CRIDF

1740

Scoping assessment of the suitability of the reuse of Marginal Waters in Rehoboth, Namibia project for CRIDF support

Deliverables

30th September

1740

D1 – D2

Scoping level review of any possible transboundary and pro-poor benefits of the potential Project

CRIDF

Scoping assessment of the suitability of the reuse of marginal waters in Rehoboth, Namibia as a possible project for CRIDF support

Project name: Scoping assessment of the suitability of the reuse of marginal waters in Rehoboth, Namibia

Final Report

September 2013

Disclaimer

The British Government's Department for International Development (DFID) financed this work as part of the United Kingdom's aid programme. However, the views and recommendations contained in this report are those of the consultant, and DFID is not responsible for, or bound by the recommendations made.

Contents

List of Figures

List of Tables

Executive Summary

The Town Council of Rehoboth recently made a request to the DWAF to explore the feasibility of a project to upgrade the sewage ponds at the town and to reuse the local domestic sewage effluent for irrigation.

The purpose of this report is to describe the assessment of the situation at Rehoboth Town in order to perform a scoping level review of the proposed Project, with a particular focus on the potential pro-poor and transboundary benefits that may accrue, and to make recommendations about the eligibility of the Project for support by the Climate Resilient Infrastructure Development Facility (CRIDF), funded by the Department for International Development (DFID) of the United Kingdom.

The following conclusions can be drawn:

1.1 The proposed project to upgrade the sewage ponds at Rehoboth town to prevent pollution and to reuse the local domestic sewage effluent for irrigation is supported by the DWAF because pollution control and water reuse is in line with the Namibian Water Policy while the promotion of irrigation is in line with the Green Scheme Policy which is aimed at increasing agricultural production and agribusiness;

1.2 The Oanob River and the Rehoboth Aquifer at Rehoboth are transboundary in nature;

1.3 If the treatment facilities are upgraded, the capacity of the plant could be increased to reduce spills under peak sewage flow conditions, the ponds could be lined properly to reduce seepage and the threat of pollution to transboundary water sources in the Orange-Senqu River basin could be reduced.

1.4 If the development of at least the first phase of an irrigation project to utilize treated sewage effluent can be supported by CRIDF, additional pro-poor benefits such as effective job creation, reduction in unemployment, improved livelihoods and increased socio-economic benefits could be achieved;

1.5 It is expected that the frequency of periods with drought conditions will most probably increase in Namibia due to climate change, but the proposed project has the potential to reduce the risks for crop production because it will increase water security for irrigation.

1.6 The treatment of waste water to water quality standards that will allow the reuse of the water on sports fields will reduce the need to use expensive potable water for irrigation

1.7 The implementation of the proposed project will contribute to the dialogue in the ORASECOM on the development and implementation of an Integrated Water Resources Management Plan and can serve as an example of projects that are making more efficient use of the available water resources in the basin and maximizing the benefits for the basin communities

1.8 It can be confirmed that the proposed project qualifies for CRIDF support

Recommendations are made in the report (Section 10) to confirm that CRIDF could take the project forward to bankability screening; precisely how CRIDF should support the project; what contributions CRIDF could make and the way forward regarding future CRIDF support.

2 Introduction

The reuse of domestic sewage effluent for the cultivation of crops under irrigation has been encouraged in Namibia in the past and implemented with various degrees of success at several towns. The Town Council of Rehoboth recently expressed a desire to explore the feasibility of a project to upgrade the sewage ponds at the town and to reuse the local domestic sewage effluent for irrigation. This request was supported by the Department of Water Affairs and Forestry (DWAF) in the Ministry of Agriculture Water and Forestry (MAWF) and was brought to the attention of the Technical Task Team (TTT) of the Orange-Senqu River Commission (ORASECOM).

The purpose of this report is to describe the assessment of the situation at Rehoboth Town in order to perform a scoping level review of the proposed Project, with a particular focus on the potential pro-poor and transboundary benefits that may accrue, and to make recommendations about the eligibility of the Project for support by the Climate Resilient Infrastructure Development Facility (CRIDF), funded by the Department for International Development (DFID) of the United Kingdom.

At the time of the scoping assessment the client for this activity was the Department of Water Affairs and Forestry (DWAF) in the Ministry of Agriculture, Water and Forestry (MAWF) in Namibia and it was specifically requested that the CRIDF team should not contact the Rehoboth Municipality until there is greater certainty on whether the project would be supported.

In view of this requirement, the Consultant arranged for a joint meeting with staff of the DWAF, a representative from the CRIDF Project Management Unit (PMU) and a Water Resources Specialist from the ORASECOM. The issues discussed at the meeting were:

- The status of the proposed Rehoboth effluent reuse Project;
- The existing interest in effluent reuse at Rehoboth;
- Information on progress with the proposed Project;
- Establish why Keetmanshoop was selected over Rehoboth for GIZ support;
- Confirmation of the commitment of the DWAF to support effluent reuse at Rehoboth;
- Views of the ORASECOM representative;
- Views of the CRIDF PMU representative about CRIDF approaches and focus areas.

The consultant subsequently had discussions with the consultants who undertook the initial investigations, as well as other technical staff in the MAWF and the Namibia Water Corporation (NamWater) who had been involved with water and irrigation issues at Rehoboth in the past (See **Table 2**). A study has also been made of a number of reports (As reflected in the reference list in Section 12) that may have a bearing on the possibilities to develop the proposed Project. A preliminary assessment has been made of the following issues regarding the Project to prepare the scoping level review report:

- The availability of fresh water and domestic sewage effluent for possible re-use;
- Local socio-economic situation;
    - The condition of the effluent treatment infrastructure and possibilities for utilizing the treated effluent

- The potential to expand the Project to address more beneficiaries;
- How the project can support climate resilient livelihoods for the poor;
- How to increase the eligibility of the Project for CRIDF support;
- Evaluation of potential transboundary (water quantity and quality) and pro-poor benefits;
- Threat of potential pollution of the shared transboundary groundwater resources;
- How the project could support the dialogue process in ORASECOM and the formulation of the Basin-Wide IWRM plan currently being developed by the Commission;
- Review of cost estimates;
- Assess CRIDF eligibility;

Recommendations are made in the report to confirm the project as a project CRIDF could take forward to bankability screening; whether and precisely how CRIDF should support the project; what contributions CRIDF could make and the way forward regarding future CRIDF support.

3 Background

3.1 Orientation

Rehoboth is a small historical town in the Hardap Region in central Namibia, located on the B1 road, about 90 kilometres (km) south of Windhoek, the capital city of Namibia. See **Figure 1** below.

Figure 1 Location of Rehoboth Town

The town is set in dense acacia woodland of camel-thorn, sweet-thorn and candle-pod acacia. This Acacia Forest covers an area of about 8 400 hectares (ha) within the municipal boundaries of Rehoboth and some of the large camel-thorn trees are estimated to be 2 000 years old. The main reason for the early settlement of the indigenous Nama (Khoikhoi) people at the site was the availability of open water from several natural hot-springs. These people called the place “!Anis”, which means “smoke”, and referred to the cloud of condensed water vapour that hung over the hot springs in the morning.

