The surface waters supplies to the Central Area of Namibia are dependent on local rainfall and runoff which is erratic. Over the past ten years, runoff volumes have been well below average and have been particularly poor in the 1994-1995 (Heyns, 1995) and 1995-1996 rainy seasons. This has coincided with a time when water consumption in the region is approaching the theoretical limits of the capacity of the developed resources (Heyns, 1992; JVC, 1993a; Bethune, 1996). Substantial widespread rains were recorded during the 1996/1997 summer period over large parts of Namibia. The four ephemeral rivers on which the main coastal towns and surrounding communities rely for their water supply, namely the Omaruru, the Swakop/Khan and the Kuiseb Rivers, were all in flood this year (1997). The Swakop River also flowed into the sea.

As overall rainfall volumes decrease towards the west, the variability in the size of each occurrence increases. The rainfall distribution in the Swakop River catchment, reflects this pattern of decrease from east to west (**Figure 1.3**). Because of this variability the mean annual rainfall is not a good indicator of the rainfall that can be expected every year; in turn, this makes long-term planning more difficult. In addition, the dearth of reliable long term rainfall records limits understanding of the variable climate in these arid and semi-arid regions. A good rainfall measuring network in western Namibia, coupled with flow-gauging stations along the rivers, would not only contribute to a better understanding of the hydrology of ephemeral river systems but is essential to the calculation of recharge volumes in the alluvial aquifers associated with most of these rivers. Ideally, all large water consumers in the region should contribute to the maintenance of a rainfall measuring network.

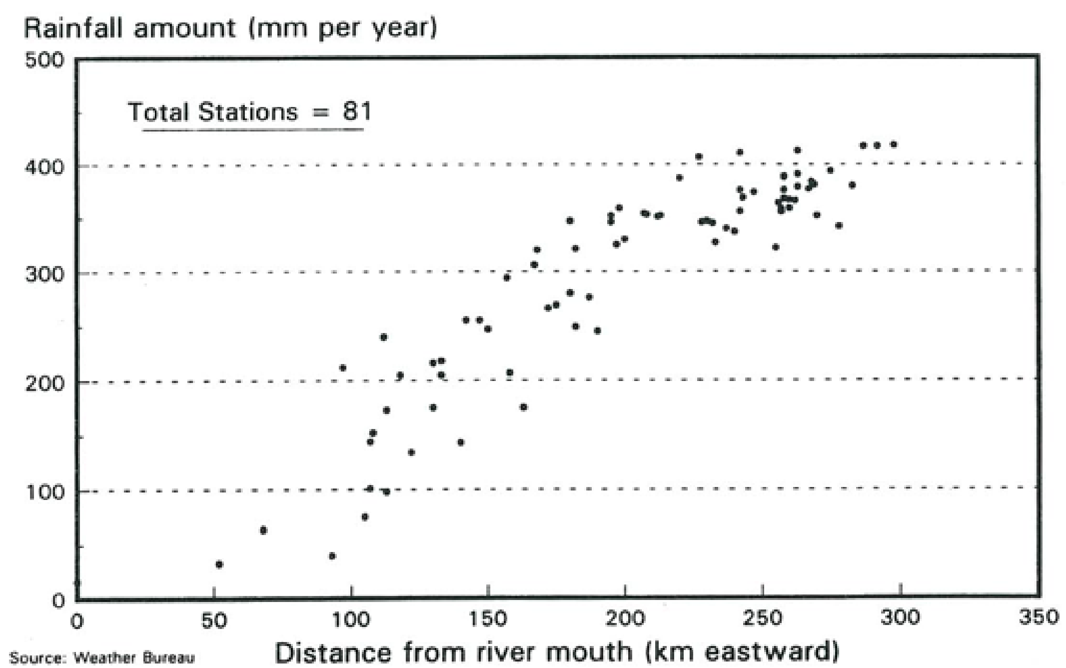


Figure 1.3: Variation in average annual rainfall over the Swakop River catchment.

ENVIRONMENTAL IMPACT ASSESSMENT OF THE PROPOSED KHAN AQUIFER RECHARGE SCHEME

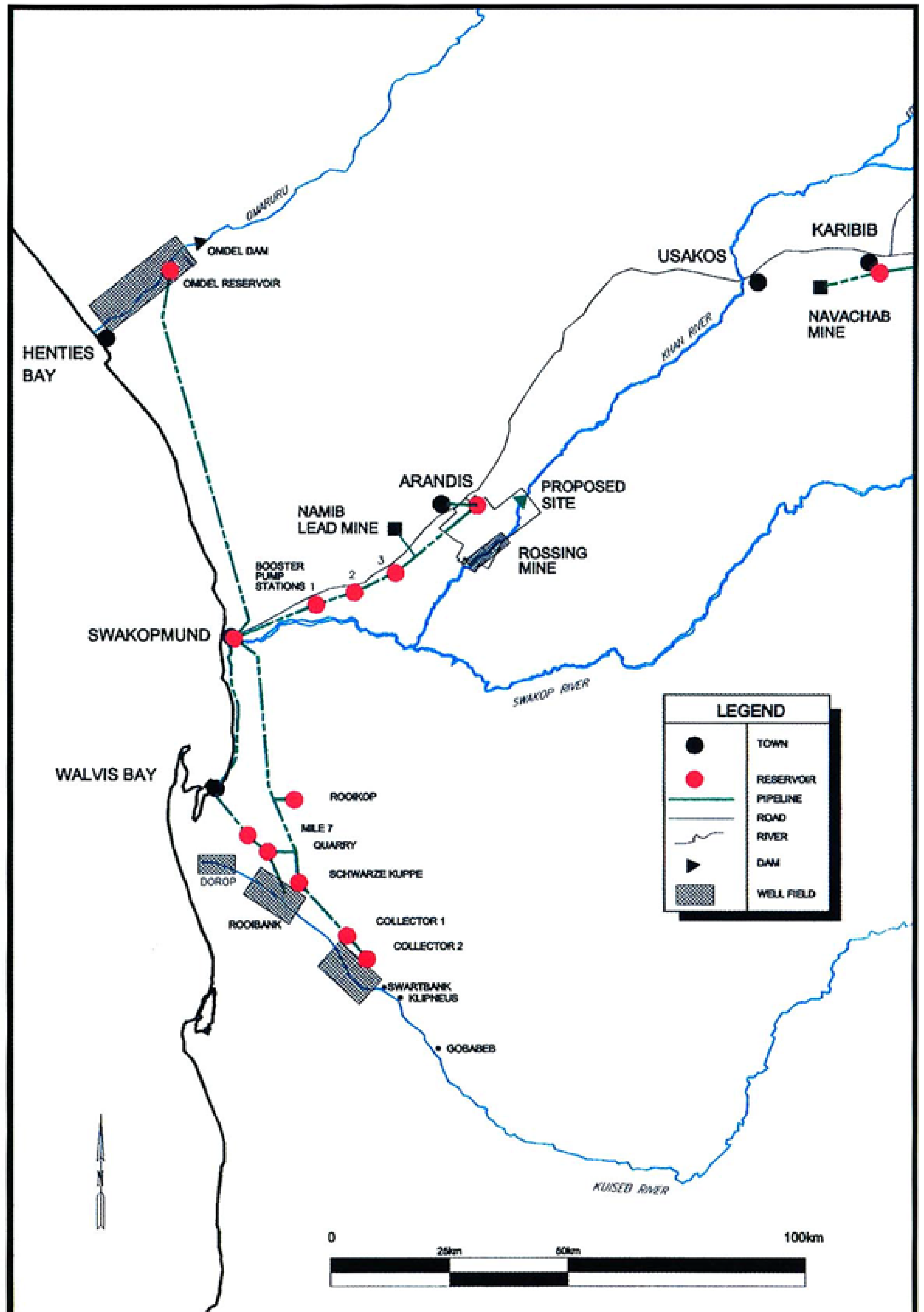
Extensive alluvial aquifers are associated with all these rivers; of particular importance are the alluvial aquifers of the Kuiseb and Omaruru Rivers. These contain large volumes of fresh water which can be used for potable purposes and which are presently used to meet almost the entire current demand of the coastal towns and mining industries of the Central Namib region. Extensive alluvial aquifers are also associated with the Khan and Swakop Rivers but the quality of the ground water stored, especially in the lower reaches of these aquifers, renders them mostly unsuitable for human consumption.

