Metago

ENVIRONMENTAL IMPACT ASSESSMENT REPORT FOR THE PROPOSED HUSAB MINE

Prepared For

Swakop Uranium (Pty) Ltd

METAGO PROJECT NUMBER: M009-03

REPORT NO.: 2

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METAGO OFFICES	
Johannesburg, South Africa Physical Address: Metago House Fourways Manor Office Park Corner Roos and Macbeth Streets Fourways Johannesburg South Africa Postal Address: P O Box 1596 Cramerview 2060 Tel: +27 (011) 467-0945 Fax: +27 (011) 467-0978 Web: www.metago.co.za	Pretoria, South Africa Physical Address: Pentagon House 669 Plettenberg Rd Faerie Glen Pretoria South Africa Postal Address: P O Box 40161 Faerie Glen 0043 Tel: +27 (012) 991-8881 Fax: +27 (012) 991-1907 Web: www.metago.co.za

ENVIRONMENTAL IMPACT ASSESSMENT REPORT FOR THE PROPOSED HUSAB MINE

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ACRONYMS AND ABBREVIATIONS

Included below is a list of acronyms and abbreviations relevant to this report.

Acronyms	Description
a	Annum
ABA	Acid Base Accounting
AEB	AEB Atomic Energy Board of Namibia
ADU	Ammonium diuranate
Al	Aluminium
AMD	Acid Mine Drainage
amsl	above mean sea level
AP	Acid Potential
APP	Airshed Planning Professionals
ARD	Acid rock drainage
ATC	The Arandis Town Council
dBA	Decibels
BID	Background Information Document
bn	Billion
Bq	becquerel unit of radioactivity (1 Bq = 1 disintegration per second)
BSC	Biological soil crust
°C	Degree centigrade
CCD	Counter Current Decantation
CEC	Cation Exchange Capacity
Ci	curie unit of radioactivity (1 Ci = 3.7 x 1010 disintegrations per second)
CIX	Continuous Ion Exchange
CO	Carbon monoxide
CO_2	Carbon dioxide
CoM	Chamber of Mines
CSIR	Council for Scientific and Industrial Research in South Africa
Cu	Copper
d	Day
dB	Decibels
DEA	Directorate of Environmental Affairs
DEM	Digital Elevation Model
DPM	Diesel Particulate Matter
DRC	Democratically Resettled Community
DRFN	Desert Research Foundation of Namibia
DU	Domestic use
DWA	Department of Water Affairs (now DWAF)
DWAF	Department or Water Affairs and Forestry
EC	European Community
EIA	Environmental Impact Assessment
EMA	Environmental Management Act
EMP	Environmental Management Plan
EPL	Exclusive Prospecting Licence
ERC	Erongo Regional Council

Acronyms	Description
ESIA	Environmental and Social Impact Assessment
ESS	Earth Science Solutions
EVA	Economic value added
FENATA	Federation of Namibia Tourist Associations
2g/ℓ	Grams per litre
GDP	Gross Domestic Product
GGP	Gross Geographic Product
GIS	Geographical Information Systems
GRN	Government of the Republic of Namibia
GSN	Geological Survey of Namibia
GWe	Giga Watt of energy
h	Hour
HBF	horizontal belt filters
H_2SO_4	Sulphuric acid
HC	Hydrocarbons
HDPE	High density polyethylene
HPGR	High pressure grinding roll
NO_2	Nitrogen dioxide
HPA	Health Protection Agency
IAP	Interested and Affected Party
IBA	Important Bird Areas
IBC	Intermediate Bulk Containers
ICMM	International Council on Mining and Metals
ICP-MS	Inductively Coupled Plasma Mass Spectrometry
ICRP	International Commission on Radiological Protection
IDP	Integrated Development Plan
IEM	Integrated Environmental Management
IFC	International Finance Corporation
IFRS	International Financial Reporting Standards
IMDG	International Maritime Dangerous Goods
IMF	International Monetary Fund
IOE	index of erosion
IPPR	Institute for Public Policy Research
IX	Ion exchange
J	Joule unit of energy
K	Potassium
k	Kilo (a thousand)
K factor	Soil erodibility factor
kg	Kilogram
km^2	square kilometres
kPa	Kilopascal
kV	Kilo Volt
ℓ	Litre
LA	Local Authorities
lb	pound (of weight)
LHU	Langer Heinrich Uranium Mine

Acronyms	**Description**
LLRD	Long lived Radioactive Dust
LM	Local Municipality
LOM	Life of Mine
LSL	Loaded Strip Liquor
LV	Low Voltage
M	Mega, million, x 10^6
m	Milli one thousandth x 10^{-3}
m	Metre
M	Million
Mg	Magnesium
m/s	metres per second
mamsl	Metres above mean sea level
MAP	Mean Annual Precipitation
MAR	Mean Annual Runoff
masl	metres above sea level
MAWF	Ministry Water Affairs and Forestry
MAWRD	Ministry of Agriculture Water and Rural Development (now MAWF)
MEE	Metago Environmental Engineers
MET	Ministry of Environment and Tourism
MFMR	Ministry of Fisheries and Marine Resources
mg	Milligram
mg/ℓ	milligram/litre
MHSS	Ministry of Health and Social Services
min	Minute
ML	Mining Licence
Mlb(s)	Million pounds (of uranium in the context of this SEA)
MLR	Ministry of Lands and Resettlement
mm	Millimetres
mm/a	millimetres per annum
Mm^3	million cubic metres
Mm^3/a	million cubic metres per annum
MME	Ministry of Mines and Energy
MMSD	Mining Minerals and Sustainable Development Project
MoHSS	Ministry of Health and Social Services
MPC	Mineral Processing Complex
MRA	Marine Resources Act
MRLGH	Ministry of Regional and Local Government and Housing
$mSv.a^{-1}$	millisievert per annum
MTI	Ministry of Trade and Industry
MV	Medium Voltage
MW	Mega Watt
MWTC	Ministry of Works Transport and Communications
N$	Namibian Dollar
NACOBTA	Namibia Community based Tourism Association
NACSO	Namibian Association for Community Based Natural Resource Management Support Organisations

Acronyms	Description
NAG	Net Acid Generating
NAF	Not acid forming
NamPower	Namibia Power Corporation
NamWater	Namibia Water Corporation Ltd
NaOH	Sodium Hydroxide
NAPHA	Namibia Professional Hunters' Association
NAPP	Net Acid Producing Potential
NCCI	Namibian Council for Commerce and Industry
NDP	National Development Plan
NEPRU	Namibian Economic Policy Research Unit
NGO	Non Governmental Organisation
NHA	National Heritage Act
NIED	National Institute for Educational Development
NIMCIX	National Institute of Metallurgy continuous ion exchange
NIMT	Namibian Institute of Mining & Technology
NLA	Newtown Landscape Architects
NMCF	Namibian Mine Closure Framework
NMS	Namibia Meteorological Service
NNNP	Namib Naukluft National Park
NNP	Net Neutralising Potential
NO_x & NO_2	Oxides of nitrogen & Nitrogen dioxide
NP	Neutralising Potential
NPC	National Planning Commission
NPR	Neutralising Potential Ratio
NRPA	National Radiation Protection Authority
NSX	Namibian Stock Exchange
NTB	Namibia Tourism Board
NWP	National Water Policy
O/C	Outcrop
ORP	Oxidation reduction potential
OSL	Luminescence
P	Phosphorus
PAF	Potentially acid forming
PAH	Polycyclic aromatic hydrocarbons
PAYE	Pay-As-You-Earn
Pb	chemical symbol for lead
Pers. comm.	Personal communication
PLS	Pregnant leach solution
PM10	Particulate matter less than 10 microns in size
PPP	Public Participation Process
R roentgen	unit of radiation exposure
Ra	chemical symbol for radium
RCD	Reverse Circulation Drilling
RMP	Radiation Management Plan
Rn	chemical symbol for radon
ROD	Record of Decision

Acronyms	Description
ROM	Run Of Mine
RSA	Republic of South Africa
RTE	Rare, threatened or endangered
RUL	Rössing Uranium Mine
RWD	Return Water Dam
SABS	South African Bureau of Standards
SADC	Southern African Development Community
SAG	Semi-Autogenous Grinding
SAIEA	Southern African Institute for Environmental Assessment
SAM	Social Accounting Matrix
SAR	Sodium adsorption ratio
SDU	Sodium diuranate
SEA	Strategic Environmental Assessment
SEMP	Strategic Environmental Management Plan
SIA	Social Impact Assessment
SME	Small to Medium Enterprise
SMME	Small Medium and Micro Enterprise
SO_2	Sulphur dioxide
SPLP	Synthetic preparation leaching procedure
STC	Swakopmund Town Council
Sv	sievert unit of equivalent dose
SX	Solvent Extraction
TAM	Total Available Moisture
TASA	TASA Tour & Safari Association of Namibia
TCLP	Toxicity characteristic leaching procedure
TDS	Total Dissolved Solids
Th	chemical symbol for thorium
TOC	Total Organic Carbon
TOR	Terms of Reference
TSP	Total suspended particulates
TWQG	Target Water Quality Guidelines
U	chemical symbol for uranium
UP	Uranium peroxide
USC	Uranium Stewardship Council
VAC	Visual Absorption Capacity
W	Watt
WCRA	West Coast Recreational Area
WHO	World Health Organization
WRD	Waste Rock Dumps
WRMA	Water Resource Management Act 2004 (Act 24 of 2004)
WTY	Waste Transition Yard
XRF	x-ray fluorescence
Zn	Chemical symbol for zinc
µ	micro - one millionth
$\mu Sv.a^{-1}$	Micro Sievert per annum

EXECUTIVE SUMMARY

General introduction

Swakop Uranium (Pty) Ltd (Swakop Uranium) is a wholly-owned subsidiary of Extract Resources Ltd (Extract), which is an Australian-based uranium exploration and development company. Exploration activities have been undertaken by Extract in Exclusive Prospecting Licence (EPL) 3138, which includes the Husab (previously Rössing South) and Ida Dome deposits. Swakop Uranium plans to develop the Husab deposit into a uranium mine with a design capacity to produce approximately 8000 tonnes of uranium oxide per annum at 70% contained uranium which amounts to approximately 15 million pounds per annum. The mine will comprise a conventional load and haul open pit mining operation, processing plant, mine residue disposal facilities, and support infrastructure and services.

The proposed Husab mine is the subject of this environmental impact assessment (EIA). It is located approximately 5km south of the existing Rössing Uranium Mine in the northern part of the Namib Naukluft National Park (NNNP). The project setting and planned infrastructure layout is shown in Figures 1 and 2 respectively.

Given the practicalities of planning and coordination with parastatal organisations such as NamPower and NamWater, all of the off site linear infrastructure components (although considered as part of the mining project during the scoping phase of this EIA) are being assessed in a separate report that will follow on from the distribution of this EIA report.

Environmental impact assessment process

Prior to the commencement of the Husab Project, authorisation is required on the basis of an EIA report. On request of MET: Directorate of Environmental Affairs, the draft EIA regulations (2010) have been used as a guideline for this EIA process and report. To supplement this, reference has also been made to the Namibian environmental assessment policy (1995). In accordance with this legal framework the EIA approach included the following:

- The scoping process was conducted to identify the environmental issues associated with the proposed Husab Project and to define the terms of reference for the required specialist studies and the EIA.
- Specialist studies were commissioned in accordance with the relevant terms of reference. The specialists were selected on the basis of their expertise and knowledge of the project area.
- The EIA report was compiled on the basis of the findings of the specialist studies
- The Husab EMP report was compiled to elaborate on the mitigation objectives and actions that were described in the EIA report.

- A project specific public participation process was conducted. As part of this process the regulatory authorities and interested and affected parties (IAPs) were given the opportunity to attend information sharing meetings, submit questions and comments to the project team, and review the background information document, scoping report and EIA report. All questions and comments that were raised by the authorities and IAPs have been included and addressed in the EIA report.

Environmental impact assessment findings

The cumulative assessment (incremental contribution of the Husab Project plus existing baseline conditions) of the proposed Husab Project presents the potential for significant positive economic impacts and significant negative environmental and social impacts. In this context, Swakop Uranium will be required to follow a two-pronged approach to managing its impacts. The first ‘prong’ is the management of its incremental impacts, and the second ‘prong’ is working collectively with other mines, the Chamber of Mines, non-government organisations, industry and government to tackle the regional strategic issues that have been identified and detailed in the Central Namib Uranium Rush Strategic Environmental Assessment.

Swakop Uranium will go a long way to mitigating the potential negative impacts by committing to apply the findings of the cumulative assessment and related mitigation objectives and actions to its project. However, some of these potential negative impacts will remain as high negative residual impacts even with mitigation. The most significant impacts in this regard are: impacts from the physical destruction and general disturbance of biodiversity, impacts from particulate matter related air pollution, impacts on sense of place and the related impacts on the tourism industry, and inward migration related impacts on the already stressed regional infrastructure and services (housing, education, health care, sanitation, power and water supply). In the case of people related impacts, the assessment focused on third parties only and did not assess health and safety impacts on workers because the assumption was made that these aspects are separately regulated by health and safety legislation, policies and standards.

It follows that there will be people that oppose the project development on the grounds of the negative environmental and social impacts, but there will also be people that support the project on the grounds of the positive economic impacts. Ultimately, the decision makers will be required to prioritise either the positive economic impacts or the negative environmental and social impacts.

Discussion of the potential impacts is provided below. A tabulated summary of the cumulative impacts is presented in Table 1 thereafter.

Fig 1

Fig 2

Topography – potential injury to people and animals form hazardous excavations and infrastructure: All excavations and infrastructure into which or off which people and animals can fall are considered hazardous. If unmitigated, the potential negative impact is high because the hazardous excavations and infrastructure may cause injury to people and animals even though the project will be situated in a remote area and the related impact probability is not high. This potential impact can be mitigated to an acceptable level through the following measures:

- access control through barriers, warning signs and security check points;
- education and training of workers and the public; and
- design, construction and implementation of infrastructure stability and safety design measures.

Notwithstanding the above, the open pit remains a concern in the long term because it will not be backfilled.

Soil – potential loss of soil resources from pollution and/or physical disturbance: The physical loss of soils and/or the loss of soil functionality are important issues because as an ecological driver, soil is the medium in which most vegetation grows and in which a significant range of vertebrates and invertebrates exist. In the context of mining, it is even more of an issue if one considers that mining is a temporary land use where-after rehabilitation is the key to re-establishing post closure land capability that will support conservation and ecotourism type land uses. Soil is a key part of this rehabilitation.

In the unmitigated scenario, there are a number of activities that will disturb and potentially damage the soils through physical disturbance and/or pollution. Key measures include the following:

- limiting the disturbance footprint of the project;
- stripping, storing and maintaining soils in accordance with the soil management plan;
- reusing stored soil during the rehabilitation and restoration process (excluding the sizeable footprints of the open pit and mineralised waste facilities);
- pollution prevention through infrastructure design, and education and training of workers;
- implementation of procedures to enable fast reaction to contain and remediate spills; and
- post rehabilitation auditing to determine the success of the rehabilitation.

This will marginally reduce the potential impact. Notwithstanding the above, uncertainty remains about the possibility of reinstating and/or creating two specific soil features. These include the surface crust that has been identified on the plains and the less permeable calcrete layer that is situated below the topsoil horizon. Both of these features are considered to be important from a moisture retention perspective and the surface crust has the added role of erosion prevention. On-going pilot tests will be conducted by Swakop Uranium to determine the most effective means of creating similar features for the restoration and rehabilitation process.

Biodiversity – potential loss of biodiversity from physical destruction, reduction in water resources and/or various other pollution and physical disturbance factors: In the broadest sense, biodiversity (which includes vegetation, vertebrates and invertebrates) provides value for ecosystem functionality, aesthetic, spiritual, cultural, and recreational reasons. The known ecosystem related value includes: soil formation and fertility maintenance, primary production through photosynthesis as the supportive foundation for all life, provision of food and fuel, provision of shelter and building materials, regulation of water flows and water quality, regulation and purification of atmospheric gases, moderation of climate and weather, control of pests and diseases, and maintenance of genetic resources.

The proposed project activities and infrastructure have mostly been positioned in the least sensitive biodiversity areas. The most sensitive areas to the south of the project (for example the Welwitschia Plain) have been avoided as have the majority of the sensitive areas along the north western and south western boundary (springs, the Gypsite Plain, and the main known habitats for the Husab Lizard on the koppies and ridges and between the Gypsite Plain and the Khan River). Even so, the footprint size of the open pits and mineralised waste facilities on the Gypsite and Grassy plain habitats will be significant. This has negative implications for the biodiversity of the area in general, but particularly for the gerbils, zebras and some endangered and vulnerable invertebrates. In the mitigated scenario, the mine will apply the following hierarchy and related mitigation measures:

- first attempt to avoid highly sensitive and irreplaceable biodiversity areas;
- if this is not possible then implement measures to enable effective restoration and rehabilitation. These measures include:
    - delineation of the areas prior to disturbance,
    - relocation of species prior to disturbance,
    - obtaining permits for the destruction or removal of protected species, and
    - rehabilitation of the disturbed areas to restore biodiversity functionality; and
- if this is not possible then investigate appropriate biodiversity offsets.

Periodic surface water run-off and the existence of near surface water resources are understood to be key ecological drivers for vegetation (including the Welwitschia Plains) within and downstream of the proposed project site. In addition, surface water run-off promotes the downstream dispersion of seeds and nutrients. Given that the project layout will prevent significant impacts to the west of the on site water divide, no material impacts are expected on the springs to the west of the project site. Therefore the discussion below focuses on the plains to the south of the project site. In the unmitigated scenario, where infrastructure and activities significantly reduce downstream surface water flow, these processes will be restricted and in the worst case where surface water flow is cut off by the proposed project, some of the Welwitschia plants in the plain could lose their source of water. In the mitigated scenario, the catchment run-off reduction attributable to the mine footprint is approximately 5% which is not considered a significant issue. The key mitigation measures include the following:

- minimising the project footprint;
- isolating the project site from the rest of the catchment through the construction of diversion berms to divert clean surface and near surface flow around the project site;

- directing the diverted clean surface and near surface flow into the natural drainage channels downstream of the project site; and
- contributions to scientific studies on the mechanisms and water resources that the Welwitschia plants utilise for survival.

Significant biodiversity and related linkages could also be lost (in the unmitigated scenario) through the disturbing aspects of pollution in the broadest sense, lights, power lines, water dams, noise, vibration, poaching and vehicle movement. In the mitigated scenario, the focus will be on training workers and enforcing practical solutions to address each risk. Key mitigation measures include:

- minimising the use of light and where necessary use yellow lights;
- equipping power lines with bird deterrent measures;
- keeping all construction camp occupants within the camp after working hours;
- zero tolerance of killing or collecting biodiversity;
- vehicle speed control measures;
- fencing of dams; and
- maintenance of noisy equipment.

Even with mitigation some of these biodiversity impacts will remain high negative impacts.

Radiological (direct radiation) – potential health impacts associated with exposure to direct radiation: In the context of the natural environment, radiation can occur from natural sources such as cosmic and terrestrial radiation. In the context of a mine, radiation in the form of alpha radiation, beta radiation and/or gamma radiation typically originates from mineralised substances (ore, mineralised waste, uranium product) and non-mineralised radioactive contaminated waste.

In the unmitigated scenario, with uncontrolled access to the various mine sources, third parties may be exposed to doses that are above the recommended limits if they visit the site on a daily basis for an extended period (for example a year). In such a scenario, the elevated doses have the potential to physically damage human tissue and cells and cause related health impacts. In the mitigated scenario, third party access is controlled and there will be no exposure to direct radiation related doses that exceed the recommended limits. Key related measures include:

- access control through barriers, warning signs and security check points; and
- education and training of workers and the public.

Surface water – radiological and non-radiological pollution of surface water and related potential human health impacts: Surface water runoff occurs infrequently and for a short duration after rainfall events. Near surface water flow continues for longer periods. The remote possibility exists that pollution can be carried by surface and near surface water flow to either the Khan or Swakop Rivers and it may pollute the related water resources which could have human health impacts.

In the case of the Khan River it must be noted that most of the project infrastructure has been located out of the Khan catchment. In the case of the Swakop River, surface and near surface water would have to travel approximately 15km across the plains.

In the mitigated scenario, the mine will contain pollution on site. The key related measures include the following:

- pollution will be contained at source on the project site by means of bunds, berms, trenches and a dirty water containment system that comprises lined dirty water dams that are designed for a minimum 1:100 year rainfall event;
- clean surface and near surface water will be diverted around the project site and be kept separate from the dirty water containment system;
- assessing the effectiveness of these measures through monitoring during significant rainfall events. If monitoring indicates the potential for unacceptable pollution, additional pollution prevention measures will be taken.

Groundwater – water abstraction and potential impacts on vegetation and third parties:
Dewatering the pits will lower the existing ground water levels in the zone of influence to levels of approximately 400m below surface immediately adjacent to the pits. There are four potential impacts to consider: impacts on surrounding groundwater users that abstract water from the deeper bedrock aquifer, impacts on natural springs, impacts on vegetation, and impacts on the flow of the Khan River and the associated users of alluvial aquifer water (human and vegetation) from this river. These impacts are summarised as follows:

- The closest third party boreholes in the deeper bedrock aquifer will not be impacted because they are situated approximately 19km to the east of the open pits, outside of the dewatering zone.
- The current average water level in the bedrock aquifer zone of influence is approximately 60m. It follows that there are no anticipated impacts on either the vegetation or the natural springs that occur in areas situated above this bedrock aquifer. This conclusion is based on the specialist's view that both the springs and vegetation rely on rainfall recharge of the shallow sandy zones that are situated near surface above the bedrock, and these shallow sandy zones are not hydraulically connected to the basement rock aquifers.
- Flow within the Khan River alluvial aquifer is estimated at 500m^3/day. The closest users of this water source (located within 5km of the proposed open pits) are Rössing Mine and vegetation (including the protected *Acacia erioloba* – camel thorn). If the dewatering zone should reach this aquifer the seepage out of the aquifer towards the open pits is predicted to be in the order of 1m^3/day. This amounts to an aquifer loss of less than 1% which is unlikely to have any noticeable effect on the two main water users: the vegetation and Rössing mine.

In the mitigated scenario, the mine will implement a groundwater monitoring programme to monitor the potential impacts on other groundwater users and take corrective action where necessary.

Groundwater - radiological and non-radiological pollution of groundwater and related potential human health impacts: The ground water specialist's conclusion is that in the long term the cone of depression from the open pits is so significant that it will pull the potential groundwater pollution plume towards and into the open pits. There is a limited period in the operational phase when the drawdown cone is insufficient to control all pollution movement, but during this period the extent of the pollution plume is not more than 100m from the waste facility. On the basis of this conclusion, there will be no off site pollution impact on any groundwater resources which means that no third parties will be exposed to pollution.

In the mitigated scenario, the mine will implement the following key measures:

- The tailings and waste rock mineralised waste facilities will be equipped with liners, seepage detection and seepage collection measures to ensure that any seepage from these facilities is captured before it can pollute the ground and near surface water resources; and
- Implementation of a groundwater monitoring programme to monitor potential pollution and take corrective action should unexpected pollution plumes be identified.

Air – non-radiological pollution and related potential human health impacts: In the operational phase the main contaminants include: inhalable particulate matter less than 10 microns in size (PM10), larger total suspended particulates (TSP), and gas emissions including sulphur dioxide (SO_2), nitrogen dioxide (NO_2), carbon monoxide (CO) and diesel particulate matter (DPM). The construction and decommissioning phase contaminants will be similar but without the emissions associated with the operating acid plant (mainly SO_2). At closure there will only be potential for PM10 and TSP. At certain concentrations, each of these contaminants can have health and/or nuisance impacts.

The prediction from the air dispersion modelling is that only PM10 is a material concern. In this regard, the incremental impacts are generally of low significance, but because the existing baseline PM10 concentrations for the region already exceed the evaluation criteria, the cumulative impacts have a high significance at the closest third party receptor points (Arandis, Rössing Uranium Mine and the big Welwitschia tourist site) in both the unmitigated and mitigated scenario.

Key dust mitigation measures include the following:

- dust suppression of roads through chemical binding agents and/or water sprays;
- dust control at crushing and screening areas through water sprays and dust extraction hoods;
- dust control at material handling points through water spays; and
- monitoring of PM10 and dust fallout.

Air – radiological pollution and related potential human health impacts: The radiological air pathway comprises radon gas and the radioactive component of PM10 and TSP. The predicted public health related dose rates for all of these components are insignificant and therefore the impact significance is low in both the unmitigated and mitigated scenario. The abovementioned dust mitigation measures apply.

Noise pollution: Noise pollution will have different impacts on different receptors because some are very sensitive to noise and others are not. For example, workers in general do not expect an environment free of work-related noise and so they will be less sensitive to environmental noise pollution at work. In contrast, visitors to the NNNP are likely to be sensitive to unnatural noises and so any change to ambient noise levels because of mine related noise will have a negative impact on them and their expectations of a wilderness experience.

Predicted noise impacts are all within the relevant evaluation criteria at sensitive receptor sites. This does not mean that third parties will not hear the mine related activities, but the related impacts are expected to be low to medium in both the unmitigated and mitigated scenarios. Given this, limited mitigation is required, but confirmatory monitoring will be done early in the operating phase to verify the model predictions.

Blasting: blasting is associated with the following pathways that can injure third parties and/or damage structures: fly rock, vibration and air blast. Given the remote setting of the proposed project the probability of any blast related impacts is low. The issue will however require mitigation because the consequences associated with this impact type are potentially significant. Key measures include the following:

- fly rock will be contained within 500m of each blast site;
- ground vibration at the closest third party structures will be less than 12mm/s peak particle velocity; and
- air blast at the closest third party structures will be less than 130dB.

Archaeology – potential damage to archaeology sites: The specialist study identified the old German railway line and the associated Welwitschia siding as the most important sites that could be damaged by the project. The siding in particular is considered to be unique and highly sensitive. In the unmitigated scenario both of these features are at risk of being damaged by project related infrastructure. The key mitigation measures include the following;

- where possible, the old German railway line will be cordoning off from mine related infrastructure and left undisturbed;
- the Welwitschia siding will be reconstructed and preserved as an information centre;
- workers will receive training and education on preserving archaeological sites; and
- where any archaeological sites will be disturbed and/or destroyed they will be surveyed and this information will be used to apply for the necessary destruction permits.

Visual impact: The area in which the proposed Husab Project is situated is considered to have a significant visual landscape. Determining features include: the landscape character, the sense of place, the aesthetic value, the sensitivity of the visual resource and sensitive views. In the latter case the most sensitive views are those from the Welwitschia related attractions to the south of the project site.

The most intrusive and visible project infrastructure will be the mineralised waste facilities that will remain in the long term. In the unmitigated scenario, the potential visual impact on these sensitive views is considered high. The rating remains high in the mitigated scenario although the possibility of a visual offset, through the development of alternative similar tourist attractions, may reduce this in future if such a possibility exists and if it is developed. Key related mitigation measures include the following:

- limit land disturbances;
- final shaping of infrastructure will attempt to avoid harsh angular shapes and care will be taken to integrate structures into the surrounding landscape;
- night lights will be used sparingly to illuminate specific areas only. The use of high pole flood lights will be avoided where possible;
- littering will be prevented; and
- Welwitschia related tourist offset sites will be investigated outside of the visual impact zone.

Socio-economic – economic impact: The proposed Husab Project is predicted to have a significant positive impact on both the Erongo regional economy and the Namibian economy in the following ways: investment in the Namibian economy, foreign exchange income, increase in employment and household income, increase in local economic development and procurement, and increase in taxes. The project is also predicted to have a negative economic impact is on tourism. This stems from the possibility that the experience of tourists in the area around the mine may be compromised to the point that tourists and operators choose not to visit this area to the same degree in future. This impact is one that may negatively impact both direct tourism employment in the Erongo region and tourism activity within the NNNP and West Coast Recreation Area (WCRA). It may also indirectly impact on various components of the associated hospitality sector.

In both the unmitigated and mitigated scenario, the net economic impact is considered to be significantly positive. With the effective implementation of management measures that address economic issues across all phases of the mine's life cycle, the positive economic benefits can be enhanced and the mining and tourism sectors can co-exist such that negative impacts on tourism are limited. In this regard, a collective management effort is required from the government, mining and tourism sectors. Key related mitigation measures include the following:

- hiring of local people where possible;
- procuring of local goods and services where possible;
- implementing formal skills development programmes;
- incorporating economic considerations into closure planning; and

- co-operating with the tourism sector, government, other mines and non-government organisations to limit the negative impacts on tourism through supporting conservation efforts, supporting public awareness campaigns, establishing tourism offset sites, and assisting relevant authorities with the maintenance of key infrastructure such as gravel roads in the NNNP.

Socio-economic – potential inward migration impacts: There are a number of negative issues that can arise from inward migration of job seekers to urban areas (Walvis Bay, Swakopmund and Arandis in particular) in the Erongo region. These include: increased pressure on health, education, housing, and sanitation infrastructure and services that are already under stress, the potential for development of informal settlements, increase in crime and increase in the spread of disease including HIV/AIDS and tuberculosis. While it is not possible to establish a defendable direct causal link between the proposed Husab Project and the regional phenomena of inward migration, it is reasonable to assume that inward migration will occur both directly and/or indirectly from regional economic development in general, and that the Husab Project is a significant part of this development.

In both the unmitigated and mitigated scenario this issue is significant and addressing it with effective mitigation measures requires a collective effort from government, local municipalities, neighbouring mines and other entities in the commercial sector. The key related measures include the following:

- focussed investment on community infrastructure, education, housing, sanitation services, and/or health;
- the investment must be focussed in the existing proclaimed towns (Arandis, Walvis bay and Swakopmund);
- ensuring that workers have access to formal houses; and
- collaborating with local authorities to prevent increase in crime and informal settlement development.

Socio-economic- link between the mine and community: The establishment of the Husab Mine can directly and indirectly impact on people both in the workplace and in the context of worker families and communities. In this regard, there is a link between issues at the community of the workplace and the community of the residential place. These issues include: radiation exposure management, health, education and training.

With effective implementation of the mitigation measures, this potentially negative impact can become a positive one. The key mitigation measures are as follows:

- implementation of a stakeholder engagement and communication strategy;
- development of a formal complaints (grievance) procedure;
- maintenance of an employee profile that can assist with managing impacts and informing closure planning;

- development of worker radiation, HIV/AIDS and tuberculosis programmes that can be extended to contractors, service providers and the communities where Husab workers reside;
- ensuring formal home ownership; and
- extending employee education programmes on social and health issues into the interest communities.

Table 1: Summary of potential cumulative impacts associated with the proposed Husab Project

Section	Potential impact	Significance of the impact (the ratings are negative unless otherwise specified)	
		Unmitigated	Mitigated
Topography	Injury to people and animals from hazardous excavations and infrastructure	**High**	**Medium**
Soils and land capability	Loss of soil resources from pollution	**High**	**Low**
	Loss of soil resources from physical disturbance	**High**	**Medium to High**
Biodiversity	Physical destruction of biodiversity from clearing land and placing infrastructure	**High**	**High**
	Loss of biodiversity from the reduction of water resources as an ecological driver	**High**	**Low**
	General disturbance of biodiversity through a range of aspects including dust, noise, vibration, pollution, lighting, power lines, water dams, poaching, and vehicle movement.	**High**	**Medium to High**
Radiological – direct radiation	Direct physical exposure to radiation from on site sources	**Medium to Low**	**Low**
Surface water	Pollution of surface water – radiological and non-radiological	**Medium**	**Low**
Groundwater	Water abstraction impacts on third party users	**Low**	**Low**
	Groundwater contamination– non radiological	**Low**	**Low**
Air quality	Air pollution – non radiological	**High**	**High**
	Air pollution – radiological and related secondary pathways	**Low**	**Low**
Noise	Noise pollution in the context of sensitive receptors within the NNNP.	**Medium to Low**	**Medium to low**
Blasting	Blast injury to third parties or damage to structures	**Medium**	**Medium to low**
Archaeology	Damage to archaeological sites and landscapes	**High**	**Medium**
Visual impacts	Visual impact from sensitive views within the NNNP.	**High**	**Medium to High**
Socio-economic impacts	Cumulative economic impact including the positive impacts on regional and national economies and the potential negative regional impacts on tourism.	**High+**	**High+**
	Inward migration of job seekers that may add stress to the current regional infrastructure and service deficiencies, lead to poor living conditions, increased crime and accelerated spread of disease in urban areas.	**High**	**Medium to High**
	Link between the mine and communities. Related issues include radiation exposure management, health, education and training	**Low to Medium**	**Low to Medium +**

Project time table

Subject to authorisation, the construction programme will begin in 2012 and will overlap with the commencement of mining operations. Based on current planning, the estimated closure year is 2028.

ENVIRONMENTAL IMPACT ASSESSMENT REPORT FOR THE PROPOSED HUSAB MINE

1 INTRODUCTION

1.1 INTRODUCTION TO THE PROPOSED PROJECT

Swakop Uranium (Pty) Ltd (Swakop Uranium) is a wholly-owned subsidiary of Extract Resources Ltd (Extract), which is an Australian-based uranium exploration and development company. Exploration activities have been undertaken by Extract in Exclusive Prospecting Licence (EPL) 3138, which includes the Husab (previously Rössing South) and Ida Dome deposits. Swakop Uranium plans to develop the Husab deposit into a uranium mine with a design capacity to produce approximately 8000 tonnes of uranium oxide per annum at 70% contained uranium which amounts to approximately 15 million pounds per annum. The mine will comprise a conventional load and haul open pit mining operation, processing plant, mine residue disposal facilities, and support infrastructure and services.

The proposed Husab mine is the subject of this environmental impact assessment (EIA). It is located approximately 5km south of the existing Rössing Uranium Mine in the northern part of the Namib Naukluft National Park (NNNP). The regional and local settings of the proposed mine are shown in Figures 1-1 and 1-2 respectively. Given the practicalities of planning and coordination with parastatal organisations such as NamPower and NamWater, all of the off site linear infrastructure components (although considered as part of the mining project during the scoping phase of this EIA) are being assessed in a separate report that will follow on from the distribution of this EIA report.

1.2 INTRODUCTION TO THE ENVIRONMENTAL IMPACT ASSESSMENT

Prior to the commencement of the mining project, environmental clearance is required on the basis of an approved EIA report. The content of the EIA report is informed by the requirements of the Namibian Environmental Assessment Policy (1995). As an added guide, the most recent version of the draft EIA regulations (2010) have been used in parallel with the Policy requirements to inform the approach to and structure of this EIA. Additional information on relevant environmental laws and policies is provided in Chapter 2.

The required components of the EIA report are included in Table 1-1 below:

TABLE 1-1: REQUIREMENTS FOR EIA REPORTS

Draft EIA Regulation requirement	Policy requirements	Reference in the EIA report
Details of the environmental assessment practitioner (EAP) that compiled the report and the expertise of the EAP to carry out the EIA, including CVs.	List of compilers.	Section 1.2.2 and Appendix A.
Detailed description of the proposed	Project proposal.	Section 6.

Draft EIA Regulation requirement	Policy requirements	Reference in the EIA report
activity.		
Description of the environment that may be affected by the activity.	The affected environment.	Section 4.
Details of public participation process: List of persons, organisations and organs of state that were registered as interested and affected parties (IAPs). A summary of comments received from and a summary of issues raised by IAPs, the date of receipt of these comments and the response of the EAP to the comments. Copies of any representations, objections and comments received from IAPs.		Section 3, Appendix B, Appendix C, Appendix D.
Description of need and desirability of proposed activity and identified potential alternatives to the proposed activity, including advantages and disadvantages that the proposed activity or alternatives may have on the environment and the community that may be affected by the activity.		Executive summary, Section 5.3.
Indication of methodology used in determining the significance of potential impacts.		Section 7.
A description and comparative assessment of all alternatives identified during the environmental impact assessment process.		Section 5.
A description of all environmental issues that were identified during the environmental impact assessment process, an assessment of the significance of each issue and an indication of the extent to which the issue could be addressed by the adoption of mitigation measures.		Section 7.
An assessment of each identified potentially significant impact, including - • cumulative impacts; • the nature of the impact; • the extent and duration of the impact; • the probability of the impact occurring; • the degree to which the impact can be reversed; • the degree to which the impact may cause irreplaceable loss of resources; and • the degree to which the impact can be mitigated;	The assessment and evaluation.	Section 7.
A description of any assumptions,	Assumptions and	Section 8

Draft EIA Regulation requirement	Policy requirements	Reference in the EIA report
uncertainties and gaps in knowledge;	limitations. Incomplete or unavailable information.	
An opinion as to whether the activity should or should not be authorised, and if the opinion is that it should be authorised, any conditions that should be made in respect of that authorisation.	Conclusions and recommendations.	Section 9.
An environmental impact statement which contains: • a summary of the key findings of the environmental impact assessment; and • a comparative assessment of the positive and negative implications of the proposed activity and identified alternatives; and • any specific information that may be required in terms of the Act.		Section 9 Executive summary.
	Management plan Monitoring programme Audit proposal.	Appendix Q.
	Executive summary Contents page Introduction.	See above.
	Terms of reference.	Appendix B.
	Approach to study.	Section 1.2.1
	Administrative, legal and Policy requirements.	Section 2
	Environmental contract.	To be issued by MET.
	Definitions of technical terms. Acknowledgements.	See above.
	Appendices.	See end of report.

FIGURE 1-1: REGIONAL SETTING

FIGURE 1-2: LOCAL SETTING

1.2.1 EIA APPROACH AND PROCESS

A summary of the approach and key steps in the EIA process and corresponding activities are outlined in Table 1-2.

TABLE 1-2: EIA PROCESS

Objectives	Corresponding activities
Project initiation/screening phase (June – August 2009)	
• Notify the decision making authority of the proposed project. • Initiate the environmental impact assessment process.	• Project initiation meetings and site visit with the Swakop Uranium technical team to discuss the project requirements, identify environmental and social issues and to determine legal requirements. • Meeting with the Ministry of Environment and Tourism (MET): Directorate of Environmental Affairs (DEA). • Written notification submitted to MET (27 July 2009).
Scoping phase (August – February 2009)	
• Identify interested and/or affected parties (IAPs) and involve them in the scoping process through information sharing. • Identify potential environmental issues associated with the proposed project. • Consider alternatives. • Identify any fatal flaws. • Determine the terms of reference for additional assessment work.	• Notified government authorities and IAPs of the project and EIA process (telephone calls, e-mails, faxes, distribution of background information documents, newspaper advertisements and site notices). • Scoping meetings with authorities, and IAPs (11-13 August 2009). • Confirmation that there were no identified fatal flaws. • Compilation of scoping report (August 2009). • Distribute scoping report to relevant authorities and IAPs for review (December 2009). • Forward finalised scoping report and IAPs comments to MET for review (February 2010). • Confirmation from Mr Freddy Sikabonga of MET to proceed on the basis of the scoping report.
EIA/EMP phase (October 2009 to October 2010)	
• Provide a detailed description of the potentially affected environment. • Assessment of potential environmental impacts. • Design requirements and management and mitigation measures. • Receive feedback on EIA and EMP.	• Investigations by technical project team and appointed specialists. • Compilation of EIA and EMP reports. • Distribute EIA and EMP reports to authorities and IAPs for review (October /November 2010). • Forward EIA and EMP reports and IAPs comments to MET for review (November/December 2010). • Receive and circulate MET decision

1.2.2 EIA TEAM

Metago Environmental Engineers (Pty) Ltd (Metago) is the independent firm of consultants that has been appointed by Swakop Uranium to undertake the environmental impact assessment and related processes. Colleen Parkins (the initial project manager who left the project at the end of 2009) has approximately 15 years of experience. Brandon Stobart (the reviewer and replacement project manager) has 13 years of relevant experience and is certified with the Certification Board for Environmental

Assessment Practitioners of South Africa (EAPSA) as an Environmental Assessment Practitioner (EAP). Alex Pheiffer (the replacement reviewer) has approximately 10 years of experience and is registered as a professional natural scientist in South Africa. The relevant curriculum vitae documentation is attached in Appendix A.

The environmental project team is outlined in Table 1-3.

TABLE 1-3: ENVIRONMENTAL PROJECT TEAM

Team	Name	Designation	Tasks and roles	Company
EIA project leader	Michele Kilbourn Louw	Swakop Uranium environmental manager	Responsible for the interface between Swakop Uranium and the environmental team, and for ensuring implementation of the EIA outcomes	Swakop Uranium
EIA Project management	Colleen Parkins and Brandon Stobart	Project manager	Management of the process, team members and other stakeholders. Report compilation	Metago
	Joanna Goeller and Natasha Daly	Project assistant		
	Brandon Stobart and Alex Pheiffer	Project review	Report and process review.	
Specialist investigations	Hanlie Liebenberg-Enslin	Air quality	Air quality impact assessment	Airshed Planning Professionals
	Ian Jones	Soils and land capability specialist	Soils and land capability assessment	Earth Science Solutions
	Graham Young	Visual specialist	Visual impact assessment	Newtown Landscape Architects
	John Kinahan	Archaeologist	Heritage resource assessment	Quaternary Research Services
	Gerrie Muller	Social specialist	Social impact assessment	Metago Strategy4Good
	Gerrie Muller	Economist	Economic impact assessment	Metago Strategy4Good
	Gerhard Liebenberg and Gert De Beer	Radiological specialists	Radiological impact assessment	Nuclear Energy Corporation of South Africa
	Alex Speiser and Ariol Ashby	Co-ordination	In-country public participation co-ordination	Independent consultants
	Theo Wassenaar	Biodiversity	Project leader/ecologist	African Wilderness Restoration
	Coleen Mannheimer		Vegetation assessment	Independent consultant
	Joh Henschel		Vertebrate assessment	Gobabeb Desert Research Foundation
	John Irish		Invertebrate assessment	
	Jeff Jolly	Water scientist	Groundwater assessment	Aquaterra
	Ben van Zyl	Acoustical Engineer	Noise Study	Acusolv

Team	Name	Designation	Tasks and roles	Company
	Gordon MacPhail	Engineer	Engineering mitigations and Hydrology assessment	Metago

1.2.3 CONTACT DETAILS FOR RESPONSIBLE SWAKOP URANIUM PARTIES

The Swakop Uranium contact details for the project are included in Table 1-4.

TABLE 1-4: SWAKOP URANIUM CONTACT DETAILS

Title	**Environmental manager**	**CEO**
Name	Ms Michele Kilbourn Louw	Mr Norman Green
Postal address	PO Box 81162 Olympia Windhoek Namibia	PO Box 81162 Olympia Windhoek Namibia
Telephone number	+264 61 300 220	+264 61 300 220
Facsimile number	+264 61 300 221	+264 61 300 221

2 ENVIRONMENTAL LAWS AND POLICIES

The Strategic Environmental Assessment for the Central Namib Uranium Rush (SEA) (SAIEA, 2010) provides a comprehensive overview of relevant Namibian laws and policies. This section draws information from the SEA and other legal sources in Namibia.

The Republic of Namibia has five tiers of law and a number of policies relevant to Uranium mining and these include:

- The Constitution.
- Statutory law.
- Common law.
- Customary law.
- International law.

Key policies currently in force include:

- The EIA Policy (1995).
- The Minerals Policy of Namibia (2002).
- Namibia's Environmental Assessment Policy for Sustainable Development and Environmental Conservation (1994).

As the main source of legislation, the Namibian constitution makes provision for the creation and enforcement of applicable legislation. In this context and in accordance with its constitution, Namibia has passed numerous laws intended to protect the natural environment and to mitigate against adverse environmental impacts.

However, current Namibian legislation is a mixture of pre and post independence laws, some of which has yet to be repealed with modern, updated legislation. This has led to the development of gaps in the enforceability of parts of the legislation. These gaps stem from parts of current legislation not being geared to the needs of modern development in Namibia.

Namibia's policies provide the framework to the applicable legislation. Whilst policies do not often carry the same legal recognition as official statutes, policies can and are used in providing support to legal interpretation when deciding cases.

2.1 APPLICABLE LAWS AND POLICIES

In the context of uranium mining in Namibia, there are several laws and policies currently applicable. Each of these is discussed in detail below.

2.1.1 NAMIBIA'S ENVIRONMENTAL IMPACT ASSESSMENT (EIA) POLICY OF 1995

This policy promotes accountability and informed decision making through the requirement of EIAs for listed programmes and projects.

2.1.2 ENVIRONMENTAL MANAGEMENT ACT

To enforce the policy on EIAs, the Environmental Management Act (EMA) (7 of 2007) has been compiled, but is yet to practically come into force because the required regulations are still in draft form. The EMA is expected to improve the management of impact assessments in Namibia through the establishment of an environmental commissioner, who will approve environmental plans and through requiring government agencies to work as a cohesive decision-making agents to ensure long term sustainable resource use.

2.1.3 THE ENVIRONMENTAL INVESTMENT FUND OF NAMIBIA

The Environmental Investment Fund of Namibia Act (13 of 2001) provides for the creation of a fund that will be used to support sustainable environmental and natural resource management. The source of the funds will include penalties/fines paid and/or property forfeited in terms of non-compliance and/or crimes as set out in EMA.

2.1.4 THE MINERALS ACT

The Minerals Act (33 of 1992) is another tool which is used to ensure compliance to the EIA policy by requiring that adequate environmental protection is guaranteed on projects prior to issuing a mining or prospecting permit.

2.1.5 THE WATER ACT

The Water Act (54 of 1956) regulates the abstraction of groundwater for mining purposes. This Act is also an example of the older legislation which does not meet the needs of Namibia's modern development patterns. In recognition of this, the Water Resources Management Act (24 of 2004) has been drafted and published. It is still to come into force. This Act is more relevant to addressing Namibia's geohydrological and climatic contexts.

2.1.6 THE NAMIBIA WATER CORPORATION

The Namibia Water Corporation Act (12 of 1997) charges the corporation to supply bulk water, based on need and availability. The corporation is also charged with the duty of conserving water resources in the long-term.

2.1.7 THE FOREST ACT

The Forest Act (12 of 2001) allows for the declaration of protected areas in terms of soils, water resources, plants and other elements of biodiversity. This includes the proclamation of protected species of plants and the conditions under which these plants can be disturbed, conserved, or cultivated.

2.1.8 PARKS AND WILDLIFE MANAGEMENT BILL

The Parks and Wildlife Management Bill (2009) aims to provide a legal framework for the sustainable use and maintenance of Namibia’s ecosystems, biological diversity and ecological processes; and repeals the Nature Conservation Ordinance (4 of 1975). This Bill allows the Namibian Ministries of Environment and Tourism and Minerals and Energy, to allow mining to take place within parks subject to the relevant assessments and authorisations.

2.1.9 NATURE CONSERVATION ORDINANCE

The Nature Conservation Ordinance (4 of 1975) provides for the declaration of protected areas and protected species.