In 1845, a mission was established among the resident Nama at !Anis by the German Rhenish Missionary Society. The missionary, Franz Heinrich Kleinschmidt, renamed the settlement Rehoboth. However, in 1864 the Nama abandoned the area as a result of an attack by another Nama group called the Orlam Afrikaners.

Today, the main inhabitants of the town comprise the Baster community. They are the descendants of people who migrated across the Orange River in 1868 from De Tuin in the Northern Cape in South Africa and were allowed to settle peacefully at Rehoboth. They also started farming with large and small stock on the surrounding farmland.

Administratively, Rehoboth is classified as a town, divided into eight neighbourhoods, called “blocks”. The oldest, more central part of the town comprises blocks A, B and C. Block B contains most public services and shops. Public amenities include Government offices, a post office, a hospital, a number of primary and secondary schools, churches, banks, a market, shops and a district court with a resident magistrate. Block D on

the more elevated western side of the town is home to the more affluent inhabitants. Block E is the poorest neighbourhood, located in the eastern part of the town, comprising serviced erven (water, electricity and water borne sewage) with informal housing units. The neighbourhoods presently under development on the northern side of the town are Blocks F, G and H. There are also a number of lodges, including a tourism centre and a Spa at the hot springs.

3.2 Location in the Orange River Basin

The main tributaries of the Orange River in Namibia are the ephemeral watercourses of the Fish River, flowing southwards into the Orange, and the ephemeral watercourses of the Nossob River and the Auob River, flowing south-eastwards to their confluence with the Molopo River on the border between Botswana and South Africa. Rehoboth is located on the Oanob River in the Auob River catchment which is part of the Molopo – Nossob sub-basin of the Orange-Senqu River Basin.

The Auob River drains the central highland to the south of Windhoek in a south-easterly direction. The headwaters of the Oanob River is in the upper reaches of the Auob, but the surface runoff from the higher lying mountainous topography dissipates in a sandy plain upstream from where the Auob originates. The water flow in the Oanob therefore does not continue on the surface into the Auob, but probably flows underground as groundwater. In fact the drainage pattern is marked incorrectly in Figure 2.1 in Reference 19 because it excludes the Oanob from the Auob basin and places it in the Fish River catchment. See **Figure 2** with the corrected catchment boundary in red.

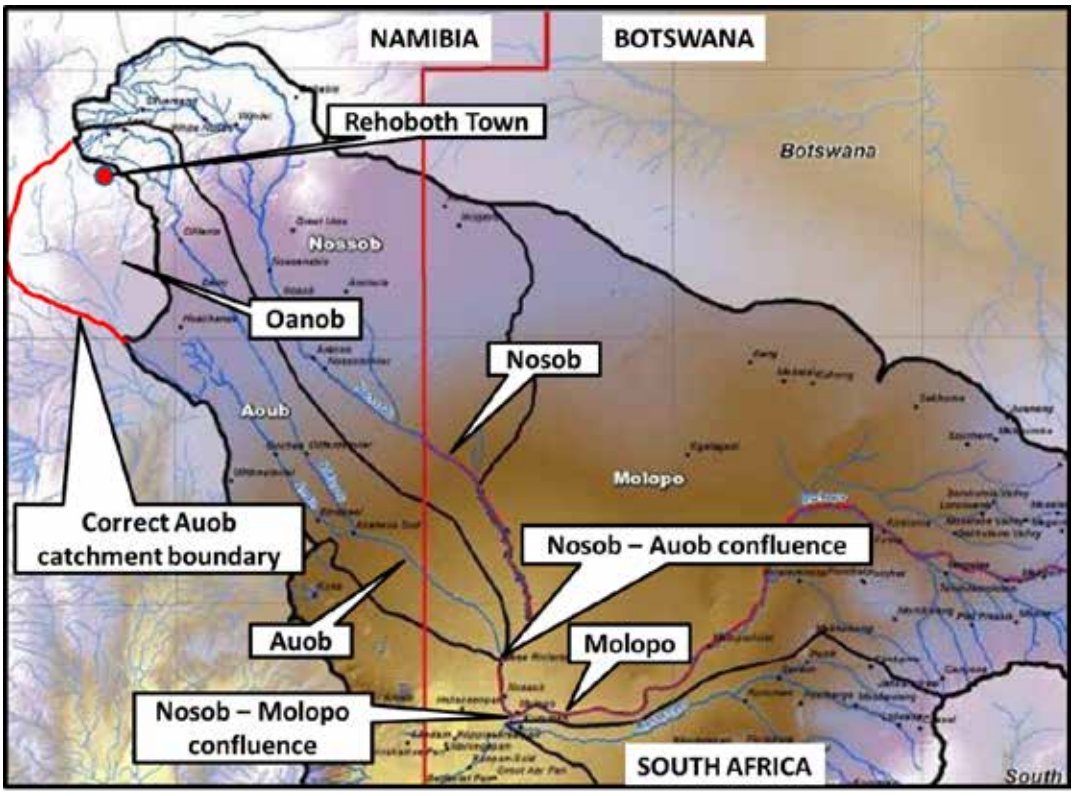

Figure 2 The Nossob River catchment

4 Climate

4.1 Rainfall

Rainfall in Rehoboth is highly seasonal, variable and spatially unevenly distributed. Most precipitation occurs as intense local showers during the summer period (October to April). The peak rainfall months are February and March. Rainfall generally comes from convective thunderstorms in the late afternoon and is sometimes accompanied by hail. The mean annual rainfall at Rehoboth is 250 millimetres (mm), although a record 731 mm was measured in the 2010/2011 rainy season.

4.2 Evaporation

It is estimated that in Namibia about 83% of the precipitation evaporates within hours and only 17% is available as green water (14%) and 3% is available as blue water in the form of surface runoff (2%) and groundwater (1%). The mean annual potential evaporation at Rehoboth is about 3 200 mm. The rainfall is 12.8 times less than the potential evaporation and this huge deficit is the main cause of the arid conditions at Rehoboth.

4.3 Temperature

The average monthly high temperature varies between 32°C and 22°C while the average monthly lowest temperature varies between 7°C and 17°C. Frost is not a major problem for crop production.

4.4 Aridity and Climate Change

It is well known that the distribution of rainfall over time and space is much more variable in drier climates compared to wetter ones. This causes a high spatial and temporal variability in rainfall, both within and between years. Another feature of the dry climate in Namibia is the severe impacts drought has on the biological production. The majority of the population is rural and very dependent on the climate for their livelihoods. Similarly, the urban population depends on good rainfall and runoff in the rivers that feed reservoirs and aquifers to sustain their water supply needs. During multi-year droughts the biological production commonly drops dramatically and reserves of food, grazing for livestock, livestock numbers and water are severely depleted. Given the extremely dry climate, high variability and a large dependency on rainfall to sustain both rural and urban livelihoods, an accurate understanding of the climate, as well as the interaction between climatic and physical determinants, is essential for sustainable planning and management to ensure water and food security, especially for the poor.

Due to the aridity of the Namibian climate all rivers in the interior of the country are ephemeral, meaning that they only flow when rainfall is sufficient, normally only for short periods during the rainfall season. This limits the potential of the surface water sources and the recharge of groundwater.