1.1 Water supply issues in the Central Namib Area of Namibia

In 1995, the Department of Water Affairs of Namibia commissioned a consortium of companies consisting of overseas and local expertise (GKW Consult, Bicon Namibia and Parkman Namibia), to establish the current and projected demands for water and identify the most feasible source of fresh water to supply the inhabitants of the Central West Coast region until the year 2020 (KfW, 1996). The largest water consumers in the region are the towns of Walvis Bay and Swakopmund with estimated populations of 34,000 and 21,600, respectively, in 1995 (DANCED, 1996; KfW, 1996), and the Rössing Uranium Mine. Two additional water consumers are Henties Bay and Arandis, with estimated 1995 populations of 3,200 and 4,400, respectively. The present total population for the area is estimated at 65,000 and is expected to increase to 163,000 by the year 2020 (KfW, 1996).

The fresh water resources of the region presently being exploited are limited to two large alluvial ground water systems; namely the Kuiseb aquifer south of Walvis Bay and the Omaruru aquifer in the delta of the Omaruru River at Henties Bay. The water from these two aquifer systems is distributed by pipeline to the major consumers: Walvis Bay, Swakopmund, Rössing Mine, Henties Bay, Arandis and the farming community in the lower reaches of the Swakop River (**Figure 1.4**). Both of these aquifers show signs of over-exploitation.

The combined sustainable yield of these two aquifers has been determined during extensive investigations by DWA over many years to be 11.4 Mm^3/year (KfW, 1996). By 1994, total water consumption had reached 10.5 Mm^3/year and this is expected to increase to 18.2 Mm^3/year by 2020. During 1994/95 the water consumption for Walvis Bay was 4.8 Mm^3, for Swakopmund 3.95 Mm^3 and for Arandis 0.21 Mm^3 (KfW, 1996). During the same period the Rössing water consumption from the CNSWS was 2.1 Mm^3/year. A further 0.25 Mm^3 of brackish water was drawn from the Khan River aquifer. The predicted future demand for water from the two alluvial ground water sources amounts to 10 Mm^3/year.



CSIR | MAP OF CENTRAL NAMIB STATE WATER SCHEME | FIG.: 1.4

At current rates of growth in demand for fresh water, the calculated sustainable yield of these two aquifers will match the demand by the year 1999. It is important to note that the concept of "sustainable yield" from these aquifers does not include the sustainability of the overall ecosystem. The sustained yield of water for human use can be increased to a point where insufficient water remains for vegetation and animals. Indeed, the removal of vegetation would increase the "sustainable yield" characteristics of an aquifer.

Other sources of ground water that are currently exploited include the lower Swakop River and the Khan River at Rössing. Along the lower Swakop River, downstream of the confluence with the Khan River, farmers abstract some 0.529 Mm^3/year of brackish water for farming purposes. To supplement their fresh water supply from the CNSWS, Rössing presently abstracts about 0.25 Mm^3/year from the alluvial Khan River aquifer along the mine frontage of the Khan River (**Figure 1.4**).

During the past decade the calculated safe yield of the Omdel aquifer (4.5 Mm^3/year) has been exceeded; in effect, the aquifer has been "mined". For example, 6 Mm^3 of ground water was abstracted in 1991 and the forecast demand for 1997 is 10 Mm^3 (DWA, 1991b; Tordiffe, 1996). Surface water recharge to the aquifer is sporadic. Until recently, the last major flood to significantly benefit the Omdel aquifer occurred in 1985 when the aquifer was recharged with approximately 11.5 Mm^3. Infiltration tests indicated that the aquifer could be recharged by a maximum of 8 Mm^3/year. Average annual natural seepage from the aquifer to the Atlantic ocean is estimated to be 14 Mm^3 (Tordiffe, 1996), whilst recharge by throughflow from the upstream alluvial layers, is estimated at 3.5 Mm^3 (Nawrowski, 1995).

As part of a strategy to increase the ground water reserves along the West Coast, the Department of Water Affairs completed a 40 Mm^3 dam in the Omaruru River in 1994. The dam is some 4.5 kilometres upstream of the Omaruru Delta (Omdel) aquifer (Tordiffe, 1996; **Figure 1.4**). The purpose of the dam is to allow the silt in trapped flood waters to settle, and then divert the clear water to a suitable downstream infiltration system. Due to the high evaporation rate, it is not considered viable to retain the water in the dam. In 1997 the first floods were captured by the dam. However, no detailed information about the impact of the recent floods on the recharge to the aquifer is yet available. Nonetheless, the DWA expects the Omdel scheme to enhance the currently available fresh water supplies of the CNSWS by approximately 4 Mm^3/year.

Three well fields, Swartbank, Rooibank and Dorop, are operated in the Kuiseb aquifer (**Figure 1.4**). These have been over-exploited in recent years and the effect on the riparian vegetation is clearly visible. Based on additional information collected over many years, the safe yield of the Kuiseb aquifer was reduced to 3 Mm^3/year in 1990, compared to the 30 Mm^3/year determined in 1960 (Jacobson *et al.*, 1995).

As mentioned previously, projections are that the overall fresh water demand of the region will rise steadily to exceed the sustainable long term yield of the ground water aquifers within about 5 years. Several alternative water source options for the West

Coast have therefore been investigated by KfW (1996) and DWA (1997). These include iceberg harvesting, solar distillation, the utilization of coastal fog, importing water by tanker from the Zaire River, reclamation of treated wastewater, construction of additional surface water and ground water recharge dams, and salt water desalination. The study concluded and recommended that desalination of saltwater be considered as the most feasible future water source and it is estimated that the desalination plant should be operational by 2000.

The choice of a desalination option, though expensive, represents the only long-term sustainable option to supply potable water to the West Coast of Namibia. In future years, desalination will have to be expanded to meet at least some of the needs of the Central Areas of Namibia.