2.1.10 NAMIB NAUKLUFT NATIONAL PARK MANAGEMENT AND TOURISM DEVELOPMENT PLAN

The Development plan (2004) provides a set of policies and guiding principles. A key topic is restoration of degraded ecosystems. The plan also states that no development should result in a decline of more than 10% in the population of a species of special interest (eg. *Welwitschia mirabilis).*

2.1.11 NATIONAL HERITAGE

The National Heritage Act (27 of 2004) provides protection and conservation of places and objectives of significance, as all archaeological and paleontological objects belong to the state.

2.1.12 RADIATION PROTECTION

The Atomic Energy and Radiation Protection Act (5 of 2005) is concerned specifically with ionizing radiation, including hazardous substances from radiation sources or materials. The Act lists all activities requiring authorisation including possession of nuclear material, disposal, storage, and the operation or use of radiation sources.

Two draft regulations have been drafted to assist in the implementation of the Act and both of these regulations are expected to be promulgated in the near future, these are:

- Regulation for protection against ionizing radiation and for the safety of radiation sources (MoHSS, 2008a); and

- Regulations for the safe and secure management of radioactive waste (MoHSS, 2008b).

2.1.13 STRATEGIC ENVIRONMENTAL ASSESSMENT FOR THE CENTRAL NAMIB URANIUM RUSH

The first draft of the SEA was published for comment in August 2010. The SEA provides a big picture overview and advice on how to avoid and/or limit cumulative negative impacts and to enhance opportunities in the uranium sector. The Strategic Environment Management Plan (SEMP) provides a practical framework in terms of which existing and proposed mines can plan, collaborate, monitor, and manage issues that can impact on society, the economy and the environment.

2.1.14 EQUATOR PRINCIPLES

Equator Principles were compiled by representatives of various banks who identified the need to create a banking industry framework to address environmental and social issues in project financing. These principles are used as a benchmark for the financial industry to evaluate and manage the social and environmental impacts of projects financed through institutions which are Equator Principle signatories. The Principles and related commentary are presented in Table 2-1.

TABLE 2-1: EQUATOR PRINCIPLES

High level description of Principles	**Comments in relation to the proposed project.**
Equator Principle 1: Review and Categorisation	
All projects are categorised based on the magnitude of their potential environmental and social risks and impacts. Category A projects have potential significant adverse social or environmental impacts that are diverse, irreversible, or unprecedented. Category B projects have limited adverse social or environmental impacts, which are site-specific and largely reversible, while Category C projects have minimal social or environmental impacts.	The proposed Husab Project is a category A project.
Equator Principle 2: Social and Environmental Assessment	
A social and environmental impact assessment (SEIA) process, relevant to the nature and scale of the project, must be undertaken to address the potential social environmental risks and impacts of the project, incorporating specialist studies where necessary. The assessment is also required to propose relevant mitigation and management measures.	The EIA and EMP reports address most of the related issues as set out in Exhibit ii of Principle 2. Some aspects not covered in the EIA and EMP report will be covered as part of ongoing environmental, health, safety and social management.
Equator Principle 3: Applicable Social and Environmental Standards	
For projects located in non-OECD* countries, the assessment will refer to the IFC** Performance Standards (1-8) and the applicable industry-specific Environment, Health and Safety Guidelines. The performance standards address Social and Environmental Assessment and Management Systems, Labour and Working Conditions, Pollution Prevention and Abatement, Community Health, Safety and Security, Land Acquisition and Involuntary Resettlement, Biodiversity Conservation and Sustainable Natural Resource Management, Indigenous Peoples and	While the EIA and EMP cover many of the applicable aspects of these performance standards, some will be covered through the proposed on site management systems and procedures.

High level description of Principles	Comments in relation to the proposed project.
Cultural Heritage. The relevant EHS Guidelines include: General EHS Guidelines (environment, occupational health and safety, community health and safety, decommissioning and closure) and EHS Guidelines for Mining. The SEIA must also address compliance with relevant host country laws, regulations, and permits that pertain to social and environmental matters.	
Equator Principle 4: Action Plan and Management System	
An action plan, the level of which must be appropriate to the nature and scale of the project, which describes and prioritises the actions needed to implement the mitigation measures, corrective action and monitoring measures necessary to manage the social and environmental risks and impacts identified in the SEIA must be compiled. A social and environmental management system must be established and maintained to implement the action plan and corrective actions required to comply with host country laws and regulations as well as the requirements of the IFC performance standards and guidelines.	The management recommendations in the EIA and the plans in the EMP will be integrated into a formal on site management system.
Equator Principle 5: Consultation and Disclosure	
Projects which may have a significant adverse impact on local communities are required to undertake a consultation process. The consultation process must ensure the community's free, prior, and informed consultation, and it must be demonstrated that the project has adequately incorporated the community's concerns.	A comprehensive disclosure and consultation process was followed as part of the EIA process.
Equator Principle 6: Grievance Mechanism	
Consultation, disclosure and community engagement must continue through the construction and operational phases of a project. A grievance mechanism must be established as part of the management system in order to receive and facilitate the resolution of concerns and grievances raised by those affected by the project. The affected communities must be informed about the grievance mechanism process, which must address all concerns promptly and transparently, in a culturally appropriate manner, and must be accessible to all community members.	Objectives and actions in this regard have been included in the EIA and EMP reports.
Equator Principle 7: Independent Review	
Equator Principle compliance of the SEIA, action plan and public consultation process must be assessed by an independent social or environmental expert, who is not directly related to the borrower, on behalf of the lending institution	The EIA and EMP reports will be reviewed by independent experts.
Equator Principle 8: Covenants	
Covenants must be incorporated into the financing documentation whereby the borrower is committed to comply with relevant host country environmental legal requirements, comply with the action plan, to provide periodic reports as required by the financial institution to document compliance with the action plan and host country environmental and social laws, regulations and permits, and to decommission the facilities in accordance with an agreed decommissioning plan.	Swakop Uranium is committed to these covenants.
Equator Principle 9: Independent Monitoring and Reporting	

High level description of Principles	Comments in relation to the proposed project.
The project is required to appoint an independent environmental and/or social expert, or to retain qualified and experienced external experts to verify monitoring information which is reported to the financial institution.	Swakop Uranium will implement this as required.
Equator Principle 10	
Financial institutions which are signatories to the Equator Principles are required to report publically at least annually about their Equator Principle implementation processes and experience. The reports typically include, as a minimum, the number of transactions, project categorisation, and the implementation process.	This principle is relevant to financial institutions (banks) which are signatories to the Equator Principles.

**Organisation for Economic Co-operation and Development*

***International Finance Corporation*

3 PUBLIC CONSULTATION

The range of environmental issues to be considered in the EIA has been given specific context and focus through consultation with authorities and IAPs. Included below is a summary of the people consulted, the process that was followed, and the issues that have been identified.

3.1 AUTHORITIES AND INTERESTED AND AFFECTED PARTIES (IAPS)

The following authorities and IAPs are involved in the EIA process:

- **National authorities:**
  - Ministry of Environment and Tourism (MET);
    - Directorate of Environmental Affairs (DEA);
    - Directorate of Parks and Wildlife (DPW);
  - National Heritage Council of Namibia;
  - Ministry of Mines and Energy (MME);
  - Ministry of Agriculture, Water and Forestry (MAWF);
  - Ministry of Health and Social Services (MHSS);
  - Ministry of Labour and Social Welfare; and
  - Ministry of Works, Transport and Communications.
- **IAPs:**
  - farmers and landowners;
  - mines and industries;
  - non-government organisations and associations;
  - local authorities (Erongo Regional Council, Swakopmund and Walvis Bay Municipalities);
  - parastatals such as NamWater and NamPower; and
  - any other people/entities that choose to register as IAPs.

3.2 STEPS IN THE CONSULTATION PROCESS

Table 3-1 sets out the steps in the consultation process that has been conducted to date:

TABLE 3-1: CONSULTATION PROCESS WITH IAPS AND AUTHORITIES

TASK	DESCRIPTION	DATE
Notification - regulatory authorities and IAPs		
Written notification to MET	A background information document (BID) regarding the project was sent to MET. A copy of the covering e-mail is attached in Appendix B.	27 July 2009
IAP identification	Stakeholder databases of other uranium projects in the area were used as a starting point to compile a database for the Project. The database was updated to include additional IAPs and has been updated during the EIA as required. A copy of the IAP database is attached in Appendix C.	July 2009

TASK	DESCRIPTION	DATE
Distribution of BID	BIDs were distributed via email to all IAPs on the project's public participation database and were available at the scoping meetings. A copy of the BID is attached in Appendix B. The purpose of the BID was to inform IAPs and authorities about the proposed project, the EIA process, possible environmental impacts and means of participating in the EIA process. Attached to the BID was a registration and response form, which provided IAPs with an opportunity to submit their names, contact details and comments on the project.	July – August 2009
Site notices	Site notices were placed at the Swakopmund Library, the Walvis Bay Library, Arandis Town Hall, the Swakopmund Information Centre, the Swakopmund Town Council, the Ida Camp office and the Ida Camp entrance on the C28. Copies of the site notices and photographs of the places where site notices were displayed are attached in Appendix B.	30 July 2009
Newspaper advertisements	Block advertisements were placed as follows: o The Namibian (31 July, 5 August and 10 August) o The Republikein (28 July) o The Allgemeine Zeitung (28 July and 10 August); and o The New Era (31 July, 4 August and 10 August). Copies of the advertisements are attached in Appendix B.	July - August 2009
Scoping stage meetings and submission of comments		
Scoping meetings	Four scoping meetings were arranged, one in Windhoek, Swakopmund, Arandis and Walvis Bay respectively. The same project information was presented at all meetings. Minutes of the meetings are attached in Appendix B.	11 – 13 August 2009
Review of scoping report		
IAPs and authorities (excluding MET) review of scoping report	Copies of the scoping report were made available for review at the following places: MET library and Windhoek National library, Walvis Bay public library, Swakopmund public library, Arandis public library and the Swakop Uranium town office in Swakopmund. Electronic copies of the report were made available on request (on a CD). Summaries of the scoping report were distributed to all authorities and IAPs that are registered on the project's public involvement database via post and/or e-mail. Authorities and IAPs were given 30 days (excluding the school holiday period) to review the scoping report and submit comments in writing to Metago. No written comments were received.	end November 2009 to end January 2010.
MET review of scoping report	A copy of the final scoping report, including authority and IAP review comments, was forwarded to MET on completion of the public review process. No substantial comments were received. Metago received verbal instruction with a follow up letter from Mr Sikabonga to proceed with the EIA on the basis of the scoping report terms of reference. These are included in Appendix B.	February 2010

TASK	DESCRIPTION	DATE
Review of EIA report		
IAPs and authorities (excluding MET) review of EIA report	Copies of the EIA report have been made available for review at the following places: MET library and Windhoek National library, Walvis Bay public library, Swakopmund public library, Arandis public library and the Swakop Uranium town office in Swakopmund. Electronic copies of the report were made available on request (on a CD). Summaries of the EIA report have been distributed to all authorities and IAPs that are registered on the project's public involvement database via post and/or e-mail. Authorities and IAPs have been given 30 days to review the EIA report and submit comments in writing to Metago.	End October 2010
MET review of EIA report	A copy of the final EIA report, including authority and IAP review comments, will be forwarded to MET on completion of the public review process.	End November 2010

3.3 SUMMARY OF ISSUES RAISED

A description of issues that have been raised to date by authorities and IAPs is given in the issues table included in Appendix D. Issues raised pertain to:

- the EIA procedure;
- the technical project aspects;
- decommissioning and closure;
- blasting;
- biodiversity soils and land use;
- heritage resources;
- visual;
- water;
- air quality;
- radiological aspects;
- noise; and
- socio-economic.

4 DESCRIPTION OF THE CURRENT ENVIRONMENT

The baseline information provided in this chapter must be read in the context of a unique area of the Namib Naukluft National Park (NNNP) and the West Coast Recreation Area (WCRA).

4.1 GEOLOGY BASELINE

Information in this section was sourced from the Swakop Uranium Exploration Geologists, the geochemical specialist study included in Appendix E (Metago Water Geosciences, 2010) and the groundwater specialist study included in Appendix J (Aquaterra, 2010).

4.1.1 INTRODUCTION AND LINK TO IMPACTS

Geology has both physical and chemical implications for mining projects. From a physical perspective, the geology influences the mine design. It also determines the underlying aquifer regime and it has significant influence on groundwater flow through features such as dykes, channels, faults and fractures.

The chemical composition of the geology is an important factor in determining whether the project will be acid generating. It also determines some of the potential contaminants that can be emitted by the mine, particularly the mineralised waste facilities.

To understand the basis of these potential impacts, a baseline situational analysis is described below.

4.1.2 DATA COLLECTION

Data was collected via the project's drilling programme, geophysics, lab analysis and geochemical interpretation of drilling core samples. The drilling and interpretation of the resource and the geological featrues was undertaken by Extract Resources and Aquaterra, the environmental lab analysis was undertaken by SGS Laboratories and the goechemical interpretation was undertken by Metago Water geosciences.

The borehole data base in the vicinity of the current resource for pit Zones 1 and 2 at Husab includes diamond boreholes and RC holes. All of these boreholes have been drilled by Swakop Uranium since discovery of the deposit in 2008. The boreholes have been typically drilled towards the west, with a dip of -60 degrees. The resource data base contains 255376 chemical assays (99.7%) and factored down hole radiometric data (0.3%).

Samples from RC boreholes were analysed for uranium content by Inductively Coupled Plasma Mass Spectrometry (ICP-MS) after multi-acid digest. A smaller group of samples has been analysed for uranium by Pressed Pellet XRF.

Subsequent resource estimation was based on a nominal 75 ppm uranium product cut off. The mineralisation constraints were based upon sectional interpretation and three dimensional analyses of the available drilling data.

Identified fracture zones were drilled and analysed by Aquaterra as part of the groundwater investigation.

Static geochemical laboratory test work of drilling core samples and pilot plant residue was done by SGS in Perth Australia. The laboratory tests included:

- Acid-base Accounting (ABA) according to the EPA-600 modified Sobek method.
- Sulphur speciation.
- Grain-size distribution.
- Total leachable metal content.
- Toxicity characteristic leaching procedure (TCLP) extraction tests.
- Synthetic preparation leaching procedure (SPLP) extraction tests.

Geochemical analysis and interpretation of the laboratory results was done by Metago Water Geosciences.

4.1.3 Results

4.1.3.1 Regional and local geology

The Husab Project uranium deposit is located within the Erongo Region alaskite belt of western central Namibia. The Erongo Region alaskite belt lies within the South Central Zone of the Damara Orogenic Belt, located in an area of extensive isoclinal folding and basement uplift.

Examples of primary granite hosted uranium mineralisation of “Rössing” type in the Erongo Region, are associated with folded Neoproterozoic metasediments and gneiss of the lower section of the Damara (Pan-African) Orogeny. Examples include the Rössing Mine, Rössing South (re-named Husab), Etango (Goanikontes), and Valencia. All of the known occurrences share broadly similar geological and age characteristics, and occupy structurally prepared dilational sites, usually within 6 kilometres of exhumed Palaeo to Middle Proterozoic basement complexes. Ubiquitous basement doming in the South Central Zone is a product of northeast-southwest crustal shortening resulting from the closure of a pre-existing intra-continental rift system.

The uranium mineralisation at Husab Project is hosted predominantly by a series of semi-conformable alkali feldspar granitic to pegmatitic dykes intruding schists, quartzites and calc-silicate rocks of the Rössing Formation. Quartz-diopside calc-silicate uints, and quartz-biotite schists make up minor components of the mineralised inventory at the Husab Project. The mineralised zones are arranged around the limbs of local dome structures cored by amphibole and pyroxene bearing gneiss of the Khan

Formation (Nosib Group). The presently defined uranium resources at Husab are located on the eastern limb of the Husab Anticline, although uranium mineralisation is known from the western limb of the Husab Anticline also. Only minor uranium bearing alaskite dykes are present within the underlying Khan Formation and overlying Chuos Formation.

Uranium mineralogy at the Husab Project comprises mainly fine grained disseminated uraninite, with local coffinite, traces of pyrochlore (betafite) and brannerite, together with occasionally abundant secondary uranium silicates developed on joint planes and fracture surfaces. Extraction test work on the Husab Project mineralised material confirms high uranium recoveries from a conventional acid leach processing route.

4.1.3.2 Physical on site geology

The Husab Project is dominated by a series of north-northeast to northeast trending regional scale antiforms and synforms, which make up the main structural architecture of the entire Central Zone of the Damara Orogenic Belt (DOB). These meta-sedimentary folds or dome-like structures of the DOB are cored by gneissic and metasedimentary rocks of the Abbabis Formation (Figure 4-1). The basement rocks are covered to the northeast and south by stranded cover sequences of flat-lying calcrete and alluvial deposits, which are associated with a broad northeast trending valley.

The basement gneisses outcrop as a series of semi-ovoid features within the Central Zone of the DOB, in general forming somewhat poorly exposed extensions to the basement rocks exposed in the Swakop River Gorge and in the Khan River Valley. Flanking Damara Sequence sediments show a complex pattern of folding and faulting, and the whole sequence is extensively invaded by syn- and post-tectonic granitoids and pegmatite swarms. Cross-cutting Mesozoic dolerite dykes are also evident locally.

The Namib Group Sands, which overlie the bedrock, vary in thickness from under a meter in the very northwest of the study area, to over 140m to the east and south. Contouring of the depth to bedrock, indicates a palaeo-basin trending northeast-southwest through the area (Figure 4-2), broadly parallel to the current Khan drainage line. The lithology varies from surficial, unconsolidated sands, to semi-consolidated fine grained gravels, with clay horizons also encountered in the southern and southeastern end of the study area. The palaeo-basin does not appear to be open to the southwest, since bedrock outcrops stop any path towards the Swakop River.

Extensive resource definition drilling carried out over the Husab Project Zones 1 and 2 since 2008 has produced a large granite hosted uranium resource amenable to open cast mining and conventional acid leach processing. The Husab Project appears to be geologically similar to other examples of primary uranium deposits hosted by leucogranites (alaskites) within the Erongo Region uranium province, albeit it is a large example and has higher than average grades.

Isolated fault lines were identified by the geological investigations. These faults have been drilled and tested for water bearing features, but in all cases are dry and are therefore not considered to be preferential flow paths for groundwater.

4.1.3.3 Geochemistry

The key conclusions from the geochemical test work and analysis are as follows:

- A portion of the Husab waste rock sequence is characterised as potentially acid forming (PAF).
- The pilot plant residues (tailings) are generally characterised as PAF.
- The acid neutralising potential of non acid forming waste rock samples is highly variable and results in a wide range of mixing ratios for neutralisation of PAF mine residues.
- SPLP and TCLP leach tests of different Husab waste rock samples flag aluminium as an element of concern.
- The overall predicted leachate quality of the tested Husab waste rocks, with the exception of aluminium, meets the Namibian drinking water limits (class D).
- The predicted leachate quality of the pilot plant residues exceed, for numerous elements, the Namibian drinking water limits (class D) and therefore require containment within the project dirty water circuit or treatment prior to discharge. Especially highly elevated metal concentrations are of concern.

4.1.4 CONCLUSION

Successful exploration has located a large alaskite hosted uranium deposit concealed beneath valley fill gravels approximately 5 kilometres south of the Rössing Uranium Mine in the Erongo Region of western Namibia. Feasibility studies carried out on the deposit suggest that a large scale conventional truck and shovel mining operation combined with an acid leach processing plant can be viably established at Husab. The large scale of the uranium deposit at Husab could result the establishment of one of the largest uranium mines in the world.

No preferential groundwater pathways have been identified which means that groundwater modelling of pollution dispersion does not take the influence of any such pathways into account.

The design of the mineralised waste facilities (waste rock and tailings) and the control of water pollution in particular is influenced by the fact that some waste rock and the plant residues are predicted to be PAF. In addition, the leachate quality of the tailings in particular is predicted to exceed the relevant Namibian water quality guidleines.

FIGURE 4-1: GEOLOGY PLAN VIEW

FIGURE 4-2: GEOLOGICAL CROSS SECTION

4.2 CLIMATE BASELINE

Information in this section was sourced from the air specialist study included in Appendix K (Airshed 2010), and the surface water study included in Appendix I (Metago Australia, 2010).

4.2.1 INTRODUCTION AND LINK TO IMPACTS

As a whole, the various aspects of the climate that are discussed influence the potential for environmental impacts and related mine design. Specific issues are listed below:

- Rainfall and fog influence erosion, evaporation, vegetation growth, rehabilitation planning, dust suppression, the mine water balance and the mine water management plan.
- Temperature influences air dispersion through impacts on atmospheric stability and mixing layers, vegetation growth, and evaporation which influences the mine water balance and rehabilitation planning.
- Wind influences erosion, the dispersion of potential air pollutants, and evaporation which influences the mine water balance and rehabilitation planning.

To understand the basis of these potential impacts, a baseline situational analysis is described below.

4.2.2 DATA COLLECTION

On site meteorology was obtained from the Husab weather station and analysed. Hourly average wind speed, wind direction, temperature and rainfall data measured over the period October 2008 to June 2010 were used to inform the local dispersion potential of the site.

Historical rainfall data was sourced from the Digital Atlas of Namibia and more recent daily rainfall records were also sourced from Rössing Uranium Mine from 1987 to April 2009, as well as by Langer Heinrich Uranium, from February 2007 to April 2009.

4.2.3 RESULTS

4.2.3.1 Rainfall and fog

The average rainfall in the west coast region is low with an annual average of 23 mm measured over the period 1962 - 1967 at Gobabeb. Historical records for Swakopmund, dating as far back as 1899, indicate an annual average of 14 mm. More recent statistics for Swakopmund indicate the total annual rainfall for 2008 to be 30 mm (http://weather.namsearch.com). According to the Directorate of Environmental Affairs, Ministry of Environment and Tourism Digital Atlas of Namibia, rainfall within the Erongo Region ranges between 0-50 mm at the coast to 400 mm in the northeast of the region. The Husab Project falls within the less than 100 mm/year rainfall belt (http://209.88.21.36/Atlas/Atlas_web.htm). Monthly rainfall recorded at Husab is presented in Figure 4-3.

FIGURE 4-3: MONTHLY RAINFALL

FIGURE 4-4: DIURNAL TEMPERATURE PROFILE

As is typical of arid areas, rainfall can vary considerably and can be of great intensity and depth when it occurs. The Husab Project maximum design rainfall depths for various return periods have been determined using long term stochastic extrapolations based on an observed daily rainfall (Rössing) for the period 1987-2009. The 22 year daily record was extrapolated to a 1000 year rainfall record using a stochastic model developed by the Australian Bureau of Meteorology. Extreme events (design rainfall depths) were then determined by fitting a gamma distribution function, as this was a best fit to the synthetic rainfall record, and compared well to the observed rainfall data. The resulting rainfall depths per return period are as follows:

TABLE 4-1: RAINFALL DEPTHS AND RETURN PERIODS

Return periods	10 years	20 years	100 years	10000 years
Rainfall depths	9mm	13mm	27mm	50mm

Fog, a form of precipitation, is characteristic of this region. Swakopmund, for instance, has high incidences of fog days of more than 125 days per year (http://209.88.21.36/Atlas/Atlas_web.htm). Within the Erongo Region, fog can extend up to 110 km inland with an average number of days per annum recorded at Gobabeb of 102 between 1964 and 1967. The annual fog precipitation at Swakopmund was estimated to be 35-45 mm in relation to 20 mm that was measured 40 km inland. Fog is expected to occur at the Husab site in the range between 50 and 90 days per year.

4.2.3.2 Temperature

Air temperature is an important parameter for the development of the mixing and inversion layers with relative humidity being the inverse function of ambient air temperature, increasing as ambient air temperature decreases. Historical data for the region indicate similar average monthly and annual temperatures along the Namib Coast. The range between the coldest and warmest months is also small being 9℃ at both Swakopmund and Walvis Bay. Frost is not associated with the region but extreme temperatures of over 40℃ have been linked to strong easterly “berg” winds. Air temperature is important, both for determining the effect of plume buoyancy (the larger the temperature difference between the plume and the ambient air, the higher the plume is able to rise), and determining the development of the mixing and inversion layers. The diurnal temperature trend for the Husab site is presented in Figure 4-4.

4.2.3.3 Evaporation

Evaporation rates are between 2400-3400 mm per year increasing from the coast inland reaching a maximum in the central part of the Erongo Region (http://209.88.21.36/Atlas/Atlas_web.htm). The Husab Project falls within the 3000-3200 mm per year evaporation rate region. This indicates that evaporation will significantly exceed rainfall making the area a water stressed area.

4.2.3.4 Local atmospheric dispersion potential

Pollution concentration levels fluctuate in response to changes in atmospheric stability, to concurrent variations in the mixing depth, and to shifts in the wind field. Spatial variations and diurnal and seasonal changes in the wind field and stability regime are functions of atmospheric processes operating at various temporal and spatial scales. Atmospheric processes at macro- and meso-scales need therefore be taken into account in order to accurately parameterise the atmospheric dispersion potential of a particular area.

The occurrence of the various stability classes associated with the 16 main wind directions are presented in Figure 4-5. Stable atmospheric conditions tend to result in high ground level concentrations for ground level emitters such as fugitive dust from unpaved roads and crushers. At Husab a high frequency of very stable (F – stability) conditions occurr predominantly from the north to the northwestern sector.

4.2.3.5 Local Wind Field

Wind roses comprise 16 spokes, which represent the directions from which winds blew during a specific period. The colours used in the wind roses, reflect the different categories of wind speeds; the red area, for example, representing winds of 6 to 10 m/s. The dotted circles provide information regarding the frequency of occurrence of wind speed and direction categories in 6% increments. The frequency with which calms occurred, i.e. periods during which the wind speed was below 1 m/s are also indicated.

Seasonal and monthly variations in the wind field recorded on site are provided in Figure 4-6 and Figure 4-7 respectively.

The wind field is characterised by dominant northwesterly winds. Wind from the north-northwest occurred 13% of the time with calm conditions occurring 20% of the time. There is not much variation between night-time and day-time wind flow, with a slight increase in frequency of winds from the north and northeast during the night. The night-time conditions are also characterised by lower wind speeds and a higher percentage of calm conditions.

Significant variation in seasonal wind field was observed. During the summer and spring months north-northwesterly winds dominate with an increase in easterly, east-northeasterly and west-southwesterly airflow during the autumn and winter months. The so-called “easterly winds” associated with high wind speeds occurred most frequently during the month of July (Figure 4-7).

FIGURE 4-5: WIND DIRECTION AND STABILITY CLASS

FIGURE 4-6: SEASONAL WIND ROSES

FIGURE 4-7: MONTHLY WIND ROSES

The greater the wind speed, the greater is its potential for mobilising particles and dispersing them. Given the different particle size distribution of the various wind erodible sources, each source is expected to have its own wind speed threshold above which the wind will mobilise and disperse particles. Examples of the required wind speeds per source are provided in Table 4-2.

TABLE 4-2: WIND SPEED THRESHOLD OF PARTICLE SOURCES

Potential particle source	Wind Speed Threshold (m/s)
Topsoil	8.7 m/s
Tailings	11 m/s
Waste rock dumps	11.6 m/s
Run of mine	11.6 m/s
Low grade stockpile	11.7 m/s

4.2.4 CONCLUSION

The climate aspects as discussed above assist in understanding the baseline climate and the potential impacts which may result. As a summary,

- Average rainfall and fog related precipitation is low but evaporation is high. This means that the area is water stressed which has implications for water supply and management, dust suppression, and vegetation growth.
- There is potential for flood events, which means that storm water and flood control will have to cater for long dry periods and short storm events. Furthermore, erosion control measures will be required to cater for the storm events.
- The range of temperatures, and contrast between stable atmospheric periods and windy periods will influence the dispersion of airborne pollution. In the more stable periods the ground level concentrations at the Husab site will be greatest, which will have potential impacts on worker health and vegetation. The stronger winds from the east will more easily mobilise dust and disperse this over greater distances. This may impact third parties and wind erosion must be controlled.

4.3 TOPOGRAPHY BASELINE

Information for the topography section was sourced from site visits by the EIA team, desktop review of the surface water specialist study (Appendix I) and the topographical characterisation of the visual specialist study (Appendix N). More detailed descriptions of the surface water and visual aspects are provided in Sections 4.8 and 4.13 respectively.

4.3.1 INTRODUCTION AND LINK TO IMPACTS

Changes to the current topography by project related infrastructure development may impact on surface water drainage, visual aspects and the safety of people and wildlife. The most significant changes to the topography will be from the establishment of the open pits and mineralised waste disposal facility (tailings and waste rock). To understand the basis of these potential impacts, a baseline situational analysis is described below.

4.3.2 DATA COLLECTION

The main source of data collection was a series of site visits by the EIA project team, review of topographical maps and a review of the project layout in relation thereto.

4.3.3 RESULTS

The Husab site is located on a gently sloping plain that is distantly surrounded by hills and koppies. The Khan and Swakop River valleys occur to the north, northwest, south and south west of the site. Water currently flows across the site from the north and north east to the south and south west in a series of shallow surface washes. The animals and people that have access to the site (in the context of the NNNP and the Husab exploration project) are not faced with any particularly dangerous excavations or infrastructure because aside from limited disturbances from the current Husab exploration project, the area is mostly undeveloped and represents a natural environmental state. Topography is depicted on Figure 1-2 and Figure 4-16.

4.3.4 CONCLUSION

The Husab mine infrastructure and excavations will alter the topography and influence topographical aspects such as surface water drainage, visual landscapes and the safety of people and wildlife.

4.4 SOIL BASELINE

Information in this section was sourced from the soil specialist study included in Appendix F (ESS 2010).

4.4.1 INTRODUCTION AND LINK TO IMPACTS

Soils are a significant component of most ecosystems. As an ecological driver, soil is the medium in which most vegetation grows and a range of vertebrates and invertebrates exist. In the context of mining, soil is even more significant if one considers that mining is a temporary land use where-after rehabilitation (using soil) is the key to re-establishing post closure land capability that will support post closure land uses.

The proposed project has the potential to damage the soil resource through physical loss of soil and/or the contamination of soils, thereby impacting on the soils ability to sustain natural vegetation and reducing land capability. Contamination of soils may in turn contribute to the contamination of surface and groundwater resources.

Loss of the topsoil resource reduces chances of successful rehabilitation and restoration.

To understand the basis of these potential impacts, a baseline situational analysis is described below.

4.4.2 DATA COLLECTION

Geological and topocadastral maps were used to provide an overview of the area, while colour imagery at a scale of 1:10 000 was used as the base map for the soil survey.

The field study of the site was performed using various survey grids, with the majority of the area being assessed on a grid of between 300m and 500m depending on the complexity of the soil patterns noted. The areas of potential impact by infrastructure construction and open pit mining were assessed in more detail. The majority of observations used to classify the soils were made using a hand operated Bucket Auger and Dutch (clay) auger.

Terrain information, topography and any other infield data of significance was also recorded, with the objective of identifying and classifying the area in terms of:

- soil types to be disturbed/rehabilitated;
- soil physical and chemical properties;
- soil depth;
- erodibility of the soils;
- construction soil utilisation potential, and
- soil nutrient status.

A suite of representative samples were taken and sent for analyses for both chemical as well as physical parameters. A select number of samples were submitted, each sample containing a number of sub samples from a particular soil Form or Type, which is representative of the area in question, thus forming a "composite sample", which in turn is representative of the soil Form rather than a specific point sampled. Sampling of the soils for nutrient status was confined where possible to areas of undisturbed land. However, some of the better soil and rock exposure, and areas where sampling could be undertaken are associated with the sumps that had been dug as part of the exploration process. These sites expose the profile from surface to the hard rock or evaporite contact in most cases. Samples were taken at intervals down the profile within the sump environment, and where appropriate, samples of the soil were taken for analysis.

4.4.3 RESULTS

4.4.3.1 Soil forms

As with any natural system, the transition from one system to another is often complex with multiple facets and variations. In this context, three groupings of soil forms were identified (read this section with reference to the soils map in Figure 4-8):

- The transition zone between the rocky outcrops (o/c) and the washes and desert plain comprises a group of generally shallow to very shallow (less than 400mm- navy blue shading on soils map) well sorted but poorly structured (apedel to single grained) fine to very fine grained sandy loams and silty loams that are associated with the in-situ materials of the rocky mountainous/hilly terrain upslope of both the desert plains and associated wash zones. These soils are generally founded on a hard rock base or lithocutanic horizon, and returned poor vegetative cover for the most part.
- The soils that make up the washes comprise unconsolidated materials of varying composition, are generally deep (from 600mm to more than 800mm –red and green shading on the soils map), and vary in texture from fine grained silt and sand to pebble and cobble size materials. In almost all cases mapped, the outwash materials are founded on a hard rock base that comprises either the host lithology (bedrock) or a sequence of evaporite derived sediments of varying consistency (calcium carbonate). This underlying layer may be significant to the overall ecological success of the area in its natural state, and could form a potential barrier layer that can potentially hold water close to the surface, but below the sands where it is available to some fauna and flora, and does not easily evaporate.
- The desert plain soils are characterised by moderately deep to shallow (400mm to 600mm – brown shading on soils map) silty sands which may have one, or both, of the surface crusting and the deeper calcrete layer. The soil structure is generally apedel to single grained and is associated with tufts of grass cover where the crust is absent or thin, and almost baren desert plains where the crust is greater than 100mm in thickness.

In terms of the Taxonomic Classification the major soil types encountered on the project site include those of the orthic phase Clovelly, Oakleaf, Dundee, Fernwood, Mispah, Glenrosa, Augrabies, Coega, Trawal, Montagu and Prieska Forms with minor areas of hydromorphic form soils including the Pinedene and Avalon Forms.

FIGURE 4-8: SOILS MAP

4.4.3.2 Soil Physical Characteristics

The majority of the soils mapped at Husab exhibit apedel to single grained structure, low to very low clay content and a leaching character. With high evaporation and low rainfall, the conditions are conducive to the formation of evaporate layers which are crusted calcifications at, or close to, the surface. The calcrete layers so formed may be an important feature of the biosphere and may contribute to the sustainability of the ecological systems in the desert environment.

In addition, the normal soil forming processes are at work, with in-situ soils with shallow depth and sandy loam textures characterising the rocky hill slopes and rocky desert, while the colluvial derived soils are characterised by deeper, sandy loams and sandy clay loams that bound on a hard rock or calcrete "C" horizon.

In contrast to the colluvial derived materials, the alluvial soils or stratified alluvium is characterised by variable texture and grain size distribution through the profile, with a mixture of fine and coarse materials in layers, a result of flood events and changes in the depositional energy of the events with time.

The soils do not retain water other than between the evaporate surface crust and deeper calcrete layers and are prone to erosion if the vegetative cover is removed and the topsoils are disturbed. They are also prone to compaction by heavy vehicle traffic or if overlain by heavy structures.

Soil distribution

The distribution of the soils is closely linked to the depositional mechanisms and environment, along with the topography and parent materials from which the soils are derived.

The Heavy Clay Rich Soils

Clay rich soils are virtually absent on site although some kaolinite associated with weathering of the calcite/calcium carbonates occur at the base of the soil profiles. The presence of these weathered clays should be identified during the mining process, and where possible, these materials stored as separate stockpiles for future use at rehabilitation. These materials will be invaluable in the reconstruction of barrier layers in the soil profile if required, and are the only materials available in the area for this purpose.

Soils derived from the more calcium rich parent materials (calc silicates and hardpan calcrete) that form the hard base to some of the soil profiles, exhibit some degree of structure, with weak crumby and weak blocky structure occurring where weathering of these materials occurs. This saprolitic layer is generally quite thin (<500mm) and underlain by the schists and calc silicates of the local geology. Intake rates and drainage through these calcrete layers is slow, forming the underlying inhibiting layers to the soil profile.

Light Textured – Single Grained to Apedal soils

The majority of the soils to be disturbed at the Husab site are classify as light textured soils that returned high inflow rates, good to very good drainage characteristics, and low to very low water holding characteristics. These are some of the more sensitive soils in the area, and will erode if not protected from the affects of wind and water erosion.

Shallow soils

The generally shallow rooting depths of the soils that dominate the area (<400mm) are associated with the resistant lithologies/host rock geology, while the deeper soils are associated with the alluvial flood plains/washes and the transitional zone desert plain materials. Shallow soil depths within the wash environment are generally associated with the hard rock geology or a variation of calcrete layers.

4.4.3.3 Soil chemical characteristics

Soil acidity/alkalinity

The dominant soils mapped in this area are slightly alkaline (pH = 8.1 to 8.7), but still generally within the accepted range for good nutrient mobility.

In general, it is accepted that the pH of a soil has a direct influence on plant growth. This may occur in a number of different ways including:

- the direct effect of the hydrogen ion concentration on nutrient uptake;
- indirectly through the effect on major trace nutrient availability; and
- by mobilising toxic ions such as aluminium and manganese, which restrict plant growth.

A pH range of between 6 and 7 most readily promotes the availability of plant nutrients to the plant. However, pH values below 3 or above 9, will seriously affect, and reduce the nutrient uptake by a plant.

Soil salinity/sodicity

Generally, the soils mapped in this area are non saline in character, but are prone to sodic/salt development where evaporation has concentrated the salts at surface and/or within the profile.

The salinity and/or sodicity is of importance in a soil's potential to sustain growth. Highly saline soils will result in the reduction of plant growth caused by the diversion of plant energy from normal physiological processes, to those involved in the acquisition of water under highly stressed conditions.

In addition soil salinity may directly influence the effects of particular ions on soil properties. The sodium adsorption ratio (SAR) is an indication of the effect of sodium on the soils. At high levels of exchangeable sodium, certain clay minerals, when saturated with sodium, swell markedly. With the swelling and dispersion of a sodic soil, pore spaces become blocked and infiltration rates and permeability are greatly reduced.

In general the mapped soils at Husab are are in the range of non to slightly saline. The soils are prone to sodic/salt development where evaporation concentrates the salts at surface in a crust, or within the soil profile as a calcrete layer. It follows that for salts to be retained, good water management will be required for areas where the soils are disturbed.

Soil fertility

The soils at Husab have moderate levels of some of the essential nutrients required for plant growth with sufficient stores of calcium and sodium. In this regard, levels of Zn, P, Mg, Al, Cu and K are generally lower than the optimum required.

Significantly large areas of soil with a low level of plant nutrition were mapped across the Husab site. These conditions for growth are further compounded by the high permeability and low clay and carbon contents of the majority of the soils.

There are no indications of any toxic elements that are likely to limit natural plant growth in the soils mapped within the study area.

Nutrient Storage and Cation Exchange Capacity (CEC)

The potential for a soil to retain and supply nutrients can be assessed by measuring the cation exchange capacity (CEC) of the soils. The low organic carbon content and very low clays are detrimental to the exchange mechanisms, as it is these elements which naturally provide exchange sites that serve as nutrient stores. These conditions will result in a low retention and supply of nutrients for plant growth.

Generally, the CEC values for the soils mapped in the area are low and enhanced due to the low clay contents.

Soil organic matter

The soils mapped are all extremely low in organic carbon as would be expected for a desert environment. This factor, coupled with the moderately low to low clay contents for the majority of the soils mapped, will adversely affect the erosion indices for the soils, with a very high index prevailing for the majority of the materials classified at Husab.

4.4.3.4 Soil Erosion and Compaction

The resistance to, or ease of, erosion of a soil is expressed by an erodibility factor ("K"), which is determined from soil texture, permeability, organic matter content and soil structure.

The majority of the soils mapped can be classified as having a high erodibility index in terms of their clay content (very low), organic carbon (very low) and structure (structure less), which is off set and tempered by the almost flat terrain to an index of moderate.

These factors are enhanced on the more mountainous terrain by the low level of vegetation cover and steepness of the slopes, while the valley environments and desert plains are characterised by low erosion indices due to the flatness of the terrain, the presence of the hardened evaporite layer and the generally better vegetation cover associated with a better soil cover.

The "B" horizon is also potentially prone to erosion if the topsoil is removed.

The concerns around erosion and compaction, are directly related to the disturbance of the protective vegetation cover and topsoil that will be disturbed during any mining or construction operation. Once disturbed, the actions of wind and water are increased.

4.4.4 CONCLUSION

In summary, the findings of the soil study for the proposed Husab Project are as follows:

Large areas of soil with low levels of plant nutrition were mapped. Furthermore, soils have a high permeability and low clay and carbon content making them susceptible to erosion and compaction.

The soils are associated with an evaporite layer either at surface as a crust and/or as a calcrete layer deeper in the soil profile. These layers may be significant to the ecological balance of the desert environment because they are believed to retain water content in the soil horizons beneath the crust and above the calcrete layer.

Well planned management actions during the planning, construction and operational phases will save time and money in the long run, and will have an impact on the ability to successfully "close" an operation once completed.

4.5 LAND CAPABILITY BASELINE

Information in this section was sourced from the soil specialist study included in Appendix F (ESS 2010).

4.5.1 INTRODUCTION AND LINK TO IMPACTS

The land capability classification is based on the soil properties and related potential to support various land use activities. The proposed project has the potential to significantly transform the land capability through the placement of infrastructure in particular. To understand the basis of this potential impact, a baseline situational analysis is described below.

4.5.2 DATA COLLECTION

The South African Chamber of Mines Land Capability Rating System in conjunction with the Canadian Land Inventory System were used as the basis for the land capability study.

Using these systems, the land capability of the study area was classified into four distinctly different and recognisable classes, namely, wetland, arable land, grazing land and wilderness.

4.5.3 RESULTS

The land capability classification as described above was used to classify the land units identified during the pedological survey. In summary, of the total area investigated 6420ha. Figure 4-9 illustrates the distribution of land capability classes.

4.5.3.1 Arable Land

The very low rainfall of this area (<100mm/a) limits the utilization potential of the study area to very low intensity grazing and wildlife conservation. There is little prospect of using the land for crop cultivation.

4.5.3.2 Grazing Land

The areas that classify as grazing land are generally confined to the well drained soils. These soils are generally darker in colour, but are capable of sustaining palatable plant species. In addition, there should be no rocks or pedocrete fragments in the upper horizons of this soil group. If present this will limit the land capability to wilderness land.

4.5.3.3 Wilderness / Conservation Land

The majority of the area in question classifies as either conservation or wilderness land based on the shallow rocky nature of the soils and their inability to sustain grazing and crop yield.

4.5.3.4 Wetland

Wetland areas are defined in terms of soil characteristics, the topography as well as vegetation criteria. These zones (wetlands) are dominated by hydromorphic soils (wet based) that often show signs of structure, and have plant life (vegetation) that is associated with seasonal wetting or permanent wetting of the soil profile.

The wetland soils are generally characterised by dark grey to black (organic carbon) in the topsoil horizons and are often high in transported clays and show variegated signs of mottling on gleyed backgrounds (pale grey colours) in the subsoil's.

There are no true wetland soils (wetness too deep below surface – must be within 500mm of surface) present within the study area.

4.5.4 CONCLUSION

The current land capability is listed as wilderness and grazing in the majority of the study area. This will be changed by the project development. Therefore, impact management and rehabilitation planning are required to achieve acceptable post mining land capabilities.

FIGURE 4-9: LAND CAPABILITY MAP

4.6 BIODIVERSITY BASELINE

Information in this section was sourced from the biodiversity study included in Appendix G (AWR 2010).

4.6.1 INTRODUCTION AND LINK TO IMPACTS

In the broadest sense, biodiversity provides value for ecosystem functionality, aesthetic, spiritual, cultural, and recreational reasons. The known value of biodiversity and ecosystems is as follows:

- soil formation and fertility maintenance;
- primary production through photosynthesis, as the supportive foundation for all life;
- provision of food and fuel;
- provision of shelter and building materials;
- regulation of water flows and water quality;
- regulation and purification of atmospheric gases;
- moderation of climate and weather;
- control of pests and diseases; and
- maintenance of genetic resources (key for medicines, crop, and livestock breeding).

The ecosystem under consideration is a virtually pristine Namibian ecosystem that occurs in the NNNP. It is mostly untouched by any anthropogenic developments except for the old German railway, and some tourism and exploration activities. Development of the proposed mine (through its infrastructure and activities) will impact on the land surface which may impact one or more of the following biodiversity parameters:

- Biodiversity composition in terms of species and their abundance. Key engineer species are particularly important because a limited change in their numbers may have a disproportionate effect on the ecosystem's stability or resilience. Rare, threatened or endangered (RTE) species are important because impacts on them have wider relevance than the site alone.
- Biodiversity structure which is the organisation of biological units in time and space. The spatial structure component of this concept refers to the distribution of organisms across space; for example, species populations may be driven from one habitat to the next or may be fragmented, and movement patterns may be disrupted. The food web structure and interactions component of this concept refers to the flow of energy and nutrients through an ecosystem by the mechanisms of predation, herbivory and parasitism; for example, the loss of particular habitats may have disproportionate impacts on a particular species, because its food resource occurs there. Lastly, the habitat linkages component of this concept refers to the flow of matter and energy across the landscape and thus the persistence of spatially separate habitat patches and ecosystems.
- Key biodiversity processes in terms of functional linkages of parts or components of an ecosystem through a directed flow process; for example, in an arid environment, run-off and run-on of water

dictate the spatial arrangement and hence scale of ecological processes; without these the ecosystem may collapse. Predation is another key process, as is dispersal.

To understand the basis of these potential impacts, a baseline situational analysis is described below.

4.6.2 DATA COLLECTION

4.6.2.1 Methods

In addition to the conventional concepts around the investigation of biodiversity, there are two principles that were applied to the Husab Project investigation and assessment:

- First, ecosystems are complex, multi-interacting systems with sometimes unpredictable behaviour. This means that precaution is always a high-level guiding principle, and assessment and management must be done in a continuously learning and adaptive approach.
- Second, an ecosystem should be studied and understood from both the perspective of structure (the identity and abundance of species that it contains) and function (the way in which matter and energy flows through the ecosystem by virtue of processes and interactions among species).

Omitting either of these two aspects will limit one's ability to understand and manage impacts on the ecosystem. Given this, neither structure nor function can be completely understood without a specific spatial context. The landscape influences organisms' activities and interactions on a basic level and therefore the data collection emphasis was placed on the detection of spatial patterns in structure and function (habitats), with the aim of presenting an explicit visual picture of where in the project area the most sensitive places and processes are located.

The following basic methods were used to achieve the above:

- A literature study was done to describe the physical and ecological context of the project, and species lists were compiled from various published sources and museum records.
- The landscapes of the study area were classified and mapped to serve as the basis for further fieldwork planning and refinement for the ultimate production of a vegetation map. Habitats were identified using an iterative process informed successively by field observations, preliminary biodiversity and physical data analysis and final data analysis. Habitat sensitivity was determined based on a broadly accepted number of criteria that reflected the habitat's functional value, and its vulnerability and resilience in the face of disturbances.
- Field surveys were conducted of the plant assemblage as well as of fauna activity patterns, including large fauna movements. The plant assemblage was surveyed using 95 stratified-randomly located plant sampling plots, where the health of the biological soil crust (BSC) was also assessed. Large fauna movements were assessed by identifying and logging the coordinates of spoor of zebra, springbok, and ostrich along 79 randomly placed line transects of varying length. Animal activity was

measured in 79 circular plots and gerbil burrows were surveyed in 79 strip transects located close to the activity plots.