Even though predictions of the future climate in Namibia are still uncertain when it comes to the finer detail, most models predict that maximum temperatures will increase and less rainfall will fall during a shorter rainfall

season. However, when it rains the rainfall will be more intense due to increased temperatures and humidity resulting in an increased frequency in convective storms.

From the above it can be inferred that the frequency of periods with drought conditions will most probably increase. The availability of grazing and water for stock farming will decline and crop production will rely more on the availability of water for irrigation.

One way to improve this situation at smaller towns like Rehoboth, where at present it is not economically viable to reclaim sewage effluent to meet potable water quality standards, is to at least treat domestic sewage effluent to the Namibian water quality standards (Reference 7) that would make the water suitable for crop production or to use it to water sports fields or landscaping features in the town.

5 Socio-economic situation at Rehoboth

5.1 Population

The Namibian population was 2 104 900 in 2011, comprising 1 083 600 females (51% of the total population) and 1 021 300 males (49% of the total population). The population of Rehoboth town was 29 200 in 2011, comprising 14 800 women (51%) and 14 400 men (49%). The ratio of women to men is consistent with the Namibian population. The population density in the town is about 2 900 persons/km².

5.2 Employment

The unemployment rate in Namibia is estimated at around 34%. In urban areas about 30% are unemployed and about 37% in rural areas. Almost 39% of females are unemployed compared to around 29% of males who are unemployed. It can be argued that it is about the same for Rehoboth.

5.3 Poverty

The GINI coefficient for Namibia is 0.5971 according to the results of the Namibia Household Income and Expenditure Survey for 2009/2010. This indicates a high level of inequality in the distribution in income. Although the inequality in the distribution of income decreased from 0.701 in 1993/94 to 0.604 in 2003/2004 and to 0.5971 in 2009/2010 it is still among the highest in the world.

About 20% of Namibian households are poor while poor people are estimated to be about 29% of the total population. The poor are disproportionately located in rural areas, mainly pensioners, subsistence farmers, households with lower level of education, women and households with bigger average household size. The poverty incidence in the Hardap Region where Rehoboth is located, is 25.97% in comparison to the national average of 28.73%.

5.4 Equitable water tariffs

The present cost of bulk water in Rehoboth is N$7.50/m³ (1 NAD = 1 ZAR). As far as the management of water supply is concerned, the improved maintenance of infrastructure, such as the repair of leaking pipes and valves, as well as the replacement of broken water meters and the reduction of water theft, have been addressed to avoid expensive, unaccounted for water losses. The implementation of equitable water tariffs to make water more affordable to vulnerable groups received serious consideration with the implementation of a block tariff system for the residents in the town. See **Table 1** on the next page. This tariff system makes provision for a tariff for a lifeline quantity of water for the low income portion of the consumers and increasing tariffs for the middle and higher income groups who consume more water for other uses such as gardening and swimming pools.

The treatment of waste water to water quality standards that will allow the reuse of the water on sports fields will reduce the need to use expensive potable water for irrigation. The reuse of the treated effluent for irrigation will

also contribute to skills development, create more employment opportunities and enhance poverty alleviation. This is a clear illustration of the need to introduce an equitable water tariff structure to accommodate the poor, not only based on the principles of cost recovery, but more importantly, to strengthen social responsibility.

Table 1 Rising Block Tariffs

Use	Volume (m^3/month)	Cost (N$/$m^3$)
Domestic	0 - 20	8.10
	21 – 36	10.25
	37 – 46	10.70
	>47	11.88

When domestic sewage effluent is recovered for reuse at Rehoboth, the untreated water is basically available for free, but the treatment process selected to achieve the water quality standard required for a certain use, as well as the infrastructure required to distribute the water to the point of use, will eventually determine the cost of the water and the economic viability of the intended use.

6 Water demand

Rehoboth is an independent Municipality and the Regional Development Plan (RDP) for the Hardap Region (Reference 12) identified Rehoboth as a primary growth point.

The Town Council implemented a waterborne sewer system to replace the pit latrines in Block E in Rehoboth. Several new extensions are planned in Rehoboth, which include the 455 residential plots for high income residents, 1000 erven for middle to low income residents and the extension of the sewer system to an additional 500 erven. The Town Council is also planning the development of smallholdings along the Oanob River to the south of Rehoboth that will require approximately 1.5 Mm³/a of raw water for irrigation from the Oanob Dam. They are also contemplating the development of some small holdings near the sewage oxidation ponds to reuse the effluent for irrigation purposes and in this report possible irrigation models are proposed for consideration. According to the Hardap RDP an aquaculture project is planned near the Oanob Dam and the raw water demand could be about 360 000 m³/a while the potable water demand would be about 120 000 m³/a.

The very high increase in the water demand in the past has been managed by implementing water demand management measures such as an appropriate water tariff structure, water conservation, and reducing water leakage. The future water demand at Rehoboth was estimated by the NamWater (Reference 16) by considering past water demand trends, the effect of water demand management and the proposed future developments at Rehoboth. The water demand estimate provides for a scenario to accommodate a low, high and expected demand. The expected demand will be used for planning purposes and monitored to enable adjustments where required. It is expected that the water demand will increase from the present 1.45 Mm³/a to 1.9 Mm³/a in 2030.

