority of which is reused for irrigation (agriculture and landscape irrigation) purposes, as well as meeting environmental flows, groundwater recharge and recreational impoundment.

Oman

In Oman, Petroleum Development Oman (PDO) produces nearly five barrels of water for every barrel of oil. The water is mixed with the oil and gas deposits and brought to the surface during production. The water contains small amounts of salts and oil, and is often pumped back into the well. PDO are in the process of researching reed fields to absorb the contaminants from the water and making the water available to the local communities. During the reed-bed process, the water becomes more saline due to evaporation. The water will also be used to grow salt-resistant crops. The use of the reed-beds has reduced the costs to PDO of pumping the water back into the wells, as well as reducing the $CO_2$ emissions.

## 2.2 SUMMARY OF IMPORTANT ISSUES

### 2.2.1 Institutional

The main problem identified in the research relating to institutional structures and arrangements was the separation of functions and responsibilities between agencies for water management and sewage services functions. Water resource management issues is usually the responsibility of a higher tier of government, whereas sewage services is usually a lower order organisation or municipality and this resulted in a lack of coordination, differing goals and standards, as well as conflicting developments or installations.

A second identified problem is the need for a paradigm shift, instead of first looking to potable reclamation solutions, to rather begin with reuse or recycling in order to reduce the demand on potable water for non-drinking purposes. Whilst this falls into Water Demand Management, which is dealt with in another project, this problem was identified in this research and questionnaire responses.

### 2.2.2 Legislation

In terms of the legislation in the basin, Botswana's National Wastewater and Sanitation Planning and Design Manual (2003) provides some guidance towards the reuse of water. The Manual highlights the difference between water quality standards and water quality guidelines.

Water quality standards are legal impositions enacted by means of laws, regulations or technical procedures, which are established in countries by adapting guidelines to their national priorities and taking into account their technical, economic, social, cultural and political characteristics and constraints. Water quality guidelines on/for the reuse of water quality are mainly based on research and epidemiological findings, and as such provide guidance for making risk management decisions related to the protection of public health and the preservation of the environment. (Botswana).
In the rest of the world, there are more advanced pieces of legislation and guidelines for the reuse of water. For example:

**Europe** The European Urban Waste Waster Treatment Directive (91/271/EEC) defines standards for the collection, treatment and discharge of urban waste water and waste water from some industrial sectors. The Directive states that (with a few exceptions) all urban waste water discharges greater than 10,000 person equivalents to coastal waters and greater than 2,000 person equivalents to freshwater and estuaries will be subject to secondary treatment by 2005. (Radcliffe, 2006)

**Australia** At a Federal level, the National Water Quality Strategy (NWQMS) *National Water Quality Management Strategy Australian Guidelines for Water Recycling Management Health and Environmental Risk* (Phase 1) published in 2006, provides a national reference for the supply, use and regulation for the reuse of water. The guidelines aim to provide a consistent risk based approach to reusing water. The guidelines do not specify end uses for the water, but rather provide a process to determine if the environmental and health risks are being adequately managed. There are both health and environmental targets set for individual hazards as well as a number of end uses.

**United States** California's Waste water Reclamation Criteria (Title 22) has been the basis for many other sets of regulations. (Radcliffe, 2006).

**Tunisia** National Reuse Policy (Decree 89-1047). (Radcliffe, 2006).

### 2.2.3 Environment

Many of the environmental impacts identified through the research relate to desalination of sea water plants. The intakes to the plants lead to marine life impingement. There is currently research into better intake designs for the plants, so as to avoid the entrainment of the marine life. In the Middle East, an outbreak of red tide has affected some of their desalination plants. The intakes have to be shut down to avoid contamination. On a positive aspect, both the US and Australia are looking to implement requirements for desalination plants to be carbon neutral, and research into wind and solar energy supplies is currently in process.

With regards to boreholes, in the karst (limestone) areas, excessive pumping from boreholes can result in deeper lime-rich water being exposed to oxygen and thereby causing the lime to precipitate and block the borehole. The borehole then has to be abandoned and re-drilled.

Recycling, reuse or reclamation of water will usually result in an environmental benefit, as the water released into the environment will be of a better quality. One of the trends identified in the international research, is that one of the main reuses of marginal waters was to meet environmental flow requirements.

### 2.2.4 Health

The main health impact identified, related to water quality assurance, and therefore the implementation of strict regulations. The reclamation of water for potable use, even for aquifer recharge or dilution purposes was ranked fairly low among the examples researched.
The main use of marginal water, identified through the research, was for irrigation purposes. Within this use, there is the need for strict regulation and enforcement, to prevent the contamination of foodstuffs from the waste water.

Irrigation with untreated waste water is very hazardous to health, with both fieldworkers and consumers being at high risk of helminth infections; consumers are also at a high risk of bacterial infections such as cholera and typhoid fever. Treated effluent for irrigation must meet the faecal coliform guidelines of less than 1 000 parts per 100ml to protect consumers from these bacterial diseases.

