Research and monitoring needs
Maintain a regular check on the presence of waste material in and around the construction site and work force camp.

5.2.5.3 Disturbance of local archaeological sites

Impact statement
Construction activities and the movements of large numbers of workers around the KARS Dam construction site could result in damage to or loss of archaeological sites. The research, educational and historical value of such sites could be lost.

Impact description
The only known archaeological site of possible interest is a small chalcedony outcrop used in the manufacture of stone implements and located some 10 kilometres away from the proposed KARS Dam site. There are no known archaeological sites in the immediate vicinity of the dam site. There would therefore appear to be little chance of this impact occurring.

Impact significance
The impact significance must be negligible in view of the apparent absence of archaeological sites near the dam site.

Impact mitigation
None required.

Research and monitoring needs
None required.

5.2.5.4 Severance of public access to the bed of the Khan River

Impact statement and description
Construction of a dam wall and the subsequent inundation of the dam basin will reduce the previous accessibility of the area to members of the public. Fencing off the dam site will exclude public access. Potentially affected parties are members of the Namib Off-road Club, desert touring companies and other individuals who may drive up the bed of the Khan River on an *ad hoc* basis.

Impact significance
It may be possible to allow public access over a 25 metre high dam wall via a firm "pathway" at the side of the dam wall (e.g. over the spillway) if this can be built during construction. In this case, it would also be necessary to provide access around the upstream flooded area to prevent vehicles bogging down in silt deposits. The steep topography of the terrain, coupled with the proximity of the Rössing property and protected areas within the Namib Naukluft Park, precludes the development of alternate routes outside the bounds of the bed of the Khan River.

The direct significance of this impact is considered to be minor. However, the secondary significance of this impact lies in the choice of alternative route(s) that the affected parties might use. The use of other, perhaps more sensitive, areas as alternate routes could have far greater impacts than the severance of public access caused by the dam wall alone.

Impact mitigation
No mitigation required other than the prevention of impacts resulting from people visiting the area. A possible option in this regard is the erection of a fence to limit public access to vulnerable portions of the dam wall and downstream spreading grounds.

The option of creating a safe "pathway" over the spillway region of the dam wall should be examined to test its feasibility.

Research and monitoring needs
None required.

5.2.5.5 Potential changes to the beach front in Swakopmund

Impact statement and description
There is a perception that, if the KARS Dam is built and is able to trap and retain small- to medium-sized floods, this will greatly reduce the quantity of sediments discharged from the mouth of the Swakop River into the shore zone of the Atlantic Ocean. It is perceived that sediments discharged by the Swakop River are vital to sustaining the beaches in Swakopmund.

Impact significance
There are no accurate estimates of the sediment load carried by the middle reaches of the Swakop River since construction of the Von Bach and Swakoppoort dams. However, since the contribution of Khan River flood flows to total flow in the lower Swakop River has increased, and assuming that both rivers have similar sediment-carrying capacities, it is clear that the contribution of sediments from the Khan River has also increased in proportion. Based on the Khan River's contribution to flood volumes in the lower Swakop River (**Section 4.2.6**), it is estimated that the Khan River now contributes an average of some 20 % of the total sediment load to the lower Swakop River. If the Khan River sediment load is eliminated, it will have a minor to moderate negative effect on sediment loads in the lower Swakop River.

Erosion and deposition patterns along the Namibian coastline are affected by the northerly directed longshore drift and, to a minor extent, by material brought down by local rivers during floods. The erosion pattern at Swakopmund beaches is similar to that at Sandwich Harbour to the south of Walvis Bay. Indications from coastal studies conducted elsewhere along the coastline are that coastal erosion rates have increased substantially in recent years. Sediments brought down the Khan and Swakop rivers and discharged into the sea generally have a very short-lived effect

before they are dispersed by wind and wave action. Therefore, the effect on the beaches of a reduction in the sediment load brought down by the Khan River is expected to be minor.

Impact mitigation
No mitigatory actions are considered to be technically or economically feasible.

Research and monitoring needs
A watch should be kept of rates of beach erosion and deposition at beaches along the Namibian coastline to determine if there is a regular pattern.

At Swakopmund, annual elevation surveys should be carried out of the beaches along a number of transects or profiles. If possible, a close check should be kept on rates of sediment transport along the coastline.

5.2.5.6 Interruption of sand-mining activities near Swakopmund

Impact statement and description
There is a perception that the sediments brought down by the Khan and Swakop Rivers replace the building sand that is removed during sand mining activities near the mouth of the Swakop River. Any reduction in the loads of sediment brought down by the Khan and Swakop rivers will adversely affect the replacement of this building sand.