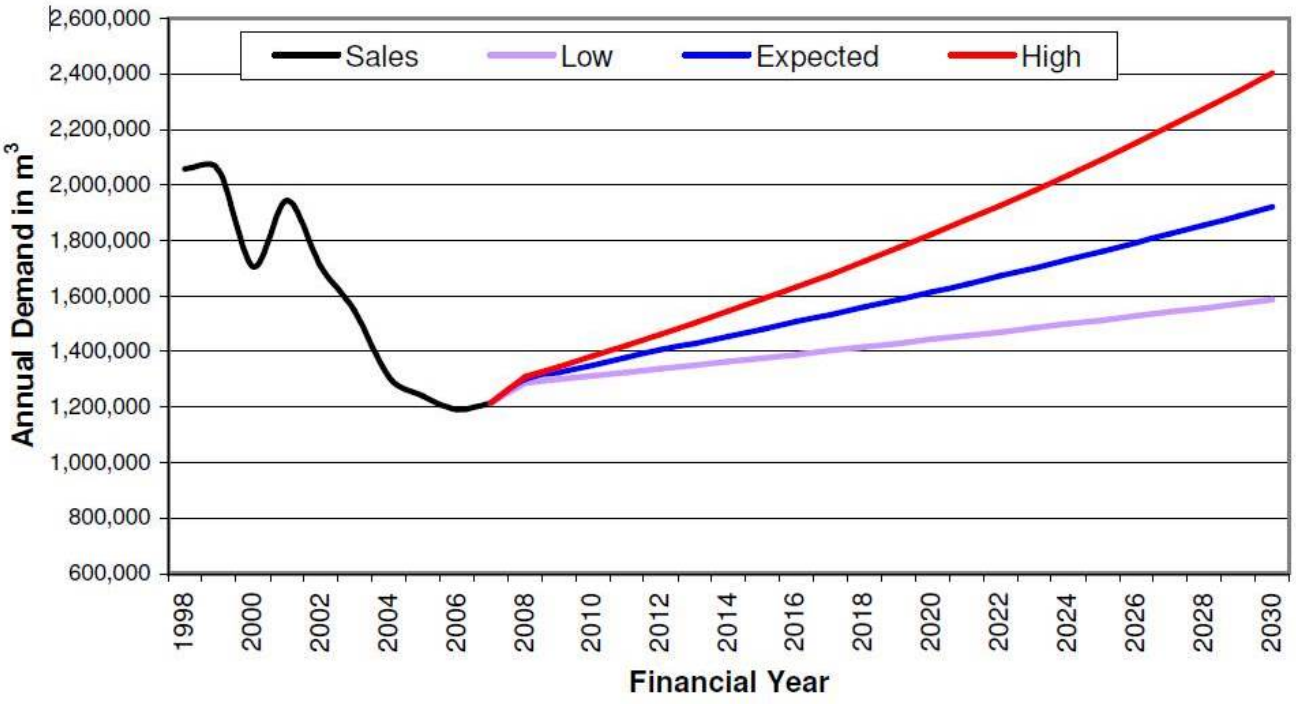

Figure 3 Water Demand Estimate for Rehoboth

7 Water resources

7.1 Location

The water resources at Rehoboth are basically surface water impounded in the Oanob Dam, about 6 km west of the town, groundwater from an aquifer immediately to the south of the town and the possibility to reuse water recovered from domestic sewage effluent at the oxidation ponds to the east of the town (See **Figure 4**). The water from the hot springs in the town is presently fully utilized for recreational purposes.

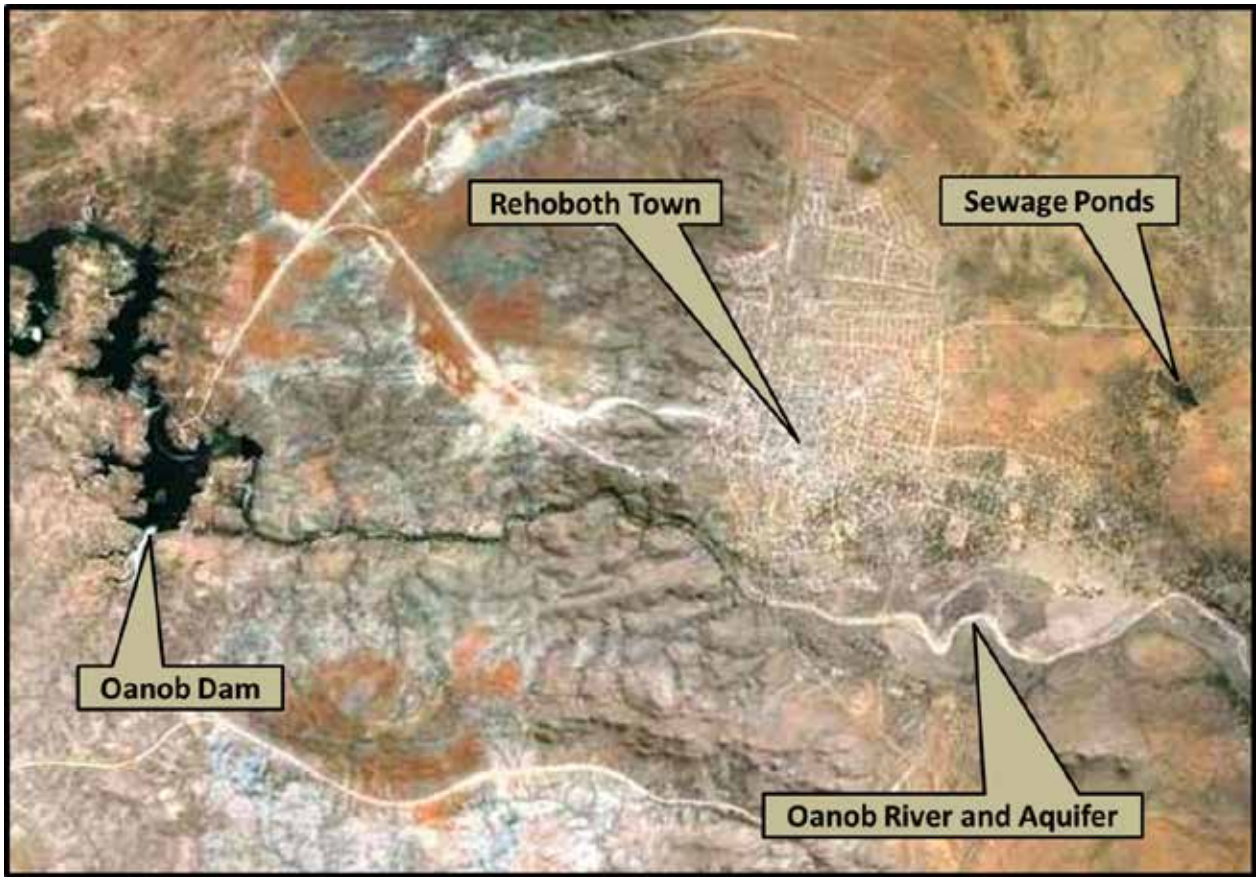

Figure 4 Location of Water Resources at Rehoboth

7.2 Surface Water

The Oanob River catchment upstream of the Oanob Dam covers 2 726 square kilometres (km²) and the mean annual rainfall in the upper catchment is 350 mm. The mean annual runoff at the Oanob Dam is 14.2 Mm³. The dam, completed in 1990, has a volume of 35.5 Mm³ and a 95% assured safe yield of 4.2 Mm³/a. (Reference 4)

The dam has a scour valve with a capacity of 16 cubic metres per second (m³/s) and water can theoretically be released for ecological purposes downstream of the dam or to recharge the alluvial aquifers in the river downstream of the dam.

7.3 Groundwater

The alluvial aquifer to the south of Rehoboth comprises two compartments. The upper compartment can store about 4.7 Mm³ and the lower compartment can store about 22 Mm³. It is estimated that 4 Mm³ can be abstracted economically from the upper compartment, which is just south of the town. The average annual recharge of the aquifer is estimated at 1.22 Mm³, which means that the assured annual safe yield from aquifer is in the order of 1 Mm³ (Reference 5).

The water from the aquifer was used in the past (until 1990) to supply water to Rehoboth, but due to the over abstraction and poor recharge to the aquifer it could no longer supply the demand at Rehoboth and it became necessary to develop the Oanob Dam water supply scheme.

7.4 Conjunctive use of surface water and groundwater

After the Oanob Dam was completed, several studies were done to allow the release of water from the dam for ecological purposes and to recharge the depleted aquifer. The reason for considering the release of water for ecological purposes was the concern that the said camel-thorn tree forest at Rehoboth was in jeopardy due to the reduced water table and that the situation could be reversed to restore the ecological integrity of the vegetation. (See Reference 6)

The other advantage was that the release of water for ecological purposes would also recharge the aquifer and by using the surface water (which would have evaporated over time) to recharge the aquifer, it would make it possible to increase the efficiency of the Oanob Dam by storing water in an aquifer where it cannot evaporate and could be used later when there is a drought cycle and the river has not produced sufficient runoff which could be stored in the dam to meet the water demand at Rehoboth. (See Reference 21)

7.5 Waste Water

Rehoboth is not a town with heavy industries that can generate waste water that it is too toxic for reuse. It is therefore possible to recover the domestic sewage effluent to water quality standards that will make the water suitable for certain uses and could therefore be regarded as an additional source of water for the irrigation of crops, vegetables, flowers or sports fields.