- Species composition analyses were used as basis for determining the spatial extent and nature of plant species co-occurrence, which was in turn used to determine the boundaries of vegetation units.
- Invertebrates were surveyed using three preservative pit traps in each of vegetation units.
- Small mammals were surveyed using three grids of 30 Sherman live traps randomly located within a sample of the habitats of the study.
- The field survey for reptiles focused on actual sightings of reptiles at different times of the day. Tissue samples were also taken for DNA analysis from eight specimens of four lizard species. Individuals were subsequently released at the capture site.
- Particular attention was paid to identifying keystone structures or species, because of their critical role in ecosystem function.
- All data were transferred to a GIS platform. Apart from the drafting of a vegetation map, the GIS was used to analyse spatial patterns in vegetation and animal activity. The resulting series of maps depicted the spatial distribution of community ecological variables and other biodiversity characteristics and helped to inform the process of setting habitat sensitivity levels. A satellite image was used as backdrop for all mapping.
- Surface hydrology was determined by digitising the drainage lines visible on the satellite image across the whole plain.

4.6.3 RESULTS

4.6.3.1 Habitats

The structure and function of the biodiversity of the project area could be described by focussing on plant communities, vertebrate communities or invertebrate communities. However, in order to present one reference point of the structure and function of the project area, the biodiversity is also described by habitat.

In broad terms, habitats are places where organisms live. Habitat requirements include characteristics such as availability of required nutrients, energy, water, the absence of toxins, shelter, geophysical conditions, and suitable micro-climatic conditions.

In total 12 habitats were defined based on their physical and ecological characteristics. The location of the habitats are presented visually on figure 4-10 and discussed in detail in Table 4-3. The habitats include: Khan River, Rocky Valley Drainages, Plains Drainage Channels, Pink Gramadoelas, Black Gramadoelas, Marble in Gramadoelas, Gypsite Plain, Grassy Plain, Hard Undulating Plain, Koppies and Ridges on Plains, the Welwitschia Plain, and Aquatic Habitat.

FIGURE 4-10: COLLECTIVE HABITATS

TABLE 4-3: HABITATS

Name	Physical characteristics	Ecological characteristics	Keystone structures/processes
Khan River (and Swakop River)	• Large drainage channel • Deep sandy bottom with silt layers and gravels • Deeply incised valley • Low gradient	• High disturbance rate with regular flooding • Regular re-charge of superficial aquifer • Route for animal dispersal and movement • Supports significant kudu and ostrich populations • Discrete vegetation assemblage includes large trees that depend on regular replenishment of aquifer and in turn provides habitat to a suite of invertebrate trophic guilds dependent on large woody vegetation • Seasonal standing water	• Large trees and thickets are probably important for invertebrate diversity • Grazing and browsing for large mammals • Movement corridor • The valley walls and large trees provide shelter from wind, blown sand and sun • Aquifer recharge
Rocky Valley Drainages	• Smaller drainage channels • Sandy bottom • Deeply incised rocky valley • Gradient varies, can be high	• Often contain saline or fresh perennial or ephemeral springs with associated vegetation and birdlife • Springs may actually be considered a habitat on their own • Small perched aquifers may be common • Well-defined movement corridors for wildlife; critical for zebra and kudu to access springs. Also supports Rüppel's Korhaan • Carries a diverse assemblage of herbs that includes a high proportion of endemics and near-endemics	• Springs • Large trees • Drainage lines
Plains Drainage Channels	• Distinct large (5 - 15 m across), sinuous drainage channels • Sandy bottom • Low gradient	• Represents the largest drainage channels of the Grassy Plain; all smaller tributaries are grouped with the Grassy Plain habitat itself • Experiences infrequent disturbances through flooding • Sandy substrate is well-drained • May form perched aquifers where sub-surface geology allows it • Important for the transport of water for downstream Welwitschia populations • Most southeastern of these channels has high	• Large trees • Welwitschias • Drainage lines

Name	Physical characteristics	Ecological characteristics	Keystone structures/processes
		vegetation diversity including several protected species • Welwitschia plants are significantly associated with small tributary drainage channels	
Pink Gramadoelas	• Complex incised gneiss/granite bedrock • Friable rock, steep sides, many nooks and crannies, loose scree slopes • Small gullies and drainages with pockets of sand accumulation • Water retention features	• High diversity of nooks and crannies forming shelter for a range of mammals, reptiles and birds • Small gullies contain sandy substrates with many plant species, including *Commiphora oblanceolata* • Forms the only habitat for klipspringer, dassie rat, pygmy rock mouse and red rock rabbit, amongst other rupicolous species • Includes an ecotone of gneiss hillocks along the southern edge dissected by numerous small rivulets and gullies that form the headwaters of the rocky valley drainages and contain a diverse assemblage of plants, including a high proportion of endemics and near-endemics	• Nooks and crannies, complex structure • Small gullies (drainage lines)
Black Gramadoelas	• Complex incised metamorphosed sediments, mostly black or dark grey • Small gullies and drainages with pockets of sand accumulation	• High diversity of nooks and crannies, but little resource retention • Small gullies contain sandy substrates where most of the vegetation is located	• Drainage lines
Marble in Gramadoelas	• Two folded bands of marble cutting across the gramadoelas, with layers striking nearly vertical • Layered stone structure, many nooks and crannies • Water retention probably high	• Layered character may result in water percolation and retention in rock fractures • Characterised by relatively high levels of vegetation biomass and presence of *Euphorbia virosa*, *Commiphora oblanceolata* and *Sarcocaulon marlothii*. A number of protected species occur here, including *Aloe namibensis, A. asperifolia* and *Sterculia africana* • Floristically these bands are extensions of the marble ridges on the grassy plain, but adjacent rocky ridges makes meso- and micro-environment different	• Drainage lines

Name	Physical characteristics	Ecological characteristics	Keystone structures/processes
Gypsite Plain	• Indistinct area, best expressed in northern part of study area, located more or less along the Khan-Swakop watershed • Hardpan gypsite layer, possibly caused by long-term condensation and evaporation of fog pushing out of the Khan River, with shallow loamy gravel or sand cover • Specific erosion pattern with sharp edges on small gullies	• Small (0.5 – 2m) mostly circular depressions that store water seasonally and results in vegetation rings, often containing perennial grasses and annual grasses and herbs, including endemics such as *Cleome carnosa*, *Jamesbrittenia barbata* and *Sporobolus nebulosus* • Small mammal (primarily gerbil) burrows are apparently strongly associated with these depressions, possibly resulting in localised fertilisation and increased water penetration; may thus be a keystone feature • Ample evidence of zebra grazing in these areas • Erosion patterns (numerous parallel sharply cut rivulets) on the edges of the plain apparently associated with high vegetation productivity • Strong (although not complete) association of *Arthraerua leubnitziae* with Gypsite Plains; *A. leubnitziae* may represent a minor keystone structure	• Circular depressions • Gerbil burrows • *A. leubnitziae* shrubs
Grassy Plain	• Largest part of study area, consists of pale semi-consolidated eroded material • Substrate mostly deep loamy gravel-sand • Drained by numerous sinuously twisting drainage channels that often fan out and disappear on very gentle or flat slopes • Includes sheet drainages that are too small to map out separately • Includes area underlain by metamorphosed sediments of the Kuiseb formation forming fine-grained dark sandy surfaces • Includes small pockets of aeolian	• Contains high numbers of annual and perennial grasses • Primary habitat for small burrowing and digging mammals: gerbils, suricates and a number of unidentified viverids; especially gerbil burrowing may result in localised fertilisation (potential keystone process and keystone group) • Possibly important area for re-charge of superficial aquifer/s on the plain (needs to be confirmed through dedicated study) • Probably seasonally important grazing areas for zebra; year-long important grazing areas for springbok and ostrich • Represents the only habitat with significant numbers of Cape hare • Together with Rocky Valley Drainages and Plains	• Level areas that are potentially important aquifer recharge areas • Gerbil burrows

Name	Physical characteristics	Ecological characteristics	Keystone structures/processes
	sand at the edge of the gramadoelas, integrating with the sandy bottom of rocky valley drainages	Drainage Channels, is important habitat for Rüppel's Korhaan • Includes a significant part of the *Welwitschia* population; those parts of this habitat containing *Welwitschia* plants are dealt with as an independent habitat (Welwitschia Plain)	
Hard Undulating Plain	• Southeast area surrounding the large marble koppies • Hard semi-rocky undulating surface with loose gravel • Drained by numerous small runnels as well as sandy gullies and washes • Loose substrate is very shallow except in the larger washes	• Drainage pattern and hard layer is unique in area; not including perennial grasses, the drainages in this habitat support the highest biomass of vegetation outside the rivers • Contains small circular depressions with high density of grass, possibly caused by activity of gerbils • Contains vegetation species either not yet found, or rare, elsewhere in study area (*Chascanum garipense, Anticharis imbricata, Anticharis ebracteata*). • Important grazing/movement area for zebra • High numbers of Springbok • Seasonally forms small water holes in depressions • Highest density of larger woody species (*Salsola* sp., *A. erioloba*) outside the Khan River valley • Also includes a significant part of the *Welwitschia* population; those parts of this habitat containing *Welwitschia* plants are dealt with as an independent habitat (Welwitschia Plain)	• Drainage lines • Circular depressions • Gerbil burrows
Koppies and Ridges on Plains	• Composite of all rocky ridges, some of which consist of marbles and limestones (these are extensions of the prominent marble bands in the gramadoelas), others of metamorphosed sediments of the Khan Formation	• Discrete and unique habitat distinctly different from grassy plain • Mostly elevated above plain, possibly good fog traps, which may explain relatively high vegetation biomass and species diversity • Contains a number of plant species uniquely associated with it in this area, including *Euphorbia*	• Nooks and crannies • Possibly fog traps

Name	Physical characteristics	Ecological characteristics	Keystone structures/processes
	• Ranges in height from barely above the surface of the grassy plains to ~150m • Almost always have an erosion fan consisting of loose, marble-derived sand and pebbles	*giessii, Aloe asperifolia, Avonia albissima, Commiphora virgata, Commicarpus squarrosus, Larryleachia marlothii, Hereroa puttkamerana, Hoodia pedicellata* and others. Also the favoured habitat of *Commiphora oblanceolata*. • Erosion fans may be prime habitat for gerbils, with relatively higher numbers there • Marble ridges overall of higher biodiversity value than the ridges formed by metasediments • Most are seed traps and form shelter from wind and wind-blown sand for many plants and animals.	
Welwitschia Plain	• Represents those parts of the Grassy and Hard Undulating Plains that also contain numerous *Welwitschia mirabilis* plants • Has loamy-gravel substrate cut with numerous small sheet and shallow linear washes in twisting and herringbone patterns • The washes on the grassy part of the plain are clearly visible from the air but often indistinct on the ground.	• This plain is distinguished from the rest of the Grassy Plain mainly by the dominance of *Welwitschia mirabilis* that appears to be strongly associated with washes on the plain • Welwitschias may be keystone structures because each individual plant harbours a range of vertebrate and invertebrate animals that would not otherwise occur here. Some invertebrate species may be symbiotic with Welwitschia.	• Drainage lines (numerous shallow washes) • Individual Welwitschia plants.
Aquatic Habitat	• Occurs mostly in the form of seepages or springs in the rocky valleys adjacent to the Khan River. Also a relatively large saline spring on the southern edge of the study area. • Springs are ephemeral or perennial	• Provides critical habitat for specific plants, birds, amphibians and a range of invertebrate species • Provides critical resource for a number of water-dependent mammal species such as zebra and kudu • Seasonal effect of ephemeral springs will be important determinant of space use by zebra	• Seasonally or permanently available water • Lush vegetation is attractive to birds and insects • Seasonal supply of critical resource

4.6.3.2 Discussion of species and communities

Plants

As a general comment it is important to note that the study area and its surroundings appear to form an 'island' of unusually high plant diversity in the context of the central Namib Zone. Moreover, plant vigour was generally good because on a three-point scale from poor to good none of the plots were scored as anything else but "good".

Although there is significant overlap, the location of plants and plant communities does not strictly adhere to the defined 12 habitats that have been observed in the study area. It follows that the plants in the study area should be divided into 13 basic plant communities (see Figure 4-11 and Table 4-4):

TABLE 4-4: PLANT COMMUNITIES IN THE STUDY AREA

	Community Name	Description
1	***Acacia erioloba-Faidherbia albida* community**	Plant community of sandy riverbed habitat.
2	***Acacia erioloba-Petalidium variabile* community**	Plant community of broad sandy drainage corridor habitat.
3	***Zygophyllum stapffii-Acacia erioloba- Petalidium pilosi-bracteolatum* community**	Plant community strongly associated with three broad sandy drainage line habitats that incise the grassy plain and converge near the road to the old Husab mine.
4	***Commiphora oblanceolata-Stipagrostis dinteri* community**	Plant community of very rugged ridges and gullies forming the Khan River canyon.
5	***Commiphora saxicola-Petalidium canescens* community**	Plant community associated with the very dark, rough and steep metasediments that make up the Black Gramadoelas habitat.
6	***Zygophyllum stapffii-Petalidium variabile* community**	Plant community of the rounded gneiss hillocks incised by narrow sandy gullies with strongly weathered sides.
7	***Arthraerua leubnitziae-Zygophyllum stapffii* community**	Plant community of a sandy-gravelly zone dominated by *Stipagrostis* spp. at the top of the grassy plains, often with subsurface gypsite and small, shallow depressions.
8	***Stipagrostis* spp community**	Plant community associated with flat sandy-gravelly plain sloping upwards from southwest to northeast with *Stipagrostis* spp dominant.
9	***Zygophyllum stapffii-Welwitschia mirabilis* community**	Plant community on a series of dark grey sparsely vegetated gravelly ridges with *Stipagrostis* spp. and *Zygophyllum stapffii* dominant. Foot slopes carry numerous *Welwitschia mirabilis.*
10	***Euphorbia virosa-Commiphora oblanceolata* community**	Plant community of the prominent koppie and ridges and gorges, characterised by *Euphorbia virosa and Commiphora oblanceolata.*
11	***Zygophyllum stapffii-Commiphora oblanceolata* community**	Plant community of the smaller marble ridges on the plains.
12	***Stipagrostis* spp-*Petalidium pilosi-bracteolatum* community**	Plant community found on the hard, undulating plain with stony surface incised by sandy gullies.
13	***Stipagrostis* spp-*Salsola* sp community**	Small low-lying area of saline soil limited to the southernmost part of the study area and dominated by *Stipagrostis* spp. and *Salsola* sp.

FIGURE 4-11: PLANT COMMUNITIES

As part of understanding the plant communities a list of 248 plant species was compiled for quarter degree grid squares 2215CA and 2215CD, which includes the study area. Of the 248 species, 177 have been collected or observed in the study area, or are expected to occur based on their habitat affinities. The highest plant diversity is expected on the Koppies and Ridges on Plains, the lowest on the northwestern sandy heads of the Rocky Valley Drainages (as may be expected of an unconsolidated substrate) and the second lowest on the Grassy Plain. A full list of species is included in Appendix G (AWR 2010).

Of the 48 endemic and 37 near-endemic (to Namibia) species thought to occur in the general area, 28 and 19 respectively have already been collected or observed on site and another 9 and 7 respectively are expected to occur. Table 4-5 provides a summary of the more significant endemic, near endemic and protected plant species found, or expected to be found, within the 12 habitats associated with the project site.

In a desert the surface flow and capture of water is arguably one of the most important factors that determine the presence and spatial distribution of organisms (especially plants). The study area and adjacent areas are drained by a large number of washes, mostly towards the Swakop River and hemmed in by two parallel watersheds. The Welwitschia population in the study area is located at the confluence of a number of the larger drainage lines at the lower end of the plain. Welwitschia density may be related to the volumes of water that infrequently run down this drainage system. The largest Welwitschia individuals, including the so-called Giant Welwitschia (tourist attraction), are all associated with this area. Some or more of these Welwitschias may be at risk with the development of the project.

TABLE 4-5: SUMMARY OF RESTRICTED-RANGE ENDEMIC PLANT SPECIES, PROTECTED PLANT SPECIES AND NEAR-ENDEMIC PLANT SPECIES OF CONSERVATION CONCERN FOUND, OR EXPECTED TO OCCUR, IN THE HUSAB STUDY SITE.

Listing is in alphabetical order within four categories of endemism. Categories were similar to Burke (2007) and Burke et al. (2008), with the only difference being that Mendelsohn et al.'s (2002) vegetation zones were used instead of regional boundaries. Distribution of endemics is based on records from the National Herbarium database (SPMNDB). Conservation status, Red Data Categories: LC = least concern; NT = near threatened; VU = vulnerable; NA = not assessed (Loots 2002, 2005). Recorded on site (R). Expected on site (E).

Species	Longevity	Habitat location	Conservation status	Recorded / Expected	Comments
Species that are only known from the central Namib or have only occasionally been recorded elsewhere					
Aizoanthemum galenioides	annual	Plains, drainage lines, hills, rocky outcrops, inselbergs	LC	R	Most commonly recorded along the central Namib coast, however reasonably common on sandy plains at Husab, possibly due to fog carried inland by river courses.
Cleome carnosa	annual	Sandy drainage lines, shallow depressions on plains, hills, rocky outcrops and inselbergs	LC	R	Usually only found in drainage lines, occasionally on plains.
Helichrysum marlothianum	annual	Sandy watercourses		E	Known from only a few collections in four quarter-degree squares centred on the general Rössing area.
Species known from the central Namib and one other vegetation zone					
Aloe namibensis (Namib Aloe)	Perennial, long-lived	Prefers sandy pockets on rocky slopes and ridges, also occurs on sides of gneiss/granite gullies	Protected LC Cites II	R	Occurs as far east as the escarpment zone. Potentially impacted by several uranium developments.
Crotalaria colorata subsp. *Colorata*	perennial	Drainage lines, gullies, rivers		E	Previously recorded from southern Namib also, but that record an incorrect determination.
Lithops ruschiorum	Perennial, long-lived	Reasonably restricted habitat preferences, usually occurring on rocky slopes on hills and ridges	Protected LC	E	Has been reliably reported from Husab in the vicinity of the Giant Welwitschia site (G. Erb pers. comm.) as well as elsewhere in the EPL. Recent work (Loots In prep) has confirmed its presence as far north as the Khumib River. It is a cryptic species with typically widely scattered sub-

Species	Longevity	Habitat location	Conservation status	Recorded / Expected	Comments
		composed of quartz, pegmatite, calcrete, calcite and marble substrates.			populations. Although it has been assessed as 'least concern (LC)' by the Red Data list it is a formally protected species that has been impacted by the Rössing mine in the past; this should be factored in when the sensitivity of habitats is being considered.

Species known from the central Namib and more than one other vegetation zone					
Aloe asperifolia (Kraal Aloe)	perennial, long-lived	Depressions, drainage lines, gullies, plains, hills, rocky outcrops and inselbergs	Protected LC	R	Slow-growing.
Arthraerua leubnitziae	perennial, long-lived	Depressions, drainage lines, gullies, plains, hills, rocky outcrops and inselbergs	LC	R	Fog-dependent, potentially impacted by several uranium developments.
Commiphora saxicola (Rock Corkwood)	perennial, long-lived	Depressions, drainage lines, gullies, hills, rocky outcrops and inselbergs	LC	R	Potentially impacted by several uranium developments but reasonably widespread.
Commiphora virgata (Slender Corkwood)	perennial, long-lived	Hills, rocky outcrops and inselbergs	LC	R	Potentially impacted by several uranium developments but very few were recorded during fieldwork for current project. This is the far western edge of its distribution range; it is more common on the escarpment.
Dauresia alliariifolia	perennial	Hills, rocky outcrops and inselbergs	LC	R	Reasonably widespread.
Euphorbia giessii	perennial	Only occurs on rocky ridges, commonly seen on marble ridges in study area	LC	R	Possibly fog-dependent, virtually restricted to the desert biome. Only known from rocky ridges, which form a relatively small proportion of the central Namib.
Petalidium canescens	perennial	Depressions, drainage lines, gullies, plains, hills, rocky outcrops and inselbergs	LC	R	Reasonably widespread.
Petalidium pilosi-	perennial	Drainage lines, marble	LC	R	Fragmented population across its range. Common in large washes and on

Species	Longevity	Habitat location	Conservation status	Recorded / Expected	Comments
bracteolatum		ridges			marble ridges at Husab, which may represent its western-most limit in the central Namib. Not recorded in recent work at Langer Heinrich, Rössing or Goanikontes.
Zygophyllum cylindrifolium	perennial	Depressions, drainage lines, gullies, plains, hills, rocky outcrops and inselbergs	LC	R	At Husab most common on marble ridges.
Zygophyllum stapffii	perennial, long-lived	Drainage lines, rivers, rocky slopes, shallow depressions on plains	LC	R	Fog-dependent, potentially impacted by several uranium developments.

Near-endemic and protected species not mentioned above					
Acacia erioloba (Camel Thorn Tree)	perennial, long-lived	Drainage lines, rivers, hills, inselbergs	Protected	R	Increasing threats countrywide.
Combretem imberbe (Leadwood)	perennial, long-lived	Drainage lines, rivers	Protected	E	Considered a sacred tree by the Herero people, threatened by illegal harvesting for fuel.
Commiphora oblanceolata (Swakopmund Corkwood)	perennial, long-lived	Marble ridges, hills, rocky outcrops, inselbergs, gullies.	NT	R	Disjunct distribution, central Namib population appears to be centred on Husab EPL. Not found at Langer Heinrich, very few at Rössing, low numbers at Goanikontes. Of concern because thought to possibly be a distinct taxon from the Northern Namib and Angolan populations.
Euclea pseudebenus (Wild Ebony)	perennial, long-lived	Drainage lines and rivers	Protected	R	Widespread in Namibia.
Faidherbia albida (Ana tree)	perennial, long-lived	Rivers	Protected	R	Widespread in Namibia.
Hoodia currorii (Hoodia)	perennial	Marble and other rocky ridges and slopes, plains	LC	R	Illegal collecting a threat.
Hoodia pedicellata (Hoodia)	perennial	Marble and other rocky ridges and slopes	VU	R	Main threat thought to be illegal collection.
Larryleachia marlothii	perennial	Marble and other rocky ridges and slopes	Protected	O	Often collected illegally.

Species	Longevity	Habitat location	Conservation status	Recorded / Expected	Comments
Maerua schinzii (Lamerdrol)	Perennial, long-lived	Riverbanks, rocky slopes	Protected	R	Widespread in Namibia.
Sterculia Africana (Tick Tree)	Perennial, long-lived	Rocky slopes	Protected	R	Reasonably widespread in Namibia.
Tamarix usneoides (Wild Tamarisk)	Perennial	Riverbeds and large drainages	Protected	R	Widespread in Namibia.
Welwitschia mirabilis	Perennial, long-lived	Depressions, drainage lines, plains, rocky slopes	Protected LC	R	Large proportion of central Namib population appears to be concentrated on this EPL.(Kers 1967, Cooper-Driver 1994)
Ziziphus mucronata (Buffalo Thorn)	Perennial, long-lived	Riverbanks and large drainage lines	Protected	R	Widespread in Namibia.

Invertebrates

Approximately 194 invertebrate species or morphospecies are expected to occur in the study area. Of these 132 (all Phylum Arthropoda) were actually recorded. From the perspective of trophic guilds, very few flower-feeders or fruit-feeders were encountered during the survey, because these trophic resources are only available for a short time following rain. No wood-eaters, whose adult forms are usually also flower-feeders, were encountered. No primary grass-eaters were recorded, but secondary grass-eaters included the harvester ants and the harvester termite. No dung feeders were seen, but microfloral feeders like the tiny booklice were found in large numbers at the Khan metasediment ridges and the Hard Undulating Plains. A full list of species is included in Appendix G (AWR 2010).

At least 45 invertebrates endemic to Namibia occur in the study area of which 21 (47%) are endemic to the central Namib only, 13 (29%) are endemic to a wider area, but still found only within the borders of Namibia, while the remaining 10 (22%) are near-endemic. The central Namib endemics comprise six solifuges, three scorpions, seven beetles, two flies, two silverfish and one grasshopper.

The endemic invertebrates (both observed on site and expected on site have been assigned to habitat types (see Figure 4-12) that (as for the plants) do not exactly correlate to the defined habitats of the project study area because the vegetation and invertebrates are not confined by definite boundaries in all cases. The number of endemic invertebrates provides an indication of the importance of the habitat types for vertebrates.

TABLE 4-6: INVERTEBRATE ENDEMICS PER INVERTEBRATE HABITAT TYPE

Invertebrate groupings per invertebrate habitats	Number of endemic invertebrates
Khan River	6
Rock valley drainage	24
Dry plain wash	25
Pink Gramadoelas	13
Black Gramadoelas	13
Gneiss gullies	29
Succulent shrub watershed	29
Grassy plains	27
Khan ridges	28
Limestone marble ridges	15
Marble ridges	16
Undulating Gneiss plains and gullies	25
Saline community	4
Welwitschia site	4

FIGURE 4-12: INVERTEBRATE HABITATS

Five of the invertebrate species are considered Critically Endangered, four are Endangered and two are Vulnerable. These are described in Table 4-7.

TABLE 4-7: ENDANGERED INVERTEBRATES PER INVERTEBRATE HABITAT TYPE

Abbreviations for vegetation types: BLGR – Black Gramadoelas; DWOP – Dry washes on plains; GNGU – Gneiss Gullies; GRPL – Grassy Plains; KHAN – Khan River; KHMR – Khan Metasediment Ridges; LIMA – Limestone-Marble Ridges; MARI – Marble Ridges; PIGR – Pink Gramadoelas; ROVD – Rocky valley Drainages; SALC – Saline Community; SSWS – Succulent Shrub Watershed; UGPG – Undulating Gneiss Plains and Gullies; WELW – Welwitschia-specific site. E – expected. O – observed.

Species	**Common name**	**Red Data status**	**Invertebrate habitat type**													
			KHAN	**ROVR**	**DWOP**	**PIGR**	**BLGR**	**GNGU**	**SSWS**	**GRPL**	**KHMR**	**LIMA**	**MARI**	**UGPG**	**SALC**	**WELW**
Blossia planicursor	Solifuge	Critically Endangered						E	E	E	E			E		
Ctenolepisma occidentalis	Silverfish	Critically Endangered		E	E			E	E	E	E			E		
Metaphilhedonus swakopmundensis	Flower beetle	Critically Endangered		E	E	E	E					E	E			
Nothomorphoides irishi	Jewel beetle	Critically Endangered		E	E			E	E	E	E			E		
Pteraulacodes hessei	Bee fly	Critically Endangered						E	E	E	E			E		E
Julodis namibiensis	Jewel beetle	Endangered						E	E	E	E			E		
Lawrencega longitarsis	Solifuge	Endangered						E	E	E	E			E		
Lawrencega solaris	Solifuge	Endangered						E	E	E	E			E		
Zophosis (Z.) cerea	Toktokkie	Endangered			O						O	O	O			
Acmaeodera liessnerae	Jewel beetle	Vulnerable		E	E	E	E	E	E	E	E	E	E	E		
Zophosis (Z.) dorsata	Toktokkie	Vulnerable			O			O	O	O	O		O			
Number of Threatened species:			**0**	**4**	**6**	**2**	**2**	**9**	**9**	**9**	**10**	**3**	**4**	**8**	**0**	**1**

Overall the findings from the survey confirmed the central Namib (including the study area) as an important area for invertebrate biodiversity, particularly in terms of endemics. Invertebrates showed highest levels of diversity and number of threatened and endemic species in the Succulent Shrub Watershed plant community (part of the Gypsite Plain habitat).

Mammals

A list was compiled containing 45 mammal species that have either been recorded on the study area, or are expected to occur based on their habitat affinities. About 12% of the 41 species listed (a full list of species is included in Appendix G (AWR 2010)) are endemic or near-endemic to the sub-continent, ~8% to Namibia, and approximately 9% to the Namib. Four of the species are considered near-threatened, and one, Hartmann's mountain zebra, is considered vulnerable. Species considered to be at risk from the project are Hartmann's mountain zebra and all rupicolous small mammal species. Table 4-8 provides details on the species of conservation concern. This table should be read in the context of the habitats depicted on figure 4-10.

In describing mammal movement and activity the following aspects are highlighted. Overall, the highest levels of corridor-like movement (mostly zebra spoor) appeared to occur in the northwestern section on the watershed or along the entrances to the numerous rocky valleys. A second less intense band of multi-directional movement, mostly springbok and ostriches, fewer zebra, occurred in a northeast-southwest band across the middle of the large plain. This suggests that animals move between the springs in the Khan River's tributaries valleys and grazing on the Grassy Plain and beyond. Zebra clearly tended to utilise the southeastern (mostly multi-directional movements) and northwestern sections (mostly corridor-like movements) most intensely. The density of Gerbil burrows and the percent active burrows peaked in the northern section of the study area, centred on the Gypsite Plain habitat. Higher gerbil burrow density and active burrows in the Gypsite Plain area and the central southern part of the study area probably also signify higher density of gerbils themselves, and may explain the related higher levels of plant productivity. This relationship of gerbils with plant productivity will be a good management tool and indicator of rehabilitation success in the future.

TABLE 4-8: MAMMAL SPECIES OF CONSERVATION CONCERN

Habitat codes are: r: Khan River, rvd: Rocky Valley Drainages, pdc: Plains Drainage Channels; pg: Pink Gramadoelas, bg: Black Gramadoelas, mg: Marble in Gramadoelas, gp: Gypsite Plain, grp: Grassy Plain, hup: Hard Undulating Plain, krp: Koppies and Ridges on Plains, Wp: Welwitschia Plain. Endemic status indicates whether the species is restricted to a specific geographic area: central Namib refers to the region between the Kuiseb and Ugab Rivers; Namib refers to the Namib desert;. Conservation status refers to IUCN status: CR: Critically Endangered, EN: Endangered, VU: Vulnerable, NT: Near threatened

Order/ family	Species (common name) Status notes	Recorded (Y)	Habitat											Endemic	Conservation status
			R	rvd	pdc	pg	bg	mg	gp	grp	hup	krp	Wp		
Hyaenidae	*Crocuta crocuta* (spotted hyena) Occasionally roam the area, scats were recorded	Y	X	X	X	X		X	X	X	X	X	X		NT
	Proteles cristatus (aardwolf) Unlikely to occur in study area, being at very edge of its range, but was recorded at Langer Heinrich		X	X	X				X	X	X		X		NT
Procaviidae	*Procavia capensis* (rock hyrax) Found in Pink and Black Gramadoelas, but more common closer to Khan River. Widespread but has close association with rocky terrain.	Y	X	X		X	X	X				X			NT

Order/ family	**Species (common name) Status notes**	**Recorded (Y)**	**Habitat**											**Endemic**	**Conservation status**
			R	**rvd**	**pdc**	**pg**	**bg**	**mg**	**gp**	**grp**	**hup**	**krp**	**Wp**		
Vespertilionidae	*Cistugo seabrai* (Angolan hairy bat) Poorly known, may be synonymous with *C. Lesueri*		X?											Namib (near)	NT
Equidae	*Equus zebra hartmannae* (Hartmann's mountain zebra) Near-endemic sub-species with fragmented population in Namibia. Tinkas-Khan population is largest in protected area. Important functional role as only large grazer that occurs in any numbers in central Namib.	Y	X	X	X	X	X	X	X	X	X	X	X	Namib	VU

Birds

Potential impacts on birds are likely to be relatively small compared to other taxa, because in general most birds are highly mobile and will probably move in response to disturbances. There are some exceptions to this generalisation, particularly in relation to power lines. This is why the desktop study findings described below will be augmented with the findings of a field study and related assessment that will be reported as part of the linear infrastructure EIA.

The baseline desktop study identified 108 species that have ranges that overlap with the study area although not all of these species' habitats will occur here. A full list of species is included in Appendix G (AWR 2010). Although a significant proportion of the species (31%) are either endemic or near-endemic to the subcontinent, only about 4% are near-endemic to Namibia and one species (1 %) is endemic to the Namib. One species (Martial Eagle) is Endangered in Namibia and Near-Threatened across its range, and one more species (Lappet-faced Vulture) is rated as Vulnerable in Namibia. Species considered to be at risk from the project are Rüppel's Korhaan, Ludwig's Bustard, Common Ostrich, Lappet-faced Vulture, and Gray's Lark. Each of these is discussed in further detail below.

Rüppel's Korhaan is near-endemic to Namibia with its distribution extending only marginally to southwestern Angola. The optimum habitat of this bird is flat gravel and sandy plains, and it nests on the ground. It is sedentary and monogamous, feeding on invertebrates, small reptiles and vegetable matter.

Ludwg's Bustard is near-endemic to South Africa and Namibia, extending partly into Angola. It prefers semi-arid dwarf shrublands in areas with less than 500mm rain per year and is nomadic within this area. The bustards as a whole, are currently experiencing population declines, with Ludwig's bustard among the most threatened. Specific threats include high mortalities as a result of collisions with overhead power lines.

There is no data on the size of the southern African wild population of Ostriches, but it is likely to be small. The genetic identity of the wild population is threatened throughout its Southern African range by the translocation of domesticated 'Oudtshoorn' ostriches, hence the protection of the wild population, especially in parks, is critical.

The Lappet-faced Vulture is uncommon. The NNNP may harbour one of two largest populations of Lappet-faced Vultures, where an estimated 40 – 50 pairs are known to occur. The population is decreasing due to poisoning, trapping, shooting and electrocutions. In Namibia 10% of the population was eradicated in one single deliberate poisoning incident in 1995. The recovery from population decreases is low because of delayed breeding and low fecundity. Pairs are territorial and may have 2 – 3 nests that are used in rotation. Most pairs will use the same tree (nest) continuously up to at least 13 years.

Gray's Lark is endemic to the Namib Desert and is locally fairly common, especially on the gravel flats between Swakopmund and Henties Bay. It is also well represented in the Skeleton Coast Park and the NNNP. However, it is resident, sedentary, and locally nomadic. All populations within the mine's footprint may thus be displaced or destroyed. It forages around zebra and antelope droppings and entrances of rodent burrows; it may thus depend on these organisms for food.

Reptiles

In many respects, the study area is an ecotone for reptile assemblage (an area that has overlapping reptile distributions). Most importantly, it is located at the core of the known range of a lizard that has a particularly small geographic distribution, the Husab Sand Lizard. Altogether, the above makes the study area of high significance for reptiles.

The most common species are the coastal Namib day geckos, common barking geckos, Namaqua chameleons, short-headed sand lizards and the Western three-striped skink. Husab sand lizards appear to be common on marble ridges, most notably on the marble ridge located in the Gramadoelas. It may favour patches of light rock on dark rock, possibly for the thermal range.

The most abundant snake species are the horned adder and the Namib sand snake. The Koppies and Ridges on Plains was the most diverse, but the Welwitschia Plains, the vegetated Plains Drainage Channels, and the Khan's tributaries also have a high diversity. The Grassy Plains habitat is intermediate, while the Black Gramadoelas and Gypsite Plains have relatively low reptile diversity. The highest numbers of chameleons was recorded in the canopies of *Arthraerua leubnitziae* shrubs.

A list of 23 reptile species was compiled from observations in the study area, and it is expected that a further 30 species might occur. A full list of species is included in Appendix G (AWR 2010). All but seven of the 53 species are endemic to the sub-continent, approximately 53% to Namibia, approximately 21% to the Namib, and approximately 9% to the central Namib. Two species are considered vulnerable and four species are data-deficient, to be treated as vulnerable. One species is considered to be potentially at high risk from the project, namely, the Husab Sand Lizard.

TABLE 4-9: REPTILE SPECIES OF CONSERVATION CONCERN

Habitat codes are: r: Khan River, rvd: Rocky Valley Drainages, pdc: Plains Drainage Channels; pg: Pink Gramadoelas, bg: Black Gramadoelas, mg: Marble in Gramadoelas, gp: Gypsite Plain, grp: Grassy Plain, hup: Hard Undulating Plain, krp: Koppies and Ridges on Plains, Wp: Welwitschia Plain. Endemic status indicates whether the species is restricted to a specific geographic area: central Namib refers to the region between the Kuiseb and Ugab Rivers; Namib refers to the Namib desert; Namibia to the country's geopolitical boundaries and sub-Region to the southern African region (with the Zambezi and Kunene Rivers as northern borders). Conservation status refers to IUCN status: VU: Vulnerable, NT: Near threatened, DD: Data Deficient.

ORDER Family	Species (common name) • Status notes	Recorded (Y)	Habitat in Project Area											Endemic status	Conser vation status
			r	rvd	pdc	pg	Bg	mg	gp	grp	hup	krp	wp		
CHELONIA (TORTOISES)															
Testudinidae (tortoises)	*Stigmochelys pardalis* (leopard tortoise)		X	X											VU
SERPENTES (SNAKES)															
Atractaspididae (African burrowing asps)	*Atractaspis bibronii* (Bibron's burrowing asp) • Soft ground, washes • Presumably local population with small distribution around Arandis could be nov.sp. (J.D.Visser pers.comm.) • conservation status sensitive, following precautionary principle		X	X	X								X	central Namib	DD
	Telescopus nov.sp. (Damara tiger snake) • Rocks, hills • Unnamed species, locally distributed					X	X	X			X	X	X	Namib Desert	DD
LACERTILIA (LIZARDS)															
	Pedioplanis husabensis	Y				O	O	O				O		central	DD

ORDER Family	**Species (common name)** • **Status notes**	**Recorded (Y)**	**Habitat in Project Area**											**Endemic status**	**Conservation status**
			r	**rvd**	**pdc**	**pg**	**Bg**	**mg**	**gp**	**grp**	**hup**	**krp**	**wp**		
	(Husab sand lizard) • among boulders and on koppies • species confined to core of Uranium Province, high potential of cumulative impacts • possibly VU													Namib	
	Pedioplanis nov.sp. cf. *inornata* (Northern plains sand lizard) • rocky plains • species being described • study area is thought to be near the southern boundary of wider distribution between Swakop and Ugab rivers, probably LC	Y									O		X	central Namib	DD
	Pedioplanis namaquensis quadrangularis (poss.nov.sp.) quadrangular Namaqua sand lizard) • sandy hummocks around vegetation • northern subspecies of Namaqua sand lizard likely to be elevated to species level • this subspecies is widespread in northern Namibia, probably LC		X	X	X				X				X	Namibia	DD
Varanidae (monitors)	*Varanus alibgularis* (rock monitor) • Khan riparian enables it to intrude desert • High risk of poaching makes this species vulnerable		X	X											VU

Amphibians

In the Namib, living conditions for frogs occur only in the form of springs and ephemeral pools. Four amphibian species have ranges that overlap with the study area. A full list of species is included in Appendix G (AWR 2010). None were recorded during field surveys for this project, but all were previously recorded by the authors in nearby areas of the Namib Desert. Although none of these species have a special conservation status, the occurrence of amphibians in this hyper-arid area is considered to be of special significance, and their habitats worthy of special attention. This is because living conditions for frogs occur only at a few small pools, and these are usually temporary in nature. Management of amphibians will simultaneously benefit many other aquatic organisms, most of which have dormant phases tolerant of drought.

4.6.3.3 Landscape function analysis

The generally low nutrient index values suggest that organic matter decomposition and nutrient cycling is low, particularly in disturbed (burrows and tracks) inter-patches, but is higher in vegetated patches (see Figure 4-13). Landscape function varied between the various habitat types, with Koppies and Ridges on Plains showing higher stability than all the others. Generally low nutrient index values in all habitats suggest that plant growth will be as much limited by nutrient availability as by water. The Koppies and Ridges on Plains habitat appears to be least limited by nutrient availability. Relative to the natural habitat types, the disturbed and rehabilitated sites showed low soil stability (but a good infiltration capacity), indicating an enhanced potential for sheet erosion and generally lower function than natural areas. Marbles in Gramadoelas and Plains Drainage Channels tend to have a greater proportion of patch cover. Patches (surface features that influence the capture of nutrients and water) were either absent or covered only a small fraction in the disturbed and rehabilitated sites. The most sensitive “No go” areas (see Figure 4-13) tended to have higher stability and nutrient index values and all sensitive areas had a higher proportion of patches per unit area.

4.6.3.4 Habitat sensitivity

Habitat sensitivities are presented on Figure 4-13. The final integration of sensitivity ratings across all taxa was based on a qualitative assessment of how the mammal, bird, reptile, amphibian and invertebrate communities should alter the original habitat ratings based mainly on plants. Sensitivity scores did not correspond perfectly with habitat delineations - e.g. some parts of the Koppies and Ridges on Plains and the Rocky Valley Drainages are either Very Sensitive or No-Go Areas (acknowledging their role as corridors and water sources) while the rest of these habitats are least sensitive or Sensitive. Most importantly, for various reasons, the Welwitschia Plain is a No Go Area. About 34% of the study area has been designated as Least Sensitive, with about 20% being Sensitive, 27% Very Sensitive and 20% as No Go Areas.

FIGURE 4-13: SENSITIVITY OF COLLECTIVE HABITATS

4.6.4 CONCLUSION

The study area is important for the central Namib biodiversity because it is situated in a triangular area in close proximity to two significant rivers (the Khan River to the northwest and the Swakop River further to the southwest). It is the view of the biodiversity team that these rivers and associated valleys allow water and nutrients to reach into the desert from the wetter hinterland and fog to reach further into the desert from the coast than would be expected. Given that water and nutrients are key ecological drivers in the desert this is an important and unique aspect that drives the habitats, floral life and faunal life in, and adjacent to, the study area. It is this situation that, inter alia, underpins:

- a larger than expected zebra population; and
- predicted higher fauna and flora biodiversity and productivity of the plains.

Moreover, on the plains there is surface geological complexity that underpins the diversity of ecological conditions and habitats. In addition, the system of surface washes that channel sheet run-off across the plains to the south and south west (and possibly recharge shallow perched aquifers) appear to support a significant population of the well known and much publicised *Welwitschia mirabilis.*

The contrasting habitats associated with the plains, the river valleys and the transitional zones in-between provides a range for many taxa of conservation importance some of which are endangered, data deficient, vulnerable, near threatened and/or protected.

In conclusion, it follows that the study area hosts significant biodiversity composition, structure and processes. The development of the project will threaten all three of these parameters and therefore project layout, process design and ongoing management must take this into account. In particular, the more sensitive areas must be avoided, linkages between habitats must be maintained and processes such as water and nutrient flows must be impeded as little as possible.

4.7 RADIOLOGICAL BASELINE

Information in this section was sources from the specialist radiological study attached in Appendix H (NECSA 2010).

4.7.1 INTRODUCTION AND LINK TO IMPACTS

Uranium mines are necessarily associated with potential radiological impacts. These impacts occur through the following pathways:

- direct exposure to ionising radiation;
- exposure to radioactive doses through water consumption;
- exposure to radioactive doses through inhalation of dust and radon gas;
- exposure to radioactive doses through the consumption of affected soil and food sources.

To understand the basis of these potential impacts, a baseline situational analysis is described below.

4.7.2 DATA COLLECTION

Data collection was achieved by literature review (including review of the SEA (SAIEA 2010)), baseline monitoring, laboratory analysis at the Nuclear Energy Corporation of South Africa (NECSA) laboratory in South Africa and analysis and reporting by NECSA consultants.

The radiological monitoring programme commenced in the second half of 2009. This is still in progress and it involves:

- gamma radiation surveys;
- radon gas surveys;
- sampling and analysis of water for radionuclide content;
- sampling and analysis of dust for radionuclide content; and
- sampling and analysis of soils, sediments and biodiversity for radionuclide content.

4.7.3 RESULTS

4.7.3.1 Direct exposure to radiation

In the context of the natural environment, radiation can occur from natural sources such as cosmic and terrestrial radiation. Preliminary baseline external dose rates on the project site indicate an average natural dose of 0.5 $mSv.a^{-1}$ with an upper 95 percentile value of 0.8 $mSv.a^{-1}$ in a scenario where people are situated on site and without any shielding from the measured terrestrial radiation for approximately 8 hours a day over an extended period (e.g. 1 year).

In the context of the proposed mine, radiation typically originates from mineralised substances (ore, mineralised waste, uranium product) and radioactive non-mineralised waste in the form of alpha radiation, beta radiation and/or gamma radiation. This can add to the naturally occurring radiation which is an issue particularly for workers that operate in close proximity to the more radioactive sources on a long term basis. These radiation doses typically reduce to a trivial level of 10 $\mu Sv.a^{-1}$ at distances of more than 500 m from these mineralised sources.

4.7.3.2 Aquatic pathway

The relevant discussion on the radiological component of groundwater is provided below. No information is available for surface water, which is an infrequent occurrence as discussed in Section 4.8.3.

Background groundwater doses ranged from approximately 0.3 $mSv.a^{-1}$ to over 1 $mSv.a^{-1}$ for Swakop River water and from 0.6 $mSv.a^{-1}$ up to 3 $mSv.a^{-1}$ for water collected within the mining area.

4.7.3.3 Air pathway

Natural baseline radon gas monitoring is still in progress but the initial results indicate low potential on site doses (if the same people are exposed on a daily basis in any given year) averaging 0.4 mSv/a with a 95 percentile at 0.7 $mSv.a^{-1}$ in the scenario where exposure is 50 % indoors and 50 % outdoors. It must be noted that the data is incomplete and should therefore only be used indicatively.

When considering third party exposure, there is some international debate about the relevant dose limits for radon gas. For uncontrollable sources actions are recommended as to optimise radon doses below 10 mSv/a. Actions for controllable sources are still unclear as per draft recommendations of the International Commission on Radiological Protection (ICRP) in 2010 but the annual recommended dose limit of 1 $mSv.a^{-1}$ (from all sources excluding medical and natural sources) is considered relevant for new practices in the context of this EIA.

No site specific data is available for the radioactive component of inhalable and fallout dust (PM10 and TSP). This will be included in the annual baseline data report.

4.7.3.4 Secondary pathways (soil and food)

Soil and food contamination are mainly related to the transfer of radioactivity from the soil to plants used as food, directly or via forage or pasture. Human ingestion doses have been calculated through such pathways using transfer parameters. When radioactive contaminated food present 100 % of people's diet, meat, milk and egg consumption could present doses at 10 % to 20 % of those related to water consumption while crop ingestion relates to doses less than 1 % of those from water consumption. High doses of just above 1 $mSv.a^{-1}$ were calculated for the scenario where analysed grass, found at the boundary of the Husab Project site, was assumed to be consumed by stock. If these animals form a significant contribution to the food chain of the people in the area, it may require further investigation as it will form part of an uncontrollable background dose that the people may receive.