Impact significance
Thermoluminescence dating techniques have revealed that the extensive sand deposits which have been mined in recent years are between 340 and 8,700 years old. No evidence could be found to support the contention that recent small- and medium-sized floods have brought down comparable material from the upper catchment. Instead, these smaller floods cause erosion of the existing deposits in the lower reaches of the Khan and Swakop rivers and merely re-distribute the material which is already in place. Therefore, any alteration of the current flooding regime in the Khan and lower Swakop rivers will have a negligible effect on the availability of new material for sand mining.

Impact mitigation
The current, somewhat haphazard methods of sand mining could be better organized so that the available sand resources could be utilized efficiently. This could also help to reduce water lost through evaporation and thereby help to reduce increased salinization of the ground water.

Research and monitoring needs
Annual evaluation of the areas affected by sand mining and the quantities of sand removed. In addition, a coherent management plan should be developed to facilitate sustainable utilization of the sand resources.

An annual elevation survey of the river bed profile at the two sand mining sites should be carried out to determine the rates of sand deposition and/or erosion.

5.2.5.7 Potential for sand dunes to migrate across the Swakop River into Swakopmund

Impact statement and description
There is a perception that those Swakop River floods which are able to reach the sea also scour out wind-blown sand dunes (from the south of the Swakop River) and prevent these from encroaching into the town of Swakopmund.

Impact significance
Examination of aerial photographs taken over the last thirty-five years have revealed that the large sand dunes located on the south bank of the Swakop River have been stationary during this period and have not migrated into or across the Swakop River. The predominant wind direction is towards the north-north-east and small quantities of wind-blown dune sand have accumulated in the bed of the Swakop River. In the event that these large sand dunes begin to migrate, their primary direction will be aligned with the wind direction. This could result in small quantities of sand dune material crossing the Swakop River in the region of Kilometre 3, where new smallholding plots have been laid out.

Any reduction in flood volumes in the lower Swakop River is unlikely to have any noticeable effect on the position or movement of these sand dunes, and they are unlikely to migrate across the Swakop River into the existing residential areas of Swakopmund.

Impact mitigation
None required.

Research and monitoring needs
Regular annual checks should be maintained on the sand dunes to determine whether or not they display any tendency to begin mobilizing. If the dunes start to mobilize the situation should be re-evaluated.

5.2.5.8 Impacts on the quantity and quality of ground and surface water available for downstream users

Impact statement and description
Farmers located along the lower reaches of the Swakop River already experience difficulties due to a progressive lowering of water levels, and thereby reduced quantities of water available, as well as a deterioration in the quality of water drawn from the bed of the Swakop River. There is a widespread belief that the proposed KARS Dam will cause a severe deterioration in water quality and cause a further drop in water levels. This will further reduce the quantities of water available for downstream suers and the water will become unfit for irrigation or stock-watering.

In turn, this could cause these farming activities to becoming uneconomic and, eventually, result in the cessation of all farming activities.

Impact significance

Modelling results have indicated that the current lowering of the water table and deterioration in water quality in the lower Swakop River is due largely to reduced surface water flows in the Swakop River as a result of the operation of the Von Bach and Swakoppoort Dams. Reduced surface water flows have caused recharge rates to decline, whilst evaporation at wetlands and by invasive vegetation has contributed significantly to a deterioration in water quality.

The surface (flood) water flows in the Khan River have helped to alleviate some of these problems. Prior to the construction of the Von Bach and Swakoppoort dams, the contribution from the Khan River was relatively small compared with that from the Swakop River. However, since these two dams were built, the importance of the Khan River contribution has increased rapidly. To date, it is estimated that, in the case of small floods (< 10 Mm^3), the Khan River could contribute anything up to 40-50 % of the total flow in the lower Swakop River. On several occasions, flows in the lower Swakop River have been derived entirely from the Khan River with no surface flows contributed by the Swakop River.

If small floods in the Khan River are trapped and prevented from reaching the Swakop River, the modelling results anticipate that, under worst case conditions, this could cause a further drop in ground water levels of some 10 to 40 centimetres, together with an increase in total dissolved salts of some 1,400 mg/ℓ (equivalent to a 15 % increase in the current total dissolved salts content of the ground water). This could potentially have moderate to serious impacts on irrigation farmers along the lower Swakop River.

In the absence of floods large enough to spill over the KARS Dam, and the slow flow rate of ground water in the Khan River (an average linear velocity of approximately 1 kilometre per year), any direct ground water effect arising from the proposed KARS Dam will not reach the lower Swakop River during the expected life of the KARS Dam. By the time that the KARS Dam would be decommissioned, any surface water flood flows would rapidly recharge the alluvium and improve ground water quality.

However, the loss of small- and medium-sized surface floods in the lower Khan River could result in there being virtually no surface recharge (at least to the lower Khan River) during the expected lifespan of the KARS Dam.

The bed of the Swakop River is above sea level and no sea water would intrude into the Swakop River aquifer as a result of declining water levels.