### 2.2.5 Costs

This financial comparison is an indication of the relative costs of implementing various marginal water approaches in the basin. The operational, maintenance and capital costs were obtained from actual projects in the basin. Where the capital costs were provided as a once off fixed cost, it was first converted into an annual cost using an interest rate of 10% per annum, capitalised 6 monthly over a 20 year period and then converted into a per cubic metre cost. The cost of the rainwater tank assumes a life of 10 years and that the $5m^3$ tank can meet a demand of 15 Kl per month for 6 months of the year. This might be a generous assumption in the drier areas. Conventional surface water resource schemes and water supply were used as benchmarks.

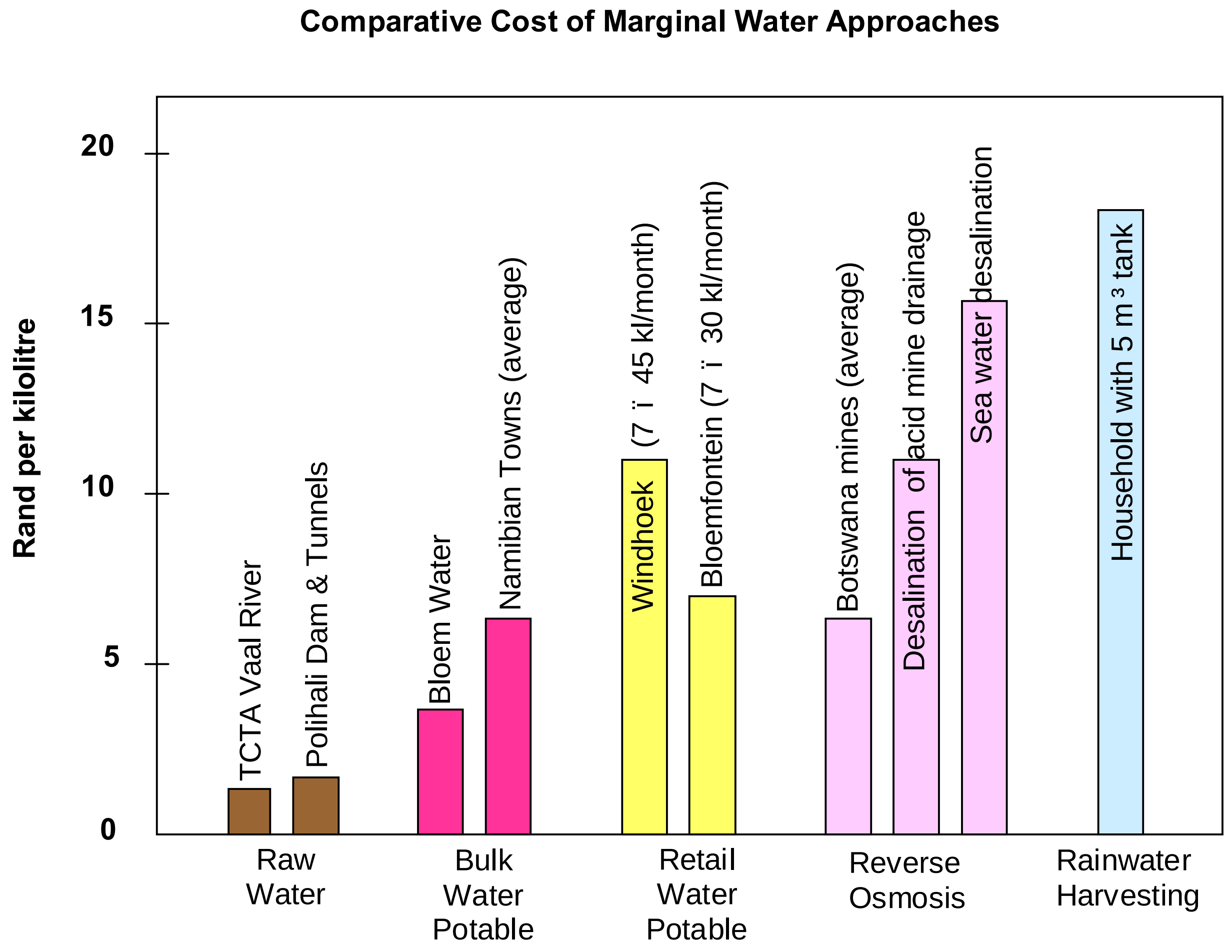


**Figure 2.2** Comparative cost of water

The cost of the marginal water approaches indicated in **Figure 2.2**, are indicative and actual costs will depend on a number of factors and especially on the quality of the influent. The poorer the influent the higher the cost of desalination. Desalination of sea water being on the higher end of the cost spectrum. From the results it appears that the cost of marginal water is not out of the ordinary, and while more expensive than the price of conventional water supplies in South Africa, the cost of marginal water is competitive with the cost of water in the drier Namibia.

The cost of marginal water should not be a deterrent to a more detailed preliminary design level analysis which would result in more accurate costing and perhaps a more cost efficient approach.

## 2.3 TRENDS AND FUTURE POTENTIAL OF MARGINAL WATERS

Use of marginal water use has become common practice in many countries of the world. As available conventional resources are taken up, water users are forced to make increasing use of marginal waters. Factors, other than just the scarcity of water may force countries to opt for reusing water.