4.7.4 CONCLUSIONS

To augment the project specific results provided by NECSA (2010) it is worth noting the comparable information provided by the SEA (SAIEA, 2010). In this regard, the SEA predicts that the cumulative annual average dose to people in Arandis (including mining contributions but excluding water exposure) is 1.69$mSv.a^{-1}$. When removing the natural dose contribution of 0.90$mSv.a^{-1}$, the background dose falls within the ICRP effective annual limit of 1$mSv.a^{-1}$.

Given the public health concerns associated with uranium mines and radiation, the project planning and design must take account of the various radiation sources, pathways and receptors in order to limit the potential health risks to an acceptable level.

4.8 SURFACE WATER BASELINE

This information in this section was sourced from the specialist hydrology study attached in Appendix I (Metago 2009) and should be read with reference to Figure 4-14.

4.8.1 INTRODUCTION AND LINK TO IMPACTS

In the context of the desert environment most surface water either evaporates or percolates into the ground. In very few instances does strong rainfall lead to temporary flowing surface water resources. Regardless, water is a key driver in the desert environment both in terms of consumption and use by humans and biodiversity in the broadest sense.

The proposed Husab Project will introduce a range of infrastructure and activities that have the potential to change surface flow patterns, reduce run off into the natural environment and pollute surface water resources. To understand the basis of these potential impacts, a baseline situational analysis is described below.

4.8.2 DATA COLLECTION

The following activities took place for data collection:

- Site inspections.
- Sourcing and review of rainfall data from Rössing mine and Langer Heinrich mine.
- Interpretation of elevation survey information.
- Flood hydrology calculations and analysis.

4.8.3 RESULTS

4.8.3.1 Surface drainage and catchments

All the rivers in the area are non-perennial, with flow only taking place after major rainfall events. The rainfall event data has been included in Section 4.2.3.

The closest major river (the Khan River) is incised into a rugged valley, approximately 3km away and 200m below the plain where the proposed project will be located. The Khan is one of the major river systems in the Namib desert, draining water from the inland plateau to the coast after major rainfall events. Approximately 20km to the south of the proposed project site, the Swakop river is similarly incised into the surrounding terrain. The confluence of these two rivers is approximately 23 km southwest of the site, still some 45km from the coast. Both river systems have subsurface stream flow in the river alluvium.

Incoming surface water runoff is expected to enter the project site via three upstream sub-catchments, varying in size, from the north and east (see Figure 4-14). This runoff in expected to be limited and will flow for very short periods of time following significant rainfall events. Sub-catchment 2 covers a significant area of approximately 34 000 hectares.

The plains area, where the proposed open pits and infrastructure will be developed, drains gently to the south and southwest (towards the Swakop River) in a number of washes. To the west of the proposed project area there is a catchment divide (which forms a surface flow divide) and surface water flow to the west of the divide flows into the Khan River. This is reflected on Figure 6-1. In this regard, some of the Zone 1 pit area and limited power related infrastructure is located to the west of the divide, but all other infrastructure is to the east of the divide.

Surface flows have been calculated for the purpose of designing infrastructure to cater for a minimum of the 1:100 year flood event.

Flood lines have not been modelled for the Khan and Swakop Rivers because these river systems are contained in deep valleys and are too far from the proposed site to be physically affected. Khan River floodlines will be modelled as part of the linear infrastructure EIA report. No floodlines have been modelled for the washes within the plains and project site, because surface runoff will flow in the washes and over the rest of the plain predominantly as sheet flow after rainfall events.

4.8.3.2 Surface water use

In this context, surface water covers both water that is found on the surface (albeit temporarily in most cases) and water that is found in the upper parts of the ground water regime. The most apparent surface water users are biodiversity and humans. Detailed discussion on these uses is provided in Sections 4.6 and 4.9 respectively.

4.8.3.3 Surface water quality

No surface flow was available at the time of the field investigations. Information on sub surface water quality is provided in Section 4.9.

4.8.4 CONCLUSION

In the context of biodiversity the project design and implementation should limit its impact on the surface flow and quality associated with the washes that cross the desert plain. This could be particularly important for the *Welwitschia mirabilis* population located to the south and southwest of the proposed project site.

Project design and implementation must also prevent any contaminated run-off from reaching the Khan and/or Swakop Rivers because although the closest downstream human water users are located more than 20km downstream, the possibility that contamination could reach these users has not been discounted.

In essence, dirty water should be contained on site and clean water should be allowed to flow in the natural environment to as great an extent as possible.

FIGURE 4-14: SURFACE WATER COURSES AND CATCHMENTS

4.9 GROUNDWATER BASELINE

The information in this section was sourced from the specialist hydrogeology study attached in Appendix J (Aquaterra 2010) and the results from subsequent monitoring and also included in Appendix J (BIWAC, 2010 and DD Science, 2010).

4.9.1 INTRODUCTION AND LINK TO IMPACTS

Water is a key driver for biodiversity and humans in the desert environment. It is therefore significant that the project may impact on both groundwater quantity and quality. Mining of the open pits could impact on the water quantity through groundwater drawdown associated with dewatering of the open pits. The development of the mineralised waste facilities and spills from the process plant could impact on the groundwater quality. To understand the basis of these potential impacts, a baseline situational analysis is described below.

4.9.2 DATA COLLECTION

The groundwater baseline information was obtained from:

- A desktop study of existing regional information.
- A review of geological data from the mineral exploration drilling.
- Sampling, testing and analysing of boreholes for permeability, yield, depth and water quality.

4.9.3 RESULTS

4.9.3.1 Identified aquifers

Three different aquifer systems were identified in the study area. These are listed below:

- Saturated alluvium associated with major rivers (ie Khan and Swakop Rivers).
- Saturated alluvium associated with the Husab Project plain.
- Fractured / weathered bedrock aquifers.

Borehole yields and storage for the saturated alluvium associated with the Husab plain and the bedrock aquifers are generally low, with yields from the bedrock aquifers generally below 1 L/s and yields in the saturated Husab plain alluvium dependent on recharge from surface run-off/rainfall which is generally low. The Khan and Swakop alluvial aquifers can yield between 5-15 L/s (Table 4-10), however the long terms yield is questionable and abstraction from these narrow alluvial aquifers is tightly controlled (by Government abstraction licenses) to limit drawdown in the aquifer system.

4.9.3.2 Existing Groundwater Use

The Khan River alluvium aquifer is used the most. Upstream from the Rössing area, the alluvial aquifer is utilized for supply to the towns of Karibib and Usakos. In that area, water levels fluctuate in balance between abstraction and recharge, with water levels rising to near surface after flood events, but dropping to over 20m below surface due to abstraction between recharge events.

Data on existing abstraction boreholes in the Swakop and Khan River alluvial aquifer systems around the Husab Project site are contained in Table 4-10. These boreholes are used by Rio Tinto (Rössing mine).

TABLE 4-10: DETAILS ON ALLUVIAL AQUIFER SUPPLY BOREHOLE

Borehole	E	N	Pump Depth	Yield (L/s)	Comment
Swakop River Alluvium					
ES122 (WW200 4553)	502 700	7485490	20 -30m	+5	Swakop Uranium bore- Not currently used
Khan River Alluvium					
Rössing has a number of production borehole which abstract water from the Khan River alluvium (20 -30m thick)				5 -15	Rössing used to abstract up to 1500 kL/day – unclear what the current situation is.

Downstream of the Khan and Swakop River confluence farmers abstract water for unspecified and unmetered domestic/irrigation uses These farmers are located more than 20km downstream of the Husab Project site.

Currently, abstraction is also taking place from fractured bedrock aquifers on the Husab Project site, to supply water for exploration drilling. Abstraction rates from bedrock aquifers are even lower than from the alluvial aquifers (Table 4-11), with yields under 1 L/s.

TABLE 4-11: DETAILS ON BEDROCK AQUIFER SUPPLY BOREHOLES ON THE HUSAB SITE

Bore	Borehole ID	E	N	Pump Depth	Yield (L/s)	Comment
1	RRC269	505800E	7503700 N	190m	0.62	In use
2	RRC256	506250E	7505400 N	190m	0.62	In use

Review of data from the Department of Water database does not show any third party bedrock boreholes within at least 20km from the proposed mine site. The hydrocensus undertaken during September 2009 (Table 4-12) did locate 23 borehole to the east of the mine site, only six of which are currently used for domestic purposes and livestock watering. The closest of these is approximately 19kms from the proposed pits and is on the eastern side of the mountain range to the east of the site, so is located in a different catchment.

TABLE 4-12: DETAILS OF FARM BOREHOLES TO THE EAST OF THE MINING AREA

Latitude (°S)	Longitude (°E)	Ground Elevation (mamsl)	Farm Name	Farm Number	Type	Exposed outer casing	Use	Type	EC (mS/m)	TDS (ppm)	pH	Temp (°C)	Water Level (m)	Comment
22.49796	15.3182	864	Bloemhof	G109	Borehole	0.2	Not Used						13.85	
22.48293	15.31308	869	Bloemhof	G109	Borehole	0.1	Used	WP + PH					18.25	
22.49766	15.31682	862	Bloemhof	G109	Borehole	0.3	Not Used						12.73	
22.53667	15.25795	761	Bloemhof	G109	Borehole	0.1	Not Used						8.73	
22.57203	15.35535	849	Geluk	G116	Borehole	0.3	Used	PH					7.51	
22.27078	15.10224	805	Trekkopje	G120/REM	Borehole	0.3	Not Used						6.36	
22.27083	15.10223	825	Trekkopje	G120/REM	Well	0.5	Not Used						6.35	
22.2712	15.10397	811	Trekkopje	G120/REM	Borehole	0.2	Not Used						8.15	
22.17408	15.04457	822	Trekkopje	G120/REM	Borehole	0.2	Not Used						21.02	
22.38768	15.25144	780	Valencia	G122	Borehole	0.35	Used	SUB					60.72	
22.51566	15.36319	923	Vlakteplaas	G110/1	Borehole	0.5	Used	M					9.13	
22.50963	15.40168	977	Vlakteplaas	G110/1	Borehole	0.3	Used	WP	1300	8453	6.99	26.3	39.64	Pumping
22.50818	15.40087	972	Vlakteplaas	G110/1	Borehole	0.4	Not Used						20.46	
22.45186	15.34169	924	Vlakteplaas	2 G110	Borehole	0.5	Used	WP, PH, Sub	463	2781	7.35	30.5	30.85	Pumping

Installation type : WP =Windmill pump, M =Mono pump, Sub= Submersible pump (electrical), PH=Power Head type pump

4.9.3.3 Groundwater Recharge

With a rainfall of under 100mm per annum, recharge to most aquifers (especially bedrock aquifers) is expected to be very low (under 1% of total rainfall). Where surface water runoff is concentrated (ie alluvial aquifers in rivers) recharge to the aquifer systems can be enhanced. The Khan River upstream at Karibib is recharged after all large flood events, although surface runoff generated in the higher rainfall inland areas seldom reaches the coast, resulting in lower recharge to the alluvial aquifers in the coastal areas.

4.9.3.4 Groundwater levels and flow

Based on the data available (Appendix J), water levels in the shallower alluvial aquifers range from near surface to 20m below surface. Water levels in the bedrock aquifers range in depth below surface from 56 to 130m. Generally, depth to water level becomes deeper to the west and south. Groundwater level contours show a general flow gradient from the northeast to the south west (following topography), although flow patterns are less clear in the northwest of the plain, where the northern open pit (Zone 1 pit) would be developed. In this area (on or northwest of the catchment divide shown in Figure 6-1) flow towards the Khan River would be expected. Water levels in boreholes on either side of the Karibib Marble show a 20m difference in water level. Water levels within the Karibib marbles or the Kuiseb syncline (see Figure 4-2) are higher than the areas directly to the east. These higher water levels are believed to be linked to the lower permeability of the material. Moreover, the marble is expected to retard flow to the west.

4.9.3.5 Groundwater quality (non-radiological)

A summary table of the baseline water quality in and around the project site is provided in Table 4-13. Sampling locations are presented on Figure 4-15. In most cases, the samples indicate that the groundwater does not comply with either the drinking water guidelines of WHO or the Namibian class A and B guidelines.

TABLE 4-13: BASELINE GROUNDWATER QUALITY

The various sampling points were sampled on more than one occasion. These dates are reflected next to the Borehole label. In addition, two different laboratories were used, as reflected by the red numbers and table footnotes.

		Selected parameters	Total dissolved solids (TDS)mg/l	Ph	Chloride (Cl) - mg/l	Sulphate (SO_4) - mg/l	Uranium (U) -mg/l	Calcium (Ca) -mg/l	Magnesium (Mg) – mg/l	Sodium (Na) – mg/l	Potassium (K) – mg/l	Aluminium (AL)-mg/l
WHO Guideline & Namibian Group A & B Guideline			1000 No Guideline	6.5 to 8.5 6 to 9	250 250 to 600	250 250 to 600	0.015 1 to 4	no guideline 150 to 200	no guideline 70 to 100	200 100 to 400	no guideline 200 to 400	no guideline 0.15 to 0.50
Borehole reference	RS1	02/11/2009 (1)	12500	7.2	5100	3290	---	1097	220	2998	146	
		19/11/2009 (1)	13890	7.3	3690	3240	---	763	266	2930	215	
		20/09/2010 (2)	13084	7.1	4831	2648	---	798	331	3079	107	
		28/09/2010 (1)	---	---	---	---	2.939	---	---	---	---	0.531
	RS2	02/11/2009 (1)	20097	7.1	10400	2470	---	837	521	5130	484	
		19/11/2009 (1)	21406	7.3	10900	2730	---	1031	170	6524	169	
		20/09/2010 (2)	20419	7.5	9907	2528	---	944	205	6142	79	
		28/09/2010 (1)	---	---	---	---	0.0062	---	---	---	---	0.045
	RS3	02/11/2009 (1)	24283	7.1	11200	3130	---	438	638	6120	269	
		19/11/2009 (1)	25660	7.4	11900	2980	---	1250	364	6599	480	
		20/09/2010 (2)	23628	7.2	10763	2954	---	1182	442	6426	229	
		28/09/2010 (1)	---	---	---	---	0.082	---	---	---	---	0.059
	RS4	02/11/2009 (1)	3820	7.5	1320	1100	---	182	42	1297	102	
		19/11/2009 (1)	4250	7.9	2070	900	---	448	33	1013	90	
		20/09/2010 (2)	3885	7.6	1272	839	---	196	62	984	45	
		28/09/2010 (1)	---	---	---	---	0.1	---	---	---	---	1.254

Selected parameters		Total dissolved solids (TDS)mg/l	Ph	Chloride (Cl) - mg/l	Sulphate (SO_4) - mg/l	Uranium (U) -mg/l	Calcium (Ca) -mg/l	Magnesium (Mg) – mg/l	Sodium (Na) – mg/l	Potassium (K) – mg/l	Aluminium (AL)-mg/l
WHO Guideline & Namibian Group A & B Guideline		1000 No Guideline	6.5 to 8.5 6 to 9	250 250 to 600	250 250 to 600	0.015 1 to 4	no guideline 150 to 200	no guideline 70 to 100	200 100 to 400	no guideline 200 to 400	no guideline 0.15 to 0.50
RS5	02/11/2009 (1)	10800	7.4	4620	3470	---	660	115	3197	157	
	19/11/2009 (1)	10762	7.5	3730	3090	---	592	86	2604	140	
	20/09/2010 (2)	10329	7.4	3486	2954	---	643	107	2800	74	
	28/09/2010 (1)	---	---	---	---	0.264	---	---	---	---	0.058
RS6	02/11/2009 (1)	3560	7	1380	774	---	316	110	894	98	
	20/09/2010 (2)	3752	7.3	1272	761	---	291	102	758	43	
	28/09/2010 (1)	---	---	---	---	0.047	---	---	---	---	0.863
RS7	02/11/2009 (1)	34780	7.2	17000	2680	---	2383	431	10568	871	
	19/11/2009 (1)	>20000	7	17300	2530	---	1884	347	8092	710	
	20/09/2010 (2)	32023	7.1	16633	2427	---	2108	454	8936	406	
	28/09/2010 (1)	---	---	---	---	0.077	---	---	---	---	0.074
RS9	19/11/2009 (1)	6020	7.6	1700	2380	---	279	34	1511	121	
	20/09/2010 (2)	5981	7.6	1406	2398	---	281	38	1690	63	
	28/09/2010 (1)	---	---	---	---	0.112	---	---	---	---	0.908
RS10	02/11/2009 (1)	3520	7.8	1680	668	---	334	133	869	63	
	19/11/2009 (1)	2280	7.6	1090	380	---	281	65	451	37	
	20/09/2010 (2)	1429	7.1	379	280	---	178	36	238	12	
	28/09/2010 (1)	---	---	---	---	0.064	---	---	---	---	0.07

Selected parameters		Total dissolved solids (TDS)mg/l	Ph	Chloride (Cl) - mg/l	Sulphate (SO_4) - mg/l	Uranium (U) -mg/l	Calcium (Ca) -mg/l	Magnesium (Mg) – mg/l	Sodium (Na) – mg/l	Potassium (K) – mg/l	Aluminium (AL)-mg/l
WHO Guideline & Namibian Group A & B Guideline		1000 No Guideline	6.5 to 8.5 6 to 9	250 250 to 600	250 250 to 600	0.015 1 to 4	no guideline 150 to 200	no guideline 70 to 100	200 100 to 400	no guideline 200 to 400	no guideline 0.15 to 0.50
RRC256	19/11/2009 (1)	9780	7	3700	2800	---	501	86	2430	136	
	20/09/2010 (2)	9762	7.3	3302	2985	---	552	107	2669	68	
	28/09/2010 (1)	---	---	---	---	1.196	---	---	---	---	0.097
RRC269	19/11/2009 (1)	9540	7.6	3390	2640	---	383	77	2384	116	
	20/09/2010 (2)	8850	7.4	3058	2536	---	380	89	2501	68	
	28/09/2010 (1)	---	---	---	---	0.612	---	---	---	---	0.046
RSTB01	19/11/2009 (1)	8770	7.7	2700	2450	---	673	82	1819	83	
	20/09/2010 (2)	8607	7.4	3058	2881	---	777	108	2139	51	
	28/09/2010 (1)	---	---	---	---	0.321	---	---	---	---	0.034
RSTB02	19/11/2009 (1)	>20000	7.3	8320	2040	---	1148	382	3763	277	
	20/09/2010 (2)	16475	6.3	8072	2047	---	1011	464	4084	147	
	28/09/2010 (1)	---	---	---	---	0.0041	---	---	---	---	0.048
SW1 (Swakop River borehole)	19/11/2009 (1)	4080	7.1	1610	550	---	269	69	755	68	
	20/09/2010 (2)	3466	7.2	1614	354	---	314	83	786	37	
	28/09/2010 (1)	---	---	---	---	0.038	---	---	---	---	0.032
SW2 (Swakop River borehole)	19/11/2009 (1)	3560	7.3	1150	560		293	68	558	66	
	20/09/2010 (2)	4354	7.1	1908	513		424	109	919	43	
	28/09/2010 (1)	---	---	---	---	0.038	---	---	---	---	0.044

		Selected parameters	Total dissolved solids (TDS)mg/l	Ph	Chloride (Cl) - mg/l	Sulphate (SO_4) - mg/l	Uranium (U) -mg/l	Calcium (Ca) -mg/l	Magnesium (Mg) – mg/l	Sodium (Na) – mg/l	Potassium (K) – mg/l	Aluminium (AL)-mg/l
WHO Guideline & Namibian Group A & B Guideline			1000 No Guideline	6.5 to 8.5 6 to 9	250 250 to 600	250 250 to 600	0.015 1 to 4	no guideline 150 to 200	no guideline 70 to 100	200 100 to 400	no guideline 200 to 400	no guideline 0.15 to 0.50
	SW3 (Swakop River borehole)	19/11/2009 (1)	5210	7	2090	430	---	319	85	902	89	
		20/09/2010 (2)	5306	7.2	2397	591	---	444	121	1249	54	
		28/09/2010 (1)	---	---	---	---	0.042	---	---	---	---	0.043

(1) DD Science cc – South Africa

(2) BIWAC & Analytical laboratory service cc - Namibia

FIGURE 4-15: MONITORING BOREHOLES

4.9.4 CONCLUSION

In general, the area is complex from a hydrogeological perspective. The data collected provides moderate to good control and a range of probable parameters adequate for assessment of dewatering requirements and potential impacts.

The project area has a low groundwater potential, with limited groundwater encountered in the weathered/fractured bedrock, especially within the alaskites, biotite schists or calc-silicate rocks of the Rössing Formation.

Although the baseline water quality of most samples exceeds the WHO and Namibian drinking quality guidelines, the project design and implementation should aim to prevent pollution of this valuable resource.

Dewatering will always be a sensitive issue in the context of the desert environment.

4.10 AIR QUALITY BASELINE

Information in this section was sourced from the specialist study included in Appendix K (Airshed 2010).

4.10.1 INTRODUCTION AND LINK TO IMPACTS

The project will introduce new air emission sources into a relatively undeveloped environment. The more significant sources include dust entrainment from vehicle movement, crushing and materials handling. Depending on the concentration of the emissions and their related dispersion this may reduce air quality which can impact on third parties and biodiversity.

To understand the basis of these potential impacts, a baseline situational analysis is described below.

4.10.2 DATA COLLECTION

On site meteorology was obtained from the on site Husab weather station. This has been discussed and presented in Section 4.2.

A dust fallout network comprising eight single dust fallout buckets was installed on site in August 2009. The American Society for Testing and Materials (ASTM) standard method for collection and analysis of dust fall was used. Analysis was done by SGS laboratories in Swakopmund.

A PM10 sampler was also installed in August 2009 at the on site Husab weather station. The analysis of samples was done by SGS Laboratories in South Africa.

A desktop review of known emission sources in the region was also undertaken.

4.10.3 RESULTS

4.10.3.1 Sources and types of emissions

Source types present in the area and the pollutants associated with such source types were noted with the aim of identifying pollutants which may be of importance in terms of cumulative impact potentials. Sources identified as possibly impacting on air quality in the region include, but are not limited to:

- Fugitive and gaseous emissions from mining operations.
- Vehicle tailpipe emissions from national and main roads.
- Various miscellaneous fugitive dust sources (wind erosion of open areas, vehicle-entrainment of dust along paved and unpaved roads).

Each of these is discussed below in more detail.

Existing Mining Operations

Current operating mines in the Erongo region include Rössing Uranium Mine, Langer Heinrich Uranium and Navachab Gold Mine. Valencia Uranium and Trekkopje mines are approved proposed uranium mines in the region. Of these operations the only one that is expected to influence the ambient air conditions around the Husab Project site is Rössing. In addition, the possible mining operations at the Etango Project could also add to the cumulative load in future. There are a number of small scale stone operations throughout the region with two large salt works located north of Swakopmund and south of Henties bay. These sources are however located too far away to have a significant influence on the air quality at the Husab Project site.

Fugitive dust sources associated with mining activities include drilling and blasting operations, materials handling activities, vehicle-entrainment by haul vehicles and wind-blown dust from tailings impoundments and stockpiles. Mining operations represent potentially the most significant sources of fugitive dust emissions (PM2.5, PM10 and TSP) with small amounts of oxides of nitrogen (NO_x), carbon monoxide (CO), sulphur dioxide (SO_2), methane, and carbon dioxide (CO_2) being released during blasting operations and from mine trucks.

Vehicle Tailpipe Emissions

There are a number of main roads within the region. The B2 between Swakopmund and Usakos, and Swakopmund and Henties Bay is probably the busiest road in the area. Other roads within the immediate vicinity of the Husab Project include the unpaved C28 through the Namib Naukluft National Park (linking Swakopmund and Windhoek), the D1991 and the gravel road between the C28 and the big Welwitschia (tourist attraction).

Air pollution from vehicle emissions may be grouped into primary and secondary pollutants. Primary pollutants are those emitted directly into the atmosphere, and secondary, those pollutants formed in the atmosphere as a result of chemical reactions, such as hydrolysis, oxidation, or photochemical reactions. The significant primary pollutants emitted by vehicles include CO_2, CO, hydrocarbons (HCs), SO_2, NO_x, particulates and lead. Secondary pollutants include: nitrogen dioxide (NO_2), photochemical oxidants (e.g. ozone), HCs, sulphur acid, sulphates, nitric acid, nitric acid and nitrate aerosols. Toxic hydrocarbons emitted include benzene, 1.2-butadiene, aldehydes and polycyclic aromatic hydrocarbons (PAH). Benzene represents an aromatic HC present in petrol, with 85% to 90% of benzene emissions emanating from the exhaust and the remainder from evaporative losses.

Fugitive Dust Sources

Fugitive dust emissions may occur as a result of vehicle entrained dust from local paved and unpaved roads, and wind erosion from open areas. The extent of particulate emissions from the main roads will depend on the number of vehicles using the roads and on the silt loading on the roadways. The areas prone to wind erosion within the region of the Husab Project is significant. The quantification of these sources is however not a trivial task. The extent, nature and duration of windblown dust is a function of the moisture and silt content of soils, the wind speed, and the extent of exposed areas. A distinct thin crust on the surface binds the material reducing the potential for wind erosion when undisturbed. When disturbed however, very fine loose material are exposed to wind erosion. Aside from the roads and the tracks adjacent to the demarcated roads, mining activities in the area are the main source of dust generation.

4.10.3.2 Ambient air quality – non radiological

As indicated, Swakop Uranium implemented a dust fallout and PM10 monitoring network in the second week of August 2009. The monitoring will continued by the mine throughout the life of mine. Data from the monitoring campaign is provided in the sections below.

FIGURE 4-16: DUST FALLOUT AND PM10 MONITORING NETWORK

Dust deposition levels at Husab Project

Available dust fallout results are depicted in Table 4-14. On average, dust deposition levels recorded over the twelve months were low and well within the German dust fallout category of 350 mg/m²/day and the SANS limit for residential areas of 600 mg/m²/day (Airshed, 2010). The highest levels were generally recorded at site EXT08 located close to the access road and near the public road to the Welwitschia area. The single highest level recorded was 256 mg/m²/day during Dec/Jan period at site EXT02 located downwind (southwest) from the exploration activities. The lowest dust fallout levels were recorded at EXT06, located near the northeastern boundary where there is not much activity at the moment. Drilling activities are generally expected to have contributed to the instances of higher recordings.

TABLE 4-14: DUST DEPOSITION LEVELS FOR THE MONTHS OF AUGUST 2009 TO JUNE 2010

Bucket ID	Dust Deposition levels (mg/m²/day)										
	Aug '09	Sep '09	Oct '09	Nov '09	Dec '09	Jan '10	Feb '10	Mar '10	Apr '10	Jun '10	Jul '10
EXT 01	30	49	22	11	31	24	4	27	10	104	16
EXT 02	34	51	13	5	256	21	2	12	6	145	14
EXT 03	39	47	9	17	7	19	8	14	8	100	14
EXT 04	38	48	16	21	7	20	15	13	6	138	8
EXT 05	31	45	13	21	2	19	1	30	5	159	13
EXT 06	33	28	22	6	7	21	7	10	7	136	11
EXT 07	47	50	19	0	3	23	1	19	5	187	10
EXT 08	40	56	22	15	17	30	11	25	12	108	16

Ambient PM10 concentrations at Husab Project Site

The PM10 sampler was installed in August 2009 at the Husab weather station with sampling done every 6th day. During the first two quarters, all the results were either negative or very low due to damaged filters. Airshed conducted a site visit beginning of June 2010 to assess the monitoring network and procedures. The Swakop Uranium personnel conducting the exchanges follow the correct procedures but it was found that the filter cassette, when closed too tightly, cause damage to the filters. The problem has since been rectified however, insufficient data is available for inclusion in this EIA report, but will become available in future.

The SEA (SAIEA, 2010) Air Quality section provided background PM10 concentrations for the Etango site located approximately 30 km southwest of the Husab Project. The results over the period March to November 2009 resulted in a period average PM10 concentration of 40 µg/m³ for the nine-months. The highest daily concentration recorded is 329 µg/m³ and the World Health Organisation's (WHO) IT-3 of 75 µg/m³ was exceeded 11% of the time. The simulated PM10 concentrations for the SEA correlated well with the measured concentrations where avialable. Based on this information, Table 4-15 shows the ambient PM10 concentrations that apply to the potential receptors around the Husab Project.

TABLE 4-15: AMBIENT PM10 CONCENTRATIONS

Parameter	Arandis	Rössing Uranium Mine	Big Welwitschia (tourist attraction)
PM10 daily (µg/m³)	242	610	550
PM10 annual (µg/m³)	65	160	90

In the context of the above baseline data, the background is already in excess of the evaluation criteria of 75 µg/m³ and 30 µg/m³, for highest daily and annual averages respectively.

4.10.4 CONCLUSION

While dust deposition levels are generally low and well within relevant guidelines and standards, PM10 levels are already in excess of the WHO evaluation criteria. Once the project commences and the desert crust is disturbed, there will be increased emission sources that will contribute additional dust fallout and PM10. Related impacts will require consideration and management, particularly if the effects of dust can influence third parties and sensitive biodiversity.

4.11 NOISE BASELINE

This information in this section was sourced from the specialist noise study attached in Appendix L (Acusolv 2010)

4.11.1 INTRODUCTION AND LINK TO IMPACTS

The project will introduce a number of noise sources into the project area. The more significant noise sources include: drill machines, a range of vehicles, rock breakers, generators and blasting. This area is considered to be relatively quiet with wilderness characteristics. Science has not progressed to the point that the impact of noise on biodiversity is understood so the potential for noise impacts is mentioned in the context of third parties only. To understand the basis of these potential impacts, a baseline situational analysis is described below.

4.11.2 DATA COLLECTION

4.11.2.1 Test equipment

For purposes of assessing baseline conditions in the area, a survey was carried out during February 2010. The proposed mining site and surrounding area were visually and aurally inspected and measurements were taken to investigate existing ambient noise levels in the study area. Locations where noise was monitored are indicated on the map in Figure 4-17.

Three points were used: M1, M2 and M3. M1 was in the Husab Project exploration zone, sufficiently distant from the nearest drill rig and shielded by the sloping topography at the edge of the canyon to ensure that noise from Rössing Mine was clearly audible and the dominant source of noise. The purpose of this recording was to utilise the opportunity to measure the noise level at a known distance (5,6 km) from open pit mining operations similar to those planned for Husab. M2 was at a location where no mining, exploration or main road noise was audible. It is representative of conditions in the larger part of the study area south, east and west of the proposed development. The measurement at M3 serves as another sample of conditions in the quiet part of the study area, confirming the reading at M2.

Noise measurements were carried out using the following equipment: Brüel & Kjaer Type 2260 Modular Precision Sound Analyser (Ser no. 1875497), Brüel & Kjaer Type 4189 Measurement Microphone (Ser no. 1858498), and Brüel & Kjaer Type 4231 Sound Calibrator (Ser no. 2606011).

4.11.3 RESULTS

As is expected in such a remote region the survey results indicate that daytime and night-time levels are 30 dBA (see Figure 4-17). Moreover, because of the uniformity of the landscape, ambient levels are practically the same everywhere. The exception is the area to the north and northwest where noise levels are influenced by traffic on the B2, Rössing Uranium mine and Husab's exploration activities.

The nearest inhabited location relative to the proposed development is Arandis village. It is situated not far from the B2 main road and at a distance of about 18 km from the Husab Project development, with an existing mining operation in-between. As such Arandis is estimated to be completely outside audible reach of noise originating from the proposed development. Hence no sample was taken in that area. Acceptable ambient level ratings for such a small village would be 50 dBA daytime and 40 dBA night-time, respectively.

In areas where the ambient level is determined predominantly by human activity and road traffic, the night-time ambient level is typically 10 dB lower than the daytime level. This includes typical rural residential districts. The implication of this is that the environment becomes considerably more sensitive to intrusive noise at night. In wilderness areas, such as the NNNP and in most of the study area under consideration, lack of human activity and road traffic results in this 10 dB difference falling away.

FIGURE 4-17: NOISE MONITORING LOCATIONS AND AMBIENT LEVELS

4.11.4 CONCLUSION

Ambient noise levels are low and represent a wilderness type environment. An increase in noise levels due to the development of the proposed mine will increase ambient noise levels, which could have impacts on the visitor experience to the tourist attractions in the area around the proposed min site.

4.12 ARCHAEOLOGY BASELINE

Information in this section was sourced from the specialist study included in Appendix M (Kinahan 2010).

4.12.1 INTRODUCTION AND LINK TO IMPACTS

The proposed project has the potential to damage the land surface and associated archaeological resources through physical disturbance of the land. The main activities that could cause this disturbance are the placement of surface infrastructure, vehicle movement and pit and mineralised waste facility site development. To understand the basis of these potential impacts, a baseline situational analysis is described below.

4.12.2 DATA COLLECTION

The field survey was carried out on foot using parallel compass transects. All archaeological finds were logged in the field using a hand-held GPS (error 3m) as described according to standard criteria. Field notes were augmented with photographs and field sketches where necessary. The site locations listed in the site gazetteer (Appendix M) are of the highest precision class (Level 1) used in field survey.

The survey also determined the archaeological or cultural affinity of each site, noting this as to the specific activity that was carried out there or the type of remains observed. As elsewhere in this part of the Namib, many of the sites are seed diggings, small areas of disturbed ground resulting from the excavation of harvester ant nests to extract grass seed, a major desert subsistence activity during the last 1 000 years. Other important site types include artefact scatters, natural rock shelters with traces of human occupation, stone features such as huts or hunting blinds, representing the early colonial period, earthworks related to the construction and use of the narrow gauge railway line.

Radiocarbon and luminescence dating was performed on certain finds.

4.12.3 RESULTS

Of the archaeological sites falling either within or closely adjacent to the project area, 32 are located on areas of calcretized gravel, 17 are associated with rock outcrops, and eight are associated with larger hill or ridge features. Although this distribution reflects the local dominance of gravel plains terrain, there is a slightly disproportionate association with outcrops and other features, indicating that these were of importance as vantage points, and for the shelter they provided.

In keeping with the archaeology of the wider area, the project site has a small number of late Pleistocene occurrences in the form of isolated stone artefacts found on the gravel plains. The late Holocene archaeology is well represented by a number of surface artefact scatters (8), small rock shelters with evidence of occupation (7), and stone features including hut remains and hunting blinds (5). The late Holocene sites are dominated by seed diggings (33) mainly on the gravel plains, but occasionally associated with deeply weathered outcrops.

Table 4-16 provides a full list of the archaeological sites that were identified and documented. Figure 4-18 indicates the distribution of archaeological sites in relation to the extent of the project footprint area. Yellow labels indicate radiocarbon dated sites; lilac labels indicate sites sampled for OSL dating.

TABLE 4-16: FULL LIST OF ARCHAEOLOGY SITES

Archaeology site	Description
QRS 72/61	seed digging
QRS 72/63	seed digging
QRS 72/65	seed digging
QRS 72/66	seed digging
QRS 72/68	seed digging
QRS 72/69	seed digging
QRS 72/71	seed digging
QRS 72/73	seed digging
QRS 72/74	seed digging
QRS 72/75	seed digging
QRS 72/76	seed digging
QRS 72/77	seed digging
QRS 72/78	surface scatter, mainly ostrich eggshell
QRS 72/79	seed digging
QRS 72/80	low shelter with marble grindstone
QRS 72/81	seed digging
QRS 72/83	seed digging

Archaeology site	Description
QRS 72/84	seed digging
QRS 72/85	seed digging
QRS 72/86	seed digging
QRS 105/15	surface scatter LSA artefact debris with yellow chert, 50x50m >25pcs/m2
QRS 105/16	rock shelter with LSA artefact debris, including vein quartz
QRS 105/17	surface scatter LSA artefact debris, including indurated shale/hornfels
QRS 105/18	surface scatter LSA artefact debris with yellow chert, <2pcs/m2
QRS 105/19	surface scatter LSA artefact debris, including indurated shale/hornfels
QRS 105/20	earthworks for historical embankment of narrow gauge railway
QRS 105/21	stone feature 2nd millennium AD, 2mdiameter; built into southwest facing side of outcrop
QRS 105/22	grinding surface, probably relates to previous
QRS 105/23	earthworks historical
QRS 105/24	earthworks for historical embankment of narrow gauge railway
QRS 105/25	n/a
QRS 105/26	earthworks for historical embankment of narrow gauge railway
QRS 105/27	Welwitschia siding and earthworks for historical embankment of narrow gauge railway, includes dump with coal, cinders and scrap iron.
QRS 105/28	seed digging
QRS 105/30	rock shelter, south west facing, probably 2nd millennium AD, has lower grindstone in dolomitic marble
QRS 105/31	rock basins
QRS 105/32	rock shelter LSA with yellow chert in surface scatter >20pcs/m2
QRS 105/33	seed digging 4 diggings in 60m diameter area
QRS 105/34	seed digging 3-4 diggings close together
QRS 105/35	stone feature 2 hut circles
QRS 105/36	seed digging
QRS 105/37	seed digging 3 diggings in 100m diameter
QRS 105/38	seed digging
QRS 105/39	rock shelter with LSA artefact debris including yellow chert, vein quartz and ostrich eggshell
QRS 105/40	seed digging

Archaeology site	Description
QRS 105/41	seed digging
QRS 105/42	seed digging
QRS 105/43	rock shelter with marble grindstone (seed grinding shelter)
QRS 105/47	seed digging
QRS 105/48	seed digging
QRS 105/49	seed digging
QRS 105/54	stone feature, 2 hunting blinds 0.9x1.8m facing 230deg
QRS 105/57	seed digging
QRS 105/58	surface scatter MSA, including unifacial point, possible Still Bay
QRS 105/59	scatter MSA, chert flake
QRS 105/82	MSA
QRS 105/85	seed digging
QRS 105/86	seed digging with manuport
QRS 105/88	SE facing rock shelter with grinding surfaces

Occupation of three rock shelter sites (Figure 4-18) was dated using Accelerator Mass Spectrometry (AMS) of ostrich eggshell fragments. The dating results point to an episode of occupation centring on the mid-16th century AD. Comparable dates have been obtained from other sites in the Khan-Swakop confluence and it is likely that these represent a period of intensive exploitation of grass seed as a food source. Such episodes necessarily coincide with above average rainfall, especially in the Husab area which lies close to the western limit for the viability of seed exploitation. Here, as in other parts of the central Namib, evidence of seed exploitation is also associated with evidence of hunting blinds, as would follow if above average rainfall resulted in higher numbers of antelope. Dating of hunting blinds is problematic because they rarely contain dateable organic material. However, these features are suitable for OSL (Luminescence) dating and it is very likely that the OSL results for QRS 105/54 will be comparable to the radiocarbon dates reported here.

FIGURE 4-18: ARCHAEOLOGICAL SITES

The relatively high number of historical sites reflects the strategic importance of the Swakop River valley during the early colonial period. Although their individual significance is not very high, the historical sites within the Husab Project area are among the few landscape counterparts to the documentary historical record of this period in Namibia. The section of the narrow gauge railway embankment which crosses the Husab Project area is shown in Figure 4-18, which also indicates the proximity of the uranium exploration targets currently under investigation. Parts of the embankment have been used as a vehicle track for many years. The embankment was simply constructed by moving soil and gravel inward from narrow trenches on either side, the heap being levelled and compacted by hand. The rails and steel ties were removed from this section of the embankment in about 1910, leaving the embankment vulnerable to erosion.

The remains of the Welwitschia siding at the top of the railway ascent from the Khan River are a unique and highly sensitive heritage site. Of related interest is the railway embankment itself, along with a number of cuttings and other features. Although the tracks and the corrugated iron buildings of the siding are long gone, the outlines of these features are still clearly visible, as are various cinder dumps and refuse piles that delineate the site. Present access to and from the Khan River goes directly through the site and this has had a significant cumulative impact during the project exploration period. Although these sites have been severely damaged, they are still of interest and certainly warrant conservation.

4.12.4 CONCLUSION

Archaeological sites in Namibia are protected under the National Heritage Act (27 of 2004) which makes provision for archaeological assessment of large developments such as this. A survey of the study area located a number of archaeological sites, representing a discontinuous sequence of human occupation from the late Pleistocene to the early colonial era. The variety of archaeological sites found in the project area is similar to that found in adjacent parts of the Namib, reflecting a number of highly specific human adaptations to this environment.

The remains of the Welwitschia siding of the early colonial narrow gauge railway (QRS 105/27) is considered to be of high significance. The remaining sites are isolated minor finds of low archaeological significance. However, despite their low individual significance, the sites form part of an archaeological landscape that will be heavily impacted by the Husab Project. This applies especially to the narrow gauge railway siding and related earthworks.

Potential impacts and mitigation measures relating to these resources must be taken into consideration in the project layout, design and implementation.

4.13 VISUAL BASELINE

Information in this section was sourced from the specialist study included in Appendix N (NLA 2010).

4.13.1 INTRODUCTION AND LINK TO IMPACTS

The project infrastructure will change the visual environment. The key related infrastructure components are the open pit, the plant complex and the mineralised waste disposal site (waste rock and tailings). To understand the basis of this potential impact, a baseline situational analysis is described below.

4.13.2 DATA COLLECTION

The visual baseline was collected by field investigations, photographs and map interrogation.

4.13.3 RESULTS

The various aspects of the visual baseline are set out below. The relevant boundaries and features of the visual study area are presented in Figure 4-19.

4.13.3.1 Landscape character

The landscape character is defined by flat rolling topography in the foreground, with hills, koppies and mountains in the background. It is important to provide the study area context as follows:

- The proposed mine site and much of the study area are located within the NNNP.
- There are houses and camp sites in the greater study area (although none of these are within 10km from the proposed mine site).
- Man-made structures in the greater study area include linear infrastructure, the on site prospecting structures, Rössing mine to the north, Arandis town to the north and tourist facilities further afield.

4.13.3.2 Visual Resource Value / Scenic Quality

With reference to Figure 4-19, the background visual resource of the study area is high. The highest value resources are the hills, mountains, koppies, river canyons, natural vegetation and washes. Even though there are some man-made structures in the greater study area, these do not detract from the scenic beauty and dominant natural features of the total landscape.

4.13.3.3 Sensitivity of Visual Resource

It follows that the highest value visual resources described above are also the most sensitive to changes associated with the proposed project. In contrast the man-made structures are the least sensitive to these changes. As a whole the total visual resource is considered sensitive to project related change.

FIGURE 4-19: VISUAL RESOURCE OF THE STUDY AREA

4.13.3.4 Sense of Place

The sense of place results from the combined influence of the landscape on all of the viewers subjective senses. When viewed from the perspective of a tourist, the natural landscape is associated with a serene sense of place. The tourist attractions and guest/farm houses further afield evoke excitement and anticipation. The exploration and mining activities are associated with a sense of disenchantment, particularly to people not involved with the mines in question. In this regard, the people who get jobs at the mines may not experience this disenchantment but rather see the mines with a sense of excitement and anticipation.

4.13.3.5 Visual receptors

In broad terms two types of visual receptors have been identified. Sensitive tourist oriented viewers and non-sensitive mine oriented viewers. It follows that the sensitive viewer locations are situated on tourist routes and at tourist attractions. These include inter alia: the Khan River Valley and associated old German railway line, the big tourist Welwitschia and related camping site, and the Moon Valley landscape. The non sensitive viewer locations are from within the mining areas and on roads that service the mines.

4.13.4 CONCLUSION

The current visual environment in the visual study area is considered to be of high value as a visual resource. The proposed Husab Project will change the current visual environment. The impact thereof is largely dependent on the sensitivity of the views and related visual receptors. These issues must be incorporated into the project design and infrastructure.

4.14 SOCIO-ECONOMIC STRUCTURE/PROFILE

Information in this section was sourced from the specialist studies included in Appendix N (Metago Strategy4Good 2009), the SEA (SAIEA, 2010) and previous Metago work done for Langer Heinrich Uranium Mine (Metago, 2009).

4.14.1 INTRODUCTION AND LINK TO IMPACTS

The development of mining projects may require a trade-off between the social, economic and biophysical components of the environment. Hence by addressing socio-economic issues the decision-makers are able to weigh up impacts across all the components of sustainable development, thus enabling such decision-makers to evaluate whether a development is appropriate for society or not.

When one considers the socio-economic impact pathways in the context of the Husab Project, then the related investment, assuming the project is viable, will result in considerable positive employment and income generation on the one hand, and on the other hand, can also put negative pressure on existing economic activities such as tourism and on social resources and infrastructure, eg housing, health, sanitation and educational facilities.

To understand the basis of these potential impacts, a baseline situational analysis is described below.

4.14.2 DATA COLLECTION

Information in this section was primarily gained through field and desk-top research and augmented by the Uranium Rush SEA (SAIEA, 2010).

4.14.3 RESULTS

4.14.3.1 Regional setting

The regional setting of the proposed project site is included in Table 4-17 and illustrated in Figure 1-1 and Figure 1-2.

TABLE 4-17: REGIONAL SETTING

Region	Erongo Region
Local authorities	Erongo Regional Council; Swakopmund and Walvis Bay Municipalities
National authorities	MET – Parks and Wildlife
Project location	Namib Naukluft National Park
Closest town/community	Arandis – approximately 17km to the northwest. Farmers/landowners – approximately 20km to the east. Swakop River farmers – more than 20km to the southwest downstream of the Khan and Swakop confluence. Swakopmund – approximately 55km to the southwest
Catchment	Khan and Swakop Rivers

4.14.3.2 Regional and local socio-economic planning

The Regional Councils Act of 1992, the Decentralisation Policy of 1996 and the Decentralisation Enabling Act provide a legislative framework for progressive decentralisation, i.e. the transfer of comprehensive management and planning authority from central government to regional and local authorities. Although the Regional Councils are mandated by legislation that states that they must plan the development of their regions, they are constrained by the slow progress in decentralisation.

The Erongo Regional Council's (ERC) social and community portfolio covers an extensive range of developmental activities. In the context of poverty reduction and economic development, the ERC views the sound management of natural resources, such as minerals, as essential. The ERC has a number of focus areas for development, which include water resources, the environment, tourism and fishing and marine resources.

Regional Development Plans are aligned with National Development Plans (NDPs), which are a succession of five year plans aimed at achieving medium-term goals for Namibia's long-term vision. The Regional Development Plan that will align with NDP3 is currently not available. However, NDP3 stresses the need for an increased contribution to development by the minerals sector, and this aspect can be expected to be emphasised in the ERC Development Plan as well.

Developments which could impact on the entire region, such as inward migration of work seekers, have a major impact on towns and the ERC can only assist local authorities with advice. The ERC's primary development focus is on the rural areas, which are its direct responsibility.

From a local planning perspective, Swakopmund in particular has a long-term strategic plan, which makes provision for the strengthening of the tourist base, the establishment of a heavy industrial zone and the encouragement of heavy industry and a diversified economy. This strategic plan has arisen as a result of concerns about the short-medium term benefits from mining and mineral extraction versus the sustainable benefits derived from fragile ecosystems and resultant tourism industry.