Impact mitigation

There is apparently a pattern of water quality improvement towards the centre of the lower Swakop River aquifer. Water drawn from this area would be of a better quality than that drawn from the banks of the Swakop River as most farmers do at

present. However, this could pose potential risk of loss of borehole equipment if the Swakop River comes down in flood. Therefore, any move to site boreholes near the centre of the Swakop River would have to be carefully considered. In addition, permission would have to be sought from the relevant authorities before this practice was attempted.

If approved, "communal" boreholes or wells could be constructed in the centre of the Swakop River. This would improve the efficiency of use of financial resources and would also allow careful construction to withstand floods.

Flood waters from small floods (< 10 Mm^3) arising in the Swakop River catchment downstream of Swakoppoort Dam could be trapped and the ground water recharged if a small-scale aquifer recharge scheme were to be implemented in the lower reaches of the Swakop River. This would lead to a rapid improvement in water quality and would prevent any unnecessary loss of flood waters to the sea.

Research and monitoring needs

The existing Rössing Mine ground water monitoring programme should be continued. In addition, new monitoring boreholes should be developed in the farming area along the lower Swakop River. These should be used to establish any patterns of water quality change across the Swakop River, as well as any changes which take place along the length of the river. The positions of these boreholes should be decided on in consultation with the farmers. These boreholes should also be sited so that they are not affected by current ground water abstraction patterns. A regular check must be kept on water levels and water quality at all boreholes.

5.3 Socio-economic benefits

5.3.1 Improved management and monitoring of area

Impact statement and description

The area affected by the aquifer recharge scheme should be managed and monitored on a continuous basis. The current water chemistry, water level and vegetation monitoring programmes should be continued and supplemented with additional monitoring of the reservoir basin, aquifer dynamics and the diversity of bird and animal life inhabiting the area around the reservoir basin.

Impact significance

The significance of this benefit will depend on the extent of additional monitoring and management actions that are initiated. The benefit is potentially of moderate to major significance as there are few protected riverine areas in the Central Namib region. These river systems are critical for the maintenance of the delicately balanced ecological processes which function in the Namib Desert; their conservation is therefore of prime importance.

Impact optimization
Allocate appropriate resources to continue and extend the existing monitoring programmes on affected areas along the Khan River. Draw up a combined monitoring programme schedule to incorporate the additional monitoring requirements.

Research and monitoring needs
As described under benefit optimization.

5.3.2 *Improved knowledge of aquifer functioning*

Impact statement and description
There will be an improvement in the knowledge and understanding of aquifer dynamics and recharge processes within both the Khan and Swakop river aquifers. This will also allow evaluation of the efficacy of the aquifer recharge scheme and its potential for application in other arid areas, as well as the extent and significance of its environmental impacts.

Impact significance
The benefits to be gained by this knowledge are potentially of major importance in an arid country like Namibia.

Impact optimization
Monitor, record and document the progress achieved and the resulting impacts during each stage of the project. Document and store all information in an easily retrievable form.

Research and monitoring needs
As described under impact optimization.

5.3.3 *Improved conservation of existing water resources*

Impact statement and description
If this project is successful, the existing ground water reserves in the Khan River aquifer will provide an effective supplementary source of water to the Rössing Uranium Mine. This aquifer recharge scheme will supply sufficient brack water to meet the dust suppression and process water demands of the Rössing Uranium Mine and reduce the mine's dependence on freshwater supplies.

Impact significance
Despite the relatively small quantities of water involved, the benefits to be derived from the Khan River aquifer recharge scheme will be of major significance to the Central Namib region. The eventual significance will depend on the care with which the recharge scheme is operated and maintained.

Impact optimization
A balance must be maintained between water abstraction from, and water recharge to, the Khan River aquifer. The operational management of the Kars Dam and infiltration basins must be well-planned, implemented, monitored and publicised. In addition, the contribution of Khan River water to the overall water balance within the CNSWS should be regularly monitored and publicised on an on-going basis.

Research and monitoring needs
As described under impact optimization.

5.3.4 *Improved recreational opportunities*

Impact statement and description
The area around the new dam site is expected to sustain increased riparian vegetation and attract increased numbers of birds and animals to this habitat. This could provide an opportunity either to create a public access picnicking area or to proclaim a controlled access conservation area.

Impact significance
The benefit is considered to be of minor to negligible significance, depending on the decision to allow public access and the type and level of facilities provided.

Impact optimization
The dam site should be restored to as near a natural state as possible after construction is completed. Consideration should be given to allowing limited public access to the dam site and, if public access is granted, appropriate access roads should be provided as well as sanitation and suitable facilities to minimize fire hazards and littering.

Research and monitoring needs
None required.

5.4 Financial viability of the KARS project

Impact statement and description
The proposed KARS Dam facilitates the use of brackish water at a location where significant economic benefit to Rössing and local, regional and National Government coffers. The water requires minimal treatment to render it fit for industrial use, unlike present resources which comprise potable water which, in time, would comprise a base volume of desalinated sea water.