1.2 History of and motivation for the KARS Project

In all metallurgical plants processing ore, water has to be used in large quantities. In addition, the mining operation itself also requires substantial amounts of water, for example in dust suppression, milling and tailings transport. The Department of Water Affairs was contracted in 1973 to supply up to 22,000 m^3/day of water to Rössing, inclusive of 2,000 m^3/day for the town of Arandis. In the early stages of its development, water consumption at the mine was high; in-plant water consumption amounted to some 0.95 m^3 per tonne of ore milled. However, Rössing has focused considerable attention on the whole issue of water consumption and the current (1997) total water consumption at the mine amounts to 2.96 Mm^3/year. This translates to 0.298 m^3/tonne of ore milled which is extremely low by world standards.

The historical patterns of annual water consumption in the Central Namib and at Rössing are shown in **Figures 1.5a and 1.5b**, respectively. Whilst water consumption in Swakopmund and Walvis Bay have increased slowly over the last 15 years (**Figure 1.5a**), water consumption at Rössing has been reduced markedly as process and operational improvements have been implemented.

The 1996 total water demand at Rössing Mine amounted to 2.47 Mm^3. With increased uranium production during 1997, the total water consumption is anticipated to rise to about 2.96 Mm^3. With further increases in uranium production, this consumption is expected to rise to 3.22 Mm^3 in 1998, and will reach 4.1 Mm^3 in the year 2000. When full production is resumed shortly thereafter, water consumption at the Rössing Mine is expected to reach a maximum of 4.5 Mm^3. At present (1997), about 0.24 Mm^3/year (8 %) of the total water consumed is obtained from the alluvial aquifer in the Khan River.

Rössing started using brackish ground water from the alluvial aquifer in the Khan River in 1973 to supplement the fresh water obtained from the Central Namib State Water Scheme (CNSWS). The relative contribution of Khan River ground water to the mine's total needs has increased over the years and is currently some 8 % of the total water consumption.

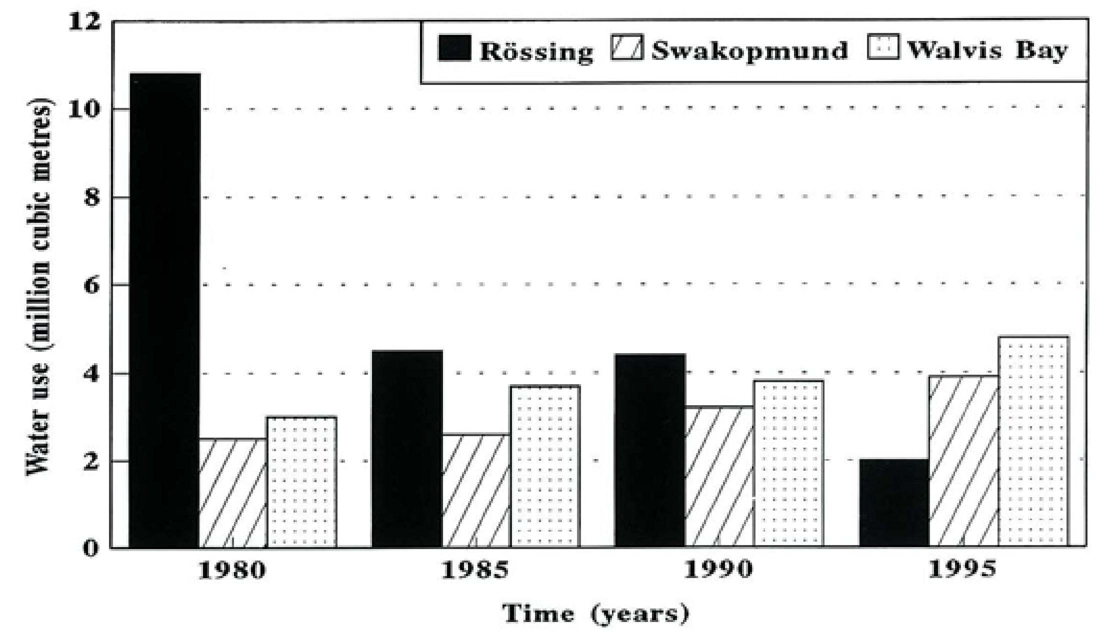


Figure 1.5a: Freshwater consumption of Walvis Bay, Swakopmund and Rössing Mine from the CNSWS since 1980.

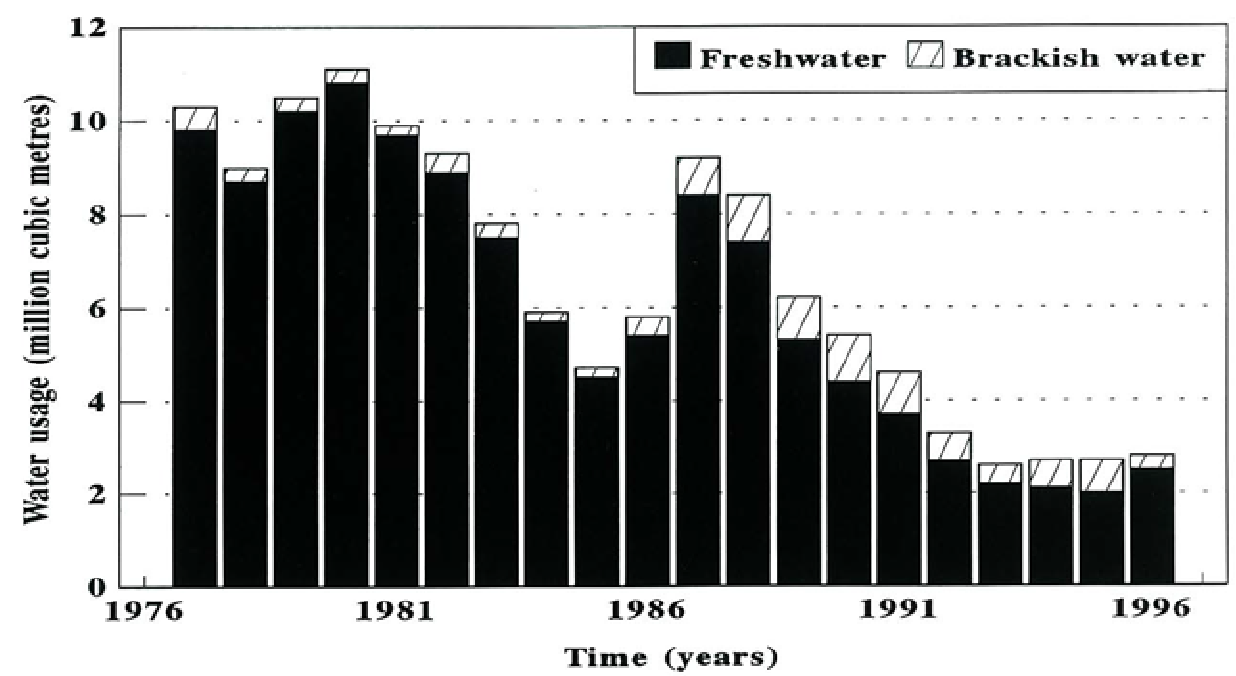


Figure 1.5b: Annual total water consumption at the Rössing Mine since 1977.