- E.g. Japan, where topographical conditions are a constraint for impoundment infrastructure.
- E.g. Oman, where water that is used in the treatment of oil, is reused for the irrigation of salt tolerant crops.

**Table 2.3** provides a summary of the status quo of marginal water use in the Basin and of the future potential. From this table, three types of trends and future potential have been identified i.e. in relation to the sources, in relation to the uses and in relation to the mechanisms. Each of these is described below.

The areas of future potential where it was recommended that further work be undertaken and which were considered for preparation of a scope of work under this project, are highlighted.

**Table 2.3** Marginal Water Use Trends and Potential within the Orange-Senqu Basin

| Type of Marginal Water use | Namibia | | Botswana | | Lesotho | | South Africa | |
|---|---|---|---|---|---|---|---|---|
| | Current | Future Potential | Current | Future Potential | Current | Future Potential | Current | Future Potential |
| Reuse water for irrigation of recreational facilities and agricultural crops with treated waste water. | Mines within basin use effluent for irrigation of sport fields and golf courses. So does Windhoek (outside basin) | Apart from current use by mines, ± 2 mill m³ domestic sewage effluent in the larger towns can become available for reuse. | Treated effluent sold for use in gardens. Sport field irrigation e.g. by Debswana mine and Maru-A-Pula school. | Sway public perception and use treated effluent water from Gabarone works for irrigation of food crops. | No information found. | Treated waste water could be used for irrigation of Maseru's sport fields and golf course. | General practice in SA. Treated waste water is discharged in river and abstracted downstream by irrigators. Some industries reuse process water for irrigation, including crop irrigation. | Current practice to be continued, however discharging institutions must ensure that they comply to quality standards. |
| Recycle and/or reuse for industrial and mining purposes with treated or untreated water. | Rössing Uranium Mine recycles ± 62% of their water purchased from NamWater. | Continuation of present use. | Localised examples, e.g. Debswana mines. | Continuation of present use. | Recycling of water e.g. in textile industry and reusing process water by e.g. SAB Miller in Maseru. Recycling at diamond mines. | Continuation of present use. | Some industries reuse their water e.g. SAB Miller. | More industries could be encouraged. There should be a financial incentive. |
| Reclamation of waste water for potable use | 24% of total water consumption of Windhoek is reclaimed water from sewage effluent (outside basin). | ± 2 mill m³ sewage effluent available from larger towns but reusing rather than reclaiming is more attractive. | Not practised in Botswana as yet. | If public perception can be swayed, waste water of Gaborone could possibly be reclaimed for potable purposes. | Not practised in Lesotho as yet. | Maseru has limited water source and should look at this option. | Not practised in South Africa as yet. (Direct reclamation). | Limited potential in basin. Other water users currently dependent on the discharged treated waste water. |
| Aquifer recharge | Aquifer recharge/banking successfully applied outside basin (Omaruru Delta Aquifer and Windhoek Aquifer). | Localised / limited opportunities. | Localised examples. | There is potential to recharge aquifers with surface water to reduce evaporation losses. Infiltration dams needed. | Not practised in Lesotho as yet. | Localised / limited opportunities. | Not practised within the basin in South Africa as yet. | Localised / limited opportunities. |
| Dual systems | Dual systems used at the mines and in Windhoek (outside basin), i.e. separate pipe systems for drinking and gardening. | Separate networks for irrigation of parks and sport fields of towns. | Car washing stations in Gaborone use treated effluent water. | Continuation of present use. | Not practised in Lesotho as yet. | Could possibly be considered for Maseru. | Not practised within the basin in South Africa as yet. | Use of dual systems including Japanese hand washing/ flushing system for toilet flushing could be introduced for Gauteng Region. |
| Use of brackish Ground water | Brackish water from Kahn River used for dust suppression at Rössing Uranium Mine. | Continuation of present use. | Used for stock drinking and wild life drinking. | Continuation and new copper mines at Ghanzi could use saline ground water as process water. | Not practised in Lesotho as yet. | Localised / limited opportunities. | Private boreholes used for stock drinking. | Current practice to be continued. Limited potential for expansion. |
| Seawater and Groundwater desalinisation | Two farms use desalinated water. Thermal distillation plant at Lüderitz (outside basin) today redundant. | Seawater: Only coastal town gets water from Orange. Brackish GW: Not regarded attractive enough. | Locked in land – no access to sea. Several GW desalination plants in operation in Botswana. E.g. Debswana mines. | Continuation and possible expansion of desalination plants for utilising saline ground water. | Not applicable for Lesotho. | Not applicable for Lesotho. | Only coastal town is Alexander Bay which does not need seawater desalinisation. No info on GW desalinisation. | Limited scope within the basin for major GW desalinisation project. |
| Rainwater & Fog harvesting | Schools harvest rainwater from roofs for drinking purposes. Some house-holds harvest rainwater for swimming pools. | Annual rainfall very low (250 mm/a). Not seen as viable option, in many places for crop production but good for drinking where other water is too saline or has a bad taste. | Harvested rainwater used for gardening and car washing e.g. at Maru-A-Pula school. 3.5 mill m³/a harvested by Debswana. | Continuation and possible expansion. | Harvested rainwater used for gardening. | Option for Maseru from rooftops of public buildings. | Individual household rainwater tanks for gardening purposes. | Better utilisation of DWAF's subsidy scheme for resource poor farmers. Rainwater tanks are being subsidised. |
| Reclaim mine drainage water | Localised / limited mine drainage. | Localised / limited opportunities. | Localised / limited mine drainage. | Localised / limited opportunities. | Localised / limited mine drainage. | Localised / limited opportunities. | Some mine GW water is currently used for mining. | Huge potential. ± 150 mill m³/a available. Currently being investigated by W.U.C. (see para.4.1.5) |