Closer to the proposed Husab Project, the Arandis Town Council has recently drafted its first local economic development (LED) strategy. The strategy emphasises the following:

- Gaining economic independence from Rössing Uranium mine and other mines in the area.
- The development of a tourism industry. The industry would use the main road leading to the tourist towns of Walvis Bay and Swakopmund. The council plans to do this by building a mine museum, identifying other tourism offerings, providing overnight accommodation and offering investor incentives.
- Taking advantage of the town's Export Processing Zone status, railway infrastructure and prevailing weather conditions to create a sizeable manufacturing/industrial sector which produces textiles and footwear. As well as create import and export storage facilities for Walvis Bay harbour.
- The establishment of small large, small and medium enterprises and a better retail sector, such as a supermarket and service station.
- Attract investors and encourage entrepreneurship in Arandis.

4.14.3.3 Regional socio-economic profile

Demographics

Erongo is Namibia's sixth largest region, extending over 63,720 km^2. The population in 2007 was estimated at 111,346 with a yearly growth rate of 1.3%. The region is sparsely populated, and its inhabitants are widely dispersed, resulting in a very low population density. Fertility and mortality rates indicate that life expectancy in Erongo is higher than the national average, while infant and under-five mortality rates are lower.

Most of the population is found in urban areas with a majority living in the towns of Walvis Bay, Swakopmund, Omaruru, Karibib, Arandis, Usakos, Uis and Henties Bay. There are a few communities that are located outside of these urban areas. In this regard, there is the Swakop River farming community and a Topnaar Nama community. The latter is located along the Kuiseb River. The Topnaar is one of the oldest inhabitants of the Namib desert and earliest records date back to 1670. Traditionally the Topnaar Nama of the lower Kuiseb Valley lived by herding cattle, gardening and gathering the nara (*Acanthosicyos horridus*). They were nomadic, restricted only by the availability of waterholes within the Kuiseb River and the nara distribution. In 1907 the NNNP was declared and the presence of the Topnaar within the NNNP has been controversial.

Education and skills

Erongo is considered to have some of the best schools in Namibia. There are 45 state schools in the region, and 13 private schools. Adult literacy rates are high compared to the national average: 92% of 15+ years are literate. Remote rural areas display lower literacy rates than urban areas. Adult literacy rates are high compared to the national average as 92 % of 15+ years are literate. In general, more female than male children attend school and in all constituencies, except Daures, females are more literate than males. Remote rural areas display lower literacy rates than urban areas, and a significant proportion (19 %) of women in rural areas lack the ability to read and write. The minerals sector contributes substantially to further education by means of bursaries, of which more than 350 new ones were granted in 2006-2007. Almost all major operations are devoting significant levels of resources to education and skills training, both of their own employees and also of the wider community. Notwithstanding the above, the SEA (SAIEA, 2010) indicates that there is insufficient schooling in place to support current demand and the situation will be worse for the potential demand associated with influx of people from new developments such as the proposed Husab Project and other proposed mines.

Employment

Sixty eight percent of all employees are employed in the private sector, where the number of males is almost double that of females. The state sector employs about 16 % of all employees in the region, and men dominate this employment sector as well.

Erongo's major urban centres, Swakopmund and Walvis Bay, comprise more than 50 % of the region's economic base, and they contribute more than 25 % to national GDP.

Sixty six percent of employees are dependent on wages and salaries as the main sources of income, compared to the national rate of 41.4 %. This makes the workforce vulnerable to downscaling, retrenchment and closure of projects.

Industrial activity is limited and based on fish processing, which is concentrated in Walvis Bay. Constraints on industrial development are the lack of a sufficient supply of water and a sufficiently large local market.

Small scale mining is an important economic activity in the region. Most of the small-scale miners operate at a subsistence level, but the sector is important for providing employment and livelihoods. Large scale mining activities in the region include Rössing Uranium, the Navachab gold mine, Langer Heinrich Uranium, AREVA and the coastal salt operations. Benefits accruing to local communities from mining operations are substantial. Contributions to local and regional economies include procurement of goods and services, and remittances sent back to the areas of origin of employees. These remittances play a significant role in sustaining families and livelihoods in those regions.

Tourism resources in the Erongo region are exploited by only a small section of the business community. This limits the benefits the sector could offer to community development in the region. Erongo has extensive and varied tourism potential and could offer a wider range of experiences to visitors by co-operation and skills development in all the groups active, or with the potential to be active, in the sector.

Health Care

Health services in the region are relatively good. The construction of new health facilities has brought health services closer to the communities. There are state hospitals in Omaruru, Usakos, Swakopmund and Walvis Bay. Swakopmund and Walvis Bay have a private hospital each, and clinics serve both the urban and rural population. However, clinic services are not adequate as it is difficult to attract staff to rural areas and existing facilities require renovations.

Health and health-associated social ills vary throughout the region and are largely determined by the urban or rural setting. HIV/AIDS, unemployment and substance abuse, particularly of alcohol, are found throughout the region. Commercial sex is not a regional or rural concern, but is mainly related to the coastal towns, in particular to the harbour town of Walvis Bay.

HIV/AIDS is a serious problem for the region's development. The regional prevalence rate of 27 % is the highest in the country. The region also has the highest tuberculosis (TB) rate in the country at 1,380 per 100,000 population.

The SEA (SAIEA, 2010) indicates that existing health care facilities are already functioning in stressed conditions. This situation could become worse with the influx of people associated with developments such as the proposed Husab Project.

Settlement patterns

Only one-third of Erongo residents were born where they live. The rest have come to their place of residence from elsewhere. Compared with all 13 regions of Namibia, no other region has such a high rate of people living in an area where they were not born. This rate of influx is one of the causes of the growing shortage and increasing prices of houses and related services as documented in the SEA (SAIEA, 2010).

4.14.3.4 Regional economic environment

After the Khomas Region, the Erongo Region has the second highest income per capita in the country. This relative prosperity is based on fishing, mining and tourism. All three sectors are important in that they:

- are all significant contributors to the Erongo regional economy and the Namibian Gross Domestic Product (GDP);
- all earn Namibia significant foreign exchange;
- all provide significant employment opportunities;
- all require both goods and services from other sectors which implies significant economic multiplier benefits; and
- all have potential for future growth.

One of the key concerns raised by stakeholders during the EIA Scoping public participation processes, was the issue around the cumulative impact mining may have on tourism. From purely economic sectoral data, it is not easy to ascertain how large Namibia's tourism industry is as tourists spend their money in different sectors, of which the hotels, restaurants, retail, transport and financial services sectors are the most significant. All these sectors have obvious backward and forward linkages, so the multiplier is equally at play in this sector as in any other.

With regards to the tourism sector, the hotel and restaurant sector had a GGP of N$ 1 billion in 2009. This gives some kind of indication of the magnitude of the tourist industry, which is estimated at 2% total GGP for the Erongo region. This would exclude expenditure of tourists on other sectors, eg Transport, Services and Retail. Should one include these, the specialist estimates that the upper level of the Tourism GGP contribution would have been 4% in the region for 2009. This number is in line with the national GDP number for 2007 which is 3.8% of GDP (SAIEA, 2010). In contrast, the mining sector is relatively larger at 30 % of total GGP for the region, and is responsible for a significant amount of the Namibian exports and foreign earnings, which means that declines in the commodity cycles have a major impact on the country's economy. This relative percentage is greater than the national contribution to GDP which was at 20% in 2009 (SAIEA, 2010).

However, from an employment and livelihood perspective, tourism has a low cost to create jobs and this sector sustains many lives in the Region. Tourism employment in Erongo is relatively much bigger than the Namibian national average (proportionately three times the size). The specialist estimates that the national tourism industry has approximately 13 000 employees (the SEA (SAIEA, 2010) put this amount at 18 000), of which we estimate nearly 6 000 are employed by the tourism industry. In contrast, the mining industry in Namibia had a total 8 000 employees in 2007 nationally of which we estimate 3800 are employed in the Erongo region. Thus from a job creation point of view; it confirms that tourism is significant, as 6000 jobs are 20% of the total workforce of Erongo. Furthermore, as is pointed out in the SEA (SAIEA, 2010), the sector has seen significant growth over the past fifteen years, with tourist arrivals increasing more than threefold from 254,978 in 1993 to 833,345 in 2006. Moreover, the coastal region provides 16% of national bed occupancy (an indicator of tourism popularity) and the most desired destinations in Namibia were Swakopmund (30%), Etosha (27%) and Sossusvlei (16%).

Thus from a direct income (salaries, wages and gross profits) point of view, the mining sector in Erongo earns approximately R4bn and the Tourism sector R570 million. From a direct livelihood perspective (thus employees), the comparison is an estimated 6 000 employees for Tourism and 3 800 employees for the mining industry.

The ryder to this comparison is that the hospitality sector has a relatively low employment multiplier, whereas mining is relatively high (based on South African input-output tables). This can easily be explained by the tremendous buying power of the mining industry, thus supporting many downstream industries. After leakage, these multipliers are probably 2.5 and 5.0 for Tourism and Mining respectively. Thus mining could account for up to 19 000 employees and Tourism for 12 000 employees in Erongo. Given that large margins of errors can occur in these estimates, from an employment perspective, both industries can be said to contribute equally in direct, indirect and induced employment creation.

Namibia has a relatively open economy, meaning that a very high percentage of its economic base comprise of imports and exports. This confirms that much of its production is being exported (e.g. fish, diamonds and uranium), and most of its manufactured products are imported. Most significantly, Namibia's imports exceed its exports and hence its foreign reserves will always be under pressure. As with any economy, exports are critical for economic growth and this is probably more so the case in Namibia.

Namibia is overly dependent on diamond exports for its foreign exchange earnings. Diamonds made up 35% of total mineral exports in the third quarter of 2008, which means that developments like the Husab Project will assist in diversifying the risk.

The main economic activities in the Erongo Region are concentrated in the two coastal towns of Walvis Bay and Swakopmund, as well as the surrounding mines and exploration operations. The smaller towns offer limited employment opportunities, while opportunities in agriculture, small-scale farming and tourism are scattered widely throughout the region. In this regard, Swakopmund and Walvis Bay comprise more than 50% of the region's economic base, and they contribute more than 25% to national GDP.

It follows that there is significant in-migration of people to Walvis Bay and Swakopmund in particular. People migrate to these areas for various reasons, but two of the more common reasons are to seek jobs and to establish businesses. The sectors that attract these people are mining, tourism, fishing and to a lesser extent agriculture.

4.14.3.5 Land use in the region

The three most significant land uses in the Erongo region are conservation/tourism, agriculture and mining.

Conservation/tourism

Much of the Namib Desert falls within conservation areas, and National Parks account for almost a third of the land use within the Erongo Region. These areas include The Namib section of the Namib Naukluft National Park and the National West Coast Tourist Recreational Area.

Agriculture

Areas of the Central Namib Desert which have not been proclaimed as conservation areas usually have no surface water and little or no available groundwater. Consequently, they are generally of very low agricultural potential and cannot support formal farming activities. Two types of farmers are active in the Erongo Region: communal farmers and commercial farmers. Communal farmers are involved in small-scale production for own consumption or for sale at the local, often informal, markets. The following aspects of commercial farming could be found in the Erongo region:

- livestock, i.e. both small and large stock,
- game, and
- irrigation, i.e. vegetables, grapes and citrus.

Farms located on the lower portion of the escarpment/desert transition are considered totally unsuited to any farming practice. Nearer the coast, formal farming is undertaken on several small holdings in the lower Swakop River. Dairy and vegetables are produced here for the local market. Towards the interior portion of the Central Namib Desert, informal farming was conducted along the courses of most of the rivers and still continues along the rivers to the north of the Swakop River. Several groups of Topnaar raise goats, cattle and donkeys along the lower reaches of the Kuiseb River.

Mining

Mining activities account for a significant portion of land-use in the Erongo Region. According to the Ministry of Mines and Energy, as at 1 September 2006, in excess of 100 licences and/or Exclusive Prospecting Licences were registered or pending with the Ministry, though most of these have not yet been activated. In the context of Uranium a moratorium was placed on issuing any further prospecting licenses to allow the government and other stakeholders to determine how best to handle the “Uranium Rush” (SAIEA,2010). The main commodities mined are uranium and gold. Extensive salt mining also occurs along the coast at Walvis Bay. Prior to the start of mining operations at Rössing Uranium, several small- to medium-scale prospecting and mining operations were located in the Central Namib region, focusing mainly on copper, tin and semi-precious stones.

Small-scale mining is an important economic activity in the region. A total of 521 claims were registered or pending with the Ministry of Mines and Energy as at 1 September 2006. The main commodities are semi-precious stones, dimension stone and tantalite-cassiterite.

4.14.3.6 Socio-economic profile of Swakopmund

Demographics

Swakopmund has a population of approximately 42 000 people. During the tourist season the population doubles with both domestic and foreign tourists visiting the coastal town.

Approximately 6 000 people currently live in the informal settlement, the Democratically Resettled Community (DRC). The largest part of the migratory workforce occupies temporary housing facilities in Mondesa.

The unemployment rate is difficult to state because of the different ways in which unemployment is defined, and because of the mobility of a large sector of the population. The unemployment rate is estimated to be in the region of 40 % in the town, and in excess of 55 % in the DRC.

Employment

The economic stability of the town is mainly based on the hospitality industry, mining and to a lesser extent small scale industries. The mainstay of the economy has traditionally been the tourist sector, as Swakopmund is well-positioned for visits to the eco-tourism sites which give the region its unique appeal. Numerous tour companies use the town as a base for trips to sites such as the Namib Naukluft National Park, the Skeleton Coast, Spitzkoppe and the Brandberg.

Education

There are six state primary schools, five state secondary schools and three private schools in Swakopmund.

Healthcare

Swakopmund has one primary health care clinic, a TB clinic, one state hospital and one private hospital.

Water

Swakopmund is supplied with drinking water from the Omdel aquifer. The Omdel Scheme is currently being utilised to the maximum as a result of an historical over-estimation of its capacity. High water losses are experienced, and these are ascribed largely to illegal connections and ageing infrastructure. Plans are in place to partially replace the lines which are too old to meet the demands of the developing town.

A significant increase in the number of households and inward migration to informal settlements and backyard shacks could place demands on supply which will be difficult to meet.

Waste management

Swakopmund has experienced problems with its cleansing services as a result of the influx of people and the inadequacy of the existing current solid waste dump. To address these problems, the Swakopmund Town Council (STC) has introduced additional refuse removal trucks to maintain a good standard of service.

Power

Swakopmund currently has no infrastructure problems with the supply of electricity to consumers. However, there is ongoing dissatisfaction with Erongo Regional Electricity Producer (Erongo RED), which, the STC maintains, has resulted in duplication of services and an escalation of the cost of electricity. When the STC was the service provider, non-remunerative services were partially funded from surpluses generated from the supply of electricity, but this is no longer possible. These services become more onerous and more necessary as the informal settlements grow disproportionately to municipal resources to fund them.

In the DRC, electricity connections are supplied to facilities that are carrying out high-priority services, such as day-care centres, but there is no electricity for domestic consumption. Paraffin is generally used for cooking, and candles for lighting.

Settlement patterns

The attraction of potential job opportunities, which stimulates inward migration, has led to an ethnically mixed town. The white population is relatively large and there is a significant presence of German-speaking residents. The number of foreign nationals in Swakopmund is increasing as mining companies bring in their own staff and expertise. The DRC has been described as a “melting pot”, with people arriving from all the regions in Namibia, as well as from neighbouring SADC and other African countries.

4.14.3.7 Socio-economic profile of Walvis Bay

Demographics

Walvis Bay has a population of approximately 61 000 people. A significant number of migrant workers from other regions move in and out of the town depending on seasonal availability of work opportunities, however information on their numbers is not available.

Employment

Although Walvis Bay is the principal port of Namibia, the economy of the town is fairly diversified. The major economic activities are fishing and the onshore processing of fish. The industry has survived periods of decline and continues to play an important role in the development of Walvis Bay. The need for ship repair and maintenance, both to the fishing and other industries, has led to the emergence of well-equipped engineering firms with a high degree of expertise. The number of support industries to these has increased accordingly.

The main manufacturing activities take place within the Export Processing Zone (EPZ). The EPZ companies are involved in the manufacturing of plastic products, automotive parts, fishing accessories, bathroom fittings and diamond cutting and polishing. Not only does the EPZ develop the country's manufacturing industry, it also creates much needed employment.

Most of the suppliers and service providers to mining companies are based in Walvis Bay. These range from small engineering companies to larger transport companies and suppliers of fuel and lubricants. An increase in activity in the uranium mining sector has resulted in a significant increase in local procurement, especially in engineering and transport service.

Another emerging sector is tourism. Walvis Bay hosts a number of premier eco-tourism sites, such as Sandwich Harbour and the Walvis Bay Lagoon.

Healthcare

Walvis Bay has one state hospital, one private hospital and five clinics serving urban and rural Walvis Bay.

Education

There are six state primary schools, five state secondary schools and two private schools in Walvis Bay.
As far as learner numbers are concerned, Walvis Bay is the fastest growing town in the country. Every year, in addition to normal growth, the schools start with about 150 more learners than the projected figures for the year. The Ministry of Education is accommodating the overflow in rented facilities and by shift teaching. Extra classrooms are being built and plans have been approved for a school which will be ready by 2010. The new school will be a combined primary and secondary school, which will accommodate 840 children. With the interventions in Swakopmund and Walvis Bay, the authorities are looking at having enough places for learners by 2012. Although the school system would be in a better position than it is in currently, a substantial increase in numbers in 2013 would be difficult to accommodate.

Water

Walvis Bay receives potable water from 57 boreholes in the Kuiseb River well field and uses recycled sewage water for irrigation of public places. As a result of a series of power outages that affected borehole operations at Swartbank, Walvis Bay has experienced severe water supply crises twice in 2009. The supply of water from the Kuiseb River and the maintenance of the infrastructure are the responsibility of NamWater. At the time of this report, no solution had been proposed to solve a critical growth problem for Erongo's major industrial centre.

Power

According to a spokesperson for NamPower the current electricity capacity in the various towns in the region are sufficient for intended development and no problems for development in the immediate future are foreseen. However, developments in Erongo, particularly in the minerals sector, indicate that substantially more power would be needed in the short-term. An EIA commissioned by NamPower for a coal-fired power station in the vicinity of Walvis Bay has been completed, but no further information on progress is available.

Waste management

The Walvis Bay Municipality has a landfill site and five compactors to deal with waste. The desert is also used as a location for dumping waste, as the sand quickly covers the material. There are recyclers for plastic, paper and metals. Hazardous waste is dealt with in an incinerator at the landfill site, which serves the entire region.

Settlement patterns

Five distinct residential areas can be identified in Walvis Bay:

- the formerly "black township" of Kuisebmond, low income groups, with a few representatives of the middle to upper income groups;
- the formerly "coloured" township of Narraville, low – middle income groups;
- Walvis Bay Central, middle income groups;
- Meersig and Langstrand, upper – wealthy income group.

Within the urban areas the living conditions reflect the inequitable distribution of wealth that is one of the characteristics of the Namibian economy. Houses in Langstrand and Meersig are spacious, have expansive views and are removed from industrial activity. Kuisebmond and Narraville erven are smaller, as are the houses. In Kuisebmond, as many as ten informal dwellings, plus a formal dwelling, have been reported on one erf. The views from both suburbs are largely of industry and main roads, and this situation is likely to be compounded by proposed new developments, such as the light industrial zone near Narraville. Unlike other towns, Walvis Bay does not have demarcated informal settlement areas and this has resulted in the proliferation of backyard shacks in Kuisebmond.

4.14.3.8 Socio-economic profile of Arandis

Demographics

Arandis is a small and arid rural town with approximately 4 500 inhabitants. It is located approximately 60km from Swakopmund on the B2 road to Windhoek. The settlement was established in the early 1970s to house mine employees of Rössing Uranium Mine. In 1992, Arandis was handed over to the Namibian Government and is currently managed by the Arandis Town Council.

Arandis has seen much employment volatility in its history. In the early 1990's, Rössing Uranium started retrenching a considerable amount of employees as Uranium prices dropped considerably. It saw its workforce decline from 4 000 employees in 1990 to 860 in 2005. This decline in work-force has had a significant effect on Arandis' small economy and quality of life.

Arandis is by no means a wealthy settlement. Most of its inhabitants fall in a low income bracket and other than mining, there are very little work opportunities, especially for women. Its houses are mostly small (2-3 bedrooms), with basic amenities. It has water and power services but any increase in housing in the town will have to be accompanied by capital intensive infrastructural development, especially water.

The resurgence in the Uranium prices is presenting Arandis with new prospects and its population is likely to grow strongly as more uranium mines open in the area and in-migration takes place.

Employment

As is expected, the majority of the town's employment is in the mining industry; however, with the support of the Rössing Foundation, it is now endeavouring to diversify into other industries. To this end, It has recently also launched an industrial park with the hope of stimulating small scale industrial enterprises.

***Edu*cation**

There are three schools in Arandis, namely; Arandis Primary School, Urbanus B Dax Senior Primary School and the Kolin Foundation Secondary School. The town council states that the schools provide good quality education. The town also houses the Namibian Institute of Mining and Technology (NIMT) which is well respected for being a good mining technical skills college.

Healthcare

Arandis has one public primary health care clinic and a private clinic. Residents have to travel to nearby towns for hospital care.

Water

Water is pumped from Swakopmund. The council states that this is a costly exercise and most residents cannot afford current rates.

4.14.3.9 Land use in Husab EPL

Land surface rights in the EPL, which are mostly part of the Namib Naukluft National Park, are owned by the Namibian Government care of the MET – Parks and Wildlife. The EPL provides Swakop Uranium with the right to conduct approved activities associated with prospecting in the designated areas. There are no known servitudes or other land encumbrances in the EPL. In addition to the prospecting activities, tourist activities continue as per the discussion below.

4.14.3.10 Land use surrounding the Husab EPL

This section should be read with reference to Figure 1-2.

Land immediately surrounding the EPL is used for conservation, eco-tourism, mining (Rössing Uranium) and mineral exploration activities.

The closest communities to the EPL and specifically the Husab Project site (located in the northwest section of the EPL) are:

- Arandis to the north west– approximately 17km from the project site;
- farmers to the east – approximately 20km from the project site.
- farmers to the southwest – more than 20km from the project site.

There are a number of significant tourist attractions within the Namib Naukluft National Park and the adjacent WCRA. Some of the tourist attractions are in close proximity to the Husab Project site. These include:

- the Khan River valley (less than 5km west and south west) which offers a range of special interests and a unique wilderness experience;
- the big tourist *Welwitschia* (approximately 10km to the south); and
- the Moon Valley landscape (approximately 20km to the southwest).

A network of roads exists in the vicinity of the Husab Project site. Major roads include:

- The B2 from Swakopmund to Windhoek, approximately 15km to the west;
- The C28 from Swakopmund to Langer Heinrich, approximately 30km to the southwest;
- The D1991/D4570, approximately 20km to the southwest; and
- The gravel road to the south that runs between the C28, the big Welwitschia and the farms to the east of the proposed project site.

There are a number of other mining and mineral exploration companies in the region that are engaged in either exploration, construction and/or operational activities. Those closer to Husab Project site include:

- Rössing Uranium Limited (operational – 5km to the northwest);
- Bannerman Resources (exploration & feasibility phase- 30km to the southwest);

- Reptile Mining (exploration – 35km to the southeast);
- Langer Heinrich mine (operational – 35km to the southeast);
- Areva Resources Namibia/Trekkopie (construction – more than 30km to the northwest);
- The Forester Group/Valencia (ML awarded but not yet in construction phase – 30km to the northeast).

4.14.4 CONCLUSION

As a general comment the socio-economic situation is increasingly becoming stressed which means that society, the economy, and related infrastructure and functions are not adequate. A project of magnitude proposed by Swakop Uranium will change the current socio-economic situation and potentially add to the socio-economic stresses.

Therefore, while the potential for positive economic impacts is significant, cognisance must also be taken of the potential negative impacts on infrastructure, society and the tourism industry. In this regard, project planning must be mindful of:

- the growing influx of people into the region;
- the shortage of basic services and infrastructure for housing, sanitation, education and health;
- the potential conflict between mining and conservation/tourism land uses;
- disruption to the social and economic cohesion of the region;
- impacts on health and social welfare both in the workplace and in the homes and communities of the workers.

5 ALTERNATIVES CONSIDERED

5.1 CURRENT AND FUTURE LAND USE ALTERNATIVES

In the broader area where the Husab Project is proposed, current land–use comprises conservation and ecotourism in the NNNP and WCRA, and mining at Rössing Uranium Mine. The land within the project is currently a conservation area with prospecting in terms of an EPL. Should mining go ahead, the conservation land use in this part of the national park will be altered for the long term. Should mining not go ahead the land will continue to be used for conservation and possible eco-tourism.

5.2 PROJECT ALTERNATIVES

5.2.1 MINERAL PROCESSING AND RELATED ISSUES

5.2.1.1 Importing Acid

The option of importing acid is the alternative to the preferred option of producing acid on site in an acid plant. Strong sulphuric acid could be imported through Walvis Bay harbour. A storage facility would be required at the harbour, from where it would be transported to site by rail and/or road.

5.2.1.2 Communition Circuit

Various communition (crushing and milling) circuits were considered as alternatives. High pressure grinding roll (HPGR) was initially considered, but discarded in favour of a Semi-Autogenous Grinding (SAG) milling circuit, which is expected to result in reduced quantities of dust.

5.2.1.3 Solvent Extraction Stripping

Scenarios for the stripping process in the solvent extraction circuit were considered. Initially an ammonia strip process was considered as this is the most common method of stripping in the uranium industry with the production of ammonium diuranate (ADU). ADU is subsequently calcined at high temperature (± 800˚C). As a consequence of an evaluation of alternative technologies the stripping process was changed to a sodium carbonate strip which produces sodium diuranate (SDU), which is subsequently leached and precipitated with hydrogen peroxide to produce uranium oxide. This eliminates the requirements for handling of potentially dangerous ammonia and for the disposal thereof. It also does not require the high temperature calcining. Both safety and energy costs are reduced as a result.

5.2.2 SURFACE INFRASTRUCTURE LAYOUT OPTIONS

In developing the project layout, two infrastructure layout options were considered. The preferred option is presented in Section 6 (Figure 6-1). The alternative site layout option, which was an earlier option in the project planning process is indicated in Figure 5-1. This layout option occupied a much greater surface area, as the tailings and waste rock dumps were separate and their height was lower, thus occupying a larger footprint. The waste rock landforms were also located on both sides of the open pit. The preferred layout adopts a different philosophy for mine residue management, by combining the waste rock and tailings into a single footprint.

An alternative assessment matrix was used to evaluate the two surface infrastructure options, mainly in terms of the waste storage facilities, as these show major differences between the two options.

In assessing the best alternative for the surface layout, the following criteria were distilled out as being the criteria of consequence:

- the layout should result in the smallest disturbance footprint;
- potential pollution sources should be contained;
- sensitive biodiversity areas and related ecosystem functions should be avoided;
- potential visual impacts should be limited;
- the carbon footprint of the project should be limited by keeping the waste facilities as close as possible to the centroid of activities which is the proposed open pits and processing plant.

The site layout matrix is provided in Table 5-1. The criteria considered for each option were given a score of one or two, one being the most preferable, and two being least preferable. The option with the lowest score, taking all of the criteria into account, was considered the most preferable. On the basis of these criteria, the preferred site layout is the one presented in Figure 6-1 (option A). Option B is the alternative layout, previously considered.

FIGURE 5-1: SURFACE LAYOUT ALTERNATIVE OPTION (B)

TABLE 5-1: SITE SELECTION MATRIX

1 – preferred, 2- least preferred.

Criteria	**Option A** (Figure 6-1)	**Option B** (Figure 5-1)	**Discussion**
Impacts on sensitive biodiversity areas	1	2	Option B has a greater footprint, encroaches on more areas of high sensitivity. Moreover, the dedicated tailings facility encroaches onto the Welwitschia Plain.
Groundwater impacts	1	2	Although the predicted seepage from the mineralised waste facilities is drawn to the open pits during most of the life of mine and post closure, option B results in particle distribution that is greater in extent to that which is associated with option A. Option A also has the benefit of only one pollution source that has to be contained and not three as in option B.
Surface water impacts	1	2	Both site layout options will cover surface washes. In both cases, engineering designs will divert clean water around the waste facilities and back into the washes. For option B, the landform on the western site of the pits could result in run-off moving to the west of the watershed and into the Khan River valley. In Option A, none of the sources encroach on the watershed and Khan catchment.
Air quality impacts	1	2	The difference in rating relates to the exposed surface area of the above ground tailings facility. It is assumed that the greater the exposed area of tailings, the greater the potential source for windblown contamination. This will be greater for option B.
Noise impacts	1	1	No relative difference has been identified.
Archaeology impacts	1	1	No relative difference has been identified.
Visual impacts	2	1	Option A incorporates a significantly higher dump with the smaller footprint. Option B incorporates three separate facilities, although the dump heights would have been far lower.
Carbon footprint and energy use	1	2	The carbon footprint is smaller for option A as waste rock will come directly out of the pits and onto the waste rock dumps. Zone 1 will feed waste rock to the north extent of the waste rock dump, and Zone 2 will feed waste rock to the southern extent of the waste rock dump. Tailings will be transported from the plant via conveyor to the tailings storage facility. For option B, the haulage and conveyor distances are far greater.
Physical footprint (relates to disturbance of land including soil and land capability)	1	2	The physical disturbance footprint is smaller for option A and larger for option B.
The radiation exposure from tailings	1	2	Option A allows for the tailings to be enclosed by waste rock. Option B exposes the entire tailings facility to the surrounding environment.
Total scores	11	17	Option A is preferred.

5.2.3 WATER SUPPLY OPTIONS

Currently two water supply options are being considered for the construction phase, namely:

- Water will be supplied by NamWater from the Rössing reservoir through the Khan River valley to site, in an overland pipeline.
- Water pumped to site from a series of boreholes on the Swakop River, via a booster station and an overland pipeline.

These construction water alternatives are being considered and assessed as part of the linear infrastructure EIA report.

For the operation phase, desalinated water will be supplied by NamWater. The water supply pipeline has been investigated by various parties and, at present, a pipeline from the south seems likely. This pipeline would also provide water to other mining operations such as Langer Heinrich and Bannerman. Assessment of the impacts of this option will form part of the linear infrastructure EIA report.

5.2.4 POWER SUPPLY OPTIONS

Alternatives for temporary 66kV power supply provided by NamPower on overhead lines include the carrying of the line on either a single pole or on H frame wooden poles through the old Khan mine valley. Diesel generators are another option.

Permanent power will be supplied by NamPower, via a new substation near Arandis airport fed by a regional power line with a T-off 220kV double line to a dedicated substation on site, the Husab substation. The offsite infrastructure is the subject of the linear infrastructure EIA report.

5.2.5 TRANSPORT ROUTES

Although the permanent preferred route for the road is from the B2 across the Khan River Valley, this is the subject of the linear infrastructure EIA report.

5.2.6 MINERALISED WASTE MANAGEMENT OPTIONS

Three options were considered for mineralised waste:

- Separate facilities for waste rock and tailings.
- A co-disposal option where the tailings is inter-dumped with the waste rock at a ratio of seven trucks of rock to one truck of tailings in a single facility.
- A conjoined disposal option where a part of the waste rock dump is conjoined with a tailings facility.

As per the discussion in Section 5.2.2 the option of having separate waste rock and tailings facilities was ruled out. At the current stage of design, the co-disposal option has not been conclusively proven feasible either from the perspective of acid neutralisation and pollution control, or from the technical operational perspective. The preferred option for the EIA and related feasibility study is therefore the conjoined option.

5.3 THE “NO PROJECT” OPTION LINKED TO NEED AND DESIRABILITY

The assessment of this option requires a comparison between the alternative of proceeding with the proposed project with that of not proceeding with the proposed project.

Proceeding with the project will result in significant positive economic impacts, but it will also result in significant negative environmental and social impacts (refer to Section 7). Not proceeding with the project leaves the status quo (refer to Section 4).

As the proposed project site is within the NNNP, proceeding with the project will allow exploitation of the mineral resource but will change this area of the NNNP forever. Not proceeding with this project will leave the mineral resource undeveloped, but the area within the NNNP will be preserved.

To answer the question of whether there is a need for the project and whether it is desirable, one must look partly to the Namibian government to understand its broader economic objectives, partly to unemployed people in Namibia and their related need for jobs, and partly to the world energy supply dynamics because the most significant positive motivations for this project are economic. In contrast, on many environmental and a few social grounds there is little to support the notion that the project is either needed or desirable.

6 PROJECT DESCRIPTION

The project description has been separated into the following phases: construction, operation, decommissioning and closure. These phases are described below.

6.1 CONSTRUCTION PHASE

The purpose of the construction phase is primarily to establish the infrastructure and activities required for the operational phase.

6.1.1 SITE FACILITIES FOR CONSTRUCTION

A number of contractor working areas will be established on site during the construction phase. These work areas will either be within the footprint of the planned operational infrastructure, or in the dedicated contractors lay-down area to southwest of the plant complex. A site layout map is attached as Figure 6-1.

The following facilities will be required for the construction phase.

- workshop and maintenance areas;
- stores for storing and handling fuel, lubricants, solvents, paints and construction materials;
- contractors lay-down areas;
- mobile site offices;
- offices, workshops, operators lunchroom, laydown areas for early mining operations to undertake required waste stripping;
- explosive magazines and bulk explosives manufacturing plant;
- temporary accommodation camp;
- waste collection and storage areas;
- wash bay for washing equipment and vehicles;
- parking area for cars and equipment;
- change houses;
- ablution facilities; and
- temporary power and water supply infrastructure.

FIGURE 6-1: SITE LAYOUT

6.1.2 Construction activities

Construction activities take place during the establishment and preparation of the site for mining and mineral processing. Early mining activities, such as soil stripping and overburden/waste removal will coincide with the construction phase. A table of construction activities is provided in Table 6-1. The "x's" in the table indicate which activities may be associated with the construction of the various infrastructure items.

6.1.3 Topsoil management

Topsoil is to be stripped to a depth of 300mm from all areas that are planned to be disturbed. This would include all the contractor laydown areas, plant and mining complex, construction camp area and mine workshops and offices. This topsoil will be placed in stockpiles of up to 20m high and will be considered a future rehabilitation growth medium. Topsoil from the conveyor routes, internal access roads and the mining haul roads, power lines will be placed in low windrows.

The greatest volumes of topsoil will be from the surface area of the two pits, run of mine (ROM) stockpile and the mineralised waste facility. The topsoil will be removed in advance of the mine and mineralised waste facility's development and stockpiled in berms.

6.1.4 Construction transport

During the early construction phase all construction traffic will come from the south on the existing gravel road network that is currently used by exploration vehicles. To access the network of exploration gravel roads on the project site, traffic will travel on the C28 and then branch off to the north on the gravel road that crosses the Swakop River and routes to the west of the big tourist Welwitschia (see Figure 1-2). Once the permanent access road is constructed all construction traffic will use the permanent road. Current planning is for the permanent road to access the site from the B2 across the Khan River (the route and design of this road is the subject of a separate linear infrastructure EIA). In the normal course, the volume of trucks, busses, passenger vehicles and other traffic travelling to and from site per day is estimated at 50 vehicles (100 trips). This figure will increase to approximately 90 vehicles (180 trips) per day on weekends to cater for workers leaving and returning to the site.

TABLE 6-1: TABLE OF CONSTRUCTION ACTIVITIES

Activity		Site offices and admin facilities	Process plant, mine complex, workshops	Sewage treatment plant	On site power infrastructure	On site Water infrastructure	Contractors camp and lay-down	Pit development	Run of mine complex and conveyors	Mineralised waste facility and stockpiles	On site roads	Explosives magazine
A1	Earthworks: Drilling and blasting activities							x				
A2	Earthworks: Cleaning and grubbing and bulldozing activities	x	x	x	x	x	x	x	x	x	x	x
A3	Earthworks: Soil excavation	x	x	x	x	x	x	x	x	x	x	x
A4	Earthwork: Stockpiling of topsoil and other material	x	x	x	x	x	x	x	x	x	x	x
A5	Disposal or treatment of contaminated soil	x	x	x	x	x	x	x	x	x	x	x
A6	Backfill of material (specific grade) from borrow pits										x	
A7	Opening and management of borrow pits										x	
A8	Construction and use of new on site roads – clearing of areas								x	x		x
A9	Civil works: Foundation excavations	x	x	x	x	x	x	x	x	x	x	x
A10	Building activities	x	x	x	x	x	x		x			x
A11	Storage and handling of material: Sand, rock, cement, chemical additives in cements		x	x	x	x	x		x			x
A12	Water utilization	x	x	x			x	x	x	x	x	
A13	Mixing of concrete (batch plant) and concrete work (casting)	x	x	x	x	x	x		x			x
A14	Operation and movement of construction vehicles and machinery	x	x	x	x	x	x	x	x	x	x	x
A15	Refuelling of equipment							x	x	x		
A16	Use of cranes	x	x		x	x	x		x			
A17	Erection and destruction of scaffolding	x	x	x			x		x			x
A18	Building of shutters	x	x	x					x			
A19	Installing re-enforcement Steel		x			x			x			
A20	Handling, storage and disposal of hazardous waste • Blasting media packing material • Empty paint containers • Cements bags • Chemical additives (for cement) containers • Contaminated PPE and other (with oil, uranium, etc).	x	x	x			x	x	x	x		x

Activity		**Site offices and admin facilities**	**Process plant, mine complex, workshops**	**Sewage treatment plant**	**On site power infrastructure**	**On site Water infrastructure**	**Contractors camp and lay-down**	**Pit development**	**Run of mine complex and conveyors**	**Mineralised waste facility and stockpiles**	**On site roads**	**Explosives magazine**
	• Redundant concrete • Earth moving tyres											
A21	Handling, storage and disposal of non-hazardous waste • Steel off-cuts • Domestic waste • Wood off-cuts • Grinding wheels • Other construction waste	x	x	x	x	x	x	x	x	x	x	x
A22	Transportation of hazardous material		x	x				x	x		x	x
A23	Transportation of non-hazardous material	x	x	x	x	x	x	x	x	x	x	x
A24	Handling and storage of Hazardous material • Blasting media • lubricants • Paints • Gas (welding) • Cement • Chemical additives for cement for leach tanks only)	x	x	x	x	x	x	x	x			x
A25	Install pipelines for water and process solutions (Above ground)	x	x	x		x		x	x	x		
A26	Install of electricity lines	x	x	x	x	x	x	x	x	x		x
A27	Use of electricity generators	x	x	x	x	x	x	x	x	x	x	x
A28	Install transformers				x			x		x		
A29	Install parking bay for trucks		x					x	x			
A30	Manage construction site	x	x	x	x	x	x	x	x	x	x	x
A31	Painting, grind and welding	x	x	x	x	x	x	x	x	x		x
A32	Provision and operation of water washing and toilet facilities	x	x	x		x	x	x	x			
A33	Slope stabilization and erosion control							x		x	x	
A34	Appointment of contractors, labourers, etc.	x	x	x	x	x	x	x	x	x	x	x

6.1.5 EMPLOYMENT AND HOUSING

The construction camp will accommodate between 2000 and 4000 people for the two years from quarter one, 2012 to the end of quarter four, 2013. At the height of construction, approximately 4000 workers will be required and accommodated on site (less than 50 people are expected to live off site and to commute to site on a daily basis).

A description of the main facilities at the contractor's camp is provided in Table 6-2.

TABLE 6-2: CONTRACTOR'S CAMP

Item	Description
Duration	The camp will be a temporary facility that is required for approximately 24 months.
Capacity	The camp will be designed to house up to 4000 occupants during peak construction periods.
Occupants	Only construction workers and camp facility service personnel will be permitted to stay in the camp.
Visitors	No visitors will be allowed.
Rooms	The rooms will be a combination of prefabricated rooms, and/or containers. Rooms will house up to 4 people at a time.
Recreation amenities	The camp will be equipped with recreation amenities. These typically include: DSTV, pool tables, table tennis, gym, basketball court, canteen, and pub.
Ablution facilities	Prefab toilets and showers (linked to a septic tank) will be provided until the permanent modular sewerage plant is constructed.
Transport	The construction work cycle will be six days on duty and one day off duty. Therefore, camp occupants will be transported to and from site by bus from Walvis Bay, Swakopmund and/or Arandis on a weekly basis.
Potable water	Potable water for drinking, cooking and ablutions will be initially trucked in and then sourced via a temporary pipeline from the Rössing reservoir (this is the subject of the linear infrastructure EIA report).
Power supply	Power will be sourced from NamPower via a temporary 66kV overhead line (the off site power line is part of the linear infrastructure EIA report). The on site substation (which will be part of the operational phase facilities) will transform to 11kV and 400V. Back-up power at the contractors camp will be supplied by 12MVA portable generators.
Sewage	Sewage from the toilets will be taken off site and disposed of at the works in Swakopmund. Thereafter, sewage will be treated in the permanent modular sewage plant.
General waste	General waste will be sorted and stored before being trucked off site and disposed of at the Swakopmund waste site.
Health, safety and environment	All camp occupants will receive induction on arrival and at appropriate intervals when returning from extended leave periods. There will be ongoing awareness campaigns.
Security	The camp will be fenced and will have one access gate with 24 hour security. Camp occupants will comply with the NNNP rules concerning permits and movement outside of the designated project boundary.

6.1.6 WATER SUPPLY FOR CONSTRUCTION ACTIVITIES

Water quantity requirements for the construction activities will be 1.2 million m^3 per annum (pa) for approximately two years. Water will be supplied by NamWater via a temporary overland pipeline from the Rössing reservoir through the Khan River valley, and may be supplemented by a pipeline from a series of boreholes in the Swakop River. The off site infrastructure and supply is the subject of the separate EIA report for linear infrastructure.

6.1.7 POWER SUPPLY FOR CONSTRUCTION ACTIVITIES

Power demand during the construction phase will be approximately one megawatt. Temporary power for the construction phase will be supplied by NamPower via a temporary 66kV power line across the Khan River valley. This power line and associated off site infrastructure is the subject of the separate linear infrastructure EIA report. Back-up power for the contractor's camp will be supplied by 2MVA portable generators.

6.1.8 SANITATION FOR CONSTRUCTION

Initially, portable toilets with associated septic tanks will be used. The septic tanks will be emptied on a regular basis and the effluent disposed of at the Swakopmund Municipal sewage treatment works.

The main sewerage treatment works will be a package plant modular design, planned to be commissioned in January 2012. The treatment plant will be commissioned prior to most of the construction workers arriving on site, so that it will be available to accommodate sewage from the maximum workforce of 4000 people at the height of the construction phase. The plant will be a bio-filter process divided into the following:

- Primary settlement - receiving of raw sewage and settlement of suspended solids
- Aerobic treatment – aeration system
- Final settlement – prevents ingress of untreated effluent
- Sludge storage – provided in the base unit with 12 weeks capacity. The removed sludge will be placed on settling beds, dried, then buried within the waste rock dump or used for bioremediation.

The treated effluent water will be of 'Namibian General Standards for Wastewater Discharge into a Water Resource' and will be used for dust suppression on site during the construction phase. The location of the permanent sewage plant is indicated on Figure 6-1.

6.1.9 NON MINERALISED WASTE MANAGEMENT FOR CONSTRUCTION

Waste will be separated at source, stored in a manner that there can be no discharge of contamination to the environment and either recycled or reused where possible. The remainder will be transported off site to appropriate recycling or disposal facilities (Swakopmund for general waste and Walvis Bay for hazardous waste). A single waste management contractor will service the entire site.

Table 6-3 presents the waste management specification that has been developed for the Husab Project and outlines the waste management for all waste types. In summary, the types of non mineralised waste expected to be generated during the construction phase include:

- General waste (domestic waste and other non-hazardous waste)
- Industrial waste
- Hazardous waste

TABLE 6-3: WASTE MANAGEMENT FOR CONSTRUCTION PHASE

Waste type	Waste specifics (example of waste types)	Storage facility	End use
Non-hazardous non-radioactive contaminated solid waste (non-mineralised)	Pallets and wooden crates, cable drums, scrap metal, general domestic waste such as food and packaging	Skips in relevant work areas will be provided for different waste types. A waste management contractor will remove skips regularly to the Waste Transition Yard (WTY).	Waste will be sorted further at the WTY. Recyclable waste will be sent to a reputable recycling company. Some items may be distributed directly to the community such as pallets and wooden crates. The remainder of the waste will be transported by the waste management contractor to a permitted general landfill facility in Swakopmund for disposal.
	Building rubble and waste concrete	Designated rubble collection points will be determined to which contractors will take rubble and concrete.	The waste management contractor will regularly remove the waste from the designated collection points to the footprint of the waste rock dump.
Non-hazardous and hazardous radioactive contaminated solid waste (non-mineralised)	Contaminated sand, drill chips, old PPE, pipes etc.	Radioactive waste will be stored in sealed drums in the relevant work areas. These drums will taken to the WTY on a regular basis.	Waste will be further sorted at the WTY. Recyclable waste will be decontaminated (high pressure washing) and if successfully decontaminated will be sent to a reputable recycling company. There is no appropriate disposal site in Namibia for radioactive waste. All radioactive waste will therefore be disposed of in the mineralised waste facility.
Hazardous non-radioactive contaminated solid waste (non-mineralised).	Treated timber crates, printer cartridges, batteries, fluorescent bulbs, paint, solvents, tar, empty hazardous material containers etc.	Hazardous waste will be separated at source and stored in designated containers in bunded work areas. The waste management contractor will remove these drums regularly to the WTY.	Hazardous waste will be disposed of at the permitted hazardous disposal site in Walvis Bay by the waste management contractor.
	Hydrocarbons (oils, grease)	Used oil and grease will be stored in drums in bunded areas at key points in work areas. The bunds will be able to accommodate 110 % of the container contents and include a sump and oil trap.	The yard will have a dedicated used oil storage area that will include an impermeable concrete slab, bunding, an oil trap and sump.

Waste type	Waste specifics (example of waste types)	Storage facility	End use
		The waste management contractor will remove these drums regularly to the WTY. The yard will have a dedicated used oil storage area which will include a concrete slab, proper bunding and an oil sump. The appointed bulk fuel supplier will collect used oil for recycling.	Used oil will be sent to a reputable recycling company for recycling.
	Sewage	Sewage will be treated at a sewage treatment plant (STP) with a capacity of 0.5 Ml per day.	Sewage effluent will be used for dust supression. Sewage sludge will be dried and buried in the STP area.
Medical waste	Syringes, material with blood stains, bandages, etc.	Medical waste will be stored in sealed containers at the clinic. A waste management contractor will remove these drums regularly to the WTY.	Medical waste will be transported by the waste management contractor to a permitted incineration facility in Swakopmund for incineration.