Impact significance
Since treated water is sold on a full-cost recovery basis at minimal mark-up, any brackish untreated water used to replace the treated water would result in a real

financial saving to Rössing. Coastal residents would also benefit financially by virtue of a reduced rate of commissioning of desalination modules.

The effective use of water (per cubic metre) from the KARS Project will be of the order of N$ 0.41/cubic metre for a 20-year scheme. Over this period an average volume of 1,500 cubic metres per day would have been abstracted from the Khan River over and above currently sustainable abstraction rates. Namibia's available surface water resources are either insufficient or, if exploited, would have significant social and environmental impacts. Therefore, in the long-term, Namibia cannot avoid the need to desalinate sea water to meet the needs of its growing population and expanding economy.

Impact optimization
The KARS Project should be implemented along with all relevant mitigatory actions as soon as practicable to maximize the benefits.

Research and monitoring needs
The quantities of water used and the economic benefits gained should be monitored and publicised regularly as part of the ongoing awareness and communication campaign.

5.5 Summary of issues and anticipated impacts

The expected impacts of dam construction in the Khan River are summarized in **Table 5.1**. This table also summarizes the duration, scale, degree of reversibility, potential for mitigation and overall significance of the expected impacts.

The major ecological impacts centre on the loss of riparian and other vegetation at and above the dam site due to inundation and siltation, as well as along the lower Khan River (**Table 5.1**). The loss of riparian vegetation along the lower Khan River will also affect a portion of the dispersion/migration corridor formed by the riparian ecosystem and interference with the dynamics of the Khan River aquifer system could also have serious implications for the Khan River ecosystem. If the recommended mitigatory actions are implemented, many of the impacts are likely to have minor significance. However, in the case of impacts on downstream riparian vegetation, mitigatory actions are unlikely to succeed since it would be virtually impossible to prevent a wide-scale and medium-term lowering of the ground water table.

The major socio-economic impacts associated with the construction of a dam wall across the Khan River centres on the adverse effects on downstream users along the lower Swakop River (**Table 5.1**). The potential for mitigatory management actions on the socio-economic impacts are also summarized in **Table 5.1**.

The major benefits associated with the construction of a dam wall across the Khan River centre on the acquisition of improved knowledge of aquifer dynamics, maintenance of ground water levels for riparian vegetation along the Rössing Mine

Minor additional benefits are gained by the development of new riparian habitats along the shoreline of the new reservoir. Appropriate optimization actions, as listed in each section, including suitable monitoring programmes, enhance the perceived benefits.

An additional benefit, which cannot at this time be properly quantified, is the strong likelihood that the aquifer recharge scheme will improve the quality of the ground water in the Khan River aquifer. Whilst this observation is based on the lower total salt content of flood waters compared to existing ground water in the Khan River aquifer, the degree of improvement in ground water quality can not be predicted accurately.

The overall conclusions and recommendations as to the KARS Project and an overview of appropriate mitigatory or optimization actions that are required to minimize impacts and optimize benefits are given in **Chapter 6** of this Report.

5.6 Outline of possible mitigatory actions

Each section in **Chapter 5** has provided details of the potential impacts associated with the implementation of the KARS Project, together with appropriate mitigatory actions which would reduce the negative aspects of these impacts. A more detailed overview of these mitigatory actions is given in **Chapter 6** of this Report.

Table 5.2 summarizes the resulting impacts after these mitigatory actions have been implemented. A comparison of **Table 5.1** with **Table 5.2** provides a clear indication of the extent to which the impacts would be reduced by the mitigatory actions listed for each impact.

Table 5.1: Summary of key issues and the significance of the anticipated impacts caused by the KARS Project, **without mitigation actions**. Shading indicates all impacts which are regional and which have medium-high to high severity and significance.