### 2.3.1 Trends and future potential in relation to the sources

There are mainly four sources of marginal waters in the basin that have been utilised so far, namely:

- Treated sewage effluent
- Brackish (Saline) groundwater
- Harvested rainwater
- Treated industrial effluent

It is foreseen that the basin countries will continue to utilise these sources and there is scope to expand the present use. A further source in South Africa which has not so far been utilised to its full potential but is proposed to be utilised, is:

- Mine drainage

  At the shaft openings of abandoned gold mines in the Upper Vaal River Catchment the mine drainage water has become acidic and contains heavy metals. This poses a threat to the receiving environment. Approximately 150 million $m^3$ / annum of Acid Mine Drainage (AMD) is pumped or decanted from the mines. The AMD is proposed to be treated by a private sector company, to supplement potable water supplies in the Gauteng region.

### 2.3.2 Trends and future potential in relation to the uses

The main trends in relation to uses in the basin are:

- Rainwater harvesting for garden watering.
- Irrigation of sport fields, golf courses and suitable food crops with treated sewage effluent.
- Recharging of aquifers (water storage)
- Mine / Industrial process water
- Treated sewage effluent for domestic drinking water
- Saline groundwater for stock drinking

The following potential water uses can be further investigated:

- In **Lesotho**, the sports fields, golf course and suitable food crops in Maseru could be irrigated with treated sewage effluent instead of potable water.

- Maseru could also look at the option to reclaim its sewage water for potable use. Both these uses would defer the building a further expensive augmentation and treatment scheme from a conventional water resource.

**Botswana**

- Irrigation of crops for food production in Gaborone. The public is currently opposed to reclaiming water indirectly (through aquifer recharge) for potable uses and to irrigation, particularly irrigation of crops for food production with treated sewage water and it will be necessary to sway the public perception.
- The recharge of aquifers with treated sewage effluent in Botswana should be continued and could be expanded.
- The use of saline groundwater for mine processes can be expanded. New copper mines at Ghanzi, Botswana can be targeted for this.
- Debswana has already had success with rainwater harvesting. Additional rainwater harvesting projects in Botswana could be investigated (e.g. collecting water from the roofs of large buildings and from paved areas).

**Namibia**

- Reuse of treated sewage water of the larger Namibian towns within the Orange River Basin for irrigation of sport fields / golf courses or small scale production of suitable crops. A volume of approximately 2 million $m^3$ per annum treated sewage water is available for this purpose.
- Reclamation of treated sewage water of the larger Namibian towns in the Orange-Senqu River Basin for potable use is a possibility that could be further investigated. However without the benefit of scale, small reclamation plants might not be feasible.

**South Africa**

- In South Africa, the irrigation of vegetables by resource poor people with harvested rainwater can be encouraged. The current subsidy scheme of DWAF for subsidies on rainwater tanks can be better utilised.
- The Gauteng region has the highest rate of growth and development in the basin. This puts much strain on the limited water sources which are augmented from outside the region. The compulsory installation of dual reticulation systems for all new housing, office parks, commercial and similar developments could assist to alleviate the current water deficits in Gauteng.

### 2.3.3 Trends and future potential in relation of mechanisms (Dual systems)

Dual systems are one of the mechanisms to enable us to make use of marginal waters. The following are possibilities for future use of dual systems.

- Maseru should have a separate water distribution system for taking water to its parks, sport fields and golf course(s).
- The rainwater harvested in Maseru from the roof tops of large buildings should have a separate water distribution system for taking the water to areas of use e.g. toilet flushing.
- The larger Namibian towns should have their own distribution works (pump, pipe network, sprinklers etc.) to the sport fields and golf courses, if found to be feasible.
- The Japanese example of dual system in buildings and of hand washing basins connecting to toilet cisterns for direct water reuse could possibly be promoted in Gauteng where water deficits are expected until 2019 when the next phase of the Lesotho Highlands transfer scheme comes into operation.

# 3. ASSESSMENT OF KEY PROJECTS

## 3.1 POSSIBLE FUTURE PROJECTS

After having studied the status quo and trends of present marginal water use in and outside the basin, possible future projects were identified from the interviews with the current water users and from the workshop with stakeholders and steering committee members that followed after the submission of the draft Mid-term report. The future potential projects can be divided into two main groups, i.e.:

- Physical infrastructure projects.
- Enabling projects for future marginal water use.