The first production boreholes in the Khan River were drilled in 1973. Some of these were washed away in the 1985 floods and were re-established in 1986. Presently there are seven production boreholes in operation, spread over approximately 10 kilometres of riverbed from just upstream of Dome Gorge down to Panner Gorge. Peak total abstraction from these boreholes was close to 1 Mm^3/year during 1988-1990, but had to be reduced in 1991 due to the decline in the water table. The extension of the well field into the river compartment upstream of Dome Gorge in 1993 again resulted in an increase in abstraction.

Abstraction of brackish water from the Khan River is regulated by permits issued from time to time by the Department of Water Affairs. The current permit makes provision for a maximum abstraction of 0.87 Mm^3/year. In addition, a maximum drawdown of the water level was provisionally set not to exceed 15 metres below surface, with the requirement that vegetation monitoring must be carried out on a regular basis. The Department also has to be informed if the water level drops below 10 metres or if the routine (6-monthly) vegetation monitoring programme shows that the riparian vegetation exhibits a sudden loss of vitality.

Due to low rainfall over the past decade, the DWA recommended in 1995 that the maximum abstraction rate be reduced to 0.6 Mm^3/year. More recently, Rössing reduced total abstraction from the Khan aquifer to approximately 0.24 Mm^3/year to comply with the permit requirements relating to depth of water table.

Two alternative schemes to enhance water supply to the mine have been investigated. One option is to extend the well field further upstream and the other is to construct a dam in the Khan River and use the trapped water for artificial recharge of the aquifer. The wellfield option was calculated to produce up to 1.75 Mm^3 over a two year period with water levels being maintained at not lower than 10 metres below surface. The 10 metre level was predicted to be exceeded within two years after pumping starts if no recharge occurred to the aquifer.

The second option is to construct a dam in the Khan River to temporarily capture small to medium floods and, once the flood water had deposited the silt load in the dam, decant the clear water into the downstream alluvial aquifer. The concept is similar to that of the OMDEL aquifer recharge scheme established recently in the Omaruru River by the DWA to artificially recharge the Omaruru Delta Aquifer. This second option was estimated to be a more reliable approach to meeting Rössing Uranium's increased need for brackish water than extending the existing wellfield. If managed properly, this scheme would reduce the quantities of surface flood waters which would otherwise be "lost" through evaporation from wet sand surfaces or discharge into the Atlantic Ocean.

Rössing Management proposes to construct an alluvial dam and associated aquifer recharge scheme in the Khan River (the Khan Aquifer Recharge Scheme - KARS). The scheme would be located upstream of current mining activities and would be designed to replenish the aquifer compartment which runs along the mine frontage. It is anticipated that through this scheme Rössing will be able to increase their supply from the Khan River without compromising the existing DWA permit requirements in terms of water levels and impacts on vegetation.

Despite the strong likelihood of a desalination plant being built to enhance supplies to the coastal region, Rössing believes that other options to protect the limited potable water resources of the area need to be investigated. The KARS project is one option proposed by Rössing to reduce the mine's overall demand from the CNSWS.

For the remaining life of the mine, (currently estimated at twenty years), Rössing will still need to use substantial volumes of water from the CNSWS since the ground water resources of the Khan River alluvial aquifer cannot supply the mine's total water demand. Furthermore, the salinity of the Khan River ground water is relatively high and, if not desalinated, can only be used for industrial purposes.

Rössing has therefore advised that, in addition to the KARS project, the company fully supports the desalination concept for supplying the West Coast consumers with potable water and is actively cooperating with and assisting the authorities in this regard.

1.3 The proposed Khan Aquifer Recharge Scheme (KARS)

The concept of a dam in the Khan River to enhance ground water recharge, was first investigated in 1991 when a feasibility study was initiated for two dam sites in the Khan River along the mine frontage. Although the outcome of this investigation was positive, the project was not continued beyond the technical design phase.

However, drought conditions in the catchment of the Swakop and the Khan Rivers, with the resultant reduction of the water levels in the Khan River during the mid 1990's, prompted a reexamination of the feasibility of an artificial recharge scheme. Gordon McPhail and Associates were commissioned in 1995 to carry out preliminary modelling to assess the financial risks associated with the implementation of a scheme involving the construction of one large dam, or a number of smaller dams, on the Khan River in the vicinity of the mine. The proposal was to capture flood waters and to use these waters to artificially recharge the alluvial aquifers. The results were promising and indicated that a single large dam was favoured as it would have a more beneficial cost/storage capacity relationship than a series of smaller dams with the same overall capacity.

The newly proposed site for the KARS Dam is approximately 10 kilometres upstream of the present mining activities (**Plate 1**). The total holding capacity of the dam would be approximately 9 Mm^3 resulting in a dam wall height of about 25 metres. A main spillway on the north-western bank as well as an emergency spillway on the south-eastern bank is proposed. The primary objective of the KARS project is to capture part of the occasional surface run-off in the Khan River, namely the small floods with a volume less than 10 Mm^3. It is anticipated that, once the silt has settled out, the water will be channelled into the downstream alluvial aquifer through controlled infiltration along the surface of the river bed. This process should take place as fast as possible to ensure that evaporative losses are minimized and the largest possible quantity of water is infiltrated into the aquifer.