Environmental Component or Activity Affected		Impact Type	Sign	Scale	Duration	Severity	Certainty	Significance
Surface water flows	Khan	Direct	Negative	Local	Medium	High	Definite	High
	Swakop	Direct	Negative	Regional	Medium	Moderate	Definite	Medium
Ground water flows	Khan	Direct Direct	Positive (dam & mine) Negative (downstream)	Local Local	Medium Medium	Moderate High	Definite Definite	High High
	Swakop	Direct	Negative	Regional	Medium	Moderate-High	Definite	Medium-High
Ground water levels	Khan	Direct Direct	Positive (dam & mine) Negative (downstream)	Local Local	Medium Medium	Moderate High	Definite Definite	High High
	Swakop	Direct	Negative	Regional	Medium	Moderate	Definite	Medium-High
Ground water quality	Khan	Direct	Positive	Local	Medium	Moderate	Probable	Medium
	Swakop	Direct	Negative	Local	Medium	Moderate-High	Definite	Medium-High
Sediment loads	Khan	Direct	Negative	Local	Medium	Moderate-High	Definite	Medium-High
	Swakop	Direct	Negative	Regional	Medium	Moderate	Probable	Low-Medium
Riparian vegetation	Khan	Direct Direct	Positive (dam & mine) Negative (downstream)	Local Regional	Medium Medium	Moderate-High High	Definite Definite	High High
	Swakop	Direct	Negative	Regional	Medium	Low-Moderate	Probable	Low-Medium
Birds		Indirect	Zero	Local	Medium	Low	Possible	Low-Medium
Mammals		Indirect	Zero	Local	Medium	Low	Possible	Low-Medium
Reptiles and amphibians		Indirect	Zero	Local	Medium	Low	Possible	Low-Medium
Ecological integrity		Direct	Negative	Regional	Medium	Moderate	Probable	Medium
Dune encroachment		Indirect	Zero	Local	Medium	Low-Zero	Probable	Zero
Replacement of sand		Direct	Zero	Local	Medium	Low-Zero	Definite	Low
Beach/coastal erosion		Indirect	Zero	Local	Medium	Low-Zero	Probable	Low
Aesthetic values		Direct	Negative	Local	Medium	Low-Moderate	Probable	Low-Medium
Off-road vehicle travel		Direct	Negative	Local	Medium	Low	Definite	Low
River water utilisation	Khan	Direct	Positive	Local	Medium	Moderate	Definite	Medium-High
	Swakop	Direct	Negative	Regional	Medium	Moderate	Definite	Medium-High

Table 5.2: Summary of key issues and the significance of the anticipated impacts caused by the KARS Project, **with all mitigation actions implemented**. Shading indicates all impacts which are regional and have medium-high to high severity and significance.

Environmental Component or Activity Affected		Impact Type	Sign	Scale	Duration	Severity	Certainty	Significance
Surface water flows	Khan	Direct	Negative	Local	Medium	High	Definite	High
	Swakop	Direct	Negative	Regional	Medium	Moderate	Definite	Medium
Ground water flows	Khan	Direct Direct	Positive (dam & mine) Negative (downstream)	Local Local	Medium Medium	Moderate Moderate-High	Definite Definite	High Medium-High
	Swakop	Direct	Negative	Regional	Medium	Moderate	Definite	Low-Medium
Ground water levels	Khan	Direct Direct	Positive (dam & mine) Negative (downstream)	Local Local	Medium Medium	Moderate Moderate	Definite Definite	High Medium-High
	Swakop	Direct	Negative	Regional	Medium	Moderate	Definite	Medium
Ground water quality	Khan	Direct	Positive	Local	Medium	Moderate	Probable	Medium
	Swakop	Direct	Negative	Local	Medium	Low-Moderate	Definite	Low-Medium
Sediment loads	Khan	Direct	Negative	Local	Medium	Moderate-High	Definite	Medium-High
	Swakop	Direct	Negative	Regional	Medium	Moderate	Probable	Low-Medium
Riparian vegetation	Khan	Direct Direct	Positive (dam & mine) Negative (downstream)	Local Regional	Medium Medium	Moderate-High Moderate-High	Definite Definite	High Medium-High
	Swakop	Direct	Negative	Regional	Medium	Low	Probable	Low-Medium
Birds		Indirect	Zero	Local	Medium	Low	Possible	Low-Medium
Mammals		Indirect	Zero	Local	Medium	Low	Possible	Low-Medium
Reptiles and amphibians		Indirect	Zero	Local	Medium	Low	Possible	Low-Medium
Ecological integrity		Direct	Negative	Regional	Medium	Low-Moderate	Probable	Low-Medium
Dune encroachment		Indirect	Zero	Local	Medium	Low-Zero	Probable	Zero
Replacement of sand		Direct	Zero	Local	Medium	Low-Zero	Definite	Low
Beach/coastal erosion		Indirect	Zero	Local	Medium	Low-Zero	Probable	Low
Aesthetic values		Direct	Negative	Local	Medium	Low-Moderate	Probable	Low-Medium
Off-road vehicle travel		Direct	Negative	Local	Medium	Low	Definite	Low
River water utilisation	Khan	Direct	Positive	Local	Medium	Moderate	Definite	Medium-High
	Swakop	Direct	Negative	Regional	Medium	Moderate	Definite	Low-Medium

6. SUMMARY OF IMPACTS, MITIGATORY ACTIONS AND FURTHER RECOMMENDATIONS

This Chapter contains a brief, summarized overview of the impacts identified during the Project, together with suggestions for provisional mitigatory actions. In addition, since communication issues are critical to the success of this process, we make suggestions as to where and how the communication process can help to improve the general public's perceptions of the motives of the project proponents as well as the environmental evaluation process.