The potential physical infrastructure projects in each country are as follows.

**Lesotho:**

i. Irrigation of sport fields, the golf course and suitable food crops in Maseru with treated sewage effluent.

ii. Reclamation of Maseru's sewage water for potable use in stead of building a further expensive augmentation scheme from a conventional water resource.

iii. Rainwater harvesting from rooftops of large buildings in Maseru. Although some rainwater harvesting projects are already funded and being carried out in Lesotho there is more scope for these kinds of projects where harvested rainwater is reused within the large buildings and surrounds.

**Botswana:**

iv. Irrigation of food crops with treated sewage effluent of Botswana. This project referred to the implementation of irrigating food crops throughout Botswana with treated sewage effluent. The project would identify a pilot project.

v. Reclaiming Botswana's treated sewage effluent to potable standards. Currently reclamation of sewage effluent to potable standards is not being done in Botswana. There is some resistance from the public against such a solution.

vi. Recharge aquifers in Botswana with treated sewage effluent. Plans are already in place for the implementation of this project. This project aims to recharge certain aquifers with treated sewage effluent, within Botswana.

vii. Better utilisation of Botswana's saline groundwater. There are several plans in place already for the utilisation of saline groundwater, especially at the Debswana mines. This project is aimed at establishing the feasibility and implementation of utilising saline groundwater for various uses, particularly industry and mining.

**Namibia:**

viii. Irrigation of the sport fields or suitable crops with treated sewage effluent of larger Namibian towns. The project refers to the irrigation of sport fields and other open areas, and potentially food crops, in the larger towns within the basin, with treated sewage effluent.

**South Africa:**

ix. Installation of dual reticulation systems for new developments in Gauteng. This province is the fastest growing and developing area within the basin. The installation of dual systems for new developments (e.g. residential complexes, office parks, shopping centres) can significantly reduce the potable water requirements as treated effluent is then provided for certain secondary uses through a separate system.

x. Rainwater harvesting for food security purposes in South Africa. This project is already being carried out in some community gardening projects. The project objective is the increased implementation of rain watering harvesting within the basin for small scale projects (both irrigation and domestic purpose).

xi. Reclaiming mine water to potable standards in Gauteng. Large volumes water are being pumped from active gold mines or are decanting from abandoned mines. Some of the water from active gold mines is recycled but large volumes are released in the water courses of the basin. These volumes can be reclaimed to potable standards and distributed to Gauteng users.

Of the above physical infrastructure projects, projects (v), (ix) and (xi) were removed from the list for the following reasons:

**Project (v), Botswana:**

It was felt that the towns within the basin are not big enough to justify reclamation works. Water reclamation could have been considered for Botswana's capital, Gabarone, but this city falls outside the Orange-Senqu River Basin. Furthermore, in view of the fact that there is a perceived public resistance against this type of project in Botswana it was decided at the workshop of 11 March 2009 to rather focus on an awareness campaign that could remove any possible negativism against reclaiming sewage effluent or reusing treated effluent water for the irrigation of suitable food crops.

**Project (ix), South Africa**

Before the installation of dual systems in Gauteng can be enforced or encouraged, a set of guidelines is firstly required. It was therefore decided that the installation of dual systems in Gauteng is a bit premature and should rather follow a project that focuses on the preparation of guidelines. It was therefore decided to remove the physical implementation of dual systems as a possible project from the list and replace it with an enabling project, namely The Preparation of Guidelines for Installing Dual Systems.

**Project (xi), South Africa:**

After identifying the better usage of mine water as a possible project, the PSP was made aware of the fact that the Western Utility Corporation (WUC) is already planning a project for the treatment of mine water. WUC is envisaging a water treatment plant that will remove all heavy metals and other undesired constituents from the acidic mine water. WUC's first phase would treat as much as 75 Mℓ/day which would then be sold as potable water to Rand Water.

The inclusion of the mine water project would therefore have been a duplication of a project that has already progressed far in terms of a feasibility study.

The remaining eight possible projects on the list were then accepted for evaluation by the PSC Workshop on 11 March 2009 and, at the workshop, the following enabling projects for future marginal water use were added to the list.

xii. The preparation of guidelines for dual systems in Gauteng where the second system will supply treated wastewater for non-drinking purposes to large buildings, office blocks, shopping centres, office parks etc.

xiii. A review of the institutions, policy, legislation and guidelines in the four countries and the addressing of gaps to enable easier implementation of the physical infrastructure projects and to improve collaboration between the four basin countries.

xiv. Awareness campaign about the need and practice of reclaiming Botswana's treated sewage effluent to potable standards and about the safety of irrigating food crops with treated sewage effluent. Due to the negative public perception regarding the reuse and reclamation of sewage effluent in Botswana, this project is aimed at addressing the public perception. The outcome would be a greater public acceptance.

xv. The preparation of guidelines for use of treated waste water by the industry sector.