The present water demand at Rehoboth is about 1.4 Mm³/a and this already exceeds the safe yield of the aquifer as stated above. The estimated future water demand will be about 1.9 Mm³/a by 2030 according to **Figure 3** in Section 4. If it is assumed that 60% (Reference 21) of the used water will end up at the oxidation ponds, then the immediate availability of effluent that can be recovered for non-potable reuse is about 840 000 m³ or and this can grow to about 1.14 Mm³ by 2030. See **Figure 5** for an image of the existing oxidation ponds.

Figure 5 Oxidation Ponds at Rehoboth

8 Water Infrastructure

8.1 Water supply

The Namibia Water Corporation (NamWater) is responsible for the operation of the bulk water supply scheme and the supply of water in bulk to the Rehoboth Town Council. Raw water is abstracted from the Oanob Dam and treated to conform to the Namibia Water Quality Standards at a water treatment plant with a capacity of 720 cubic metres per hour (m^3/h). The treated water is pumped into two 2 500 m^3 terminal reservoirs where the quantity of water supplied to the town is measured.

Provision has also been made in the design of the Oanob dam to supply raw water for irrigation purposes, but until now the cost of the additional infrastructure required to supply the raw water, has been prohibitive. (Personal communication from Mr T Basson, previously Head of the Agricultural Engineering Division in the Department of Agriculture).

8.2 Water Reticulation

The Town Plan for Rehoboth makes provision for the development of 5 000 fully serviced erven. It is the responsibility of the Rehoboth Town Council to reticulate the bulk water bought from NamWater to the community. According to NamWater there are 4 600 water meters installed to measure the water supplied to the water users in the town.

8.3 Sewage Treatment

It is the responsibility of the Rehoboth Town Council to treat the domestic sewage effluent to meet the Namibian water quality standards for waste water disposal.

Due to the high evaporation and low rainfall in Namibia, as well as the small number of people having access to water borne sewage systems in the small towns in Namibia, the use of oxidation ponds to treat domestic sewage has been very successful as a low cost solution with minor maintenance implications. The domestic effluent is treated through anaerobic and aerobic processes. The water is eventually discharged into a final pond where the water evaporates, but sometimes some of the water spills and can cause pollution in the downstream environment.

However, many towns, such as Rehoboth, have grown faster than the normal population increase due to urbanisation. At some towns the growth rate is in the order of 5% per annum and even higher. The oxidation ponds at Rehoboth are already overloaded during peak periods of sewage flow from the town and overtops. The ponds are not lined and it is clear that sewage leakage through underground seepage and spilling from time to time on the surface cause pollution to the surrounding environment below and above ground level. The ponds were cleaned in 2010, but they have to be enlarged and those in existence are in need of rehabilitation. The upgrading of the existing oxidation ponds at Rehoboth has been investigated to some extent in the past and a preliminary assessment of the situation was done in 2008 by Windhoek Consulting Engineers. The estimated cost was more than N$5, 7 million (approx. £ 380,000), and the proposed works included treatment facilities to

treat the water to a standard acceptable for environmental purposes and the irrigation of crops such as maize and wheat.

9 Discussion

9.1 Selection of Keetmanshoop for GIZ support

As far as could be established, the main reasons why Keetmanshoop was selected for GIZ support instead of Rehoboth or Karasburg that were both under consideration for support, were the availability of more effluent, existing irrigation land and a person with irrigation expertise who could manage and direct irrigation activities, once the infrastructure was developed and available for operations.

9.2 Status of the Proposed Rehoboth Water Reuse Project

According to the information obtained from the consultant who prepared the report for the Rehoboth Town Council, the origin of the request for the consultancy service was the fact that the oxidation ponds became inadequate to deal with the increased sewage load. The ponds were in need of general rehabilitation, a lining to reduce pollution from possible seepage and the addition of more ponds. It was also proposed that an existing area that was previously under irrigation with water reused from the sewage effluent could be used for irrigation to stimulate job creation. The high cost of potable bulk water supply and the fact that such expensive water was used to irrigate sports fields, was another concern and it was suggested that the sewage effluent could be treated to water quality standards that would make the water suitable for reuse to water sports fields and could be used for irrigation.

The Rehoboth Town Council indicated in an undated Memorandum to the DWAF that it would be able to make a contribution of about N$1,5 million (approx. £100,000) during the 2012/13 financial year for the upgrading of the oxidation ponds, but additional support was requested. A budget of N$5.7 million was required in terms of the cost estimate made by the consultant in 2007. If this amount is escalated with inflation (6%/a), it would increase to N$8.5 million (approx. £ 570,000) in 2014, but in view of the long time that has passed, the infrastructure may have deteriorated further and more work would perhaps be required than previously anticipated, and also considering especially the request by CRIFD to investigate the possibilities to expand the project to include more beneficiaries is included.

In view of the fact that the Rehoboth Town Council could not be consulted it can logically be assumed that the desire to improve the situation still exists. Moreover, during the discussion with representatives from DWAF, it became clear that the threat of groundwater pollution by dysfunctional oxidation ponds is a major concern and the possibility for the reuse of the effluent is consistent with the water policies. The DWAF therefore supports the proposed project.

9.3 Transboundary Context

Rehoboth is located to the north of the Oanob River which is very remotely located from the main stream of the Orange-Senqu River. It is therefore appropriate to examine the transboundary context of the Oanob to confirm that the proposed Rehoboth water reuse project qualifies for CRIDF support. Support for the project could also

be strengthened if the implementation of the project would support the dialogue process in ORASECOM and the formulation of the Basin-Wide IWRM plan currently being developed by the Commission.

Two of the main tributaries of Molopo - Nossob River system, the Nossob and the Auob, originate in Namibia. After crossing the border between Namibia and South Africa, the Nossob forms the border between Botswana and South Africa. The Nossob is therefore a successive river between South Africa and Botswana as well as a contiguous river between Botswana and South Africa. Furthermore, although the Molopo – Nossob watercourse system is endorheic because there is no record that surface flow has ever reached the main stem of the Orange River, the river system is still a sub-basin of the Orange – Senqu River through possible groundwater flow and as per definition, a transboundary watercourse system. Moreover, ORASECOM has consistently defined the entire Orange-Senqu Basin, including this sub-system, as its area of interest. As such, while the ORASECOM Agreement does not define the waters to which it applies, it can be taken that reasonable and equitable use of the waters of the Orange-Senqu System must include consideration of the use of the Molopo-Nossop system.

Similarly it can be argued that the Oanob River which is an endorheic river within the Auob sub-basin of the Nossob River basin is similarly part of a transboundary river system within the Orange-Senqu Basin through groundwater flow. The transboundary context of the Oanob is clear and the proposed water infrastructure development at Rehoboth therefore qualifies for support from the CRIDF water infrastructure programme for Southern Africa.

The present concerns about optimising the use of the water resources of the Orange-Senqu River because the river is reaching closure, the threat of pollution from various sources, and the identified need to increase the benefits that the population in the basin can obtain from the water resources, are important elements of the dialogue in ORASECOM about the management of the basin. It is clear such discussions will be an integral part of the process and the formulation of the Basin-Wide IWRM plan currently being developed by the Commission. The successful implementation of the proposed project to rehabilitate the oxidation ponds and to establish a successful irrigation project that will create job opportunities at Rehoboth, will not only add value to the CRIDF support, but will serve as an excellent example of what can be achieved with an integrated approach when providing support to initiatives in the Orange-Senqu basin under the implementation of the IWRM Plan.