6.1.10 CONCURRENT MINING OPERATIONS

As the commencement of mining operations (pit development etc...) will coincide with the construction phase, permanent offices, workshops, operator's lunchroom, laydown areas will be in place during the construction phase and into the operational phase. The explosive magazines and bulk explosives manufacturing plant will also be commissioned in the construction phase. The explosives magazine and bulk explosives are discussed in more detail in Section 6.2 as part of the operations description.

6.1.11 TIME TABLE

Subject to authorisation, the construction phase will commence in quarter one 2012 and continue to quarter four 2013. The mining operations are planned to commence in July 2012.

6.2 OPERATIONAL PHASE

6.2.1 SITE FACILITIES FOR OPERATION

The operational phase will consist of the following on site facilities most of which are indicated on Figure 6-1:

- Two open pits – Zone 1 and Zone 2 pits.
- On site roads.
- Primary crusher (situated in the run of mine (ROM) complex).
- Ore stockpiles (Course ore stockpile – plant, ROM stockpile – primary crusher, low grade stockpile located to the west of waste rock dump).
- Process plant.
- Acid plant (Plant complex).
- Mineralised waste disposal facilities (conjoined waste rock and tailings).
- Explosives magazine.
- Bulk explosives manufacturing plant.
- On site water supply infrastructure.
- Stormwater management facilities.
- Clean and dirty water holding facilities.
- Sewage treatment plant.
- Reverse osmosis plant for demineralised water (Plant complex).
- Conveyors (in the plant, between plant and ROM complex, and between the plant and mineralised waste facilities).
- Soil stockpiles.
- Workshops (Plant and mine complexes).
- Stores (Plant and mine complexes).
- Salvage yard and temporary non mineralised waste handling facilities (Next to plant complex).
- Communication infrastructure.
- Lighting infrastructure.
- Helipad (Visitors centre/gate house).
- Visitors centre (Gate house).
- Change houses (Administration complex).
- Administration offices (Administration complex).
- Parking areas.
- Refuelling areas (Mine complex, ROM complex and contractors lay down area).
- Loading and off-loading areas (Mine complex).
- Weighbridges (South of plant complex).
- Medical facilities (Administration complex).

- Security infrastructure.
- Laboratory (Administration complex).
- On site power infrastructure.

6.2.2 OPERATION PHASE ACTIVITIES

6.2.2.1 Mine plan

Mining will take place in two open pits called Zone 1 and Zone 2. The stripping ratio of overburden/waste rock to ore will be roughly seven to one, meaning that seven tons of overburden/waste rock will be extracted out of the pit for each ton of ore extracted. The total mineable reserve is 206 million tonnes (Mt) of ore (at an average uranium content of 498 parts per million (ppm). At full production, approximately 170 Mt of total material on average (waste rock and ore) will be mined per annum. At the end of open pit life, 36 Mt of low grade stockpiled ore is to be fed to the process plant. The life of mine length, breadth and depth of each pit will be approximately:

- Zone 1 pit: 2.5 km long, 1.0 km wide and 400 m deep.
- Zone 2 pit: 1.9 km long, 1.4 km wide and 390 m deep.

The pits will initially be developed around smaller, higher value ore areas. This will also be undertaken in order to access the ore early in the schedule. Mining will commence in Zone 1 and Zone 2, where two small, high value ore areas will be mined during the first two years of open pit operation. In general, bulk mining will be undertaken using trucks and shovels with 15m benches and ore will be predominately mined using slightly smaller face shovels on 7.5m high benches.

6.2.2.2 Drilling and blasting

Drill and blast requirements vary considerably over the life of mine as mining moves in and out of pit stages and opening up areas of conglomerate which requires considerably less drilling. Consequently the drilling fleet size also varies over the life of the operation. A maximum of 200 holes will be drilled per blast area of 8000m^3. The drill rigs will be equipped with water sprays which should result in 70% dust control. At full production, blasting will take place roughly twice per week.

6.2.2.3 Dewatering

It is anticipated that there will be little in the way of significant dewatering efforts required given the arid environment and minimal groundwater that has been identified to date. Any water ingress will be collected via isolated in-pit sumps and collected for process water and/or dust suppression purposes. There have in the past, been isolated storm events which result in surface water flows trending from the northeast towards the open pit. Given the location of the waste dump, a surface bund will be developed along the northern lease boundary to divert this water to the south east around the waste dump and away from all mining and process operations.

6.2.2.4 Transportation of ROM

Hauling of waste rock and ore out of the pit will be undertaken using a trolley assist system. Trolley-assist is a haulage system whereby diesel electric trucks are provided with AC electrical power directly from an overhead line in the same manner as a city tram. This allows the trucks to obtain a substantial up-hill haul speed increase, often double or more when compared to a standard mechanical drive truck. The benefits are significant and include:

- Substantially increased productivity resulting in operating cost reductions. There is also a reduction in capital as fewer trucks are required to move the same amount of material.
- Fuel burn is considerably reduced as the trucks are effectively at idle when “on trolley”, resulting not only in operating costs savings but also a significant decrease in the carbon footprint of the operation.
- Engine life and engine operating costs is a direct function of the amount of time the engine spends at full load. Under trolley this is significantly reduced and therefore it would seem reasonable to assume that ongoing parts costs related to wear and tear should be reduced and engine life as a whole should increase.

6.2.2.5 Mineral processing

The section below describes the mineral processing that is required in order to extract uranium from the ore and should be read in conjunction with the process flow diagram (Figure 6-2). To provide a sense of scale the plant throughput is expected to be 15Mtpa and the tonnage production of final product is estimated at 8000 tpa uranium oxide at 70% contained uranium which amounts to approximately 15 million pounds per annum.

Primary crushing

Ore from the mine will be delivered by 280 to 320t haul trucks directly to the ROM bin, which will have a live capacity of three truckloads and can be fed from both sides. The ROM bin will feed directly into the gyratory primary crusher. The crushed ore will discharge onto an apron feeder which will feed the primary crusher discharge conveyor. Primary crushed ore will be transferred to the coarse ore stockpile via the primary crusher discharge conveyor.

The primary crusher will be a significant source of dust, particularly the ROM bin during truck tipping. Wetting sprays will wet the ore while on the truck and a set of sprays have been incorporated at the ROM bin to wet the ore stream as it is dumped. The system will be fitted with sensors and interlocks to allow these sprays to operate only when a truck is dumping. A set of fog sprays has also been included in the ROM bin to suppress dust generated. Dust suppression sprays will be used for all transfer points in the crushing area to minimise fugitive dust emissions. A water tank with 6 hours capacity will supply water for dust suppression. Ducted dust collection systems will be included with extraction hoods at all major dust generating locations throughout the crushing circuit including transfer points, crusher discharges and feeders. The collection ducts will be connected to a venturi scrubber and the dust coagulated and deposited on the conveyor to the plant with the ore. The scrubber will be fitted with a dry fan and stack for releasing cleaned air.

FIGURE 6-2: PROCESS FLOW DIAGRAM SHOWING MAIN PROCESS COMPONENTS

Course ore stockpile

A single coarse ore stockpile will be fed by the coarse ore stockpile feed conveyor. The live stockpile capacity will be designed for 48 hours of operation. This will provide the processing plant with feedstock for up to 48 hours should there be a problem with the ore supply from the mining and crushing operation. The stockpile will be partially covered with a roof to reduce dust emissions. The reclaim system beneath the stockpile will consist of two trains each fitted with eight apron feeders which will transfer ore onto each of the SAG mill feed conveyors.

ROM Stockpiles

The ROM stockpiles (which may vary in grade) will be located in front of the primary crusher and will serve the need for any blending requirements that might arise from time to time.

Low Grade Stockpile

Low grade ore is planned to be stockpiled over the life of mine in order to preferentially feed higher grade ore to the process plant. The stockpile will be located adjacent to the mineralised waste facility on the western side. The low grade ore is to be processed at the end of life of mine.

SAG Milling

The milling circuit will consists of two parallel streams of SAG mills operating in closed circuit with a coarse screen and pebble crushing circuit. Ore from the coarse ore stockpile will be fed to the SAG mills together with sufficient process water. The resultant slurry will be discharged onto the SAG mill discharge screen and washed with process water. The screen oversize will report to the pebble crushing circuit, while the undersize will report to the fines screening. The pebble crusher product will be discharged onto a pebble crusher discharge conveyor which will feed back onto the SAG mill feed conveyor. The undersize from the SAG mill discharge screen will report to a discharge hopper before being pumped to a distribution box that will distribute the feed equally between five fines screens. The fines screens oversize will report to the SAG mill feed conveyor, while the undersize will be collected in a hopper and be pumped to the leach feed tanks and cyclone cluster in the leaching circuit. Two potable water safety showers will be located in the SAG milling area for emergency purposes.

Leach Feed Preparation

The fines from each SAG mill discharge screen will be pumped to respective leach feed cyclone clusters. The cyclone overflow will report to the respective leach feed thickeners. The dewatered cyclone underflow and thickener underflows will be recombined in the respective leach feed tanks. The thickener overflow will be used for mill circuit process water. Each leach feed tank will have approximately two hours residence time for surge purposes. Leach feed pumps will pump the dense slurry to the respective leach tank trains.

Leaching

From the leach feed tanks, the slurry will be pumped to the leaching tanks which will comprise of two parallel trains of six mechanically agitated tanks operating in series under atmospheric pressure conditions. The first two tanks in each train will not be open to the atmosphere but vented to the leach vent scrubber. Concentrated sulphuric acid will be dosed progressively down the trains to ensure that the target residual acid of 2g/ℓ H_2SO_4 is maintained. Pyrolusite will be added to ensure the oxidation reduction potential (ORP) is maintained thus ensuring that sufficient iron is oxidised to assist in the leaching process. In addition, solvent extraction raffinate bleed will also be added to the first tank of each leach train and will contribute acid to the leaching process. The circuit has been designed with the ability to dose ferrous sulphate solution to the leach tanks if sufficient soluble iron is not present.

The leaching process will be performed at close to ambient temperature (nominally 25 to 35 °C). The tanks will be open-topped and will utilise bypass pipe work to allow leaching to proceed if one tank is offline for maintenance. The leach discharge slurry will flow from the final leach tank in each train to its respective leach discharge tank at approximately two hours residence time each.

An alternate option under consideration is a high temperature leach (between 70 ^{o}C and 80 ^{o}C). This would employ the same leaching equipment as is considered for the standard leach, except that high temperature steam (from steam boilers or by-product from the acid plant) would be added to the leaching vessels to achieve higher temperatures for improved uranium recovery. A second alternative under consideration is to separately leach the fines and coarse fractions with the fines in a pressure pipe reactor with oxygen to realise uranium recovery. Recombining the post pressure leach residue (which would be at a higher temperature) and the coarse fraction in the atmospheric leach would also result in an elevated temperature.

Filtration

The leached slurry will require solid / liquid separation in order to capture the solution which contains the dissolved species (uranium) for further downstream processing. The remaining solids after leaching then need to be prepared for disposal as tailings.

Filtration will be employed as the primary solid / liquid separation step and counter-current decantation (CCD) as the augmenting solid / liquid separation step should excessive fines be present that would not be adequately filtered.

From the leach discharge tanks, the slurry from each respective leach train will be pumped to respective cyclone feed distribution boxes where the density will be adjusted with addition of re-cycled solution streams and gravitated to cyclone clusters. The cyclone overflows will to be collected in leach discharge fines tanks and the underflows gravitated to filter feed mixing boxes. The fines will be pumped to the CCD circuit (comprising five thickeners). There will be an option (depending on quantity of fines) to pump a portion of the second CCD underflow back to the filter feed mixing boxes where the slurry will be flocculated ahead of being distributed to the horizontal belt filters. The overall CCD circuit underflow (washed solids) will be pumped to a fines filter feed tank.

From the filter feed mixing boxes of the two leaching trains, the flocculated slurry will be distributed between a total of eight horizontal belt filters (HBF) (maximum of seven operating and one stand-by). The dewatered filter cake will constitute the main portion of the final tailings and the washed solution containing the dissolved species will be further processed.

The tailings filter cake from the fines filter will be deposited on top of the tailings filter cake from the HBF's and conveyed to the tailings component of the mineralised waste facility. The portion of fines tailings is expected to be between 15% to 20% of the total tailings at a moisture content of between 30% to 35%. The moisture content of the filter cake from the HBF's is expected to be between 17% and 20% resulting in an overall moisture content of between 19% to 24%.

The filtrate from the HBF's will be pumped back to the leach discharge cyclones. The filtrate from the fines filtration will be recycled back to the CCD circuit. The final solution containing the dissolved species, CCD circuit overflow, will be pumped to a pregnant leach solution (PLS) clarifier ahead of storage in the PLS pond.

Ion Exchange

The clarified PLS from the PLS pond will be pumped to the ion exchange circuit. Ion Exchange will consist of eight parallel streams of continuous ion exchange circuits. The columns will be used for adsorption and elution purposes. The columns will be arranged in eight trains, with each train comprising one adsorption column and one elution column.

The dissolved uranium in the PLS will adsorb onto the resin in the adsorption column and subsequently be eluted from the resin in the elution column. The barren liquor will be recycled back in the process. Batches of eluted resin will be diverted to four fixed bed regeneration columns, for resin regeneration. The eluate (solution containing the dissolved uranium) from the elution column will be passed over safety screens and filtered in the eluate filter. Any solids from the eluate filter will be returned to the CCD circuit and the filtered eluate will be pumped to the solvent extraction (SX) circuit.

Solvent Extraction (SX)

The SX circuit will accept the partially purified and concentrated uranium eluate solution from the ion exchange circuit and produce a high grade loaded strip liquor of sufficient purity for final product precipitation. The SX circuit will be split into two identical parallel trains.

The SX circuit will consist of four stages of extraction with an after settler, three stages of scrubbing and three stages of stripping with a scrubbed organic (SO) after settler and a loaded strip liquor (LSL) after settler.

Organic reagents are to be added to the extraction stages onto which the uranium will load. The loaded organic will be scrubbed and subsequently stripped with sodium carbonate to form the loaded strip liquor. The stripped organic will be recycled back to the extraction stage for re-use. The raffinate from the extraction stage will be recycled back to the ion exchange circuit.

Precipitation and thickening

Loaded strip liquor (LSL) will be forwarded to the SDU (sodium diuranate) precipitation circuit where dilute sodium hydroxide solution (250 g/ℓ NaOH) will be added to three precipitation tanks configured in series to raise the pH and precipitate SDU. The resultant slurry will be fed to a SDU thickener where the solids will be separated. The thickener overflow will report to a SDU overflow tank which will heat the overflow solution before being pumped to the SDU barren liquor filter. The overflow will be clarified using a polishing filter to recover any residual SDU solids. A majority of the filtrate will be partially neutralised with sulphuric acid and returned to SX for use as primary strip liquor. The SDU solids from the filtration circuit will be collected in the SDU solids return tank, where it will be heated before being pumped to the SDU precipitation discharge tank. A scavenger circuit will be used to recover uranium losses from the SDU washing/filtration circuit. The leach liquor from the SDU leach will be precipitated with the addition of hydrogen peroxide and sodium hydroxide to form uranium oxide, which will be thickened and washed. The washed uranium oxide will be pumped through centrifuges ahead of being dried. The centrate from the centrifuges and barren liquors from the thickening and washing circuit will be recycled back to the SX circuit.

Product drying and packaging

The uranium oxide drying circuit will be under vacuum with a venting and scrubbing system before releasing gases back to the atmosphere. Scrubbed solids will be returned to the circuit. The dried uranium oxide product will be packaged and sealed for product despatch. The product will be packaged in 200 litre drums which will be sealed and packed into containers for transport to Walvis Bay via truck and shipped to the market.

The uranium peroxide product is a pale-yellow soluble peroxide of uranium which is easy to handle with respect to thickening and dewatering and is easily accepted by the market. Precipitation to uranium peroxide also provides a product that is free of contamination by molybdenum, zirconium and vanadium.

Reagents required in the plant

Table 6-4 provides a list of the input reagents for the process.

TABLE 6-4: PROCESS PLANT REAGENTS

Reagent	Delivery and storage
Pyrolusite	This will be delivered to site in powder form in bulk bags in a container. It will be stored in the reagent storage area in the bulk bags stack. A bin handling and feeder facility will be employed to measure pyrolusite powder into a mixing tank from where the pyrolusite slurry will be pumped to the leaching plant. The annual consumption of pyrolusite will be approximately 45 000 tons.
Flocculant	Two different types of flocculant will be required for this process. They will be delivered to site in one ton bulk bags, which will be stored in the reagent storage area in the bulk bags stack. Bags will be transferred to the mixing area using a forklift. Once mixed, the batch will be transferred to the dosing tank, which will provide 12 hours of mixed solution storage. The flocculant will be distributed to the plant by a series of dosing pumps. The total annual consumption of flocculant will be approximately 2500 tons.
Sulphur	This will be trucked to site as sulphur pellets for use in the acid plant. The tonnage will be about 130000 tpa. It will be stored in the reagent storage area in hoppers.
Sulphuric Acid	This will be produced on site in the acid plant, see Section 6.2.2.7. As a back-up option, acid will be trucked to site if required. Should concentrated sulphuric acid be imported to site in place of the acid plant, approximately 400 000 tons will be required. This would be delivered to site in isotainers (tank) and stored in acid tanks.
Shellsol 2325 diluent	This will be delivered by road tanker and unloaded into a storage tank that provides up to 60 days storage. A transfer pump will be used to transfer the diluent to the SX area where it will be added to the stripped organic tanks to make up for organic losses. Diluent is a combustible liquid and fire protection systems will be provided in the storage / distribution area. Annual consumption is expected to be about 415 tons.
Extractant - Alamine 336	This will both be delivered to site in one m^3 intermediate bulk containers (IBC's) which will be stored in a storage shed sized to allow for 60 days supply. The annual consumption is approximately 6 tons.
Modifier – Isodecanol	This will both be delivered to site in one m^3 intermediate bulk containers (IBC's) which will be stored in a storage shed sized to allow for 60 days supply. The annual consumption is approximately 6 tons.
Hydrogen Peroxide	This will be delivered to site in isotainers by bulk road tankers. It will be stored in the isotainers. This storage area will be separate from the other storage areas. Annual consumption is expected to be approximately 2000 tons.
Ferrous Sulphate	Currently this is not required in the leaching process, however adequate space is being allowed for handling and make-up should it be required at a later stage. If required it will delivered and stored in bulk bags.
Sodium Hydroxide	This (as 50% solution) will be delivered to site by road tanker and unloaded to the sodium hydroxide storage tank, which provides seven days storage. Sodium hydroxide will be transferred to the sodium hydroxide mixing tank where water will be added and the tank agitated to provide a solution of design concentration. Annual consumption is expected to be approximately 40 000 tons.
Coagulant	This will be delivered to site in one m^3 IBC's which will be stored in the reagent storage area which will provide seven days storage. The IBC's will be transferred to the mixing area using a forklift and drained into the coagulant storage tank. The coagulant will then be pumped through a static mixer where it will be mixed with raw water to provide a diluted solution which will then be stored in the coagulant dosing tank. Annual coagulant consumption is expected to be approximately 215 m^3.
Sodium Carbonate	This will be delivered to site by bulk road tanker and stored in the sodium carbonate bin, fitted with dust collector. Sodium carbonate will be fed into the agitated mixing tank by screw feeder, together with demineralised water to provide a solution of design concentration. Annual consumption is expected to be approximately 6 200 tons.
Activated Carbon	Approximately 50 tons of activated carbon will be required on an annual basis.

Reagent	Delivery and storage
	This will be delivered to site in either drums or bulk bags and stored as such until required.
Resin	Approximately 350 m^3 of make-up resin will be required for the ion exchange circuit. This will be delivered to site in bulk bags and stored as such and not exposed to the elements.
Grinding Media	Steel balls will be required in the SAG milling circuit. Steel balls will be delivered in bulk in truck and stored in the steel ball bunker near the mills. A kibble and hoist system will be employed to transfer the required quantity to the mills. Annual consumption is expected to be approximately 6 000 tons.
Water treatment chemicals	Minor quantities of water treatment chemicals will be required on site for boiler feed, cooling towers, RO plant, demineralised water plant and potable water plant. These small quantities will be delivered in small bags and stored as such and man-handled when required.
Fire suppression foam	Foam chemicals will be required for the fire suppression system in high fire risk areas. The consumption will be dependent on use.

6.2.2.6 Services required by the plant

The following services are required.

Specified water types

Refer to section 6.2.5.

Steam

A steam boiler plant vendor package will provide steam for all required areas of the process plant.

Compressed air

Plant air at 750 kPa will be provided from the two main plant air compressors and stored in the plant air receiver where it will be reticulated to the plant air utility stations. A stream of plant air will be diverted through a pair of air filters and fed to duty / standby air driers to remove moisture from the plant air. A pair of micro-filters on the outlet will remove any fine oil droplets and particulate matter from the dried air, to produce instrument quality air. The instrument air will be stored in the instrument air receiver prior to reticulation to the required plant areas.

6.2.2.7 Acid plant

Acid will be produced in a dedicated plant. The basic process related to the plant is described below.

Air will be dried in a drying tower and then compressed before being pumped into the combustion furnace together with molten sulphur. The molten sulphur will burn in the presence of the dry compressed air to produce sulphur dioxide (SO_2) gas. The hot combustion gases will be cooled before reporting to the converter system.

The vertical converter will comprise a minimum of four catalyst beds of vanadium pentoxide type catalyst facilitating the exothermic oxidation of SO_2 to SO_3. The SO_3 rich gas from the fourth catalyst bed will exit the converter and passes through an economizer to cool the gas before entering the final absorption tower, where it will be absorbed with re-circulated 98% H_2SO_4. A fifth converter will be specified to ensure maximum conversion of SO_2 to SO_3.

The gas leaving the final absorption tower will pass a high efficiency candle type mist eliminator before it is released to the atmosphere via a stack. SO_2 stripped via the mist eliminator will form sulphuric acid and will be returned to the process. The product acid will be cooled in a separate heat exchanger to 40°C and will be discharged from the pump tank by a product acid pump to the product acid tank. The final conversion efficiency will be approximately 99.8 %.

The excess heat from the SO_2 oxidation process will be recovered in the super heater and used to produce high-pressure super-heated steam.

6.2.2.8 Mineralised waste - waste rock and tailings

This section should be read with reference to Figure 6-1, Figure 6-3, and Figure 6-4, and the specialist engineering study included in Appendix P (Metago Australia, 2010).

Concept

A primary driver for the design of the mineralised waste facilities was the encapsulation of the tailings within the waste rock dump itself in an effort to minimise environmental impacts associated with direct exposure to tailings (Further discussion on the alternatives considered is provided in Section 5.2.6). The key aspects of the mineralised waste facilities are provided in Table 6-5.

TABLE 6-5: MINERALISED WASTE FACILITIES

Feature	Tailings	Waste rock
Waste Materials – source and tonnages	Approximately 213 million tonnes over the mine life.	Approximately 1457 million tonnes over the mine life.
Physical dimensions	Enclosed in the greater waste rock dump (see next cell).	A footprint of approximately 1200Ha. A height of up to 200m. Side slopes of approximately 31 to 35 degrees.
Access and access control	The entire mine infrastructure footprint (including the mineralised waste facility) will be fenced by an NNNP type standard fence. Only authorised personnel will be entitled to work within the mining and mineralised waste dumping area. Other personnel, including visitors, will be escorted once safety induction has been attended.	

Feature	Tailings	Waste rock
Method of delivery and deposition, method of ongoing development	The initial waste rock from the pit will be transported by large mining haul trucks to develop the first section of the mineralized waste facility, before the process plant is commissioned some 18 months after the start of construction. The tailings impoundment walls (approximately 100m thick), constructed of waste rock selected according to specified geotechnical criteria, will rise to final maximum height of 90m within first two years of open pit operation. This tailings deposition will be by means of conveyor stacker. The deposition will alternate between the southern and northern tailings areas until the last few years where the tailings would be deposited in the most central area of the mineralized waste facility. As the mineralized waste facility extends from either direction, the waste rock would be dumped behind in lifts of 30m. Apart from the most central area, the majority of the tailings would be covered by rock of up to 80-100m. The limited central area of the mineralized waste facility would be capped by 5m of rock as open pit operation ends some years before the decommissioning of the process plant. The waste rock for the capping would be sourced from other areas of the waste rock dump and placed utilising suitable earthmoving equipment. The waste rock sections of the mineralized waste facility will have a rate of rise of roughly 15m per annum though this will fluctuate year to year. The overall outer design limits will be achieved through dumping in 30m lifts according to a predetermined dumping schedule as a function of the prevailing production rates.	
Geochemical characteristics	Some waste rock and the tailings/filter cake are potentially acid forming (PAF), but other waste rock is non acid forming (NAF).It is not clear whether there is enough NAF waste material to neutralize the PAF waste material. There will be negligible ability of the tailings and waste rock to neutralize the barren liquor that will accompany the tailings. The barren liquor will need to be contained as it does not meet Namibian or international water quality standards.	
Lining	The tailings facility will be lined using a composite liner comprising 1.5mm HDPE underlain by a 500mm layer of selected fine grained compacted fill. The inside slope of confining embankments will be lined to a height of 10m with 1.5mm HDPE underlain by a 500mm layer of selected fine grained sandy material and thereafter, the slopes will be lined with compacted tailings.	The base of the dumps will be lined by forming a 2m minimum thickness layer of compacted selected waste overburden which forms an unsaturated zone and which is constructed in two layers.
Drainage system including return water system	Within the tailings section of the mineralised waste facility, there will be a network of filter drainage media capable of draining the tailings and maintaining minimal heads at the base of the facility. These drains will report to HDPE lined collection facilities on the western side of the mineralised waste facility. A leakage collection system will be constructed around the downstream perimeter of the mineralised waste facility and will comprise a trench excavated to refusal that is equipped with a geonet / geomembrane and a seepage collection pipe which would drain to a lined sump.	The 2m minimum thickness layer of compacted selected overburden forms an unsaturated zone and is constructed on slope (approximately 1 in 300) so that seepage flows to a control point located between the toe of the dump and the open pit. A leakage collection system will be constructed around the downstream perimeter of the mineralised waste facility and will comprise a trench excavated to refusal that is equipped with a geonet / geomembrane and a seepage collection pipe which would drain to a lined sump. This will

Feature	Tailings	Waste rock
	This will protect the surface and near surface water resources beyond the confines of the mineralised waste facility against any inadvertent seepage through the liner.	protect the surface and near surface water resources beyond the confines of the mineralised waste facility against any inadvertent seepage through the liner.
Stormwater management (clean and dirty controls)	A clean water diversion will direct all runoff and near surface water from catchments up-contour of the mine site around the mine site to the east of the mineralised waste facility. A dirty water collection system will collect all runoff water within the mine site and store this water for use in the processing plant or it will be evaporated.	

6.2.3 EMPLOYMENT AND HOUSING

During the operation phase 1200 people will be employed by the Husab Project. Employees will be housed in nearby towns such as Swakopmund, Walvis Bay and Arandis. Financial housing schemes will be provided by Swakop Uranium to assist with the renting or purchase of housing for project employees. No on site housing will be provided during the operational phase.

6.2.4 OPERATIONAL TRANSPORT

6.2.4.1 Employees

Ten bus trips will be required daily to transport the work force to and from site. A bus load will carry between 35 and 40 people. It is envisaged that a total of 250 – 300 shift workers and 350 daytime employees will work the shift roster and need to be transported in the following manner:

- Depot-to-Husab: 15H15 – 06H00 (Shift: Full Load)
- Husab-to-depot: 06H15 – 07H00 (Shift: Full Load)
- Depot-to-Husab: 07H15 – 08H00 (Daytime: Full Load)
- Husab-to-Depot: 08H15 – 09H00 (Empty return)
- Depot-to-Husab: 13H15 – 14H00 (Shift: Full Load)
- Husab-to-Depot: 14H15 – 15H00 (Shift: Full Load)
- Depot-to-Husab: 15H15 – 16H00 (Shift: Full Load)
- Husab-to-Depot: 16H45 – 17H30 (Daytime: Full Load)
- Depot-to-Husab: 21H15 – 22H00 (Shift: Full Load)
- Husab-to-Depot: 22H15 – 23H00 (Shift: Full Load)

Private vehicles will also travel to and from site daily, however this will be discouraged in an attempt to keep this to a minimum.

At this stage in conceptual planning the preferred permanent access to the site is a surfaced road that turns off the B2 and crosses the Khan River valley. This is the subject of the separate EIA report on linear infrastructure.

FIGURE 6-3: PLAN VIEW SHOWING MINERALISED WASTE FACILITIES

FIGURE 6-4: SECTION VIEW SHOWING MINERALISED WASTE LAYERS

6.2.4.2 Goods and materials

All goods will be transported to site via road. Approximately 40 trucks will deliver goods and materials to site per day.

6.2.5 WATER SUPPLY FOR OPERATION ACTIVITIES

Water for the operational phase will be piped to site. All the water piped to site during the operational phase will be potable quality. The required operational quantity is $8Mm^3/a$. A site wide water balance has been developed and is indicated in Figure 6-5.

Raw Water

Desalinated water provided by NamWater will be received on site at the raw water tank. This raw water will be of potable quality. A portion of the raw tank will be set aside as fire water reserve with the raw water pump suctions located above the fire water pump suctions. Raw water from this tank will be supplied to the required areas via the raw water pumps.

The fire water pump set will comprise an electrically powered main centrifugal pump, a diesel powered pump, and an electrically powered jockey pump. The fire water system pressure will be maintained using the jockey pump, thereby preventing premature starting of the main fire water pump. When firewater is used, the associated pressure drop in the piping will cause the electric fire water pump to start automatically. In the event of power failure or the electric powered pump failing to start on demand, the diesel-powered pump will operate. Fire water will be reticulated throughout the plant site in underground polyethylene pipes, generally running adjacent to the site roads. All hydrants and tie-ins will be located above ground and fabricated in carbon steel piping.

The raw water tank which will have a two hour water supply will feed into an HDPE lined raw water pond, which will have a two day capacity.

Potable Water

The potable water plant (a chlorination facility only) will be fed via the potable water feed tank and will be designed to provide 200ℓ of water per person per day. Two potable water pumps and two safety shower water pumps will be used to provide water for drinking and ablutions and safety showers. The potable water tank will provide seven days storage capacity.

FIGURE 6-5: SITE WATER BALANCE

Demineralised Water

The demineralised water plant will be supplied with raw water from the raw water tank and will provide demineralised water via a reverse osmosis (RO) plant. Permeate will be stored in the demineralised water tank which will provide a storage capacity of 24 hours. Duty / standby pumps will be used to transfer the demineralised water to the solvent extraction and precipitation areas. The RO reject will be pumped to the process water pond.

Gland Seal Water

Gland water of potable quality which should not contain any solids will be used in a gland water distribution system and be stored in the gland water tank prior to distribution to the required plant areas via the gland water pumps.

Process Water

The process water pond will provide storage capacity for 8100 m^3 of process water or general plant solutions. The pond will be installed with a HDPE liner.

Cooling Water

Chilled water will be supplied to the belt filter cooling water system. Raw water, chilled return water, and seal return water will be fed into a filter seal water sump. From here, the water will be pumped to the required areas of the plant, and to a cooling tower. Chilled water from the cooling tower will return to the filter seal water sump.

Water for drilling and dust suppression

Total volume of water used in the pit for drilling and dust suppression will be in the region of 2,200m^3/year at full operation. This water will be recycled water from the process water pond, and the sewage treatment plant. Mine production drilling in the pit will aim at utilising cyclones to suppress dust and thereby minimise water consumption.

Considerable water is additionally required to suppress dust along haul roads and on top of dumps through the use of adapted mining trucks. However, the use of dust suppression products is to be evaluated to conserve water as far as possible. This is planned to be undertaken during the first year of open pit operation.

Pit dewatering

In the unlikely event of water ingress into the pit, sumps will be established. Water would be drawn via a goose neck arrangement for water trucks to spray the haul roads as dust suppression.

Tailings return water

Tailings return water from the HDPE lined collection facilities will be evaporated and/or reused in the plant process.

Sewage return water

Treated sewage effluent will be used for on site dust suppression.

6.2.6 OTHER SURFACE WATER MANAGEMENT FACILITIES

Surface water runoff and near surface water flow upstream of, and within the project area after rainfall events will be managed by the following infrastructure to ensure that clean and dirty water systems are kept separate (Figure 6-6):

- Clean water cut off channels have been designed to divert any clean surface and near surface water generated upstream of the project area back into the natural environment. Clean water will be routed to a small clean water dam (Dam 1) from which it will discharge directly into the environment.
- Dirty water cut off channels have been designed to ensure that dirty water generated on the project area is firstly contained, and then diverted to an appropriate stormwater dam for containment.
- Dirty water containment facilities (Dam 2 and 3) are located at the downstream end of the project area and have been sized to contain at least the 1:100 year storm event. These dams will be lined with an HDPE liner. Water collected at these dams will be reused in the process.
- Plant storm water will be collected in the plant process water dam that has been designed to receive process water and the run-off from the 1:100year rainfall event. The plant area will be treated in isolation from the rest of the mine run-off.

6.2.7 ABLUTIONS AND SANITATION FOR THE OPERATION PHASE

One ablution block will be positioned in the plant complex, and will cater for about 200 people. A second ablution block will be positioned in the mine complex and will cater for about 400 people. A third smaller ablution block will be positioned at the ROM complex. Each of these ablution blocks will contain a change house, showers, toilets and basins. Smaller toilet facilities will be positioned at additional places within the plant and mining complexes.

The modular sewerage treatment plant constructed during the construction phase will be used for sewage treatment during the operational phase, but some of the modules may be removed to cater for a smaller throughput of sewage.

FIGURE 6-6: SURFACE WATER MANAGEMENT

6.2.8 POWER SUPPLY FOR OPERATION ACTIVITIES

Power during the operation phase will be supplied by a permanent NamPower power line. NamPower bulk supply will be derived from their existing 220 kV supply scheme that feeds Rössing, Trekkopje, and other mining operations in the area plus the towns of Swakopmund and Walvis Bay. The customer substation at the Husab Project site will be equipped with the required number of 220/66 kV transformers to deliver 66 kV for use at Husab. Two large generators will be installed on site, within the plant complex for backup power. They will be contained within 12m long marine type containers and the capacity will be approximately 2MVA each. Four smaller generators will also be positioned at strategic positions within the site, for additional back-up power (500kVa each). All the generators on site will be correctly installed within an adequately sized bund wall. The off site power infrastructure is part of the linear EIA.

6.2.9 NON-MINERALISED WASTE MANAGEMENT FOR THE OPERATION PHASE

Waste will be separated at source, stored in a manner that there can be no discharge of contamination to the environment, and either recycled or reused where possible. On site facilities will be provided at the waste transition yard (WTY) for sorting and temporary storage prior to removal and disposal to off site appropriated recycling or disposal facilities (Swakopmund for general waste and Walvis Bay for hazardous waste).

Domestic waste will be disposed of at a licensed waste disposal site in Swakopmund. On site facilities will be provided at the WTY for sorting and temporary storage prior to removal and disposal.

Industrial waste will be sorted on site, at the WTY, and either disposed of within the waste rock dumps or sent to the municipal waste sites with the domestic waste.

Hazardous waste (non radioactive) includes inter alia: fuels, chemicals, lubricating oils, hydraulic and brake fluid, paints, solvents, acids, detergents, resins, brine, solids from sewerage and sludge. Hazardous waste will be disposed of at the Walvis Bay hazardous waste disposal site.

Disposal sites for radioactive contaminated material/waste will be established within the waste rock dump as part of the mineralised waste facility. This radioactive contaminated waste will include inter alia: old personal protective equipment, drums, pipes, etc

A waste specification has been developed for the Husab Project and details waste management on site. A summary of this is provided in Table 6-6.

TABLE 6-6: NON MINERALISED WASTE MANAGEMENT FOR OPERATIONS

Waste type	Waste specifics (example of waste types)	Storage facility	End use
Non-hazardous non-radioactive contaminated solid waste (non-mineralised)	Pallets and wooden crates, rubber, cardboard, paper, cable drums, metal cut-offs. scrap metal, general domestic waste such as food and packaging	Skips in relevant work areas will be provided for different waste types. A waste management contractor will remove skips regularly to the Waste Transition Yard (WTY).	Waste will be sorted further at the WTY. Recyclable waste will be sent to a reputable recycling company. Some items may be distributed directly to the community such as pallets and wooden crates. The remainder of the waste will be transported by the waste management contractor to a permitted general landfill facility in Swakopmund for disposal.
	Building rubble and waste concrete	Designated rubble collection points will be determined to which rubble and concrete will be taken.	Building rubble will be disposed of to a designated area in the waste rock dump as part of the mineralised waste facility.
Non-hazardous and hazardous radioactive contaminated solid waste (non-mineralised)	Contaminated sand, drill chips, old PPE, pipes etc.	Radioactive waste will be stored in sealed drums in the relevant work areas. These drums will taken to the WTY on a regular basis.	Waste will be further sorted at the WTY. Recyclable waste will be decontaminated (high pressure washing) and if successfully decontaminated will be sent to a reputable recycling company. There is no appropriate disposal site in Namibia for radioactive waste. All radioactive waste will therefore be disposed of in the mineralised waste facility.
Hazardous non-radioactive contaminated solid waste (non-mineralised).	Treated timber crates, printer cartridges, batteries, fluorescent bulbs, paint, solvents, tar, empty hazardous material containers etc.	Hazardous waste will be separated at source and stored in designated containers in bunded work areas. The waste management contractor will remove these drums regularly to the WTY.	Hazardous waste will be disposed of at the permitted hazardous disposal site in Walvis Bay by the waste management contractor.
	Hydrocarbons (oils, grease)	Used oil and grease will be stored in drums in bunded areas at key points in work areas. The bunds will be able to accommodate 110 % of the container contents and include a sump and oil trap. The waste management contractor will remove these drums regularly to the WTY. The yard will have a dedicated used oil storage area which will include a concrete slab, proper bunding and an oil sump. The appointed bulk fuel supplier will collect used oil for recycling.	The yard will have a dedicated used oil storage area that will include an impermeable concrete slab, bunding, an oil trap and sump. Used oil will be sent to a reputable recycling company for recycling.
	Sewage	Sewage will be treated at a sewage treatment plant (STP) with a capacity of 0.5 Ml per day.	Sewage effluent will be reused in the process water circuit. Sewage sludge will be dried and either buried in the mineralised waste facility or used for bio-remediation.
Medical waste	Syringes, material with blood stains,	Medical waste will be stored in sealed containers at the clinic. A	Medical waste will be transported by the waste management contractor to

Waste type	Waste specifics (example of waste types)	Storage facility	End use
	bandages, etc.	waste management contractor will remove these drums regularly to the WTY.	a permitted incineration facility in Swakopmund for incineration.

6.2.10 ADDITIONAL SITE FACILITIES

6.2.10.1 Fuel and lubricant storage and use

There will be three fuelling points on site and each of these is described below. All fuel tanks will be above ground and within impermeable bunds which will make allowance for 110% containment for the largest potential failure. All day-to-day spillage within the bund and filling / delivery areas will be channelled into sumps equipped with oil traps and separators.

The main fuel depot in the mine complex, which will accept all fuel delivery during operation, will be the filling point for plant and small vehicles using “curb-side” pumps and represents the bulk storage of all fuel and lubricants for operations. This depot will consist of several storage tanks, envisaged to be constructed according to generally accepted standard for above-ground fuel storage tanks. On current planning the storage will cater for approximately 6 x 82m^3 diesel tanks, 3 x 23m^3 lubrication tanks and 1 x 23m^3 waste oil tank. These volumes may be changed in time.

The satellite fuel depot at the ROM complex will cater for heavy mining vehicle filling. This depot will consist of several storage tanks, envisaged to be constructed according to generally accepted standard for above-ground fuel storage tanks. On current planning the storage will cater approximately for 2 x 82m^3 diesel tanks. These volumes may be changed in time.

The service station and workshop for small trucks and shift vehicles will be located in the administration complex and accessible to both mining and plant vehicles. This service station will feature fuel dispensing points that are similar to commercial fuel dispensing stations. Mining, plant and administration vehicles will fuel up and be serviced at this point. The location of the service bay is in close proximity to the bulk fuel depot and fuel will be fed by pressurised pipelines for the dispensing of fuel.

6.2.10.2 Explosives use and storage

Explosives and explosive accessories will be an essential consumable in the mining process and as such a safe, efficient and reliable supply of this commodity is vital. It is projected at this stage that during the initial three years of operation the Husab Project will require 53 000t of bulk explosives and 437 000 units of explosives accessories. At peak production the project will consume 47 000t of bulk explosives and 331 000 units of explosive accessories per annum. The emulsion manufacturing plant will need to have an annual capacity of 24 000t which caters for 50% of the holes being charged with emulsion. Emulsion is a water repellent based explosive that is used to charge holes that contain water.

All explosive transportation, storage and handling will be governed by the Namibian regulations with periodic inspections undertaken by the Police and the Ministry of Mines. Handling of explosives on the mine will be under the direct supervision of an appointed person who will be the holder of a Namibian surface blasting certificate.

Explosives magazines will be located in a remote area next to the waste rock dumps, on the northern side of the mine lease area. The magazines will be specially designed, constructed and approved facilities used for the storage of blasting consumables (detonating fuse, explosives boosters, detonators, detonating timer delays and cartridges explosives). These magazines will be surrounded by earth bunds, which will be in a fenced off area, free of all plant growth. Lightening conductors shall be erected as additional protection. The magazines will be kept under lock and key with access by authorised, approved trained personnel only. The only time persons will be in the magazines will be during receiving of stock or delivery of consumables required for blasting operations.

6.2.10.3 Telecommunications

Mobile Radios on site will include dispatch consoles located in the security control room, the administration complex and the mine complex. Hand held radios, vehicle radios and a mast and antennae will be part of the mobile radio equipment.

A telephone system is proposed for communications. This will provide site wide telecommunications based on Microsoft Office communications.

A 30m high cell phone mast that will have the radio and cell-phone communication repeaters will be installed on site. The mast will be positioned once a radio survey is done, but it is most likely to be erected between the two mining pits.

6.2.10.4 Helipad

An on site helipad will be located at the visitors centre. It will allow one turbine driven helicopter (Bell 407 or similar) to land and will be used for official visits as well as emergency evacuations where necessary. The area will be approximately 100 m x 100 m and will be located in accordance with civil aviation regulations.

6.2.10.5 Laboratory

The laboratory will provide an analytical service to the metallurgical plant to assist with efficient operation and control. It will also analyse mining and exploration samples and undertake in house environmental monitoring. Accreditation of the laboratory is not envisaged at this stage and therefore a comprehensive inter laboratory program will be implemented.

The facilities in the laboratory will include:

- Sample receipt area.
- Pressure filter area.
- Wet chemistry laboratory.
- Solvent laboratory (The laboratory will be equipped with a fume extraction hood fitted with filters and a scrubber).
- XRF (x-ray fluorescence)/ICP (inductive coupled plasma mass spectroscopy) room.
- XRF preparation room.
- Sample storage area.
- Offices and record room

6.2.10.6 Medical facility/clinic

There will be an on site medical facility and clinic which will be able to address day to day medical issues and emergency medical cases. This facility will be fenced-off and fully furnished. The facility will have a fully equipped ambulance (4x4). A diesel generator will provide emergency power and will ensure full operation in the event of an emergency on the concentrator, mining infrastructure and / or consumer substation.

6.2.10.7 Security and access control

The entire mine infrastructure area will be fenced with a fence the same standard as the NNNP boundary fence. There will be an access control point on the access road which will come through the Khan River Valley (subject to the linear EIA), in the form of a gate house at the bend of the Old German Railway. The plant and mine complexes will be fenced with high security fencing and each facility will have an access control gate.

6.2.10.8 Weighbridge and parking

A weighbridge will be positioned just off the main access road to the south and outside the plant complex. The weighbridge will monitor the incoming delivery of reagents and consumables, and the outgoing shipment of uranium product. The weighbridge will be a load cell type, single truck length unit installed above ground. A waiting area will be sized to accommodate five trucks.

On site parking will be provided at the following places:

- Administration building.
- Training facility.
- Assay laboratory.
- Clinic.

- Mine offices.
- Bus drop off zone.
- Visitors centre.

6.2.10.9 Lighting

In all cases, lighting has the purpose of facilitating safety and security. Without compromising safety and security, yellow lighting will be used and high pole lighting will be avoided. Where pole lights are used they will be focussed downwards.

The plant, mine and ROM complex as well as the open pits will all operate 24 hours per day, and will thus require lighting. Lighting in the pit will consist of a number of lighting skids consisting of 4 x 1000 Watt metal halide lights standing on poles.

The plant and mine complexes will utilise a combination of high pressure sodium, pole mounted lights and building/structure-mounted lights. These are envisaged to be lit between dusk and dawn. Lighting has been designated for internal, walkway and plant occupational areas. Yellow down-lights will be used where possible.

The ROM complex will be lit externally by means of standard sodium floodlights and pole mounted lights.

6.2.10.10 Offices, visitors centre and admin buildings

The main administration building will be located between the plant complex and the mine complex. Mine production and technical offices will be located within the mine complex. This administration complex will feature:

- Combined visitor/training centre with human resources offices.
- Fire station and emergency control and response centre.
- Medical clinic.
- Central laboratories.
- Service Station.
- Change houses.
- Central kitchen.
- Administration building.
- Drop off and collection points for buses.
- Parking facilities for visitors and private vehicles.
- Helicopter landing pad.

Production and technical offices will also be located within the mine and plant complexes. A visitors centre will be located at the first access control gate - the gate house, near the bend of the Old German Railway.

6.2.10.11 Workshops and stores

Mine workshops will be required for large truck and support equipment and light vehicles. General workshops will be required for electrics, drills and general maintenance. Activities associated with the workshops include painting, grinding, welding, and repairs.

Stores will be located in the following areas:

- The plant will have a reagents store which will be a structural steel building with a concrete floor and a 300mm concrete bund around the perimeter.
- The engineering workshops will have storage facilities.
- The mine complex will have a covered component store for heavy mobile mining equipment, batteries and specialised tools.
- The heavy vehicle workshop will have a storage facility.
- ROM complex will have a lubricant store.

6.2.10.12 Salvage yard

The salvage yard will be a separately fenced off area, directly next to the process plant. Run-off from the salvage yard will be contained within the plant complex water system.

6.2.10.13 Internal roads

The road entering the administration area will be a 10m wide asphalt road. This road will be reduced to a 6m wide asphalt road within the administration area. Internal plant roads will be 10m wide asphalt roads. Curbing will act as road drainage on all roads.