## 3.2 SELECTION CRITERIA

The following eleven criteria were used for prioritising the potential projects.

i. The extent to which the project will combat poverty, the greater the better.
ii. Water stressed areas should receive preference.
iii. Does it provide an opportunity to test new technology?
iv. Will the public perception towards the possible project be positive?
v. Will the project have a beneficial impact on the basin as a whole?
vi. The extent to which the project will alleviate environmental problems.
vii. The management intensity of the project, the lower the better.
viii. The ability to duplicate (i.e. ease of adding modules and in so doing, expanding the project) or to copy project in other areas, the easier the better.
ix. Will the project leave other water users downstream in a weaker position? E.g. Water quality in the Orange River to the detriment of export grape farmers.
x. To what extent will the project lead to institutional growth?

xi. Will the project defer other projects (e.g. future augmentation projects which will be more expensive) in the basin state (locally or regionally)?

A condition with which it was recommended, all projects should be in place where a ‘marginal waters’ project is to be implemented was that all possible water conservation and water demand management (WC/WDM) measures should already be being implemented. Normally WC/WDM is the cheapest and most efficient way of making the most use of the available water. However in cases where the usage of any marginal water option would be cheaper, the latter could be pursued as long as the WC/WDM had been considered.

Apart from the above 11 criteria, a separate objective was to get a spread of projects in the four basin countries.

In terms of the spread of projects, it would be ideal to have at least one project in each of the basin countries.

## 3.3 EVALUATION MATRIX

An evaluation matrix was designed in which each project could be scored according to the listed 11 criteria. Each of the 11 criteria had the same weight.

The evaluation matrix is shown in **Table 3.3**. All 11 potential projects are listed in the first column of the matrix. In the second column (first grey column) it can be indicated whether WC/WDM had been properly considered. The second grey column shows in which country the project will be. The objective is to have an even spread of projects among the four basin countries.

Since it is required that Scopes of Work for at least five projects are prepared, it meant that at least one project should fall in each of the basin countries. The next 11 columns show11 criteria described in paragraph 3.2 above. The green colour represents the most favourable evaluation with a score of 3, the blue represents a medium score of 2 and the yellow the least favourable with a score of 1.

The awareness strategy for Botswana was awarded the highest point of 29 out 33 while the two rainwater harvesting projects (Lesotho and South Africa) were awarded the lowest score (both 23 out of 33).

**Table 3.3** Assessment of Potential Projects at workshop on 11 March 2009

# Potential Project Assessment

| Potential Projects | WC&DM | Spread of projects | Poverty Alleviation | Water stressed | New technology | Public perception | Benefits to the basin | Environmental impacts | Management intensity | Duplicate or Copy | Downstream users | Institutional growth | Defer local projects | Total | Priority Projects |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Criteria | | | | | | | | | | | | | | |
| Irrigation - Maseruand lowland towns | | Lesotho | 2 | 3 | 1 | 3 | 1 | 2 | 2 | 3 | 3 | 3 | 2 | 25 | |
| Effluent reclaim - Maseru | | Lesotho | 3 | 2 | 2 | 1 | 1 | 2 | 1 | 3 | 3 | 3 | 3 | 24 | |
| Rainwater harvest - Maseru | | Lesotho | 3 | 2 | 1 | 3 | 1 | 2 | 3 | 2 | 2 | 2 | 2 | 23 | |
| Irrigation - Botswana | | Botswana | 2 | 3 | 1 | 3 | 1 | 2 | 2 | 3 | 3 | 3 | 2 | 25 | |
| Effluent reclaim (awareness) - Botswana | n/a | Botswana | 3 | 3 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 29 | |
| Aquifer recharge - Botswana | | Botswana | 3 | 3 | 3 | 3 | 2 | 2 | 1 | 3 | 2 | 2 | 3 | 27 | |
| Saline groundwater - Botswana | | Botswana | 3 | 3 | 3 | 3 | 2 | 2 | 1 | 3 | 2 | 2 | 3 | 27 | |
| Irrigation - large basin towns | | Namibia | 2 | 3 | 1 | 3 | 1 | 2 | 2 | 3 | 3 | 3 | 2 | 25 | |
| Dual system guidelines - Gauteng | n/a | South Africa | 2 | 3 | 2 | 2 | 3 | 2 | 3 | 3 | 2 | 3 | 3 | 28 | |
| Rainwater harvest - SA | | South Africa | 3 | 2 | 1 | 3 | 1 | 2 | 3 | 2 | 2 | 2 | 2 | 23 | |
| Industrial use Guidelines (Transboundary) | n/a | All | 1 | 3 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 28 | |
| Institutional review (Transboundary) | n/a | All | 1 | 3 | 2 | 2 | 3 | 2 | 3 | 3 | 2 | 3 | 1 | 25 | |
| Other | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| Other | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | 33 |

| Key | |
|---|---|
| 3 | High |
| 2 | Medium |
| 1 | Low |

In order to satisfy the objective to achieve an even spread of projects between the four countries, it was not possible to simply choose the five projects with the highest scores. It was therefore decided to select one country specific project for each of the four basin states and then to select another two transboundary projects, with high scores that would be beneficial to all four basin states. The Terms of Reference required the selection of at least five projects.