9.4 Rehabilitating the Oxidation Ponds at Rehoboth

Due to normal population increase and urbanisation, the population in Rehoboth has increased above expectations. Housing developments to accommodate the people, the expansion of the sewer network and other developments have caused an increase in sewage effluent which cannot at all times be accommodated in the existing sewage oxidation ponds, resulting in periodic overflow of sewage effluent into the surrounding area. This overflow is upstream of the Rehoboth Aquifer and is not only a serious environmental hazard, but a threat that increases the vulnerability of the groundwater in the downstream Rehoboth Aquifer and the Oanob River to pollution.

In view of the location of the Oanob River in the Orange – Senqu River basin and the argument in paragraph 8.3 above about the transboundary nature of the Oanob, the possible contamination of the Rehoboth Aquifer by spills from the oxidation ponds at Rehoboth, should be seen as a matter of common concern to all four

ORASECOM Member States under the provisions of the revised SADC Protocol on Shared Watercourses (Art 4.2 b).

The number of existing oxidation ponds should not only be increased to accommodate the sewage flow, but the existing ponds should be lined and rehabilitated. The ponds should also be fenced to prevent access by livestock and children in view of the health hazards.

The Rehoboth Town Council has a vision to treat the sewage effluent to such a standard that the water can be reused to water sports fields, to do landscaping and to use the water for irrigation. This means that an appropriate treatment facility would be required to do some additional treatment to improve the quality of the effluent to meet the Namibian water quality standards for sewage effluent that could be utilised for the intended purposes. However, the eligibility of the proposed project for CRIDF support would be increased if the treated effluent could be directly used to improve the livelihoods of the poor.

9.5 Water availability

In the report it has been shown that the Oanob Dam, which is the main source of water for Rehoboth, has a sustainable safe yield of more than 4 Mm^3/a. The present bulk water demand of 1.2 Mm^3/a will slowly grow over time and if it is assumed that about 60% of the water will become available as sewage effluent, there will be at least 1.14 Mm^3/a available for irrigation by 2030. If the same assumptions as made in the report by Windhoek Consulting Engineers (Reference 22) to determine the area that can be irrigated under flood irrigation are accepted, at least 12 ha can be irrigated. The irrigation can also be increased over time and as funding becomes available and can grow from a present area under irrigation to the full extent of the scheme possible.

Flood irrigation is very inefficient under Namibian climatic conditions and much more can be achieved by using alternative technologies as will be suggested in the next paragraphs. The proposed production of maize and wheat is not deemed to be labour intensive and has limited possibilities for job creation.

9.6 Soil conditions

A study had been done to determine the irrigation potential of soils in Namibia (Reference 11) and the soils at Rehoboth are generally marginally suitable for crop production under irrigation because the soil is very sandy, has low water holding capacity and poor nutrient content. Local variations in soil conditions can make the soil in some areas more suitable for irrigation, such as at the oxidation ponds, but needs more detailed investigations to confirm.

The successful irrigation project at Rehoboth uses greenhouses with special growing media - Cocopeat (coir pith) to provide optimum root zone air/moisture balance.

9.7 Irrigation Models at Rehoboth

The irrigation model proposed in the report by Windhoek Consulting Engineers would have been the production of maize or wheat under flood irrigation and using mechanical means to plough, fertilise, plant, and harvest the

crops. However, this is not a labour intensive pro-poor activity because it does not create many job opportunities.

In comparison to that, the existing irrigation project of the Rehoboth Community Trust could be used as an example of a working model that has been very successful in producing flowers and vegetables for the market in the City of Windhoek, some 90 km north of Rehoboth. The irrigation project became operational in the first quarter of 2004 and the Trust remains fully committed to its prime objective which is to uplift and improve the living standards and quality of life of all inhabitants of the Rehoboth area through sustainable local economic development. A greenhouse project was initiated in 2006 at a cost of N$2.8 million and is a fully automated vegetable and flower cultivation and production facility.

From an initial plant area of 1 600 m², the greenhouse footprint has been expanded in the period from 2007 till 2010 to a total plant area of 2 800 m² or 0.28 ha. The project was financed entirely from the Trust's own resources. A donation of N$ 80,000 each was made by the Embassies of the Federal Republic of Germany and Britain toward the establishment of an additional 480 m².

Crop types produced are tomato, cucumber, green peppers, flowers *(gerbera jamesoni)*, cauliflower and broccoli. The project employs 12 people on a permanent basis and employed more than 60 skilled/semi-skilled people during construction activities. The retail prices of crops produced are very competitive with refrigerated produce which has to be imported from South Africa to meet the local demand in the towns and cities in Namibia. Rehoboth is only 90 km from the capital city Windhoek and fresh products like lettuce can be on the table every day. The majority of florists in Windhoek receive fresh flowers on a daily basis.

Finding people in Rehoboth who can work at an irrigation project would be easy because there are many unemployed people available within walking distance from the areas where irrigation can be done. Support for the project can make a pro-poor contribution by providing employment, improving the standard of living and reducing poverty.

The selection of a management model for the proposed irrigation project should also be very carefully considered because it is obvious that the core business of the Rehoboth Town Council is not to run an irrigation project. The concept that irrigation should be done under a central management with vested interests, appropriate knowledge and skills to cultivate a variety of crops (vegetables flowers, fruit) that can provide job opportunities for the unemployed has been more successful if the success of other irrigation models are analysed.

9.8 Cost estimates

The cost estimate for the project could not be updated to the level of accuracy that would be desirable, because not all the parties could be consulted. As a result the extent to which the project must be rehabilitated/extended is not yet clear and the possible support for a specific type of irrigation project is not known.

9.9 Consultations required to move forward

From the discussion it is clear that the proposed Project to rehabilitate the existing effluent treatment facility at Rehoboth to the extent that the treated water is suitable for irrigation and landscaping purposes, would meet the CRIDF objectives to achieve pro-poor and transboundary benefits. This means that the project is eligible for CRIDF support. If the recommendations to that effect in this report are accepted and adopted by the ORASECOM, then further consultations with all the parties involved are required to design and implement the project.