A haul road will run from the ROM complex to the mine complex and will be a 30m wide compacted dirt road. The road will serve trucks coming from the ROM complex to the mine complex for maintenance. A five meter wide gravel road will run parallel to the haul road and will be for passenger busses travelling from the mining complex to the ROM complex.

A three meter wide gravel maintenance road will run adjacent to the overland conveyor, from the plant to the ROM complex.

A gravel track will run from the plant complex under the power line to the on site Husab sub-station. This gravel track will then run north on the west side of the open pits and will provide access to the bulk explosives and explosives magazine. The road runs back to the plant complex on the eastern side of the pits.

6.2.11 DUST CONTROL (ROADS)

Suppression of dust within the mining operation is planned to be predominately controlled by spraying of water by large adapted haul trucks. Mining areas include the pits, active haul roads, stockpiles and dumps. The potential use of appropriate specialised commercial dust suppression products are planned to be fully investigated to reduce water consumption as well as the potential use of treated process water. This is planned to be undertaken in the first year of mining operation.

6.2.11.1 Internal pipelines

Various on site pipelines have been described in the discussion above. The pipelines will be placed in the following manner:

- Pipelines within the plant will all be located on the surface of the ground.
- All water pipelines will be on the surface of the ground, except the fire water which will be distributed all over the site via underground pipes.
- The fuel pipeline from the bulk fuel depot to the ROM complex will be on the surface of the ground.
- The sewage pipelines will all be below ground.

As a general rule the pipelines will be attached to the conveyor structures which will be 1.2m above ground. Further detail on the conveyors is provided below.

6.2.11.2 Conveyors

Conveyors will be used to transport material in the front end of the process plant between the crushers, scrubbers and some of the stockpiles. Conveyors will also be used to transport the tailings from the plant to the tailings storage facility. Summary of the on site conveyors is as follows:

- Conveyor from ROM to plant will be completely covered. These conveyors will be 1.2m above ground except where they deliver to the feed stockpile, where they are 35m above ground.
- Conveyors inside the plant will be open and will be 1.2m above ground.
- Conveyor from the plant to the TSF will be open and will also be 1.2m above ground.

6.2.11.3 Ongoing exploration

Exploration drilling will continue. It will be used to upgrade the mineral resource on a yearly basis as well as to assist with detailed mine planning going forward. Related issues have been assessed and approved in the process associated with the award of the relevant EPL.

6.2.11.4 Ongoing contractor work

The contractor administration and lay-down area, excluding the temporary accommodation area (see section 6.1) will remain in use as and when required for the life of mine. This is particularly relevant to any alterations, maintenance or refurbishment that may be required from time to time and that may require the services of contractors.

6.2.12 TIME TABLE

The process plant will commence in the first quarter of 2014 and last until first quarter 2028, making it a total of fourteen years operational life. Mining operations however will commence 18 months earlier in July 2012 to ensure timely exposure of ore for processing. The open pit life is estimated at 13.5 years (January 2012 to June 2025). In July 2025, re-handling of the low grade stockpiled ore will be undertaken and sent to the process plant. The processing of this low grade ore will take approximately two years.

6.3 DECOMMISSIONING AND CLOSURE PHASE

At a conceptual level, decommissioning can be considered a reverse of the construction phase with the demolition and removal of the majority of infrastructure and activities very similar to those described with respect to the construction phase. The closure phase occurs after the cessation of all decommissioning activities. Relevant closure activities are those related to the after care and maintenance of remaining structures.

6.3.1 CLOSURE OBJECTIVES

The planning stage for decommissioning and closure has commenced and in broad terms the main objective will be to remove as much infrastructure as possible and rehabilitate what remains to resemble the pre project land state as closely as possible. At this stage, the proposed post closure land use will be a combination of conservation and wilderness. Closure objectives have been developed against the background of the project location in the Namib Desert, within the NNNP, and immediately adjacent to WCRA, the Welwitschia Plains and a major ephemeral river, the Khan River. The following objectives have been set:

- Disturbed areas other than those comprising the open pit and mineralised waste facilities will be returned to as close to their original state as practicable.
- Permanent visible features such as the mineralised waste facilities and related environmental bunds as well as safety bunds around the open pit will be left in a form that blends with the surrounds.
- Contamination beyond the mine site by wind, surface runoff or groundwater movement will be prevented through appropriate erosion resistant covers, containment bunds and drainage to the open pit.
- Linear infrastructure comprising roads, railways, pipelines, power lines, conveyors and related components will be removed and the disturbed land rehabilitated to blend with the surrounding natural environment.
- Socio-economic impacts (including the loss of employment) will be minimised through careful planning and preparation for closure beginning three to five years before closure takes place.

The above principles and concepts will be refined as part of ongoing detailed closure planning and costing during the life of mine.

6.3.2 DECOMMISSIONING ACTIVITIES

At a conceptual level this is a reverse of the construction phase with infrastructure and activities very similar to those described in section 6.1. The conceptual decommissioning plan is as follows:

- Surface infrastructure will be demolished and removed, with the exception of the mineralised waste facilities which will remain in perpetuity. The open pits will also remain in perpetuity.

- Areas where infrastructure has been removed will be levelled and restored in terms of soils horizons, vegetation and drainage.

Open pit decommissioning

- An exclusion bund will be constructed around the northern, western and southern rims of the open pit and connect to the mineralised waste facilities which will form the eastern exclusion bund.
- Seepage water and all other contaminated water that can drain naturally to the open pit will be directed to the pit where it will evaporate.
- Access ramps to the open pit will be bunded off to prevent access down the ramps.
- The top berm of the pit will be sloped to an angle of approximately 20 degrees.
- Pit slopes will be assessed and stabilised for long term stability performance.

Mineralised waste facility decommissioning:

- The facilities (waste and tailings) will be shaped to a landform that blends with the surroundings as part of concurrent rehabilitation and in accordance with visual impact mitigation measures.
- Runoff and eroded material from the dump surface will be captured behind a perimeter bund and allowed to evaporate. Along the western perimeter the runoff and eroded material will be directed to the open pit.
- Seepage will be directed to the open pit.
- Aftercare and maintenance will be designed and implemented for the post closure phase.
- Surface and groundwater quality will be monitored regularly for a period to be agreed upon with the relevant authorities.

Process plant, primary crusher and conveyor:

The processing plant, primary crusher and conveyors will all be dismantled, and salvageable elements will be de-contaminated and sold. The remainder of the processing plant including steelwork, concrete, liners, brickwork etc will be dismantled or broken up and disposed of into the open pit. Any contaminated soil below the processing plant will also be uplifted and carted to the open pit. Conveyor belts and concrete footings as well as non-salvageable steel will be disposed of into the open pit.

The residual excavations after removal of the processing plant and primary crusher will be backfilled and levelled with selected overburden material from the open pit mining operations and covered with 500 mm of stockpiled topsoil. The plant area will be landscaped and levelled to ensure that it is contiguous with, and blends into, the surrounds. Runoff from the primary crusher site will be directed to the open pit, since this area falls within the open pit access exclusion bund. The soil and vegetation function of the land will be restored.

Workshops, diesel and oil storage explosives areas:

All structures associated with these facilities will be broken down and carted to the open pit. Contaminated soils underlying the structures will be excavated and carted to the open pit and residual excavations will be backfilled and levelled using selected overburden material from open pit mining operations. The soil and vegetation function of the land will be restored. Runoff from these areas will be directed to the open pit.

All other hard surfaces will be ripped and waste will be carted to the open pit. Pipelines and infrastructure will be removed and residual excavation will be backfilled and levelled with selected overburden material and covered with between 300mm and 500mm of stockpiled topsoil.

6.3.3 CLOSURE ACTIVITIES

It is assumed that all mining activities and processing operations will have ceased by the closure phase of the mining project. The potential for impacts during this phase will depend on the extent of demolition and rehabilitation efforts during decommissioning and on the features which will remain, such as the open pits and mineralised waste facilities.

7 ENVIRONMENTAL IMPACT ASSESSMENT

Potential environmental impacts were identified by Metago in consultation with IAPs, regulatory authorities, specialist consultants and Swakop Uranium. In case of people related impacts, the assessment focused on third parties only (third parties include members of the public and occupants of the contractors camp after working hours) and did not assess health and safety impacts on workers because the assumption was made that these aspects are separately regulated by health and safety legislation, policies and standards.

The impacts are discussed under issue headings in this section. Impacts are considered in a cumulative manner where possible such that the impacts of the proposed Husab Project are seen in the context of the baseline conditions described in Section 4. Information that has been included in Section 4 will not be repeated in this Section.

The discussion and impact assessment for each sub-section covers the construction, operational, decommissioning and closure phases where relevant. This is indicated in the table at the beginning of each sub-section. Included in the table is a list of project activities/infrastructure that could cause the potential impact per mine phase. The activities/infrastructure that are summarised in this chapter, link to the description of the proposed project (see Section 6 of the EIA report).

Mitigation measures to address the identified impacts are discussed in this section and included in more detail in the EMP report that is attached in Appendix Q. In most cases (unless otherwise stated), these mitigation measures have been taken into account in the assessment of the significance of the mitigated impacts only.

Both the criteria used to assess the impacts and the method of determining the significance of the impacts is outlined in Table 7-1. This method complies with the method provided in the Namibian EIA Policy document and the draft EIA regulations. Part A provides the approach for determining impact consequence (combining severity, spatial scale and duration) and impact significance (the overall rating of the impact). Impact consequence and significance are determined from Part B and C. The interpretation of the impact significance is given in Part D. Both mitigated and unmitigated scenarios are considered for each impact. In addition, a comment on Metago's confidence in the significance rating is provided for each impact. The confidence options range from high, to moderate to low and must be read in the context of the assumptions, uncertainties, and limitations set out in section 8.

EXAMPLE SHOWING HOW THIS CHAPTER HAS BEEN STRUCTURED

5.2 TOPOGRAPHY

Environmental component heading

5.2.1 ISSUE: HAZARDOUS EXCAVATIONS

Issue heading

Project phase and link to activities/infrastructure

Construction	Operational	Decommissioning	Closure
			N/A*
Activity/infrastructure 1 Activity/infrastructure 2	Activity/infrastructure 1 Activity/infrastructure 2	Activity/infrastructure 1	-

** N/A – not applicable.*

Bars showing phase of operation in which impacts could occur, and link to project activities

Assessment of impact

Description of the issue and associated impact in terms of severity, duration, spatial scale, consequence, probability and significance – considering all phases of project including any cumulative impacts

Tabulated summary of the assessed impact

Management	Severity	Duration	Spatial Scale	Consequence	Probability of Occurrence	Significance
Unmanaged	L	M	L	M	M	M
Managed	L	L	L	L	L	L

Conceptual description of mitigation measures

Identification of mitigation objectives and conceptual description of mitigation actions

Emergency situation

Description of any emergency situations where relevant with reference to relevant procedures

TABLE 7-1: CRITERIA FOR ASSESSING IMPACTS

PART A: DEFINITION AND CRITERIA		
Definition of SIGNIFICANCE		**Significance = consequence x probability**
Definition of CONSEQUENCE		**Consequence is a function of severity, spatial extent and duration**
Criteria for ranking of the SEVERITY/NATURE of environmental impacts	**H**	Substantial deterioration (death, illness or injury). Recommended level will often be violated. Vigorous community action. Irreplaceable loss of resources.
	M	Moderate/ measurable deterioration (discomfort). Recommended level will occasionally be violated. Widespread complaints. Noticeable loss of resources.
	L	Minor deterioration (nuisance or minor deterioration). Change not measurable/ will remain in the current range. Recommended level will never be violated. Sporadic complaints. Limited loss of resources.
	L+	Minor improvement. Change not measurable/ will remain in the current range. Recommended level will never be violated. Sporadic complaints.
	M+	Moderate improvement. Will be within or better than the recommended level. No observed reaction.
	H+	Substantial improvement. Will be within or better than the recommended level. Favourable publicity.
Criteria for ranking the DURATION of impacts	**L**	Quickly reversible. Less than the project life. Short term
	M	Reversible over time. Life of the project. Medium term
	H	Permanent. Beyond closure. Long term.
Criteria for ranking the SPATIAL SCALE of impacts	**L**	Localised - Within the site boundary.
	M	Fairly widespread – Beyond the site boundary. Local
	H	Widespread – Far beyond site boundary. Regional/ national

PART B: DETERMINING CONSEQUENCE					
			SEVERITY = L		
DURATION	Long term	**H**	**Medium**	**Medium**	**Medium**
	Medium term	**M**	**Low**	**Low**	**Medium**
	Short term	**L**	**Low**	**Low**	**Medium**
			SEVERITY = M		
DURATION	Long term	**H**	**Medium**	**High**	**High**
	Medium term	**M**	**Medium**	**Medium**	**High**
	Short term	**L**	**Low**	**Medium**	**Medium**
			SEVERITY = H		
DURATION	Long term	**H**	**High**	**High**	**High**
	Medium term	**M**	**Medium**	**Medium**	**High**
	Short term	**L**	**Medium**	**Medium**	**High**
			L	**M**	**H**
			Localised Within site boundary Site	Fairly widespread Beyond site boundary Local	Widespread Far beyond site boundary Regional/ national
			SPATIAL SCALE		

PART C: DETERMINING SIGNIFICANCE					
PROBABILITY (of exposure to impacts)	Definite/ Continuous	**H**	**Medium**	**Medium**	**High**
	Possible/ frequent	**M**	**Medium**	**Medium**	**High**
	Unlikely/ seldom	**L**	**Low**	**Low**	**Medium**
			L	**M**	**H**
			CONSEQUENCE		

PART D: INTERPRETATION OF SIGNIFICANCE	
Significance	**Decision guideline**
High	It would influence the decision regardless of any possible mitigation.
Medium	It should have an influence on the decision unless it is mitigated.
Low	It will not have an influence on the decision.

***H = high, M= medium and L= low and + denotes a positive impact.**

7.1 TOPOGRAPHY

The topography (as described in Section 4.3) will be changed by Husab's proposed infrastructure and excavations. The following related issues have been identified and are discussed further in the sections highlighted in brackets:

- hazardous excavations and infrastructure and the dangers they present to animals and humans (Section 7.1.1);
- changes to surface water flow and related impacts (Section 7.5); and
- visual impacts (Section 7.11).

7.1.1 ISSUE: HAZARDOUS EXCAVATIONS AND INFRASTRUCTURE

7.1.1.1 Introduction

With reference to Table 7-2, hazardous excavations and infrastructure include all structures into or off which third parties and animals can fall and be harmed. Included in this category are facilities that can fail (such as mineralised waste facilities). Hazardous excavations and infrastructure occur in all project phases from construction through operation to decommissioning and closure. In the construction and decommissioning phases these hazardous excavations and infrastructure are usually temporary in nature, usually existing for a few weeks to a few months. The operational phase will present more long term hazardous excavations and infrastructure and the closure phase will present final land forms that are considered hazardous.

TABLE 7-2: HAZARDOUS EXCAVATIONS & INFRASTRUCTURE - LINK MINE PHASES & ACTIVITIES

Construction	Operational	Decommissioning	Closure
Foundations Trenches Stockpiles Scaffolding Cranes Borrow pits	Open pits Stockpiles Mineralised waste facilities Water dams/reservoirs Voids Trenches Buildings and equipment Surface subsidence Pipelines	Open pits Stockpiles Mineralised waste facilities Water dams/reservoirs Voids Trenches Surface subsidence Scaffolding Cranes Piles of rubble Piles of scrap	Permanent mineralised waste facilities Permanent water dams Permanent stockpiles Open pits

7.1.1.2 Assessment of impact

Severity

In the unmitigated scenario, most of the identified hazardous excavations and infrastructure present a potential risk of injury and/or death to both animals and third parties which includes contractors and drillers staying at the mine overnight. This is a potential high severity. With mitigation, the severity reduces to medium.

Duration

In the context of this assessment, death or permanent injury is considered a long term, permanent impact.

Spatial scale

For the most part, the direct impacts will be located within the infrastructure footprint, but the indirect impacts will extend to the communities to which the people/animals belong.

Consequence

In both the unmitigated and mitigated scenario, the consequence of this potential impact is high.

Probability

Even though the proposed mine is in a fairly remote area of the NNNP, it is not impossible that curious third parties can access the site from the Khan River Valley to the northwest or from the gravel roads to the south. In the unmitigated scenario, it is possible that the hazardous excavations and infrastructure present a risk to unaccompanied third parties during all phases.

Given the proposed conjoined design for the waste rock and tailings there is very low probability of failure. The mitigation is inherent in the design.

In the case of animals in the unmitigated scenario, a number of drowning incidents can be expected because of the lure of water impoundments in the desert. Moreover, in all phases animals will have access to most of the mine.

The proposed mitigation measures will focus on infrastructure safety and on limiting access to third parties and animals which reduces the probability of the impact occurring.

Significance

In the unmitigated scenario, the significance of this potential impact is high. In the mitigated scenario, the significance of this potential impact is medium because there will be a reduction in probability that the impact occurs. The Metago's confidence level is high for this significance rating.

Tabulated summary of the assessed impact – hazardous excavations and infrastructure

Mitigation	Severity	Duration	Spatial Scale	Consequence	Probability of Occurrence	Significance
Unmitigated	**H**	**H**	**M**	**H**	**M**	**H**
Mitigated	**M**	**H**	**M**	**H**	**L**	**M**

7.1.1.3 Conceptual description of mitigation measures

Conceptual discussion of the mitigation measures is provided below and detailed in the Husab EMP (Appendix Q).

Objective

The objective of the mitigation measures is to prevent physical harm to third parties and animals from hazardous excavations and infrastructure.

Actions

During the construction, operation and decommissioning phases, barriers and/or warning signs will be used to keep people and animals away from the hazardous excavations and infrastructure. In this regard, a standard fence will be placed around all infrastructure (NNNP type fence). In addition, high security fencing and security access control will be provided around the plant, mine complex and contractor infrastructure area. All staff will be trained to attend to third parties and animals so as to avoid situations where people and animals can enter safety risk areas.

Information will be provided at stakeholder information meetings to educate third parties about the dangers associated with hazardous excavations and infrastructure.

The permanent aboveground mineralised waste facilities and other stockpiles will be designed, constructed and operated in a manner that stability is a priority, that flood protection is provided and that the risk of failure is limited to acceptable levels.

Permanent aboveground mineralised waste facilities and stockpiles will be closed in a manner that they present land forms that have similar safety attributes to the natural land forms in the area. In this regard, structures will be stable, protected from flood damage, and steep slopes will be contoured where possible.

At closure, the open pit perimeters will be bermed off with available waste rock and topsoil material. The viability of providing fencing as an additional measure will be investigated. The pit walls will be made safe from both a stability and access perspective. In the event that people or animals cross the berm and enter the pits the mitigation measures will ensure that there will be no risk of pit wall failure and that there will be safe exit options available. In addition, permanent warning signs will be in place at appropriate intervals, in appropriate languages with danger pictures to warn people of the long term safety risks of entering the open pits.

Emergency situations

If people or animals do fall off or into hazardous excavations or infrastructure causing injury, or if any mineralised waster facilities fail causing injury to people or animals, the Husab emergency response procedure will be followed.

7.2 SOILS AND LAND CAPABILITY

The information in this section was sourced from the soil specialist study in Appendix F (ESS, 2010).

Soils are a significant component of most ecosystems. As an ecological driver, soil is the medium in which most vegetation grows and a range of vertebrates and invertebrates exist. In the context of mining, soil is even more significant if one considers that mining is a temporary land use where-after rehabilitation (using soil) is the key to re-establishing post closure land capability that will support post closure land uses.

7.2.1 ISSUE: LOSS OF SOIL RESOURCES FROM POLLUTION

7.2.1.1 Introduction

With reference to Table 7-3, there are a number of sources in all phases that could pollute soils particularly in the unmitigated scenario. In the construction and decommissioning phases these potential pollution sources are temporary in nature, usually existing for a few weeks to a few months. Although the sources are temporary in nature, the potential related pollution can have long term effects. The operational phase will present more long term potential sources and the closure phase will present final land forms that may have the potential to contaminate soils through long term seepage and/or run-off.

TABLE 7-3: SOIL POLLUTION – LINK TO MINE PHASE AND ACTIVITIES

Construction	Operational	Decommissioning	Closure
General construction activities Cement mixing Management of dirty water Storage and handling of new and used materials and chemicals (including hydrocarbons) Waste management (non-mineralised) Equipment servicing Use of vehicles and equipment that may leak lubricants and fuel	Servicing equipment Management of dirty process water/effluent Storage and handling of new and used materials and chemicals (including hydrocarbons) Waste management (mineralised and non-mineralised)	General building activities Management of dirty water Storage and handling of new and used materials and chemicals (including hydrocarbons) Waste management (mineralised and non-mineralised) Equipment servicing Use of vehicles and equipment that may leak lubricants and fuel	Seepage and run-off from remaining mineralised waste landforms

7.2.1.2 Assessment of impact

Severity

In the unmitigated scenario, pollution of soils from numerous incidents can result in a loss of soil functionality as an ecological driver because it can create a toxic environment for vegetation, vertebrates and invertebrates that rely on the soil. It could also negatively impact on the chemistry of the soils such that current growth conditions are impaired. This is a high severity. In the mitigated scenario, the number of pollution events should be significantly less which reduces the potential severity to medium.

Duration

In the unmitigated scenario, most pollution impacts will remain until long after closure. In the mitigated scenario most of these potential impacts should either be avoided or be remedied within the life of the mine. Important related issues are the reaction time of the clean-up team and the chosen remediation methods, which need to be carefully considered in the desert environment because it has different underlying processes in the soil when compared to wetter environments.

Spatial scale

Potential soil pollution will be restricted to the project site.

Consequence

In the unmitigated scenario, the consequence of this potential impact is high. In the mitigated scenario, this reduces to medium because the severity and duration of the impact is reduced.

Probability

Without any mitigation the probability of impacting on soils through pollution events is high. With mitigation, the probability will be significantly reduced to low because emphasis will be placed on preventing pollution events and on quick and effective remediation if pollution events do occur.

Significance

In the unmitigated scenario, the significance of this potential impact is high. In the mitigated scenario, the significance reduces to low because with mitigation the severity, duration and probability associated with the potential the impact all reduce. Metago's confidence level is high for this significance rating.

Tabulated summary of the assessed cumulative impact – soil pollution

Mitigation	Severity	Duration	Spatial Scale	Consequence	Probability of Occurrence	Significance
unmitigated	**H**	**H**	**L**	**H**	**H**	**H**
mitigated	**M**	**L**	**L**	**L**	**L**	**L**

7.2.1.3 Conceptual description of mitigation measures

Conceptual discussion of the mitigation measures is provided below and detailed in the Husab EMP (Appendix Q).

Objective

The objective of the measures is to prevent pollution of soils.

Actions

In the construction, operation and decommissioning phases the mine will ensure that all hazardous chemicals (new and used), dirty water, mineralised wastes and non-mineralised wastes are handled in a manner that they do not pollute soils. This will be implemented through the EMP and one or more procedure(s) covering the following:

- pollution prevention through basic infrastructure design and through education and training of workers (permanent and temporary);
- the required steps to enable fast reaction to contain and remediate pollution incidents. In this regard the remediation options include in situ treatment or disposal of contaminated soils as hazardous waste. The former is generally considered to be the preferred option because with successful in situ remediation the soil resource will be retained in the correct place. The in situ options include bioremediation at the point of pollution, or removal of soils for washing and/or bio remediation at a designated area after which the soils are replaced; and
- specifications for post rehabilitation audit criteria to ascertain whether the remediation has been successful.

As part of closure planning, the designs of any permanent and potentially polluting structures (mineralised waste facilities) will take account of the requirements for long term pollution prevention and confirmatory monitoring.

Emergency situations

Major spillage incidents will be handled in accordance with the Husab emergency response procedure.

7.2.2 ISSUE: LOSS OF SOILS RESOURCE THROUGH PHYSICAL DISTURBANCE

Introduction

With reference to Table 7-4, there are a number of activities/infrastructure in all phases that have the potential to disturb soils through removal, compaction and/or erosion. The total project footprint disturbance area is approximately 1900 Hectares. In the construction and decommissioning phases these activities are temporary in nature, usually existing for a few weeks to a few months. The operational phase will present more long term activities and the closure phase will present final land forms that may be susceptible to erosion.

TABLE 7-4: PHYSICAL DISTURBANCE OF SOILS – LINK TO MINE PHASE AND ACTIVITIES

Construction	Operational	Decommissioning	Closure
Soil stripping Cleaning and grubbing Preparation of the foundations Compacting bases Opening borrow pits and trenches General building activities Slope stabilization Building roads Vehicle movement Developing open pit	Mining development Vehicle movement Stockpile development Mineralised waste development Exploration	Soil stripping Cleaning and grubbing Material movement General building activities Slope stabilization Vehicle movement	Erosion of final land forms

7.2.2.1 Assessment of impact

Severity

In the unmitigated scenario, physical soil disturbance can result in a loss of soil functionality as an ecological driver. In the case of erosion, the soils will be lost to the area of disturbance, and in the case of compaction the soils functionality will firstly be compromised through a lack of rooting ability and aeration, and secondly the compacted soils are likely to erode because with less inherent functionality there will be little chance for the establishment of vegetation and other matter that naturally protects the soils from erosion. The soils that remain beneath the permanent landforms (mineralised waste facilities) will be compacted and a lost resource. This amounts to a high severity.

In the context of the soil horizons that have been identified by the specialist, this issue is further complicated because of the occurrence of the upper soil crust on the plains and the calcrete layer beneath the soils. Both of these features are considered to be important aspects of the ecosystem functionality. In the case of the calcrete layer, the key issue is its impermeable nature which retains moisture in the lower part of the upper soil horizon. In the case of the crust, it prevents erosion of the underlying soils and may also retain moisture in those soils.

In the mitigated scenario, the soils can be conserved and reused (excluding the open pit and mineralised waste areas), but it is not yet clear whether the calcrete and crust layers can be effectively re-established with the same or similar material. As a combination, these mitigation measures reduce the high unmitigated severity to somewhere between medium and high.

Duration

In the unmitigated scenario the loss of soil and related functionality is long term and will continue after the life of the mine. In the mitigated scenario, the soil is conserved and replaced in some areas (excluding the open pit and mineralised waste areas) which reduces the duration of the impact if the soil functionality can be restored.

Spatial scale

Physical disturbance of the soil will be restricted to the area of direct influence of the infrastructure/activities associated with the proposed Husab Project.

Consequence

In the unmitigated scenario, the consequence of this potential impact is high. In the mitigated scenario this reduces to medium to high because the severity and duration of the impacts are marginally reduced.

Probability

Without any mitigation the probability of losing soil and its functionality is definite. With mitigation, the probability will be reduced because emphasis will be placed on soil conservation and re-establishment (excluding the open pit and mineralised waste areas). In this regard, there remains some uncertainty about the chances of effectively rehabilitating the calcrete and crust layers (with the same or similar material) and the role they play as ecological drivers.

Significance

In the unmitigated scenario, the significance of this potential impact is high. In the mitigated scenario, the significance could reduce but the success of the management measures remains untested and the functionality of the open pit and mineralised waste footprints will never be re-established. In addition, any un-removed soils beneath the permanent surface land forms will be a lost resource. Metago's confidence level is high for this significance rating.

Tabulated summary of the assessed cumulative impact – physical disturbance of soils

Management	Severity	Duration	Spatial Scale	Consequence	Probability of Occurrence	Significance
Unmanaged	**H**	**H**	**L**	**H**	**H**	**H**
Managed	**M-H**	**M-H**	**L**	**M-H**	**M-H**	**M-H**

7.2.2.2 Conceptual description of mitigation measures

Conceptual discussion of the mitigation measures is provided below and detailed in the Husab EMP (Appendix Q).

Objective

The objective of the measures is to minimise the loss of soil resources and related functionality through physical disturbance, erosion and compaction.

Actions

In the construction, operation and decommissioning phases a soil management plan will be implemented. The key components are:

- limit the disturbance of soils to what is absolutely necessary both in terms of site clearing and in terms of ongoing project development and use of vehicles;
- where soils have to be disturbed the soil will be stripped, stored, maintained and replaced in accordance with the specifications of the soil management plan (conservation procedure);
- even though the footprint of the open pit and mineralised waste facilities will never be rehabilitated, some topsoil should be stripped and stored from these areas because this valuable resource can be used elsewhere on the site for rehabilitation. In this regard, experience has shown that very few mines ever have enough topsoil for rehabilitation; and
- if required, pilot studies will be undertaken during the operation phase to determine the best method of re-creating the subsurface impermeable layer (in its natural form this is calcrete but it may be possible to recreate it with similar material) and crust layers, and restoring their role as ecological drivers.

As part of closure planning, the designs of any permanent structures (mineralised waste facilities and berms) will take into consideration the requirements for long term erosion prevention and confirmatory monitoring.

Emergency situations

None identified.

7.3 BIODIVERSITY

The information in this section was sourced from the biodiversity specialist study in Appendix G (AWR, 2010).

7.3.1 INTRODUCTION

The section is intended to be a high level assessment of biodiversity impacts. Therefore, readers must be aware of the content of the baseline description (Section 4.6), the content of the specialist report (Appendix G) and the content of the EMP (Appendix Q) when reading this section.

The assessment covers the following broad topics: physical destruction of biodiversity and related functions, impacts on water resources as an ecological driver, general disturbances to biodiversity. Each of these topics is individually assessed below.

It must also be noted that the secondary impacts on biodiversity associated with soil erosion, soil compaction, and physical disturbance and pollution of soils have already been assessed in Section 7.2 and will not be repeated below.

7.3.2 ISSUE: PHYSICAL DESTRUCTION OF BIODIVERSITY

7.3.2.1 Introduction

With reference to Table 7-5, there are a number of activities/infrastructure in all phases that have the potential to destroy biodiversity in the broadest sense. In this regard, the discussion relates to the physical destruction of specific biodiversity areas, of linkages between biodiversity areas and of related species which are considered to be significant because of their status, and/or the role that they play in the ecosystem.

TABLE 7-5: PHYSICAL DESTRUCTION OF BIODIVERSITY - LINK TO MINE PHASES AND ACTIVITIES

Construction	Operational	Decommissioning	Closure
Infrastructure establishment Soil stripping Cleaning and grubbing Preparation of the foundations Compacting bases Opening borrow pits and trenches Slope stabilization Building internal linear infrastructure Vehicle movement Initial open pit development Stockpile development	Soil stripping Mining development Vehicle movement waste management (mineralised) stockpile development Exploration	Material movement General building activities Slope stabilization Vehicle movement	Erosion of final land forms

7.3.2.2 Assessment of impact

Severity

With reference to the combined biodiversity sensitivity map (Figure 4-13), the proposed activities and infrastructure have mostly been positioned in the least sensitive biodiversity areas. The exception is a portion of the Zone 1 (northern) pit, an internal power line and service track on the north western boundary of the project, and part of the contractors camp. The most sensitive areas to the south of the project (the Welwitschia Plain) have been avoided and a majority of the most sensitive areas along the northwestern and southwestern boundary have been avoided (springs, the Gypsite Plain, and the main known habitats for the Husab Lizard on the koppies and ridges and between the Gypsite Plain and the Khan River). Even so, the long term disturbance area (of the open pits and mineralised waste facilities in particular) on the Gypsite and Grassy Plains habitats will be significant. This has negative implications for the biodiversity of the area in general, but particularly for the gerbils, zebras and some endangered and vulnerable invertebrates.

The gerbils are seen as potential ecosystem engineers because of their burrowing habits which are believed to enhance soil fertility and plant growth. The development of the project is likely to destroy a large number of gerbils and/or displace them into neighbouring areas which will create an imbalance with knock on effects in terms of the sustainability of the neighbouring populations, vegetation productivity and available grazing for animals.

Likewise, the zebras are important because they migrate significant distances in and around the proposed project area. In this process they transfer nutrients and connect different populations, habitats and regions. The project infrastructure and related disturbances may cause the zebras to vacate this area which has implications for the sustainability of the zebra population in the area (they need access to the springs in the west as a water source), for the role they play in the nutrient dispersion cycle and the effect they have in providing invertebrates with required habitat (eg. dung feeders).

The endangered and vulnerable invertebrates (certain beetles, solifuges and a fly) are important because of their conservation (red data) status. Development of the project is likely to destroy those individual invertebrates located in the project footprint because these are not quick enough to move away from the heavy earth moving machinery.

A further issue to consider is that once areas are disturbed invasive species are often the first to establish, which may result in a vegetation and related biodiversity imbalance.

While the Husab Sand Lizard has been flagged as a species of concern, the project layout has avoided the known preferred habitat of this species and no direct destruction related impacts have been identified. There is potential for cumulative impacts of the various mines in the restricted range of this species, but the details of this potential impact are currently unknown.

Given the above discussion, the unmitigated severity is high which may reduce to somewhere between high and medium depending on the successful implementation of the mitigation measures.

Duration

In the unmitigated scenario the loss of biodiversity and related functionality is long term and will continue after the life of the mine. In the mitigated scenario the biodiversity and related functionality may be partially restored during the operational and decommissioning phases, but given the long term nature of ecological processes in the desert, it is unlikely that full restoration will occur before mine closure, if ever. The duration is therefore high in both the unmitigated and mitigated scenarios.

Spatial scale

Given that biodiversity processes are not confined to the proposed project site, the spatial scale of impacts will extend beyond the site boundary in both the mitigated and unmitigated scenario. Key related issues are the migration of species, the flow of nutrients and linkages between biodiversity areas. The spatial scale is therefore medium in both the unmitigated and mitigated scenarios.

Consequence

In the unmitigated scenario, the consequence of this potential impact is high. Even though the severity may be reduced with mitigation, the duration and spatial scale remain high and therefore the mitigated consequence remains high.

Probability

Without any mitigation the probability associated with the impacts is definite. With mitigation, the probability may be reduced because emphasis will be placed on conserving and possibly restoring or offsetting critical areas and related biodiversity. In this regard, some uncertainty remains about the realistic chances of effectively achieving either the conservation or the restoration, thus the need to consider offsetting. In this regard, there is further uncertainty around the possibility of successfully implementing offsets.

Significance

The significance of this potential impact is high in the unmitigated and mitigated scenario. Metago's confidence level is high for this significance rating.

Tabulated summary of the assessed impact – destruction of biodiversity

Mitigation	Severity	Duration	Spatial Scale	Consequence	Probability of Occurrence	Significance
Unmitigated	**H**	**H**	**M**	**H**	**H**	**H**
Mitigated	**M-H**	**H**	**M**	**H**	**M-H**	**H**

7.3.2.3 Conceptual description of mitigation measures

Conceptual discussion of the mitigation measures is provided below and detailed in the Husab EMP (Appendix Q).

Objective

The objective of the mitigation measures is to prevent, as far as is possible, the unacceptable loss of biodiversity and related functionality through physical disturbance.

Actions

In the construction, operation and decommissioning phases the mine will implement its biodiversity management plan. The key components are:

- to generally limit mine infrastructure, activities and related disturbance to those specifically identified and described in this EIA report;
- where possible, to specifically avoid the disturbance of irreplaceable biodiversity areas and important linkages between biodiversity areas;

- where a new area will be disturbed, the following will be implemented: delineation of proposed area to be disturbed, relocation of species that can effectively be relocated (especially species of conservation concern), obtain permits in terms of the Nature Conservation Ordinance 14 of 1975 and the Forest Act, 12 of 2001 for the destruction and/or removal of protected vegetation; restoration of the biodiversity functionality, as far as is possible, in areas that have been physically rehabilitated; and follow up audits and monitoring in the short and long term to determine the success of the rehabilitation and restoration activities in terms of a range of performance indicators;
- implementation of an alien/invasive/weed management programme to control the spread of these plants onto and from disturbed areas;
- if irreplaceable biodiversity will be permanently lost and restoration is not possible, a biodiversity offset will be investigated. Issues that will be considered in the investigation are as follows:
    - the size of the potentially affected area;
    - the conservation/sensitivity status of the potentially affected area;
    - the offset ratio (in terms of the required size of the offset site) to be applied;
    - evaluation of alternative offset sites on the basis of: no net biodiversity loss, compensation for the mine's negative impact on biodiversity, long term functionality, long term viability, contribution to biodiversity conservation in the Namib including linkages to areas of conservation importance, acceptability to key stakeholders, distances from other mines in relation to dust fallout and other impacts, and biodiversity condition scores as compared to that at the mine site;
    - land ownership now and in the future;
    - status/security of the offset site, ie. will it receive conservation status;
    - measures to guarantee the security, management, monitoring and auditing of the offset;
    - capacity of the mine to implement and manage the offset;
    - identification of unacceptable risks associated with the offset; and
    - the start up and ongoing costs associated with the offset for the life of the project.

As part of closure planning, the designs of any permanent structures (mineralised waste facilities) will take into consideration the requirements for the establishment of long term biodiversity functionality, aftercare and confirmatory monitoring.

As an ongoing contribution to the knowledge and conservation of biodiversity in the NNNP, the mine will (as a minimum) contribute towards resourcing additional biodiversity studies. A priority in this regard is a study to understand more about the Husab Sand Lizard, its range, its reaction to the cumulative destruction caused by mining developments and the resultant interactions (if any) with the Western Sand Lizard that occupies adjacent ranges.

Emergency situations

None identified.

7.3.3 ISSUE: IMPACTS ON WATER RESOURCES AS AN ECOLOGICAL DRIVER

7.3.3.1 Introduction

In many of the identified habitats a key ecological driver (an element that is important for the functioning of that habitat and related ecosystem) is water. In the context of the possible project related impacts the key issue of concern is the impact of the project on surface (and near surface) water flow and the related impacts on the springs to the west of the project site and the Welwitschia Plain to the south. Table 7-6 sets out the activities/infrastructure in all phases that have the potential to reduce the availability of surface water, and change drainage patterns within and adjacent to the proposed project site.

The groundwater assessment in Section 7.6.1 concludes that dewatering the pits will only influence the deeper bedrock aquifer (approximately 60m below surface) because the bedrock aquifer is not hydraulically linked to the surface and near surface water resources. It follows that pit dewatering is not expected to impact on either the springs or the vegetation growth. This deep groundwater issue is not assessed further in this section.

TABLE 7-6: IMPACT ON WATER RESOURCES AS AN ECOLOGICAL DRIVER – LINK TO MINE PHASES AND ACTIVITIES

Construction	Operational	Decommissioning	Closure
Placement of all infrastructure, particularly the mineralised waste facilities Construction of surface water containment and/or diversion infrastructure – berms, channels, dams.	Placement of all infrastructure, particularly the mineralised waste facilities Water containment and/or diversion infrastructure – berms, channels, dams.	Placement of all infrastructure, particularly the mineralised waste facilities Water containment and/or diversion infrastructure – berms, channels, dams.	Placement of final land forms with associated water containment and/or diversion infrastructure – berms, channels, dams

7.3.3.2 Assessment of impact

Severity

Periodic surface water run-off and the existence of near surface water resources are understood to be key ecological drivers for vegetation, vertebrates and invertebrates (including the Welwitschia Plains) within and downstream of the proposed project site. In addition, surface water run-off promotes the downstream dispersion of seeds and nutrients.

Given that the project layout will prevent significant impacts to the west of the on site water divide, no material impacts are expected on the springs to the west of the project site. Therefore the discussion below focuses on the plains to the south of the project site.

In the unmitigated scenario, where infrastructure and activities significantly reduce downstream surface water flow, these processes will be restricted and in the worst case where surface water flow is cut off by the proposed project, some of the Welwitschia plants in the plain could lose their source of water.

In the mitigated scenario, the catchment area of the project site can be isolated from the greater catchment run-off. In this regard the surface water specialist (Metago Australia, 2010) has calculated that of the total 121229m^3 run-off in the relevant catchments, only 6267m^3 will be isolated and contained within the mine footprint, which amounts to a 5% reduction in catchment flow. While there is currently no scientific way of quantifying this impact on the downstream vegetation, it seems plausible to conclude that the severity will be reduced to low.

Duration

In the unmitigated scenario the loss of biodiversity and related functionality is long term and will continue after the life of the mine. In the mitigated scenario, there will be limited reduction (approximately 5%) of water resource availability and this will limit the impact, but the duration will continue after closure because the catchment isolation around the open pit and mineralised waste facilities will remain. The duration is therefore high.

Spatial scale

Given that biodiversity processes are not confined to the project site, the spatial scale of impacts will extend beyond the site boundary in both the mitigated and unmitigated scenario. The related spatial scale is medium.

Consequence

In the unmitigated scenario, the consequence of this potential impact is high. In the mitigated scenario this reduces to medium.

Probability

Without any mitigation the probability of losing highly sensitive and irreplaceable biodiversity is possible (medium). With effective mitigation, the probability reduces to low because the project catchment will be isolated from the rest of the catchment.

Significance

In the unmitigated scenario, the significance of this potential impact is high. In the mitigated scenario, the significance reduces to low. Metago's confidence level is moderate for this significance rating.

Tabulated summary of the assessed impact – water resource as an ecological driver

Mitigation	Severity	Duration	Spatial Scale	Consequence	Probability of Occurrence	Significance
Unmitigated	**H**	**H**	**M**	**H**	**M**	**H**
Mitigated	**L**	**H**	**M**	**M**	**L**	**L**

7.3.3.3 Conceptual description of mitigation measures

Conceptual discussion of the mitigation measures is provided below and detailed in the Husab EMP (Appendix Q).

Objective

The objective of the mitigation measures is to prevent significant reductions in water flows and related loss of biodiversity and ecosystem functionality.

Actions

In the construction, operation and decommissioning phases the mine will ensure that:

- the infrastructure footprint is minimised;
- clean surface and near surface water diversion measures are provided around infrastructure and activities to isolate the mine catchment from the surrounding surface and near surface water flow; and
- the diverted surface and near surface water is redirected to the natural downstream flow paths.

As part of closure planning, the designs of any permanent structures (open pits, stockpiles and mineralised waste facilities) will take into consideration the isolation requirements related to periodic, but ecologically important, surface water flow.

As an ongoing contribution to the knowledge and conservation of the biodiversity in the NNNP, the mine will (as a minimum) contribute towards resourcing additional biodiversity studies. A priority in this regard is a study to understand the mechanisms and water resources that Welwitschia plants utilise to sustain themselves in the desert environment.

Emergency situations

None identified.

7.3.4 ISSUE: GENERAL DISTURBANCE OF BIODIVERSITY

7.3.4.1 Introduction

With reference to Table 7-7, there are a number of activities/infrastructure that have the potential to directly disturb vegetation, vertebrates and invertebrates in all mine phases, particularly in the unmitigated scenario. In the construction and decommissioning phases these activities are temporary in nature, usually existing for a few weeks to a few months. The operational phase will present more long term occurrences and the closure phase will present final land forms that may have pollution potential through long term seepage and/or run-off.

TABLE 7-7: GENERAL DISTURBANCE OF BIODIVERSITY –LINK TO MINE PHASES AND ACTIVITIES

Construction	Operational	Decommissioning	Closure
General construction activities Management of dirty water Storage and handling of new and used materials and chemicals (including hydrocarbons) Waste management (non-mineralised) Servicing equipment Use of vehicles and equipment that may leak lubricants and fuel Security lights Contractors camp Vehicle movement on access roads, internal roads and off road	Servicing equipment Management of dirty water Storage and handling of new and used materials and chemicals (including hydrocarbons) Waste management (non-mineralised and mineralised) Vehicle movement on access roads, internal roads and off road Use of vehicles and equipment that may leak lubricants and fuel Security lights Mine development Material handling Ore processing	General building activities Management of dirty water Storage and handling of new and used materials and chemicals (including hydrocarbons) Waste management (non-mineralised and mineralised) Equipment servicing Use of vehicles and equipment that may leak lubricants and fuel Material handling Security lights Vehicle movement on access roads, internal roads and off road	Seepage from remaining mineralised waste facilities and stockpiles, catchment dams

7.3.4.2 Assessment of impact

Severity

In the unmanaged scenario, biodiversity will be disturbed in the following ways:

- white light attracts large numbers of invertebrates which become easy prey for predators. This can upset the invertebrate population balances;
- power lines can lead to bird kills, particularly Ludwig's Bustard and Ruppel's Korhaan;
- people may kill various types of biodiversity for food, for sport, for fire wood etc;
- people may illegally collect and remove vegetation, vertebrate and invertebrate species;
- excessive dust fallout from various dust sources may have adverse effects on the growth of some vegetation, and it may cause varying stress on the teeth of vertebrates that have to graze soiled vegetation;
- noise and vibration pollution may scare off vertebrates and invertebrates. In some instances (eg. the zebras) the animals may be deterred from passing close to noisy activities which can effectively block some of their migration paths. In other instances, vertebrates and invertebrates that rely on vibration and noise senses to locate for, and hunt, prey may be forced to leave the vicinity of noisy, vibrating activities;
- the presence of vehicles in the area can cause road kills especially if drivers speed;
- the presence of mine water dams may lead to drowning of fauna; and

- pollution emissions and general litter may directly impact on the survival of individual plants, vertebrates and invertebrates.

Taken together, the disturbances will have a high severity in the unmitigated scenario. In the mitigated scenario, many of these disturbances can be prevented or mitigated to acceptable levels, which reduces the severity to medium - low.

Duration

In both the mitigated and unmitigated scenarios, the impacts are long term because where biodiversity is compromised, killed or removed from the area this impact is likely to exist beyond the life of mine.

Spatial scale

Given that biodiversity processes are not confined to the proposed project site, the spatial scale of impacts will extend beyond the site boundary in the unmitigated and mitigated scenario. Key related issues are the migration of species and linkages between biodiversity areas. This is a medium spatial scale.

Consequence

In the unmitigated scenario, the consequence of this potential impact is high. In the mitigated scenario, this reduces to somewhere between medium and high because the severity of the impact is reduced.

Probability

Without any mitigation the probability of negatively impacting on biodiversity through multiple disturbance events is high. With mitigation, the probability will be reduced to medium because most of the disturbances can be controlled through implementation and enforcement of practices, policies and procedures.

Significance

In the unmitigated scenario, the significance of this potential impact is high. In the mitigated scenario, the significance is reduced to medium - high because the associated severity and probability are reduced. Metago's confidence level is high for this significance rating.

Tabulated summary of the assessed cumulative impact- general biodiversity disturbance

Mitigation	Severity	Duration	Spatial Scale	Consequence	Probability of Occurrence	Significance
Unmitigated	**H**	**H**	**M**	**H**	**H**	**H**
Mitigated	**M-L**	**H**	**M**	**H-M**	**M**	**H-M**

7.3.4.3 Conceptual description of mitigation measures

Conceptual discussion of the mitigation measures is provided below and detailed in the Husab EMP (Appendix Q).

Objective

The objective of the management measures is to prevent unacceptable disturbance of biodiversity.