The six selected projects, as indicated in the last column of the evaluation matrix are the following:

i. **Botswana:** Awareness campaign to promote indirect potable water reuse and irrigation of food crops with treated sewage effluent.
ii. **South Africa:** Dual reticulation system guidelines for Gauteng
iii. **Lesotho:** Irrigation of sport fields, the golf course and suitable food crops in Maseru with treated wastewater
iv. **Namibia:** Irrigation of sport fields and suitable food crops in larger Namibian towns
v. **Transboundary:** Institutional, Policy, Legislative and Guideline Review
vi. **Transboundary:** Guidelines for marginal water use for the industrial sector

# 4. POTENTIAL PROJECTS SELECTED FOR FURTHER STUDY

## 4.1 INTRODUCTION

The previous section described the selection criteria and listed the six projects that were selected for further study. Four of the six projects are country specific (one for each country) and two projects are joint projects for all four basin countries.

The ToR specify that Terms of Reference must be drafted for at least five selected projects. Terms of Reference contain the draft contract documents, which are dependent on the contracting authority, possible funding agency, and the legislation of a particular country. Selection of an enquiry document is best compiled by the implementing agent in agreement with the funding agent. Therefore it was decided that the requirement for Terms of Reference for the projects was changed to Scopes of Work.

The Scopes of Work of the six selected projects appear in Appendix B. The main objective and a summary description of the tasks are provided for each project below.

## 4.2 AWARENESS CAMPAIGN FOR THE REUSE OF TREATED EFFLUENT IN BOTSWANA

The overall objective of the project is to promote the indirect reuse of treated waste water for potable purposes in Botswana and the reuse of treated waste water for the irrigation of food crops.

A professional team is required that will prepare information material and interact with key audiences in order to familiarise them with the pros and cons of reuse of treated waste water and to establish their trust in the relevant water supply authority.

It is foreseen that this project will be undertaken by the Botswana Government and that it will take approximately 12 months to complete.

## 4.3 GUIDELINES FOR THE IMPLEMENTATION OF DUAL RETICULATION SYSTEMS IN NEW DEVELOPMENTS IN GAUTENG, SOUTH AFRICA

The objective of this project is to draft a set of guidelines and incentives, relating to the implementation and installation of dual reticulation systems primarily within large new developments such as office parks and shopping complexes, in Gauteng Province, South Africa.

A professional team is required that will identify different uses for treated waste water and harvested rainwater that will be conveyed through a second reticulation system, parallel to the potable water system. The team will then identify the risks and challenges for each of the identified uses and will seek for best practice solution for each of the risks and challenges. These will then be documented as guidelines. The team will also look at incentives for new developers to install dual systems.

An implementation plan for this initiative is also required of the team. Stakeholder Consultation and participation is required for this project.

It is foreseen that this project will be undertaken by the Gauteng Regional Office Department of Water and Environmental Affairs in South Africa, Rand Water, Joburg Water, CSIR, SALGA and WRC.

The expected duration of this project is 12 months.

## 4.4 IRRIGATION OF SPORTS FIELDS, THE GOLF COURSE AND SUITABLE CROPS WITH TREATED EFFLUENT, IN MASERU LESOTHO

The objective of the proposed study is to assess the potential for and feasibility of the irrigation of sports fields and golf courses in Maseru with treated sewage effluent.

This project calls for a professional team that will carry out a technical and economic feasibility study including the sizing and layout of a pipeline, water treatment plant, balancing reservoir, pumping station and the use of a sprinkler irrigation system, that will cost such a proposed project and that will investigate its feasibility. The PSP also has to prepare a SoW for a detailed design and the supervision of the construction of such a project (if feasible). Proper stakeholder participation is required for this project. It is foreseen that this project will be undertaken by the Water and Sanitation Authority in Maseru and that it will take approximately 8 months to complete.

## 4.5 IRRIGATION OF SPORTS FIELDS AND SUITABLE CROPS WITH TREATED EFFLUENT, IN LARGER TOWNS IN NAMIBIA

The objectives of the study are to assess the potential for the use of treated sewage effluent for the irrigation of the sport-fields and golf courses and for urban and peri-urban agriculture in, and adjacent to, the larger Namibian towns.

This project is very similar to the Maseru project described in 4.2. The main difference is that this project also needs to look into the aspect of irrigation of crops and not only sport fields.

This project therefore also calls for a professional team that will do first order lay-outs of the infrastructure required for the irrigation of sport fields and food plots. Again as part of this project, the preparation of the SoW for the tender and detailed designs of as well as supervision of the feasible projects must be covered.

Proper stakeholder participation is required for this project.

It is anticipated that this project will be undertaken by the Namibian Government and that it will take approximately 8 months to complete.

## 4.6 LEGISLATIVE, POLICY, INSTITUTIONAL AND GUIDELINE REVIEW OF BASIN STATES ARRANGEMENT WITH REGARDS TO THE USE OF MARGINAL WATERS

The purpose of this project is to identify the water related institutions, legislation and policies (both domestic and transboundary) in the basin states, assess the potential of each instrument to support or hinder the exploitation of marginal waters and to advise ORASECOM on the modifications, enhancements and change management that is required in order to effectively promote and regulate the exploitation of marginal waters in the basin states.