10 Conclusion

The following conclusions can be drawn:

10.1 The proposed project to upgrade the sewage ponds at Rehoboth town and to reuse the local domestic sewage effluent for irrigation is supported by the DWAF;

10.2 The Oanob River and the Rehoboth Aquifer at Rehoboth are transboundary in nature, and at the very least could be considered waters of common concern to ORASECOM;

10.3 If the treatment facilities are upgraded, the capacity of the plant could be increased to reduce spills under peak sewage flow conditions, the ponds could be lined properly and the threat of pollution to transboundary water sources in the Orange-Senqu River basin could be reduced;

10.4 If the development of at least the first phase of an irrigation project to utilize treated sewage effluent can be supported by CRIDF, additional pro-poor benefits such as effective job creation, reduction in unemployment, improved livelihoods and increased socio-economic benefits could be achieved;

10.5 It is expected that the frequency of periods with drought conditions will most probably increase in Namibia due to climate change, but the proposed project has the potential to reduce the risks for crop production because water will be available for irrigation;

10.6 The implementation of the proposed project will contribute to the dialogue in the ORASECOM about the development and implementation of integrated water resources management plan and can serve as an example of projects that are making more efficient use of the available water resources in the basin and maximizing the benefits for the basin communities;

10.7 It can be confirmed that the proposed project qualifies for CRIDF support.

11 Recommendations

It is recommended that

11.1 The endoreic ephemeral Oanob River within the Molopo – Nossob sub-basin in the Orange – Senqu River basin is regarded as a remotely located transboundary system that qualifies for possible CRIDF water infrastructure development support;

11.2 Funding support is given to the Rehoboth Town Council to upgrade the existing oxidation ponds to the extent that it will be possible to treat the present and future estimated volume of domestic sewage effluent in an appropriate manner to facilitate the reuse of the effluent produced to irrigate crops, on condition that the Rehoboth Town Council allows a commercialized, private entity to develop, operate and manage the irrigation project to utilize the effluent produced;

11.3 In view of the existence of successful irrigation farming at Rehoboth, CRIDF funding is provided for the development of irrigation infrastructure on a first phase pilot basis to enable the reuse of the sewage effluent and the production of high value, labour intensive crops such as vegetables and flowers;

11.4 Further studies are commissioned to:

- Plan, design, cost and construct a domestic sewage effluent treatment plant that will produce effluent that can be used for irrigation;
- Investigate the development, planning, design, cost and implementation of an appropriate irrigation project on a pilot basis with the view to expand the project over time, depending on proof of its successful operation;
- Design an appropriate model for the operation and management of the proposed irrigation project, based on the existing expertise available at Rehoboth with a similar project which obtains water from the Rehoboth Aquifer in the Oanob River at.

11.5 If adopted in principle by CRIFD, this report is submitted to the Technical Task Team of the ORASECOM for further consideration.

Report by P Heyns Pr Eng

Windhoek, September 2013.

12 References

1. Dorward, A., Kydd J., *et al (*2004). A Policy Agenda for Pro-Poor Agricultural Growth.
2. DWA (1979). Ondersoekverslag oor die Gangbaarheid van 'n moontlike Besproeiingskemea by Rehoboth dorp. (Report about the investigation of the feasibility of a possible irrigation scheme at Rehoboth Town). Report No. 3120/R7/3. Director of Water Affairs, Department of Water Affairs, Southwest Africa Namibia Branch.
3. DWA (1983). Groundwater Potential of the Haris River South and South-East of Rehoboth (Geohydrological report). South West Africa/Namibia: Geohydrology Division, Department of Water Affairs. (Report Number: 3121/G9/1).
4. DWA (1986). Planning Report on the Future Bulk Water Supply to Rehoboth. South West Africa: Planning Division, Department of Water Affairs. (Report Number: 3120/2/13/P2).
5. DWA (1989a). Rehoboth State Water Scheme Re-evaluation of the Groundwater Resources of the Oanob River in the Vicinity of Rehoboth. South West Africa/Namibia: Groundwater Consulting Services Pty Ltd for the Department of Water Affairs. (Report Number: 3121/G9/2).
6. DWA (1989b). The Potential for the Release of Water for Ecological Purposes from the Oanob Dam. Namibia: Hydrology Division, Department of Water Affairs. (Report Number: 3121/2/H3).
7. DWAF (2012). Code of Practice Volume 6. Wastewater Reuse. Department of Water Affairs and Forestry, Ministry of Agriculture and Water Affairs and Forestry. July 2012
8. Government Gazette No. 4707 10 May 2011. Namibia Water Corporation: Bulk Water Supply Tariffs. Namibia Water Corporation Limited.
9. IMLT (2006). Keetmanshoop Integrated Bio-Systems Concept Note. Institute for Management and Leadership Training.
10. Kullgren, E and Perdell, J (2010). Vulnerability and Risk Assessment of Artificial Recharge of the Oanob Aquifer in Namibia. Department of Civil and Environmental Engineering. Division of Geo Engineering, Chalmers University of Technology, Göteborg, Sweden 2010.
11. Loxton, R.F., Hunting and Associates (1971). Consolidated report on reconnaissance surveys of the soils of northern and central South West Africa in terms of their potential for irrigation. Department of Water Affairs, Windhoek.
12. Namibia Development Consultants (2001). "Hardap Regional Development Plan 2001/2002-2005/2006".
13. Namibia Statistics Agency (2010). Namibia Household Income and Expenditure Survey 2009/2010.
14. Namibia Statistics Agency (2012). Namibia 2011 Population and Housing Census. Basic Report.
15. National Planning Commission (2012). Namibia 2011 Population and Housing Census. Preliminary Results. April 2012.
16. NamWater (2008). Bulk Water Supply Infrastructure Development and Capital Replacement Master Plan for the Central South of Namibia. Central/South JV Consultants.
17. ORASECOM (2000). Agreement between the Governments of the Republic of Botswana, the Kingdom of Lesotho, the Republic of Namibia and the Republic of South Africa on the Establishment of the Orange-Senqu River Commission ORASECOM (2009). Assessment of Potential for the

Development and use of “Marginal Waters”. Report No. ORASECOM 002/2009. July 2009. Ninham Shand (Pty) Ltd.

18. ORASECOM (2009). Feasibility Study of the Potential for Sustainable Water Resources Development in the Molopo-Nossob Watercourse. Report No: 007/2009 July 2009. ILISO Consulting (Pty) Ltd.
19. ORASECOM (2009). Groundwater Review of the Molopo-Nossob Basin for Rural Communities including Assessment of National Databases at the Sub-basin level for possible future integration. Report No. ORASECOM/005/2009. Report No. ORASECOM 002/2009. July 2009. Geotechnical Consulting Services (Pty) Ltd.
20. Rehoboth Town Council (2012). Memo prepared to provide information requested.
21. SWECO (2002). Artificial Recharge to Aquifers in the Central Area of Namibia: A Study to Determine the Economic Viability of Artificial Recharge. Stockholm, Sweden: SWECO International AB for the Ministry of Agriculture and Water Resources Development, Department of Water Affairs.
22. WCE (2007). Rehoboth Oxidation Ponds - Preliminary Report by Windhoek Consulting Engineers.