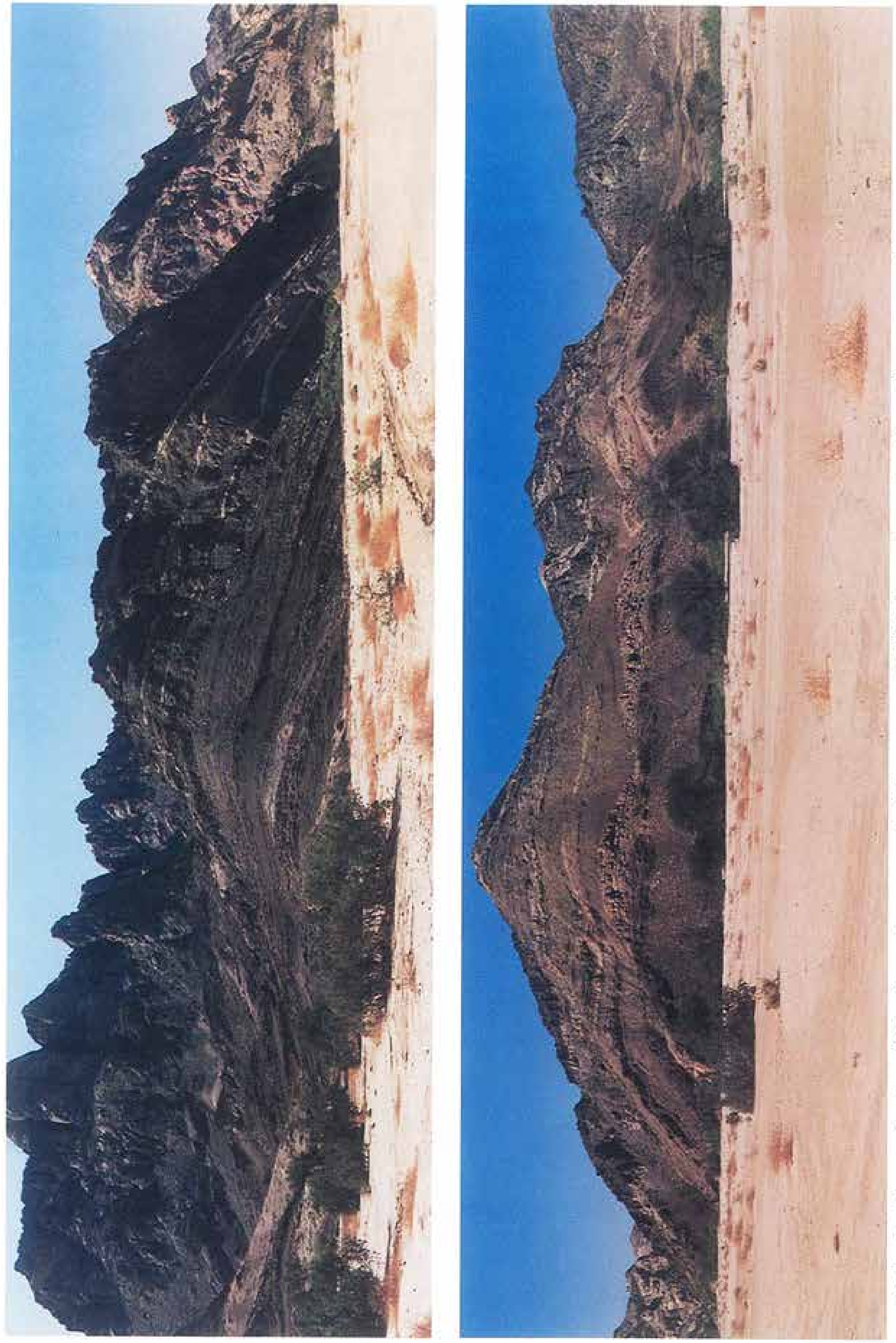


Plate 1: Panoramic view of the downstream aspect of the proposed KARS Dam site on the Khan River. From this position, the main spillway would be located on the left flank (upper photograph) whilst the emergency spillway would be located on the right flank (lower photograph). Typical riparian vegetation (*Acacia erioloba* and *Faidherbia albida*) fringe the riverbed.

It is envisaged that the KARS project will allow increased extraction of brackish water from the aquifer on a controlled and sustainable basis over the long periods between floods, thereby relieving the pressure on the already stressed fresh water resources of the West Coast area. The concept of the recharge scheme is shown schematically in **Figure 1.6**.

Once the water is infiltrated into the aquifer, it is protected from further evaporation and will slowly flow downstream towards the existing production wellfield where controlled extraction can occur. The water will be piped from the wellfield via an existing pipeline to the mine for use in their production circuits as well as for dust suppression. With the KARS scheme in operation, it is planned that the current ground water baseflow downstream of the wellfield would have to be maintained at or above the depth and flow limits specified by the DWA abstraction permit so that downstream users and the riparian vegetation in the lower Khan River do not experience adverse impacts.

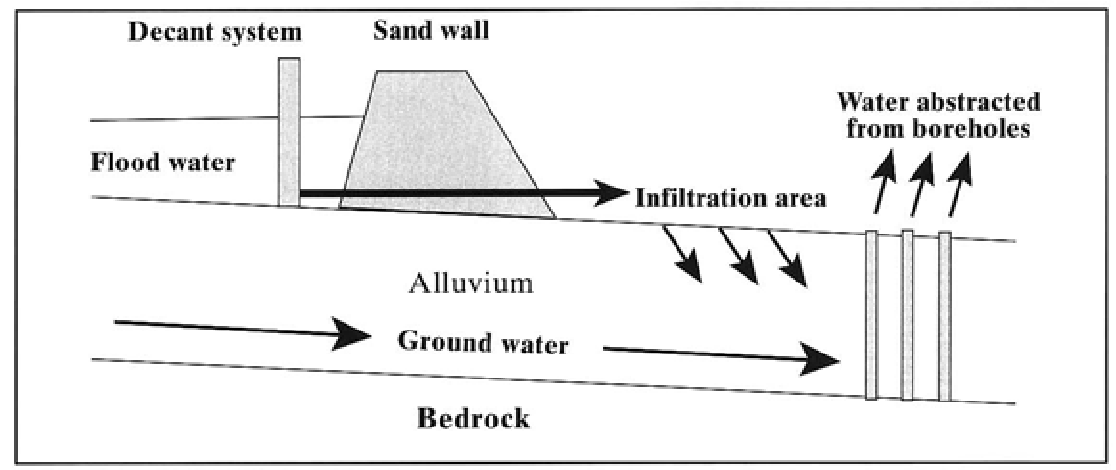


Figure 1.6: Conceptual diagram showing the components and generalized layout of the proposed Khan Aquifer Recharge Scheme in the bed of the Khan River.

1.4 Anticipated scale of the KARS Project

It is anticipated that implementation of the KARS project would allow 3,500 m^3/day of water abstracted from the Khan River bed. This is equivalent to an annual average of 1.28 Mm^3.

Given the current (1997) annual abstraction rate of 660 m^3/day (equivalent to 0.24 Mm^3/year), the KARS project represents an increase of approximately 430 % over the present abstraction rate. Abstraction could be increased to 7,000 m^3/day (equivalent to 2.55 Mm^3/year) for short periods (2-3 months) immediately after a flood event.

1.5 Structure of this report

This report provides details of an Environmental Impact Assessment (EIA) of the Khan Aquifer Recharge Scheme (KARS) Project in Namibia proposed by Rössing Uranium Limited, and is based on information which has been synthesized from a wide variety of published sources as well as specific investigations conducted during the project.

The main report consists of seven chapters arranged according to the descriptions below. **Chapter 1** contains a brief introduction providing the background to and motivation for the project in the context of the water supply situation along the West Coast, and a short description of the project. A description of the scope of the impact assessments is given in **Chapter 2**, followed by a description of the methods used to evaluate the magnitude and importance of the impacts associated with the proposed project and identified by Interested and Affected Parties (**Chapter 3**).

A description of the regional setting and environment in which the proposed scheme is to be constructed and operated follows in **Chapter 4**, providing background information on items such as Khan and Swakop River catchment characteristics, hydrology, geohydrology, ecological characteristics and general land use.

The hydrology of the river systems and the geohydrology of the associated alluvial aquifers, is of primary importance to a project of this nature, and extensive coverage of the hydrological simulations and their effects on the water systems is given in **Chapter 5** of the report.

Against the baseline described in **Chapter 5**, the report describes the main findings of the work carried out, and lists the Key Issues and Concerns that have been identified during the project. This is followed by an assessment of the potential magnitude and importance of the possible and identified impacts within the area between the proposed aquifer recharge site and the mouth of the Swakop River at Swakopmund (**Chapter 6**).

In addition, this information is placed in context by appropriate references to the remainder of the Khan and Swakop River catchment. Finally a summary of the impacts, recommendations and monitoring requirements is provided in **Chapter 7**.

An Executive Summary is provided at the beginning of the report giving a brief overview and summary of the main findings of the studies. The Executive Summary also contains a matrix table which provides a graphical summary of the Key Issues, as well the level of significance of the impacts which may be expected to occur if the proposed aquifer recharge scheme proceeds.