Full details of the anticipated environmental impacts have been listed previously under the relevant issues of concern. The reader is referred to the appropriate sections of **Chapter 5** of this Report for these details.

6.1 Key impacts and issues of concern

A summary of all the major environmental impacts and their geographical locations identified during the project are listed in **Tables 6.1 and 6.2.** In these tables, the duration of the impact, together with the scale, degree of reversibility and potential for mitigation are summarized for ecological issues in **Table 6.1** and for socio-economic issues in **Table 6.3**.

6.2 Proposed mitigatory actions and recommendations

Should Rössing Management eventually decide to continue with implementation of the KARS project, it will be necessary to implement a series of selected mitigatory actions. These mitigatory actions should be designed in such a way as to minimise adverse impacts and maximise the potential benefits associated with the KARS project. In accordance with Rio Tinto and Rössing operational policies of employing best practices during all operations, all mitigatory actions will be designed to comply with best practice. It is important to remember that all actions have an element risk and uncertainty attached to them; no actions or recommendations can be 100 % certain to succeed. However, every reasonable precaution and design technique will be taken to minimize risks within the constraints of available proven technology.

It is important that all mitigatory actions which are intended to alleviate potential adverse impacts on individuals and communities, should be designed in conjunction with the affected individuals and communities, as well as Rössing staff and, if required, staff from the Department of Water Affairs. If these individuals and communities are not involved in this process, it is unlikely that the proposed mitigatory actions will ever be successful. **Clearly, even if the KARS Project does not proceed, the mitigatory actions listed below would assist in improving the overall water management of the region**.

Table 6.1: Summary table showing the duration, scale, degree of reversibility, potential for mitigation and significance of the ecological impacts associated with the KARS Project.

ECOLOGICAL IMPACT	DURATION			SCALE			REVERSIBILITY		POTENTIAL FOR MITIGATION			IMPACT SIGNIFICANCE
	Short (S)	Medium (M)	Long (L)	Local (L)	Sub-Regional (SR)	Regional (R)	Reversible (R)	Non-Reversible (NR)	Low (L)	Medium (M)	High (H)	Assumes recommended mitigatory actions are implemented
Riparian habitat at and above construction site is lost or removed during construction			L	L				NR	L			Medium
Rare and/or endangered species are lost from the dam basin			L	L & SR			?	?		M		Low to Medium
Downstream riparian vegetation is damaged	S	M	L		SR		R			M		Medium to High
Increased spread of alien vegetation			L		SR		R				H	Low to Medium
Loss of dispersion/migration corridor	S	M	L	L & SR			?	?	L			Medium
Loss of sediments and nutrients to downstream ecosystems after dam construction			L		SR		Partially R			M		Medium
Erosion rates below dam wall elevated when water spills over spillway or spreading grounds			L	L & SR			Partially R			M		Low
Fauna are disturbed by elevated noise and dust levels during construction	S			L			R				H	Low
Water abstraction interferes with the dynamics of the Khan River aquifer system			L	L & SR			Partially R			M		Medium to High
Groundwater quality in the lower Khan River improves due to recharge		M & L			SR		Partially R		L			Low
Groundwater quality in the lower Swakop River deteriorates		M & L			SR		Partially R		L			Medium to High

Table 6.2: Summary table showing the duration, scale, degree of reversibility, potential for mitigation and significance of the socio-economic impacts associated with the KARS Project.

SOCIO-ECONOMIC IMPACT	DURATION			SCALE			REVERSIBILITY		POTENTIAL FOR MITIGATION			IMPACT SIGNIFICANCE
	Short (S)	Medium (M)	Long (L)	Local (L)	Sub-Regional (SR)	Regional (R)	Reversible (R)	Non-Reversible (NR)	Low (L)	Medium (M)	High (H)	Assumes recommended mitigatory actions are implemented
Forecasts of future water demands are uncertain or inaccurate			L		SR		?			M		Medium
Silt accumulation reduces dam lifespan and limits success of aquifer recharge project			L		SR & R		Partially R			M		Medium
Borrow areas and construction site are aesthetically unattractive	S & M			L			R				H	Low
Increased litter and waste around the construction site and camp	S			L & SR			R				H	Low
Local archaeological sites are disturbed			L	L				NR	L			Zero
Public access to the full length of the Khan River bed is severed			L	L & SR			?	?	L			Low
Sand dunes encroach into Swakopmund		M		L			Partially R		L			Zero to Low
Low rates of sand replacement affect sand-mining activities		M		L				NR	L			Low
Swakopmund beaches erode because sand is not replaced		M		L & SR				NR	L			Low
Drop in water levels affect farmers along the lower Swakop River			L		SR			NR	L			Medium to High
Deterioration in water quality affects downstream farmers along the lower Swakop River			L		SR			NR	L			Medium to High

In this regard, it will be important to ensure that all interested and affected parties are kept informed of progress over the longer-term.