13 Abbreviations

a	= annum
ASI	= Adam Smith International
CRIDF	= Climate Resilient Infrastructure Development Facility
DWAF	= Department of Water Affairs and Forestry
h	= hour
ha	= hectare
HIWAC	= Heyns International Water Consultancy
km	= kilometre
km²	= square kilometres
M	= million
MAWF	= Ministry of Agriculture, Water and Forestry
m³	= cubic metre
m³/s	= cubic metres per second
NAD	= Namibian Dollar
N$	= Namibian Dollar
NamWater	= Namibia Water Corporation Ltd
RDP	= Regional Development Plan
ORASECOM	= Orange-Senqu River Commission
PMU	= Project Management Unit
s	= second
TTT	= Technical Task Team
°C	= degrees Centigrade
ZAR	= South African Rand

Table 2 Persons consulted

No	NAME	CONTACT	ORGANISATION	REASON
1	Ms M Amakali	+264 81 290 0823	Deputy Director Water Environment, DWAF	Meeting about Rehoboth Effluent Reuse Project
2	Mr T Basson	+264 81 129 9629	Windhoek Consulting Engineers	Discussion about Rehoboth Effluent Reuse Report
3	Mr G Christelis	+264 81 250 8302	CHR Water Consultants	Groundwater and Rehoboth Aquifer
4	Mr N du Plessis	+264 81 127 9040	Senior Environmentalist NamWater	Ecological releases and artificial recharge Oanob River
5	Mr P Heyns	+264 81 128 4400	HIWAC	Consultant for ASI
6	Ms I Karumendu	+264 81 222 9209	Hydrological Technician, DWAF	Meeting about Rehoboth Effluent Reuse Project
7	Mr H Koch	+264 81 122 2588	Director Resource Management, DWAF	Meeting about Rehoboth Effluent Reuse Project
8	Mr R Kubas	+264 81 128 4150	Rehoboth Community Trust	Discussion about irrigation project
9	Mr P Liebenberg	+264 81 324 0544	Department of Agriculture	Discussion about irrigation at Rehoboth in the past
10	Mr A Mostert	+264 81 127 9266	NamWater	Discussion about river systems (Oanob) in upper Auob basin
11	Mr R Pule	+27 72 230 4669	ORASECOM	Meeting about Rehoboth Effluent Reuse Project
12	Mr G Quibell	+27 +27 82 563 4504	CRIDF	Meeting about Rehoboth Effluent Reuse Project
13	Mr J Sakupwanya	+27 74 677 6012	CRIDF	Meeting about Rehoboth Effluent Reuse Project
14	Mr G van der Merwe	+264 61 246 761	Winplan	Rehoboth town planning
15	Mr J van Vuuren	+264 81 124 4985	Previously Windhoek Consulting Engineers	Author of Rehoboth Effluent Reuse Report

ASI = Adam Smith International: CRIDF = Climate Resilient Infrastructure Development Facility: DWAF = Department of Water Affairs and Forestry: HIWAC = Heyns International Water Consultancy: ORASECOM = Orange-Senqu River Commission

CRIDF

1740

D3

Project screening tools for this project (Stage 1 – Eligibility)

(please refer to attached excel sheet)

1740

D4 – D5

Activity report

CRIDF

1740 Activity Report: D05

The purpose of this activity was to assess the eligibility of a potential project in Rehoboth, Namibia for CRIDF support. To evaluate the project, CRIDF's criteria of demand driven, pro-poor, transboundary impact and climate resilience were used.

The potential project in Rehoboth, Namibia was identified from the initial contact with the Orange-Senqu River Commission (ORASECOM), and confirmed as a project CRIDF could take forward to eligibility screening at an ORASECOM Technical Task Team (TTT) meeting.

The level of effort expended on this activity was 16 person days.

D02: Meetings and Notes of Meetings

The Activity Lead arranged for a joint meeting with staff of Namibia's Department of Water Affairs (DWAF), a representative from the CRIDF Project Management Unit (PMU) and a Water Resources Specialist from the ORASECOM at the DWAF Offices in Windhoek. The meeting was held on 15 August 2013 and the issues discussed at the meeting were:

- Status of the proposed Rehoboth effluent reuse project;
- Existing interest in effluent reuse at Rehoboth ;
- Information on progress with the proposed project;
- Establish why Keetmanshoop was selected over Rehoboth for GIZ support;
- Confirmation of the commitment of the DWAF to support effluent reuse at Rehoboth;
- Views of the ORASECOM representative;
- Views of the CRIDF PMU representative about CRIDF approaches and focus areas.

The Activity Lead subsequently had discussions with the consultants who undertook the initial investigations as well as other technical staff at the Ministry of Agriculture, Water and Forestry and the Namibia Water Corporation (NamWater) who had been involved with water and irrigation issues at Rehoboth in the past.

D03: Scoping level review of any possible transboundary and pro-poor benefits

The detailed assessment of any possible pro-poor and transboundary benefits that will be realized from this project is presented in Sections 5.3 and 9.3 respectively of the consultant's report. The report concludes that:

- The proposed project to upgrade the sewage ponds at Rehoboth town to prevent pollution and to reuse the local domestic sewage effluent for irrigation is supported by the DWAF because pollution control and water reuse is in line with the Namibian Water Policy while

the promotion of irrigation is in line with the Green Scheme Policy which is aimed at increasing agricultural production and agribusiness;

- If the development of at least the first phase of an irrigation project utilizes treated sewage effluent, the project can be supported by CRIDF. Additional pro-poor benefits such as effective job creation, reduction in unemployment, improved livelihoods and increased socio-economic benefits could be achieved;
- It is expected that the frequency of droughts will most probably increase in Namibia due to climate change, but the proposed project has the potential to reduce the risks for crop production because it will increase water security for irrigation;
- The treatment of waste water to water quality standards that will allow the reuse of water on sports fields will reduce the need to use expensive potable water for irrigation;
- The Oanob River and the Rehoboth Aquifer at Rehoboth are trans-boundary in nature;
- If the treatment facilities are upgraded, the capacity of the plant could be increased to reduce spills under peak sewage flow conditions, the ponds could be lined properly to reduce seepage and the threat of pollution to transboundary water sources in the Orange-Senqu River basin could be reduced;
- The implementation of the proposed project will contribute to the dialogue in the ORASECOM on the development and implementation of an Integrated Water Resources Management Plan and can serve as an example of projects that are making more efficient use of the available water resources in the basin while maximizing the benefits for the basin communities;
- The proposed project qualifies for CRIDF support from a technical perspective.

D04: Recommendations on whether, and how, CRIDF may support this Project

The consultant presents recommendations in the Report (Section 10) for CRIDF to take the project forward to bankability screening. Other recommendations presented in the report on precisely how CRIDF should support the project; what contributions CRIDF could make and the way forward regarding future CRIDF support are:

- Funding support is given to the Rehoboth Town Council to upgrade the existing oxidation ponds to the extent that it will be possible to treat the present and future estimated volume of domestic sewage effluent in an appropriate manner. To facilitate the reuse of the effluent produced to irrigate crops, on condition that the Rehoboth Town Council allows for a commercialized, private entity to develop, operate and manage the irrigation project to utilize the effluent produced;
- In view of the existence of successful irrigation farming at Rehoboth, CRIDF funding is provided for the development of irrigation infrastructure on a first phase pilot basis to enable the reuse of the sewage effluent and the production of high value, labour intensive crops such as vegetables and flowers;
- Further studies are commissioned to:

- Plan, design, cost and construct a domestic sewage effluent treatment plant that will produce effluent that can be used for irrigation;
- Investigate the development, planning, design, cost and implementation of an appropriate irrigation project on a pilot basis with the view to expand the project over time, depending on proof of its successful operation;
- Design an appropriate model for the operation and management of the proposed irrigation project, based on the existing expertise available at Rehoboth. Expertise was gained during a similar project which obtains water from the Rehoboth Aquifer.

D01: Project screening tools for this project (Stage 1 - Eligibility)

Using information extracted from the consultant's report, the PMU compiled Screen 1 which was used to make a decision on taking the Project forward to Stage 2.