ENVIRONMENTAL IMPACT ASSESSMENT OF THE PROPOSED KHAN AQUIFER RECHARGE SCHEME

2. THE ENVIRONMENTAL ASSESSMENT

The Namibian Department of Water Affairs has contributed to the Environmental Impact Assessment process for the Khan Aquifer Recharge Scheme (KARS) project by making available invaluable information collected through monitoring programmes over decades and by providing the results of several studies of the Khan and Swakop River systems. This information contributed to comprehensive technical, economic and environmental studies covering both the site of the proposed aquifer recharge scheme, and downstream areas which could potentially be affected by the project proposal. The environmental studies focus on assessments of the potential direct and indirect impacts of the proposed project.

In addition, an independent external review will be conducted of the study findings to evaluate the impact assessment process, as well as the extent and magnitude of anticipated impacts. This review is designed to ensure that all aspects of the Environmental Impact Assessment are conducted thoroughly and professionally, and that the study findings can stand up to international review, if required.

2.1 The legislative and policy context

Given that the entire area of interest to the KARS Project falls within Namibian borders, no considerations of international legal and policy frameworks are applicable to the project. Instead, the KARS Project must be evaluated within the context of appropriate policies and statutory regulations which prevail in Namibia.

2.1.1 The context of national policies and legislation

In the context of national policy and legislation, Namibia has instituted and accepted laws which govern the ownership and use of water and land. In Namibia, the National Constitution considers all water to be a common, national good which is owned by the state and whose use is administered by the state (Heyns, 1991).

The control, conservation and use of water in Namibia is regulated by the Water Act No. 54 of 1956 (including amendments up to 1979) and the Water Amendment Act No. 22 of 1985 (Water Act, 1956, 1985). These two Acts were promulgated in South Africa and were applied during the period prior to, and shortly after, Namibia's transition to independence. A new Water Act for Namibia is still in the process of being drafted. In the original (South African) Water Act, (which still holds in Namibia, until the new Act is passed by Parliament), ground water can be owned by individuals and this ownership is linked to the ownership of land.

Riparian land owners also have a right to use surface water that flows across their land or which lies adjacent to their land. However, the building of a dam of the size envisaged for the KARS Project, requires the approval of the Department of Water Affairs, which will also analyze the technical details and feasibility of the project.

The Namibian Department of Water Affairs, of the Ministry of Agriculture, Water and Rural Development, is charged with the responsibility of acting as custodian for the country's water resources (Heyns, 1991). The line function activities of several other Ministries (e.g. Ministry of Lands, Resettlement and Rehabilitation, Ministry of Environment and Tourism, Ministry of Works, etc.) can have major impacts upon the country's water resources and these activities need to be co-ordinated through the Department of Water Affairs (JVC, 1993b). This is in line with the concern for environmental issues, and the prevention of natural resource degradation, as expressed in the Constitution of the Republic of Namibia (Republic of Namibia, 1989).

Until 1995, there was no overall development plan or co-ordinating body which was responsible for co-ordinating development within Namibia. This situation precluded the possibility for co-ordinating the planning and development of water projects with those of other natural resources. As a consequence, many development projects were launched (and some have already been completed) by various Ministries, often without due regard for the consequences upon the natural resources under the jurisdiction of other Government bodies.

This situation has, to a large extent, been resolved with the publication of Namibia's First National Development Plan (NDP1) which covers the period up to the year 2000 (National Planning Commission, 1995). A National Water Master Plan for Namibia is expected to be produced during the next four years (National Planning Commission, 1995).

2.1.2 The context of this Project

The environmental management and conservation policies in Namibia (Brown, 1992; Republic of Namibia, 1995a) require that all development projects should incorporate an Environmental Impact Assessment (EIA). This process is designed to ensure that all environmental issues (i.e. ecological plus social issues) are examined carefully to ensure that potentially adverse effects (costs) are minimized or mitigated whilst positive effects (benefits) are maximized. In addition, this process seeks to ensure that no development project will be allowed to proceed where unacceptable adverse impacts are likely to occur.

Related to this aspect, it was accepted at the public meetings that the Draft Environmental Evaluation Report for the KARS Project will be evaluated by at least one reputable and independent external evaluator appointed in consultation with the public to ensure that the process which has been followed and the technical findings which arise are acceptable in terms of current Namibian environmental policies.

2.2 Purpose and scope of the environmental assessment

The purpose of the environmental assessment is to assess the potential positive and negative impacts on the Khan and Swakop River systems and its people, which may arise as a result of the proposed KARS Project. The scope of the downstream environmental assessment includes all those direct and indirect impacts which could arise downstream of the KARS Dam as a result of which, or which may be associated with, construction and operation activities forming part of the proposed project. The original scope of work for this Study was revised to incorporate the concerns and issues raised by members of the public who attended the public meetings that were held in Swakopmund and Arandis and through written and verbal submissions (BGIM, 1997).

2.2.1 *Scope of the study*

In consultation with Interested and Affected Parties (I&APs) through interviews, Public Meetings at Usakos, Swakopmund and Arandis, a number of key issues were identified to be dealt with in the EIA Report. These are listed in the preliminary and the final Issues Report compiled by BGIM (BGIM, 1996, 1997). The major issues and environmental impacts that must be addressed in the EIA of the KARS Project have been grouped under four main headings, and include the following:

- **Project motivation**
  - A need and desirability statement for the project;

- **Technical issues**
  - The impact on the water management systems upstream of the proposed Khan dam;
  - The design and engineering features of the dam and associated aquifer recharge mechanism;

- **Ecological issues**
  - The impact on fauna and flora immediately above and below the dam wall, as well as further down the Khan and lower Swakop rivers;
  - The impact on ecology during construction of the dam;
  - The potential for sand dunes to migrate across the Swakop River;
  - Potential changes (especially erosion) to the beach front in Swakopmund;

- **Socio-economic issues**
  - The impact on the quality and quantity of ground and surface water available for downstream water users;
  - Sand mining activities near Swakopmund;
  - Impact on the economic viability of the sea water desalination project for improved fresh water supplies to the region;
  - The financial viability of the project; and
  - Impact on the public leisure activities in the Khan River bed in the vicinity of the reservoir.

This EIA report also proposes measures that may be required to mitigate negative impacts and maximize positive benefits associated with the project. In addition, the

ENVIRONMENTAL IMPACT ASSESSMENT OF THE PROPOSED KHAN AQUIFER RECHARGE SCHEME

EIA Report also makes recommendations as to appropriate monitoring programmes which can be used to evaluate any predicted impacts and assess the success or failure of management options, together with recommendations for future research.