6.2.1 Develop an Environmental Management Plan

All mitigatory actions should be developed within the context of an environmental management plan. This plan should be drawn up to ensure that all monitoring and mitigatory actions are closely co-ordinated at all times, and that they reflect the consensus decisions reached with those individuals and communities who may be affected by the KARS Project and resultant mitigatory actions. Therefore, the environmental management plan should focus on those areas which require attention and/or action and should be developed in collaboration with the individuals concerned.

The environmental management plan must contain sufficient information on the anticipated impacts that the reasons for mitigatory action are clear. In addition, the plan must contain a list of firm and unambiguous practical suggestions for action, list the parties and individuals who shall be responsible for implementing these actions, a firm timetable within which the actions must be carried out, a description of the methods which shall be used to monitor and evaluate the success of these actions, and a schedule of reporting back to the interested and affected parties, as well as appropriate authorities.

This plan should be drawn up during the early stages of detailed planning for the KARS Project, and should form an integral part of the Project. Potential mitigatory measures which could be considered are set out below.

6.2.2 Additional aquifer recharge in the lower Swakop River

The principles of aquifer recharge considered for the KARS project could also be applied in the Lower Swakop River to overcome the progressive decline in water levels and deteriorating water quality. This action will, in addition, help to make maximum use of the available fresh water resources. Precise details of this action would need to be decided in conjunction with the potentially affected landowners and taking into account the best available geohydrological information.

6.2.3 Ground water quality - lower Swakop River

Here, too, it is feasible to improve ground water quality abstracted by landowners through a combination of aquifer recharge actions (listed above) and the judicious emplacement of abstraction points in the river bed. In addition, this would also apply to the choice of abstraction methods (wells, open cut trenches and boreholes). Once again, this will require a thorough understanding of the geohydrological conditions which prevail in the area. Within this context there are several opportunities whereby

neighbouring land owners can jointly achieve improved water availability and access to better quality water through careful emplacement of communal abstraction points and abstraction regimes. Here, too, economies of scale are possible.

6.2.4 Coastal and beach erosion

No specific mitigatory actions are feasible or necessary within the context of the KARS project. Coastal and beach erosion processes are naturally variable, and are not dependent on the supply of water or sediment from the Swakop/Khan River system. The scale of these coastal processes is outside the scope of this river system.

6.2.5 Riparian vegetation

Careful control of downstream ground water levels will ensure that the riparian vegetation does not experience adverse impacts as a result of the KARS Project. However, given the anticipated scale of water abstraction from the Rössing wellfield, it is almost certain that ground water levels will drop beyond a point which will ensure the survival of the riparian vegetation down to the junction with the Swakop River. This can only be mitigated by reducing the abstraction rate from the wellfield; in turn, this will reduce the economic attractiveness of the proposed KARS scheme to Rössing Management.

6.2.6 Water use in the lower Swakop River

Once again, the principles of aquifer recharge listed above, and concerted efforts to minimize the effects of poor water quality, will enable water use patterns that maximise the benefits of the fresh water resources of the Swakop/Khan system. This will also help to alleviate current and future pressures on other aquifer system in the Central Namib Area.

6.2.7 Sand mining

The current practices employed in sand mining activities in the lower Swakop River are having a significant adverse impact on the lower Swakop River aquifer. However, through careful management and planning this situation can not only be improved, but could also lead to an improvement in operating practices and the aesthetic values of this important tourist area. More importantly, if sand mining practices are planned in conjunction with aquifer management practices, it would result in considerable benefits to both the sand miners and to water users. **In this regard, it would be feasible to restructure the sand mining processes to minimize their negative effects on water levels and water quality, whilst using spoil material to enhance recharge.**

6.2.8 Erosion at the KARS dam site spillway

Careful design of the KARS Project, employing scale modelling techniques, would assist in minimizing the probability and scale of adverse effects caused by erosion downstream of the spillway.

6.2.9 Recreational access in the Khan River

The anticipated problems of public access through and around the KARS Dam site can be incorporated into the planning of the dam structure and recharge bunds. In this way, other than those times when water is flowing or standing in the system, access can be provided through carefully demarcated routes, thereby enabling recreational users of the Khan River continued access and use of the river system.

During periods when surface water is present in the system, selected alternative routes can be identified for recreational traffic. This should take into account the fact that it would not be desirable to allow unrestricted access to the Rössing Mine site or to the Namib Naukluft Park. Thus, recreational traffic would be required to exit the Khan River system at selected points and re-enter the system at other points upstream of the KARS Dam site.