The professional team for this project will make a study of the different legislation and institutions and will make recommendations for drafting amended legislation, policy and for enhancing institutional capacity.

This project has, like the others, a strong stakeholder engagement element and its implementation will also require a change management programme.

It is anticipated that the project duration will be approximately 8 months and it is suggested that ORASECOM administer the project.

## 4.7 BEST PRACTICE GUIDELINES FOR INDUSTRY FOR THE RECYCLING, REUSE AND RECLAMATION OF INDUSTRIAL EFFLUENT

The project objective is to develop guidelines which will:-

- Identify and classify the major water using industries in the basin states that are potential users of "marginal" waters.
- Search the international literature to determine if best practise guidelines exist for the identified industries. Summarise international best practise in terms of water management and produce water use bench marks for the different industries.
- Assess the water circuits of the industries to determine current water management practise, water volumes used and the water quality requirements of the sources of water needed for the different processes.
- Compare local practises to international best practise.
- Produce a set of guidelines for the identified industries in Southern Africa.

A set of guidelines are to be prepared for industries that include:

- Details of the processes and current practice used by industries.
- Setting benchmarks for each of the current industries.
- Setting of standards for future industries.
- A summary of the volumes of water that could be saved if the benchmarks are achieved.

This is seen as an 18 months project and it is suggested that ORASECOM administer the project.

# 5. COLOUR BROCHURE

As part of the outreach and communication efforts of this project, the service provider was requested to develop an A4 double-sided colour brochure, providing an overview of the study, including a summary of the results and a look at the way forward. 5000 copies of the brochure are to be printed.

The proposed brochure was drafted and presented at the Project Steering Committee on 18 June 2009 for comment. Approval was granted by the PSC, and 5000 copies of the brochure were printed.

During the Inception and Assessment Phases of this project, it was decided that a copy of the colour brochure would be sent to the various organisations that participated in the questionnaires and assisted with information. Approximately 250, of the 5000 brochures will be used for this purpose.

The colour brochure is attached as **Appendix B**.

# 6. WAY FORWARD

## 6.1 GENERAL

The consultant is currently drafting 3 articles for various magazines, with regards to the findings of this project. The articles will be submitted to the South Africa Institute of Civil Engineers magazine, the Water Institute of South Africa's Water and Sanitation magazine, and the Urban Greenfile, for publication. The articles will be sent to the PSC for approval prior to submitting them to the magazines.

The consultant will also prepare two papers, one for the Orange River Symposium in 2009 and one for the Water Institute of South Africa's Biennial Symposium in 2010.

## 6.2 SCOPES OF WORK

It is recommended that the ORASECOM committee and member states implement the scopes of works (Appendix C) identified and drafted through this project.

# APPENDIX A: BIBLIOGRAPHY

## A.1 FULL REFERENCE IN ENDNOTE FORMAT

**Reference:** (N/A - to be inputted when compiling Endnote database)

**Citation:**

Scott, CA, Faruqui, NI and Raschid-Sally, L. *Wastewater Use in Irrigated Agriculture: Management Challenges in Developing Countries.* **In** Scott, CA, Faruqui, NI and Raschid-Sally, L. (2003). *Wastewater Use in Irrigated Agriculture. Coordinating the Livelihood and Environmental Realities.* CAB International, in association with IWMI and IDRC.

**Format:** Book (Journal, paper, book (ISDN number if available), webpage (link))
**Location of study:** International (Countries, region, geographic area, topographic area, etc.)
**Relevant Topics:** Agriculture, irrigation, management
**Key words:** wastewater irrigation, management, developing countries.

**Short abstract:**

Cities in developing countries are experiencing unparalleled growth and rapidly increasing water supply and sanitation coverage that will continue to release growing volumes of wastewater. In many developing countries untreated or partially treated wastewater is used to irrigate the cities' own food, fodder, and green spaces. Farmers have been using untreated wastewater for centuries, but greater numbers now depend on it for their livelihoods and this demand has ushered in a range of new wastewater use practices. The diversity of conditions is perhaps matched only by the complexity of managing the risks to human health and the environment that are posed by this practice. An integrated stepwise management approach is called for, one that is pragmatic in the short- and medium terms, and that recognises the fundamental economics niche and users' perceptions of the comparative advantages of wastewater irrigation that drive its expansion in urban and peri-urban areas. Comprehensive management approaches in the longer term will need to encompass treatment, regulation, farmer user groups, forward market linkages that ensure food and consumer safety, and effective public awareness campaigns. In order to propose realistic, effective, and sustainable management approaches, it is crucial to understand the context-specific tradeoffs between the health of producers and consumers of wastewater-irrigated produces as well as the quality of soils and water, on the one hand, and wastewater irrigation benefits, farmers' perceptions, and institutional arrangements on the other. This introductory chapter to the current volume on wastewater use in agriculture highlights a series of tradeoffs associated with continued use of untreated wastewater in agriculture. Empirical results from the case studies presented in the volume shed light on devising workable solutions.

**Comments:** Introductory chapter to book.

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# APPENDIX B: COLOUR BROCHURE

# APPENDIX C: SCOPES OF WORK