2.2.2 *Study structure*

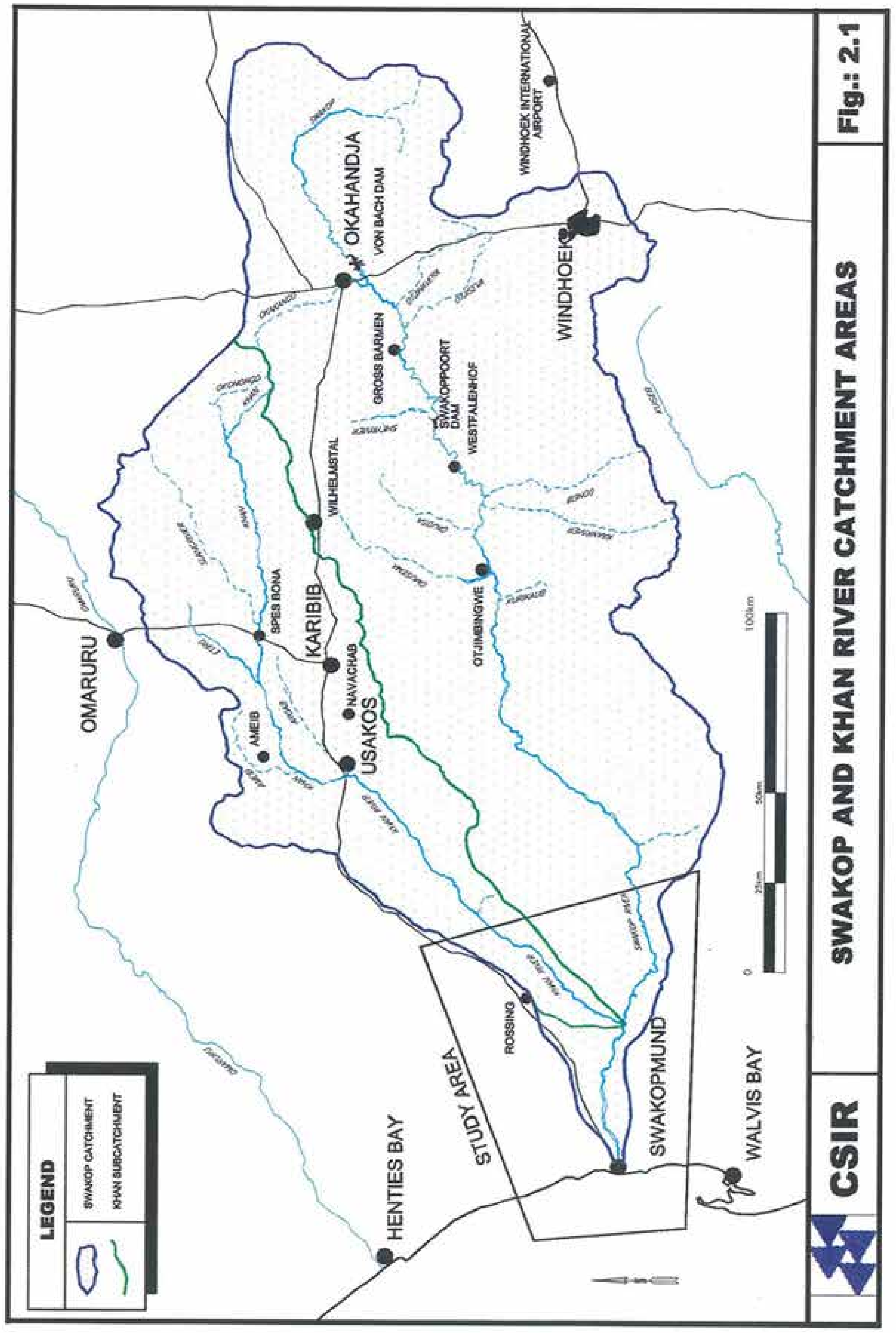
To meet the formal objectives of the Study, the work programme consisted of different stages, listed below:

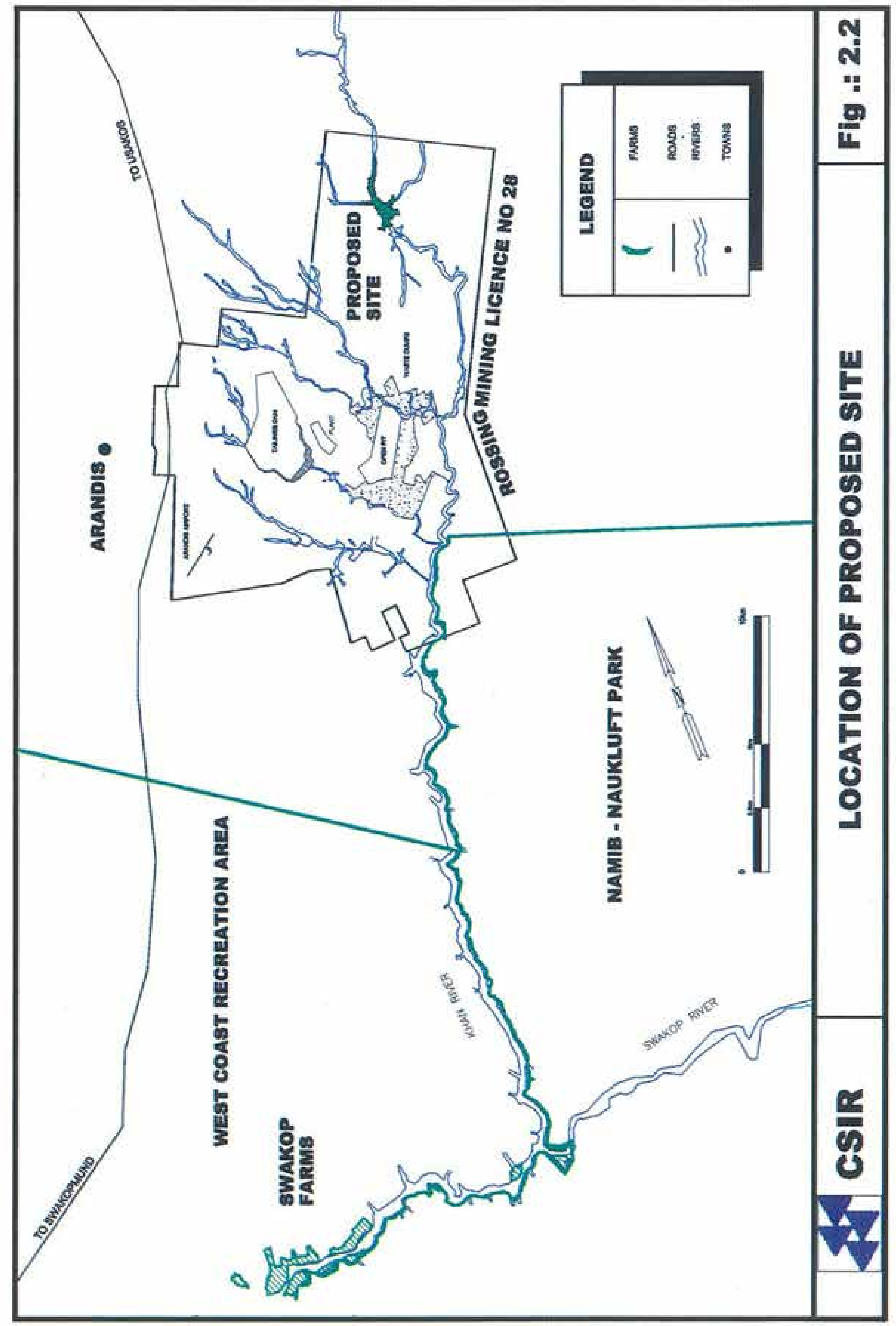
- a public consultation and scoping phase, designed to elicit the concerns of interested and affected parties in Swakopmund, Arandis and Usakos and the surrounding areas;
- collection of relevant technical information to address the concerns raised during the public meetings;
- various field surveys and special sampling surveys to address specific concerns identified during the scoping and public meeting phases;
- an evaluation of all aspects of the geohydrology of the Khan and Swakop Rivers relevant to the KARS project;
- modelling the hydrology and geohydrology of the Swakop and Khan Rivers with and without the KARS Dam in place;
- geotechnical investigations at the dam site;
- the engineering design of the dam structure, spillways and ground water recharge scheme;
- assessment of impacts;
- compilation of a Draft EIA Report for review;
- distribution of the Draft EIA Report to I&APs, (including Government Departments), and external reviewers for comment;
- collation of all comments and suggestions for improvement received from I&APs and the external reviewers; and
- Incorporation of comments, suggestions and revisions in the Final EIA Report (this document).