6.3 The communication process

The Swakop - Khan River system is an episodic or ephemeral river system and, as such, is very sensitive to any upstream modification or interference. Any proposed development project in the catchment of the Khan and/or Swakop rivers therefore needs to be thoroughly and carefully investigated prior to implementation. Moreover, it is imperative that all interested parties, including both residents who may be directly affected, and NGOs and conservationists who may be indirectly affected, be given the opportunity to fully participate in all phases of these investigations. Failure on the public relations front, as well as poor levels of consultation and involvement, could jeopardise even technically sound development projects.

Several NGOs in Namibia have expressed strong interest in natural resource conservation in the Swakop and other river catchments. One of their prime concerns has centred on the issue of possible cumulative impacts, where the proposed KARS aquifer recharge scheme is considered to add more pressure onto an ecological system which is perceived to be already under considerable strain from existing and proposed future developments. In addition, many local residents have shown high levels of suspicion towards the proposed aquifer recharge scheme.

In recent months, many newspaper articles concerning the public's perceptions of the proposed aquifer recharge scheme have appeared in the Namibian media. Whilst some of these articles are both factually correct and objective in their assessments, many articles have been factually incorrect or have drawn incomplete or incorrect

conclusions from the available information. In turn, this has led to a situation where many residents are mis-informed as to the background to the proposed project, the anticipated scale of activities and the scope and level of detail of attendant environmental investigations.

Clearly, the media have an important role to play in fully informing the public in Namibia about topical issues; this they certainly have achieved. However, their main concern seems to centre on perceptions that the proposed aquifer recharge scheme may represent a so-called "foot in the door" which could well lead to even greater or larger schemes being implemented in the future. Given the anticipated size of the present KARS proposal (a 9 Mm^3 capacity dam), and the regional shortage of water in the Central Namib Area, there may be good reason for at least some of their concern in this regard. Accordingly, it is vitally important that the Department of Water Affairs seek to communicate widely the exact scale of the present proposals, as well as the wider strategic importance of optimizing the region's scarce water resources.

It is becoming increasingly obvious that the general public need to be more fully and factually informed about the structure and findings of the project. Frequent public meetings and press releases could help to achieve this. Similarly, a philosophy of open and frank public communication must be followed at all times, together with a policy of public participation and involvement.

Throughout southern Africa, there is widespread public concern for the safety, security, affordability and integrity of regional and local water resources. Though sometimes ill-informed, considerable public debate has been focused on a number of closely-related issues in recent years. These issues have included:

- the need to centralize strategic (national, inter-basin and sub-continent) water resource management decision-making whilst de-centralizing day-to-day operational management actions;
- evaluating the suitability and affordability of alternative water resource exploitation scenarios against short-, medium- and long-term projections of economic and population growth and the resulting increasing demand for water;
- selecting and securing the technical and economic means whereby rural and urban communities can be supplied with wholesome water supplies at an affordable cost;
- the question of "ownership" of ground and surface water resources, and the attendant "right" to exploit these resources; and
- selecting those management approaches which will help to retain the essential aesthetic values and essential ecological functions associated with water systems.

The proposed KARS aquifer recharge scheme on the Khan River has presented the Namibian authorities with the opportunity to expand their current communication processes and initiate a comprehensive long-term communication process with all their citizens. Ideally, this process should not be confined to the proposed water abstraction scheme but should be extended to include all aspects of shared water resource use and similar issues.

In such a process, each community can help jointly to address the issues of public perceptions and fears around water resource management. The ultimate outcome of such an information-sharing process is a better-informed and more supportive public, who better understand the issues at stake and are better able to contribute meaningfully to the democratic decision-making process.

6.4 Actions that are required, whether or not the KARS Project proceeds

The investigative and communications processes which have been followed during the execution of this assessment of potential impacts associated with the KARS Project have yielded several important insights and findings. Also, many of the mitigatory actions which have been identified as having the potential either to minimize negative impacts or to improve the current situation, could be implemented with immediate effect. All of these mitigatory actions could assist local communities and Government Departments with their efforts to ensure long-term, sustainable water resource management in the West Coast region of Namibia.

Therefore, whether or not the Management of Rössing Uranium decide to proceed with the KARS Project, it is strongly recommended that the following actions should be implemented and maintained. The direct benefits to all stakeholders concerned would consist of the following:

- Increased quantities of water available for utilization along the lower Swakop River;
- Improved ground water quality along the lower Swakop River; and
- Improved understanding and ability to manage the ground water resources of the lower Swakop River.

The essential actions which should be implemented as soon as possible consist of the following, in order of importance or priority:

1. **A carefully designed control programme to remove as many alien trees (particularly *Prosopis*) from the river beds of the lower Khan and Swakop Rivers should be implemented. In addition, a proportion (say 50 %) of the dense growths of indigenous *Tamarisk* trees which have developed in the lower Swakop River could also be removed. These dense *Tamarisk* growths have been promoted by the reduced size and number of floods in the Swakop River, due to construction of the Von Bach and Swakoppoort dams.**