2.2.3 *Study area*

The study area for the environmental impact assessment is located in the lower portion of the Khan and Swakop River catchment. It includes the proposed dam site in the Khan River, some 10 kilometres upstream of the Rössing Mine, the Khan River Gorge down to the confluence with the Swakop River and finally the lower Swakop River down to where the Swakop River flows into the Atlantic Ocean.

The extent of the study area is shown in **Figures 2.1 and 2.2** which illustrate the larger catchment of the Swakop and Khan Rivers, and an enlarged area indicating the dam site and its relation to the Khan and lower Swakop rivers and the mining area, respectively.


LEGEND
SWAKOP CATCHMENT
KHAN SUBCATCHMENT
OMARURU
HENTIES BAY
STUDY AREA
ROSSING
SWAKOPMUND
WALVIS BAY
USAKOS
AMEIB
NAVACHAB
KARIBIB
SPES BONA
WILHELMSTAL
OTJIMBINGWE
WESTFALENHOF
SWAKOPPOORT DAM
GROSS BARMEN
OKAHANDJA
VON BACH DAM
WINDHOEK
WINDHOEK INTERNATIONAL AIRPORT
CSIR
SWAKOP AND KHAN RIVER CATCHMENT AREAS
Fig.: 2.1


TO USAKOS
ARANDIS
PROPOSED SITE
ROSSING MINING LICENCE NO 28
LEGEND
FARMS
ROADS
RIVERS
TOWNS
NAMIB - NAUKLUFT PARK
WEST COAST RECREATION AREA
KHAN RIVER
SWAKOP RIVER
SWAKOP FARMS
TO SWAKOPMUND
CSIR
LOCATION OF PROPOSED SITE
Fig .: 2.2

2.2.4 *Study team*

The Study team consisted of specialists selected from a wide variety of technical disciplines. The environmental team has worked closely with the engineering consultants to ensure that all environmental issues were investigated in relation to the scope and scale of the engineering plans, and to ensure that any engineering plans which may be developed took account of key environmental considerations.

The members of the Environmental team were:
Dr Peter Ashton, Water Resources Specialist and Project Leader, CSIR;
Mr Reinie Meyer, Geohydrologist, CSIR;
Ms Linda Godfrey, Geohydrochemist, CSIR;
Dr John Vogel, Isotope Physicist, CSIR;
Dr Stefan Woodborne, Isotope Physicist, CSIR;
Mr Siep Talma, Stable Isotope Physicist, CSIR;
Dr Peter Wade, Isotope Chemist, CSIR.
Mr Meiring Du Plessis, Irrigation Specialist, South African Water Research Commission.

Others who assisted in field surveys and data collection, or were contacted for their expert knowledge of selected aspects relating to the project or study area, included:

Mr Piet Marais, Geohydrologist, Swakopmund (ex Rössing);
Mr Piet Hamman, Hydrologist (ex DWA);
Dr John Ward, Chief Geologist, NAMDEB;
Mr Koos Schonees, Coastal Engineer, CSIR;
Various staff members of the Department of Water Affairs in Windhoek;
Mr Rainer Schneeweiss (Environmental Geologist) and Ms Sandra Kehrberg (Geohydrologist) of Rössing Uranium Limited;
Mr Lorenz Hesse, Irrigation Consultant, Swakopmund Municipality, provided important information relating to the use of ground water by smallholdings along the lower Swakop River.

The firm Metago Environmental Engineers, led by Dr Gordon McPhail, drew up the technical designs of the KARS Dam and related infrastructure. In addition, Mr Alistair James of Metago Environmental Engineers carried out the computer modelling of the effect of the KARS Dam on the hydrology and sediment transport characteristics of the Khan and Swakop river systems.

2.2.5 *Study period*

A preliminary scan to identify the main issues related to the KARS project began in November 1996 in Windhoek and Swakopmund, Namibia. As Rössing Management considered the project to be urgent in view of their assessment of the water requirements for the mine and that the drought cycle was about to be broken, BGIM prepared a preliminary list of issues so that specialist studies could start as soon as

possible if required. At this time a suitable site for the proposed dam had already been identified and the engineering consultants had been busy with a number of engineering issues relevant to the project. The preliminary scoping was followed by public meetings in Arandis and Swakopmund on 30 and 31 January 1997, respectively, followed by a visit to the proposed dam site the following day. The outcome of the personal interviews, public meetings and comments received, was compiled in an Issues Report by Brian Gibson Issue Management (BGIM, 1997) which was submitted to the CSIR in February 1997.

Throughout the project extensive coverage of the project was given in the media. A briefing paper in English, Afrikaans and German, describing the main features of the KARS project, was distributed to all I&APs and employees of Rössing. Advertisements for the public meetings were placed in the major Namibian newspapers and newsletters were distributed to I&APs throughout the project to keep them informed about progress on the project. The findings of the study, as compiled in the Draft EIA Report, were presented to I&APs at a series of public meetings during the period 27 to 29 May 1997. Copies of the Draft EIA Report were distributed at selected places in the main towns of the region to invite the public to comment on the contents. Comments on the report had to be submitted by the end of July 1997 for incorporation in the Final Report.

2.3 The role and scope of the EIA report

The main purpose of the EIA Report is to identify, on the basis of available information and the collection of new data in the field, those potential key issues and possible fatal flaws which could prevent the proposed KARS Project from proceeding. In this context, the term "fatal flaw" is used to describe an impact or set of circumstances which would be so adverse as to require the project to be abandoned or re-formulated. In addition, the EIA Report must be able to identify potential environmental impacts which may have a financial or engineering implication and should thus be taken into consideration in the design of the KARS Project.

The EIA Report also includes recommendations for mitigatory actions which can be identified at an early stage, as well as recommendations for the monitoring of those activities or environmental components where the information will be required to provide guidance to management.

The EIA studies have been carried out in parallel with the engineering feasibility studies conducted by Metago Environmental Engineers in order to provide the engineering team with information which may be relevant to the design phase of the KARS Project. It is anticipated that the next phase of the KARS Project, that of the final engineering design, will only proceed once agreement has been reached that the environmental issues have been dealt with satisfactorily and the economic analyses show that the project is viable.