<u>Actions</u>

In the construction, operation and decommissioning phases the mine will ensure that:

- the use of light is kept to a minimum, and where it is required, yellow lighting is used where possible: vertebrates should be kept away from the lighted areas with appropriate fencing where feasible;
- internal power lines will be equipped with bird deterrent measures to prevent bird kills;
- there is zero tolerance to the killing or collecting of any biodiversity;
- occupants of the temporary accommodation camps will be required to remain within the camp after working hours;
- strict speed control measures are used for any vehicles driving within the NNNP and WCRA boundaries;
- noisy equipment will be well maintained to control noise emission levels;
- all water dams will be fenced off and/or netted to prevent access by larger fauna and dams will be equipped with measures to allow fauna that may fall into the water to get out;
- dust control measures are implemented (see 7.7.1) and
- pollution prevention measures are implemented (see Section 7.2.1).

As part of closure planning, the designs of any permanent and potentially polluting structures (mineralised waste facilities) will take consideration of the requirements for long term pollution prevention and confirmatory monitoring.

<u>Emergency situations</u>

Major spillage incidents will be handled in accordance with the Husab emergency response procedure.

Certain instances of injury to animals may be considered emergency situations. These will be managed in accordance with the Husab emergency response procedure.

7.4 RADIOLOGICAL

The information in this section was sourced from the specialist radiation study in Appendix H (NECSA 2010).

Four impact pathways have been considered in the assessment of radiological impacts on human health. These are discussed further below and include:

- direct external exposure to radiation from mineralised sources;
- aquatic pathway through radio-nuclides that are carried in surface and groundwater;
- atmospheric pathway through radon gas and radio-nuclides in dispersed dust; and
- secondary pathways that include: radiation from contaminated soils, ingestion of the contaminated soils, the eating of crops that are grown on radioactive contaminated land/soil, and/or eating radioactive contaminated fish and/or animals.

No assessment is provided for the potential radiological impacts on biodiversity. This is an area that generally requires additional research. No assessment is provided for worker impacts because this is handled in terms of workplace health and safety legislation and is not considered an environmental issue.

7.4.1 ISSUE: IMPACTS ASSOCIATED WITH DIRECT EXPOSURE TO RADIATION FROM ON SITE SOURCES

7.4.1.1 Introduction

In the context of the natural environment, radiation can occur from natural sources such as cosmic and terrestrial radiation. In the context of a mine, radiation typically originates from mineralised substances (ore, mineralised waste, uranium product) and non-mineralised radioactive contaminated waste in the form of alpha radiation, beta radiation and/or gamma radiation (see Table 7-8 for the link to mine phases). In the normal course of activities, third party access to the final product is not possible due to very strict security measures and the product packaging prevents third party exposure to related radiation. The assessment therefore only focuses on the other potential on site sources.

TABLE 7-8: EXPOSURE TO RADIATION – LINK TO MINE PHASES, ACTIVITIES AND INFRASTRUCTURE

Construction for project	Operational -cumulative	Decommissioning - cumulative	Closure – cumulative
Ore Mineralised waste	Ore and product Mineralised waste Non-mineralised waste	Ore Mineralised waste Non mineralised waste	Mineralised and non-mineralised waste

7.4.1.2 Assessment of impact

Severity

Depending on the type of radiation and third party exposure thereto, direct radiation has the potential to physically damage human tissue and cells and cause related health impacts. In the context of the proposed mine activities/infrastructure, the typical dose associated with these sources is approximately $0.01mSv.a^{-1}$ at 500m from the sources which is well within the recommended $1mSv.a^{-1}$ annual dose limit (from all sources excluding medical and natural sources) that third parties should be exposed to. Closer to the sources, the doses are expected to increase.

In the unmitigated scenario where third parties may have uncontrolled access to these sources over extended periods, the severity is considered to be potentially high because the doses could exceed the recommended $1mSv.a^{-1}$ public limit. In the mitigated scenario, third party access is restricted, the potential doses are reduced and the severity reduces to low.

Duration

In both the unmitigated and mitigated scenarios, any health related impacts can be medium to long term.

Spatial scale

In both the unmitigated and mitigated scenarios the potential impact zone is close to the source within the project site.

Consequence

In the unmitigated scenario the consequence is high. With mitigation the consequence reduces to medium.

Probability

In the unmitigated scenario where access to the proposed project site is uncontrolled and third parties can come into contact with the sources, the probability of third parties experiencing radiation related health impacts is low because the dose is associated with exposure to people on a daily basis over a year period . This probability is influenced by the fact that the proposed project site is in a fairly remote area where third parties are limited in number.

In the mitigated scenario, third party access to the radiation sources is controlled and the related probability is even lower.

It must further be noted that this assessment has assumed that the proposed project area will not be used for residential development.

Significance

In the unmitigated scenario, the significance is medium to low. With mitigation this reduces to low because the probability and severity are reduced. Metago's confidence level is high for this significance rating.

Tabulated summary of the assessed cumulative impact – direct exposure to radiation

Mitigation	Severity	Duration	Spatial Scale	Consequence	Probability of Occurrence	Significance
Unmitigated	**H**	**M-H**	**L**	**M-H**	**L**	**M-L**
Mitigated	**L**	**M-H**	**L**	**M-L**	**L**	**L**

7.4.1.3 Conceptual description of mitigation measures

Conceptual discussion of the mitigation measures is provided below and detailed in the Husab EMP (Appendix Q).

Objective

The objective of the mitigation measures is to prevent direct radiation related health impacts.

Actions

Access to the site in general, and to the radiation sources in particular, will be restricted in all mine phases to prevent third parties from being in close proximity to radiation sources that could cause health impacts. This issue will be considered in further detail during the detailed closure planning because of the fact that the mineralised waste facilities will remain, that these may contain some non-mineralised waste and that the open pits will not be backfilled.

The occupants of the contractor camp will be contained within the camp after working hours. The camps will be sited at least 500m away from the on site radiation sources (mineralised and non-mineralised).

All transported product will be packaged and handled in a manner that third parties cannot be exposed to related radiation. Strict product related security measures will be continued.

External radiation from key sources (mineralised waste facilities, mineralised stockpiles, open pits, and radioactive non-mineralised waste) will be monitored.

The radiation management plan will focus on the management of the direct radiation sources, the related environmental monitoring requirements, and minimising doses to as low as reasonably achievable.

Emergency situations

Any spillage of substances that can expose third parties to unacceptable radiation levels will be handled in accordance with the Husab emergency response procedure.

7.4.2 ISSUE: RADIOLOGICAL IMPACTS ASSOCIATED WITH THE AQUATIC AND ATMOSPHERIC PATHWAYS

Given that these three radiological pathway assessments are closely linked to the outcomes of the potential pollution assessments for surface water, ground water and air, they have been dealt with separately in each of the following Sections:

- Surface water pathway – Section 7.5.
- Groundwater pathway – Section 7.6.
- Air pathway – Section 7.7.

7.4.3 ISSUE: RADIOLOGICAL IMPACTS ASSOCIATED WITH SECONDARY PATHWAYS

Third parties can be exposed to radiation through secondary transfer via the biosphere. This includes, for example, the drinking of contaminated water, eating of food grown on contaminated land (through irrigation or deposition), or eating of animals (contaminated through drinking contaminated water or eating contaminated plants). Since the aquatic pathway and plant contamination through airborne deposition is regarded as insignificant (NECSA, 2010), secondary pathway analysis has been excluded from this assessment.

7.5 SURFACE WATER

7.5.1 ISSUE: ALTERING DRAINAGE PATTERNS

The identified impacts associated with altering surface water drainage were addressed in Section 7.3. In this regard, the key issue is the loss of surface water flow volume as an important ecological driver.

7.5.2 ISSUE: POLLUTION OF SURFACE WATER – RADIOLOGICAL AND NON-RADIOLOGICAL

7.5.2.1 Introduction

With reference to Table 7-9, there are a number of pollution sources in all project phases that have the potential to pollute surface water, particularly in the unmitigated scenario. In the construction and decommissioning phases these potential pollution sources are temporary in nature, usually existing for a few weeks to a few months. Although these sources may be temporary, the potential pollution may be long term. The operational phase will present more long term potential sources and the closure phase will present final land forms that may have the potential to contaminate surface water through long term seepage and/or run-off.

TABLE 7-9: SURFACE WATER POLLUTION SOURCES–LINK TO MINE PHASES AND ACTIVITIES

Construction	Operational	Decommissioning -	Closure
General building activities Management of dirty water Storage and handling of new and used materials and chemicals (including hydrocarbons) Waste management (non-mineralised) Equipment servicing Use of vehicles and equipment that may leak lubricants and fuel Dust fallout	Servicing equipment Management of dirty water Storage and handling of new and used materials and chemicals (including hydrocarbons) Waste management (mineralised and non-mineralised) Stockpile development Dust fallout Ore processing	General decommissioning activities Management of dirty water Storage and handling of new and used materials and chemicals (including hydrocarbons) Waste management (mineralised and non-mineralised) stockpiles Equipment servicing Use of vehicles and equipment that may leak lubricants and fuel Dust fallout	Seepage, runoff and dust fallout from remaining mineralised waste and stockpiles, and catchment dams

7.5.2.2 Assessment of impact

Severity

As discussed in Section 4.8.3, surface water flow occurs infrequently and for short durations after rainfall events. Most of this water seeps into the topsoil and shallow sandy zones and flows in the near surface zones.

In the unmitigated scenario, surface water may collect contaminants (hydrocarbons, salts, chemicals, metals, radio-nuclides, and decay/daughter products) from numerous sources. At elevated pollution concentrations these contaminants can be harmful to humans if ingested directly or indirectly through contaminated vegetation, vertebrates and invertebrates (impacts on biodiversity have been assessed in Section 7.3 and will not be reassessed in this section).

The dilution effect of the flood water has not been studied in detail but it will reduce the concentration of any contaminants. Given the variability around the flood water pollution chemistry, this is assumed to be a potentially high severity until modelling and/or monitoring can show otherwise.

In the mitigated scenario, most surface water run-off should be relatively clean and the severity reduces to low because:

- by implementing a system where the dirty areas will be isolated from clean run-off and dirty water is contained and reused rather than discharged into the environment, and
- by implementing dust control measures the fallout of dust that can be collected and pollute surface water should also have been managed to acceptable levels.

<u>Duration</u>

The potential health impacts, particularly for humans in the unmitigated scenario, are long term. In the mitigated scenario, the duration of any impacts is considered to be medium to short term because third parties will not be exposed to polluted water and there should not be significant related health risks.

<u>Spatial scale</u>

The spatial scale of the potential unmitigated impacts will be restricted to potential surface and near surface water use, probably in the Khan and Swakop River systems, for as far as the contaminated surface water travels either on surface or in the shallow underlying zones. In the mitigated scenario contaminated water will be contained on site, which is a localised spatial scale.

<u>Consequence</u>

In the unmitigated scenario, the consequence of this potential impact is high. In the mitigated scenario, this reduces to low because the severity, duration and spatial scale of the impact are reduced.

Probability

Very little of the surface and near surface water flow from the proposed project site (in the Swakop River catchment) is expected to flow into the Swakop River because the site is located approximately 15km away from the river. In the case of the Khan River catchment, there is a greater probability that surface and near surface water flow could reach the river from the vicinity of the proposed project site, but almost all of the project infrastructure (and associated potential pollution sources) is located out of the Khan catchment (Figure 6-1).

Furthermore, even if polluted water reaches these rivers, they are in remote areas where the alluvial aquifer water is not utilised by humans. Once the water seeps into the river alluvium, it is expected that it will not migrate to downstream users (farmers located more than 20km downstream) because of the limited volumes in question, and the compartmentalised nature of the alluvial aquifers in the rivers (SAIEA, 2010) that is expected to limit downstream flow between compartments.

This translates into a low impact probability in the unmitigated and mitigated scenarios.

Significance

In the unmitigated scenario, the significance of this potential impact is medium. In the mitigated scenario, the significance is reduced to low because of the reduction in severity, duration and probability. Metago's confidence level is moderate for this significance rating.

7.5.2.3 Tabulated summary of the assessed cumulative impact – surface water pollution

Mitigation	Severity	Duration	Spatial Scale	Consequence	Probability of Occurrence	Significance
Unmitigated	**H**	**H**	**M**	**H**	**L**	**M**
Mitigated	**L**	**M-L**	**L**	**L**	**L**	**L**

7.5.2.4 Conceptual description of mitigation measures

Conceptual discussion of the mitigation measures is provided below and detailed in the Husab EMP (Appendix Q).

Objective

The objective of the mitigation measures is to prevent pollution of surface water run-off and related health impacts on third parties.

Actions

In the construction, operation and decommissioning phases the mine will ensure that:

- all hazardous chemicals (new and used), dirty water, mineralised wastes and non-mineralised wastes are handled in a manner that they do not contaminate surface water run-off or near surface water flow. Further detail is provided in the soils mitigation section 7.2.1 ;
- surface and near surface water management facilities will be designed, constructed and operated so that dirty water is kept separate from clean water run-off through a system of berms, channels, trenches, flood protection measures, erosion protection and dams (see section 6.2.6);
- dirty water run-off and near surface flow will be contained in three lined dams (a dam in the plant and two dams downstream of the mine site - Figure 6-6) that will be designed and constructed to contain the 1:100 year storm event; and
- if surface and near surface related discharges occur from the pollution control dams, the mine will monitor the water discharge quality (non radiological and radiological). If the quality of the monitored discharge is above acceptable domestic use levels, additional measures will be identified and implemented to prevent the future potential for surface water related discharge and pollution.

The mine's radiation management plan will include the findings of the EIA with specific attention to the management of the radiological surface water pathway, the related environmental monitoring requirements, and minimising doses to acceptable levels.

As part of closure planning, the designs of any permanent and potentially polluting structures (mineralised waste facilities) will consider the requirements for long term surface and near surface water pollution prevention and confirmatory monitoring.

Emergency situations

Major spillage incidents that contaminate flood waters will be handled in accordance with the Husab emergency response procedure.

7.6 GROUNDWATER

The information in this section was sourced from the specialist groundwater study in Appendix J (Aquaterra, 2010).

7.6.1 ISSUE: DEWATERING

7.6.1.1 Introduction

With reference to Table 7-10, dewatering of the open pits is the only activity associated with this potential impact. This activity is mainly an operational issue, but it could start towards the end of the construction phase and it could continue for part of the decommissioning phase. Dewatering the pits will lower the existing ground water levels in the zone of influence to levels of approximately 400m below surface immediately adjacent to the pits.

There are four potential impacts to consider:

- impacts on surrounding groundwater users that abstract water from the deeper bedrock aquifer;
- impacts on natural springs;
- impacts on vegetation; and
- impacts on the flow of the Khan river and the associated users of alluvial aquifer water (human and vegetation).

Of these impacts, only the impacts on the Khan River and related users are assessed in this section. The other potential impacts are dismissed as follows:

- the closest third party boreholes (in the deeper bedrock aquifer) will not be impacted because they are situated approximately 19km to the east of the open pits, outside of the dewatering zone;
- as described in Section 4.9.3, the current average water level in bedrock aquifer zone of influence is approximately 60m. It follows that there are no anticipated impacts on either the vegetation or the natural springs that occur in areas situated above this bedrock aquifer. This conclusion is based on the specialist's view that both the springs and vegetation rely on rainfall recharge of the shallow sandy zones that are situated near surface above the bedrock, and these shallow sandy zones are not hydraulically connected to the basement rock aquifers.

TABLE 7-10: DEWATERING – LINK TO MINE PHASES AND ACTIVITIES

Construction	Operational	Decommissioning	Closure
Pit dewatering	Pit dewatering	Pit dewatering	Open pit as natural sink

7.6.1.2 Assessment of impact

Severity

Flow within the Khan River alluvial aquifer is estimated at 500m^3/day. The closest users of this water source (located within 5km of the proposed open pits) are Rössing Mine and vegetation (including the protected *Acacia erioloba* – camel thorn). If the dewatering zone reaches this aquifer the seepage out of the aquifer towards the open pits are predicted to be in the order of 1m^3/day. This amounts to an aquifer loss of less than 1% which is unlikely to have any noticeable effect on the two main water users located within 5km of the open pits (the vegetation and Rössing mine). The severity is therefore considered to be low in both the unmitigated and mitigated scenarios.

Duration

In both the mitigated and unmitigated scenarios, the dewatering impact will occur over the long term. After mining, the pits will remain open and will act as an evaporative sink with a continuous drawdown of water towards the lowest point in the pits.

Spatial scale

The shortest distance between the open pits and the Khan River alluvial aquifer is approximately 3km. Any impacts on this aquifer will occur off site and are therefore considered to be of medium spatial scale.

Consequence

In both the unmitigated and mitigated scenario the consequence is medium.

Probability

While it is probable that the open pits will cause dewatering, the probability that this will both impact on the Khan River aquifer and its users is low. This conclusion is based on the fact that the modelled aquifer loss is less than 1% which does not take account of the potential impermeable Karibib marble barrier that is located between the pits and the river.

Significance

In both the unmitigated and mitigated scenario, the significance of this potential impact is low. Metago's confidence level is moderate for this significance rating.

Tabulated summary of the assessed cumulative impact - dewatering

Mitigation	Severity	Duration	Spatial Scale	Consequence	Probability of Occurrence	Significance
Unmitigated	**L**	**H**	**M**	**M**	**L**	**L**
Mitigated	**L**	**H**	**M**	**M**	**L**	**L**

7.6.1.3 Conceptual description of mitigation measures

Conceptual discussion of the mitigation measures is provided below and detailed in the Husab EMP (Appendix Q).

Objective

The objective of the mitigation measures is to prevent impacts on users of the Khan River alluvial aquifer.

Actions

It is probable that no mitigation will be required because of the low impacts that have been predicted. Even so, as a confirmatory measure the mine will establish additional monitoring boreholes, with the input of a ground water specialist, to monitor the influence of dewatering on the water levels in the Khan River. If greater impacts (than predicted) are observed, appropriate measures will be formulated and implemented by the mine in consultation with a groundwater specialist and the Department of Water Affairs.

Emergency situations

None identified.

7.6.2 ISSUE: ISSUE: CONTAMINATION OF GROUNDWATER – RADIOLOGICAL AND NON RADIOLOGICAL

7.6.2.1 Introduction

With reference to Table 7-11, there are a number of sources in all mine phases that have the potential to pollute groundwater. In the construction and decommissioning phases these potential pollution sources are temporary and diffuse in nature, usually existing for a few weeks to a few months. Even though the sources are temporary in nature, related potential pollution can be long term. The operational phase will present more long term potential sources and the closure phase will present final land forms that may have the potential to pollute water resources through long term seepage and/or run-off.

TABLE 7-11: CONTAMINATION OF GROUNDWATER –LINK TO MINE PHASES AND ACTIVITIES

Construction	Operational	Decommissioning – cumulative	Closure - cumulative
Storage and handling of new and used materials and chemicals (including hydrocarbons) Waste management (non-mineralised) Sanitation Servicing equipment	Mining development Ore processing Servicing equipment Dirty water management and related facilities Storage and handling of new and used materials and chemicals (including hydrocarbons) Waste management (mineralised and non-mineralised) Stockpile development Sanitation Pipelines	Servicing equipment Storage and handling of new and used materials and chemicals (including hydrocarbons) Waste management (mineralised and non mineralised) Sanitation Stockpiles and waste facilities Dirty water management and related facilities	Remaining infrastructure – surface water management system, mineralised waste and stockpiles

7.6.2.2 Assessment of impacts

Severity

Two types of pollution sources are broadly considered. The one type is diffuse pollution which includes ad hoc spills and discharges of polluting substances. The other type is point source pollution which includes more long term pollution associated with longer term sources such as mineralised waste facilities.

The groundwater specialist has identified that the most significant potential pollution is associated with the mineralised waste facility comprising both waste rock and tailings, which has both radiological and non-radiological contaminant components. In this regard, the geochemical analysis (Section 4.1.3.3 and Appendix E) presents a number of pollution parameters that can have significant human health impacts depending on how they are transported from the pollution source, and at what concentrations they might occur in areas where people have access to groundwater.

The first step in the pollution plume modelling was to predict the extent of pollution particle flow from the mineralised waste facility. This was done on the basis of the following key model inputs:

- a seepage rate that is equivalent to seepage through a torn liner over the full extent of the mineralised waste facility;
- a conservative assumption that no seepage is absorbed in the unsaturated zone;
- a seepage duration of 30 years where-after the facility will be dry; and
- porosity values of 1% for bedrock and 20% for alluvium.

The model conclusion is that in the long term, the cone of depression from the open pits is so significant that it pulls the pollution particles towards and into the open pits. There is a limited period in the operational phase when the drawdown cone is insufficient to control all pollution movement, but in this period the extent of the pollution plume is not more than 100m away from the mineralised waste facility.

On the basis of this conclusion, no concentration modelling was done because there will be no off site pollution impact on any groundwater resources which means that no third parties will be exposed to the pollution.

This is a low severity in the unmitigated and mitigated scenario.

Duration

The duration of ground water pollution related health impacts is low because no health impacts are predicted. This applies equally to the unmitigated and mitigated scenarios.

Spatial scale

The spatial scale of the potential impact is directly related to the spatial scale of the dispersion of any ground water pollution that in turn has the potential to impact on human health. Given that the pollution plume is mostly pulled into the open pits and that a small portion will extend within 100m of the source for a period of time, the spatial scale is localised.

Consequence

The consequence is low in both the unmitigated and mitigated scenarios.

Probability

The probability of their being any groundwater pollution impact on third parties is low because of the extremely limited extent of the plume.

Significance

In both the unmitigated and mitigated scenario, the significance of this potential impact is low. Metago's confidence level is high for this significance rating.

Tabulated summary of the assessed cumulative impact – groundwater pollution

Mitigation	Severity	Duration	Spatial Scale	Consequence	Probability of Occurrence	Significance
Unmitigated	**L**	**L**	**L**	**L**	**L**	**L**
Mitigated	**L**	**L**	**L**	**L**	**L**	**L**

7.6.2.3 Conceptual description of mitigation measures

Conceptual discussion of the mitigation measures is provided below and detailed in the Husab EMP (Appendix Q).

Objective

The objective of the mitigation measures is to prevent health impacts on third party ground water users.

Actions

Aside from the mineralised waste facility design measures (see Section 6.2.2.8) it is probable that no additional mitigation will be required because of the low impacts that have been predicted. Even so, the mine will continue with its groundwater quality monitoring programme as amended from time to time with the input of a groundwater specialist. If greater impacts (than predicted) are observed, appropriate measures will be formulated and implemented by the mine in consultation with a groundwater specialist and the Department of Water Affairs.

Emergency situations

None identified.

7.7 AIR

The information in this section was sourced from the air specialist study in Appendix K (Airshed, 2010) and the radiological specialist study in Appendix H (NECSA, 2010).

7.7.1 ISSUE: AIR POLLUTION – NON-RADIOLOGICAL

7.7.1.1 Introduction

With reference to Table 7-12, there are a number of activities in all phases that have the potential to pollute the air. In the construction and decommissioning phases these activities are temporary in nature.

The operational phase will present more long term activities and the closure phase will present final land forms that may have the potential to pollute the air through long term wind erosion.

The air specialist made use of a dispersion model to predict spatial air quality concentrations for the construction and operational phases. Given that the activities during decommissioning are similar to construction, the model findings for construction are considered applicable to decommissioning. Modelling of the closure phase is only possible when the final closure plan is documented, but it is expected that impacts at closure will not be worse than the operational phase.

Air pollution related impacts on biodiversity have been discussed in Section 7.3 and therefore this section focuses on the potential for human health impacts.

TABLE 7-12: AIR POLLUTION – LINK TO MINE PHASES AND ACTIVITIES

Construction	Operational	Decommissioning	Closure
Soil stripping Overburden removal Cleaning and grubbing Preparation of the foundations Compacting bases Opening borrow pits and trenches General building activities Slope stabilization Building internal linear infrastructure Vehicle movement and exhaust fumes Diesel generators limited drilling and blasting for mining	Soil stripping Overburden removal Drilling and blasting Crushing and screening Vehicle movement and exhaust fumes Soil management activities Mineralised waste management Stockpile development Conveyors Processing plant Diesel Generators General materials handling	Removal of infrastructure Vehicle movement and exhaust fumes General material handling Soil management activities General building activities Mineralised waste management Slope stabilization Diesel Generators	Remaining infrastructure – surface water management system, mineralised waste facilties,

7.7.1.2 Assessment of impact

Severity

In the operational phase the main project related contaminants include: inhalable particulate matter less than 10 microns in size (PM10), larger total suspended particulates (TSP), and gas emissions including sulphur dioxide (SO_2), nitrogen dioxide (NO_2), carbon monoxide (CO) and diesel particulate matter (DPM). The construction and decommissioning phases will be similar except for the emissions associated with the operating acid plant (mainly SO_2). At closure there will only be potential for PM10 and TSP. At certain concentrations, each of these contaminants can have health and/or nuisance impacts.

In order to determine the potential for health and nuisance impacts the following set (Table 7-13) of evaluation criteria have been used (full details and references are provided in Appendix K (Airshed, 2010)).

TABLE 7-13: AIR IMPACT EVALUATION CRITERIA

Contaminant	Averaging Period	Evaluation criteria	Source
PM10	Daily	75 microgram/m^3	WHO IT3
	Annual	30 microgram/m^3	WHO IT3
TSP	monthly	600mg/m^2/day residential limit and 350mg/m^2/day public general area limit	RSA and Germany
SO_2	Hourly	350 microgram/m^3	EC and RSA
	Daily	125 microgram/m^3	WHO
	Annual	50 microgram/m^3	RSA
NO_2	Hourly	200 microgram/m^3	WHO
	Annual	40 microgram/m^3	WHO
CO	Hourly	30 000 microgram/m^3	WHO
	Eight hourly	10 000 microgram/m^3	WHO

From the modelled results and related interpretation the only contaminant of material human health concern is PM10. All other contaminants result in negligible impacts which are not discussed further. It should also be noted that emissions from temporary on site diesel generators (if required at all) are considered to be less significant than the rest of the mine sources. This holds true provided that the relevant International Finance Corporation (IFC) emission limits for the diesel generators are adhered to. The relevant contaminants and related IFC limits are sulphur dioxide (SO_2 – emission limit of 1.5% to 3%), oxides of nitrogen (NO_x – emission limit of between 1.460 to 1.850 mg/Normal m^3) and diesel particulate matter (DPM – emission limit of 50mg/Normal m^3) (Airshed 2009).

Given the above, the assessment focuses only on PM10 and in this context, the most relevant off site receptor points are Arandis town (approximately 17km away), Rössing Mine (approximately 5km away) and the big Welwitschia tourist attraction (approximately 10km away). It must further be noted that people who live in Arandis and work at either Rössing mine or the proposed Husab mine will be exposed to the greatest cumulative impacts because they will be exposed at both work and at home.

Construction (and decommissioning) PM10 predictions

Table 7-14 and Table 7-15 show that in both the unmitigated and mitigated scenarios the incremental contribution from the proposed project is small when considered as a percentage of the current ambient concentrations (as presented in Section 4.10.3).

TABLE 7-14: UNMITIGATED INCREMENTAL CONSTRUCTION PHASE PM10

Parameter	Arandis	Rössing Uranium Mine	Big Welwitschia (tourist attraction)

PM10 daily (µg/m³)	8	21	40
PM10 annual (µg/m³)	1	1	2

TABLE 7-15: MITIGATED INCREMENTAL CONSTRUCTION PHASE PM10

Parameter	Arandis	Rössing Uranium Mine	Big Welwitschia (tourist attraction)
PM10 daily (µg/m³)	4	10	20
PM10 annual (µg/m³)	0.6	0.4	1

As small as these incremental contributions are, they will add more PM10 pollution to the baseline which already exceeds the evaluation criteria (Table 7-13). Therefore the cumulative severity in both scenarios is high.

<u>Operational PM10 predictions</u>

Table 7-16 shows that unmitigated incremental contributions generally exceed the evaluation criteria. Table 7-17 shows that in the mitigated scenarios the incremental contribution from the proposed project is small when considered as a percentage of the current ambient concentrations (as presented in Section 4.10.3).

TABLE 7-16: UNMITIGATED INCREMENTAL OPERATION PHASE PM10

Parameter	Arandis	Rössing Uranium Mine	Big Welwitschia (tourist attraction)
PM10 daily (µg/m³)	75	369	271
PM10 annual (µg/m³)	13	37	42

TABLE 7-17: MITIGATED INCREMENTAL OPERATION PHASE PM10

Parameter	Arandis	Rössing Uranium Mine	Big Welwitschia (tourist attraction)
PM10 daily (µg/m³)	10	45	48
PM10 annual (µg/m³)	2	4	5

As small as these mitigated incremental contributions are, they will add more PM10 pollution to the baseline which already exceeds the evaluation criteria. Therefore the cumulative severity in both scenarios is high.

The cumulative impact scenario is carried forward in the rest of the assessment below.

Duration

In both the cumulative unmitigated and mitigated scenarios, if human health impacts occur, these are potentially medium to long term in nature. This is a medium to high duration.

Spatial scale

The spatial scale of the potential cumulative impact is directly related to the spatial scale of the dispersion of any air pollution, that in turn has the potential to impact on human health. In both the unmitigated and mitigated scenarios the evaluation criteria will be exceeded off site so the spatial scale is medium.

Consequence

In the unmitigated and mitigated scenario, the consequence of this potential impact is medium to high.

Probability

In both the unmitigated and mitigated scenarios the cumulative PM10 concentrations exceed the evaluation criteria at the off site receptors. In the absence of a health risk assessment, the probability is linked to the probability of exceeding the evaluation criteria. Given this the probability is high in both scenarios.

Significance

In the unmitigated and mitigated scenario, the significance is high. Metago's confidence level is moderate to high for this significance rating.

Tabulated summary of the assessed cumulative impact –air pollution (non radiological)

Mitigation	Severity	Duration	Spatial Scale	Consequence	Probability of Occurrence	Significance
Unmitigated	**H**	**M-H**	**M**	**M-H**	**H**	**H**
Mitigated	**H**	**M-H**	**M**	**M-H**	**H**	**H**

7.7.1.3 Conceptual description of mitigation measures

Conceptual discussion of the mitigation measures is provided below and detailed in the Husab EMP (Appendix Q).

Objective

The objective is to limit the mine's contribution to cumulative air pollution impacts.

Actions

In the construction, operational and decommissioning phases, mitigation measures will be implemented for the main dust emission sources: roads, crushing and screening, and materials handling (tipping points). The recommended methods to achieve this are:

- dust suppression on permanent haul and temporary in-pit roads through chemical binding agents and/or water sprays combined with vehicle speed controls to achieve a control efficiency of 90% and at least 75% respectively;

- dust controls at the crushing and screening operation by wetting ore and installing extraction hoods with filters or scrubbers to achieve a control efficiency of 83%;
- dust controls at material handling points (loading and offloading) by water sprays to achieve 50% control efficiency.

The meteorological, PM10 and TSP monitoring programme will continue but the TSP dust buckets should be moved in accordance with the air specialist recommendations to take account of the infrastructure layout. In addition, the mine will implement a source-based dust fallout performance indicator of a maximum of 1200mg/m^2/day in the immediate vicinity of the roads, the crushing operation, the material tipping points and the mineralized waste facilities.

Quarterly performance audits and inspections will be done to verify that the monitoring is taking place according to specifications and that the mine is adhering to the specified dust fallout indicators.

As part of closure planning the designs of any permanent and potentially polluting structures (particularly the mineralized waste facilities) will, on the basis of impact modelling, incorporate measures to address long term pollution prevention and confirmatory monitoring.

The acid plant will be equipped with gas cleaning equipment that achieves the stated 99% pollution removal design efficiency.

If used, diesel generators will be operated and maintained according to supplier specifications and the IFC emission limits.

Emergency situations

None identified.

7.7.2 ISSUE: AIR POLLUTION –RADIOLOGICAL

7.7.2.1 Introduction

With reference to Table 7-12, there are a number of sources in all phases that have the potential to pollute the air. The air pollution pathway is also relevant to the transport of radon gas and radio-nuclides (as a component of PM10 and TSP). The assessment below focuses on human health impacts of air quality related radioactivity. When reference is made to the mitigated and unmitigated scenarios, these correlate to the scenarios discussed in Section 7.7.1.

7.7.2.2 Assessment of impact

Severity

Radon gas and dust related radio-nuclide emissions were calculated by the radiological specialist (NECSA 2009) using a combination of general and site specific data. This information was converted to an effective dose by using the relevant conversion factors and dose coefficients (used to convert gas concentration and radioactivity to doses) that are applicable to all third party age groups (from infants to adults).

The predicted results and related severity are discussed separately for radon gas, PM10 and TSP. In this regard, the specialist (NECSA, 2010) has presented the following evaluation criteria as a basis for the assessment of severity:

- doses below 10 $\mu Sv.a^{-1}$ are trivial and of no concern for health related impacts;
- doses below 300 $\mu Sv.a^{-1}$ are below the source constraint and are considered as low risk for health related impacts;
- doses between 300 and 1000 $\mu Sv.a^{-1}$ are below the public dose limit but are of medium risk for health related impacts; and
- doses above 1000 $\mu Sv.a^{-1}$ are above the recommended public dose and are considered as high risk for health related impacts.

<u>Radon dose predictions</u>

The assessed doses from radon inhalation for all the exposure scenarios for mitigated and unmitigated mining operations are trivial (smaller than 10 $\mu Sv.a^{-1}$).

<u>PM10 dose predictions</u>

In the unmitigated scenario, the assessed doses from dust inhalation are trivial (smaller than 10 $\mu Sv.a^{-1}$) for all third parties except for the temporary workers that stay at the temporary on site accommodation. For the temporary workers that will stay at the temporary accommodation the dose from dust inhalation is low, not exceeding 19 $\mu Sv.a^{-1}$.

In the mitigated scenario, the assessed doses from dust inhalation are all trivial (smaller than 10 $\mu Sv.a^{-1}$) for all third parties.

<u>TSP dose predictions</u>

The assessed doses from TSP for all the exposure scenarios are trivial (smaller than 10 $\mu Sv.a^{-1}$) for all third parties.

<u>Severity conclusion</u>

The effective dose severity in both the mitigated and unmitigated scenarios is low and the cumulative dose will be below 1mS.a^{-1} for all third party receptors in the impact zone.

Duration

If human health impacts associated with the predicted doses occur, these are considered to be medium to long term in nature. This applies to both unmitigated and mitigated scenarios.

Spatial scale

The potential health impacts from the air pathway are not restricted to the proposed project site. Therefore the spatial scale is medium for both the mitigated and unmitigated scenarios.

Consequence

In the both the unmitigated and mitigated scenario, the consequence is low to medium.

Probability

In both scenarios, there is low probability of any material exposure to third parties.

Significance

In both scenarios the significance of this impact is low. Metago's confidence level is moderate for this significance rating.

Tabulated summary of the assessed cumulative impact – radiological air pollution

Mitigation	Severity	Duration	Spatial Scale	Consequence	Probability of Occurrence	Significance
Unmitigated	**L**	**M-H**	**M**	**M-L**	**L**	**L**
Mitigated	**L**	**M-H**	**M**	**M-L**	**L**	**L**

7.7.2.3 Conceptual description of mitigation measures

Conceptual discussion of the mitigation measures is provided below and detailed in the Husab EMP (Appendix Q).

Objective

The objective of the management measures is to prevent unacceptable air quality related pollution impacts.

Actions

In addition to the actions described in Section 7.7.1, the proposed environmental monitoring programme will be expanded to cover:

- the radio-nuclide components of the TSP and PM10;
- radon gas emissions concentration and rates (flux) from key sources (mineralised waste facilities, mineralised stockpiles, open pits, radioactive non-mineralised waste);

- additional sampling of the radionuclide content of the relevant radioactive dust sources to validate the data used by NECSA and to assist with closure planning; and
- ambient radon gas concentrations in, and adjacent to, the proposed project site.

The Husab radiation management plan will include the findings of the EIA and the commitments in the EMP with specific attention on the management of the radiological air pathway, the related environmental monitoring requirements, and minimising doses to as low as reasonably achievable.

Emergency situations

None identified.

7.8 NOISE

The information in this section was sourced from the noise specialist study in Appendix L (Acusolv, 2010)

7.8.1 ISSUE: NOISE POLLUTION

7.8.1.1 Introduction

Two types of noise are distinguished: noise disturbance and noise nuisance. The former is noise that can be registered as a discernable reading on a sound level meter and the latter, although it may not register as a discernable reading on a sound level meter, may cause nuisance because of its tonal character (eg. distant humming noises). The impacts of both noise types are assessed below.

With reference to Table 7-18, there are a range of construction, operation and decommissioning activities that have the potential to generate noise and cause related disturbance and nuisance. No impacts are associated with the closure phase.

Potential noise impacts on biodiversity have been addressed in Section 7.3.4 and so this section will focus on the potential human related noise impacts.

TABLE 7-18: NOISE POLLUTION – LINK TO MINE PHASES AND ACTIVITIES

Construction	Operational	Decommissioning	Closure
Generators Vehicle movement Earth moving equipment General building activities Drilling Blasting	Drilling Blasting Earth moving equipment material tipping Vehicle movement Crushing Processing plant conveyors Generators	Vehicle movement Earth moving equipment Material tipping Stripping of buildings and equipment Generators	N/A

7.8.1.2 Assessment of impact

Severity

The World Bank performance standards stipulate that noise levels from a development should not cause background noise levels to increase in excess of 3dB, or exceed the following limits for residential, institutional or educational receptors: 55 dBA in the daytime and 45 dBA at night. These evaluation criteria have been used in this assessment of severity with reference to the baseline context described in Section 4.11.

Noise pollution will have different impacts on different receptors because some are very sensitive to noise and others are not. For example, workers do not expect a noise free work environment and so they will be less sensitive to environmental noise pollution at work. In contrast, visitors to the NNNP are likely to be sensitive to unnatural noises and so any change to ambient noise levels because of mine related noise will have a negative impact on them and their anticipated wilderness experience.

Conservative modelling for all operational sources predicts that the IFC evaluation criteria will not be exceeded more than 5km from the noise sources in any direction. In most directions, particularly to the south where the Welwitschia tourist attractions are located, the impact zone is closer to the noise sources at a distance of 3km. This means that all the sensitive tourist sites around the proposed project site, and the town of Arandis, will be unaffected by noise level increases and therefore the severity is low for both the unmitigated and mitigated scenarios.

Duration

In both the unmitigated and mitigated scenarios the noise pollution impacts will occur until the closure phase of the mine. This is a medium duration.

Spatial scale

In both the unmitigated and mitigated scenarios the noise impacts will extend beyond the proposed project site. This is a medium spatial scale.

Consequence

In both the unmitigated and mitigated scenarios the consequence is low.

Probability

The probability of the noise being heard by third parties at sensitive tourist locations is definite in both the unmitigated and mitigated scenarios. Whether this results in a negative impact will depend on the expectations of the third parties and their response to the audible noise. The related probability is assumed to be high.

Significance

The significance of this potential impact is low to medium in both the unmitigated and mitigated scenarios. Metago's confidence level is high for this significance rating.

Tabulated summary of the assessed cumulative impact – noise impacts

Mitigation	Severity	Duration	Spatial Scale	Consequence	Probability of Occurrence	Significance
Unmitigated	**L**	**M**	**M**	**L**	**H**	**L-M**
Mitigated	**L**	**M**	**M**	**L**	**H**	**L-M**

7.8.1.3 Conceptual description of mitigation measures

Conceptual discussion of the mitigation measures is provided below and detailed in the Husab EMP (Appendix Q).

Objective

The objective of the measures is to limit noise pollution impacts.

Actions

All registered complaints will be documented, investigated and efforts made to address the area of concern where possible.

Blasting will be conducted in the afternoons where possible because the noise impacts are reduced at this time of the day relative to the mornings.

Early in the operation phase an environmental ambient noise survey will be conducted by a qualified noise assessment professional at identified potential sensitive receptor sites to verify the model predictions. Subsequent actions, if any, will be determined by the appointed qualified noise impact assessment professional.

Emergency situations

None identified.

7.9 BLASTING

The information in the section was provided by Metago in conjunction with the Husab Project team.

7.9.1 ISSUE: BLASTING DAMAGE

7.9.1.1 Introduction

With reference to Table 7-18, blast related impacts are an issue during the construction and operational phases. Issues relating to blasting noise and blasting dust have been assessed as part of Section 7.8 and Section 7.7. The impacts assessed in this section related to infrastructure damage and/or harm to third parties.

TABLE 7-19: BLASTING DAMAGE – LINK TO MINE PHASES AND ACTIVITIES

Construction	Operational	Decommissioning	Closure
Blasting	Blasting	N/A	N/A

7.9.1.2 Assessment of impact

Severity

Blast injury to third parties may be caused by fly rock. Blast damage to third party infrastructure may be caused by the following blast related pathways:

- fly rock (that can be thrown up to 1.5km from the blast site),
- ground vibration where the peak particle velocity is above 12mm/s at low frequencies, and
- air blast above 130dB.

If any damage or injury occurs it is considered to be a high severity in the unmitigated scenario which may be reduced to medium in the mitigated scenario because the potential for blast related incidents is expected to decrease.

Duration

Injury or death is considered to be long term in nature. Therefore the unmitigated and mitigated duration is high.

Spatial scale

In unmitigated and mitigated scenarios the potential for blast related impacts is either within, or close to, the project site. In this regard, no third party structures are at risk, but there may be the odd curious third party that approaches the open pit area. This is a medium spatial scale.

Consequence

In both the unmitigated and mitigated scenarios the consequence is high.

Probability

The probability of the blast related damage to third party infrastructure is extremely low because no infrastructure is located within 5km of the proposed project site. The probability of blast related injury to third parties is low (even without mitigation) because of the remote setting of the proposed project. With mitigation the low probability is reduced even more.

Significance

The significance of this potential impact is medium in the unmitigated and medium to low in the mitigated scenarios. Metago's confidence level is high for this significance rating.

Tabulated summary of the assessed cumulative impact – blasting impacts

Mitigation	Severity	Duration	Spatial Scale	Consequence	Probability of Occurrence	Significance
Unmitigated	**H**	**H**	**M**	**H**	**L**	**M**
Mitigated	**M**	**H**	**M**	**H**	**L**	**M-L**

7.9.1.3 Conceptual description of mitigation measures

Conceptual discussion of the mitigation measures is provided below and detailed in the Husab EMP (Appendix Q).

Objective

The objective of the measures is to prevent blast related damage to third parties and infrastructure.

Actions

The blast design, implementation and monitoring will, as a general rule, ensure that:

- fly rock is contained within 500m of the blast site;
- ground vibration at the closest third party structures (Rössing Uranium Mine) is less than 12mm/s peak particle velocity; and
- air blast at the closest third party structures (Rössing Uranium Mine) is less than 130dB.

Prior to each blast the area within a 1km radius of the blast site will be cleared of third parties. Prior to each blast an audible warning will be sounded.

All registered complaints will be documented, investigated and efforts made to address the area of concern where possible.

Emergency situations

If a person or animal is injured by fly rock this must be handled in accordance with the Husab emergency response procedure.

7.10 ARCHAEOLOGY

The information in this section was sourced from the archaeology specialist study in Appendix M (QRS, 2010).

7.10.1 ISSUE: DAMAGE TO ARCHAEOLOGICAL SITES AND LANDSCAPES

7.10.1.1 Introduction

With reference to Table 7-20, there are a number of activities/infrastructure in all phases that have the potential to damage archaeological resources.

TABLE 7-20: ARCHAEOLOGY IMPACTS – LINK TO MINE PHASES AND ACTIVITIES/INFRASTRUCTURE

Construction	Operational	Decommissioning -	Closure
Infrastructure establishment Soil stripping Cleaning and grubbing Preparation of the foundations Compacting bases Opening borrow pits and trenches Slope stabilization Building internal linear infrastructure Vehicle movement	Mining development Vehicle movement waste management (mineralised) stockpile development	Removal of infrastructure Vehicle movement Material movement Slope stabilization	N/A

7.10.1.2 Assessment of impact

Severity

With reference to the archaeological baseline map (Figure 4-18), the specialist study identifies the old German railway line and the associated Welwitschia siding as the most important sites in the proposed project site. The siding in particular is considered to be unique and highly sensitive (point 105/27 on the map). The other sites in the project's zone of influence are not considered sensitive and therefore the focus of this assessment is on the railway line and siding.

In the unmitigated scenario the severity is high because parts of the old railway line will be destroyed by the open pit, the mineralised waste facility, internal roads and sections of the processing plant. In the case of the siding, the internal roads will travel through the siding site which will exacerbate the impact that has already occurred through the long term use of the road on the rail embankment.

With mitigation, damage to the remaining railway line embankment can be limited and the siding can be preserved and reconstructed. This reduces the overall severity to low and in the case of the siding may even turn the potential negative impact into something positive.

Duration

In the unmitigated and mitigated scenarios, archaeological impacts will be long term in nature.

Spatial scale

The spatial scale is localised within the site boundary.

Consequence

The consequence of this potential impact is high in the unmitigated scenario. It reduces to medium in the mitigated scenario because the severity is reduced.

Probability

Even with mitigation the impact is definite.

Significance

The significance of this potential impact is high in the unmitigated scenario and medium in the mitigated scenario. Metago's confidence level is high for this significance rating.

Tabulated summary of the assessed cumulative impact – archaeology impacts

Management	Severity	Duration	Spatial Scale	Consequence	Probability of Occurrence	Significance
Unmanaged	**H**	**H**	**L**	**H**	**H**	**H**
Managed	**L**	**H**	**L**	**M**	**H**	**M**

7.10.1.3 Conceptual description of mitigation measures

Conceptual discussion of the mitigation measures is provided below and detailed in the Husab EMP (Appendix Q).

Objective

The objective of the measures is to prevent the unacceptable loss of archaeological sites and related historical information.

Actions

Prior to construction the mine will ensure that:

- The Welwitschia siding site will be surveyed in detail to produce documentary evidence of the site as it currently exists. Thereafter it will be reconstructed and preserved as an information centre under the guidance of an archaeological specialist.
- Where possible, the old German railway line will be cordoned off from mine related infrastructure and left undisturbed. This principle will be carried through into the linear infrastructure EIA report.
- Where any archaeological sites will be disturbed and/or destroyed they will be subjected to routine survey. In addition, the rock shelters will be tested for excavation potential. This information will be used to apply for the necessary permits that are required in terms of the National Heritage Act 2004.
- All workers (temporary and permanent) will be educated about the importance of preserving archaeological sites.

During all phases prior to closure, the mine will ensure that it limits mine infrastructure, activities and related disturbance.

Emergency situations

If there are any chance finds of archaeological sites that have not been identified and described in the specialist report, the mine will follow its chance find procedure. The key component of which is to ensure that the site remains undisturbed until a specialist has assessed the site, assessed the potential damage, advised on the necessary management steps, and advised on the requirements for authority consultation and permitting.

7.11 VISUAL

The information in this section was sourced from the visual specialist study in Appendix N (NLA 2010).

7.11.1 ISSUE: VISUAL IMPACT

7.11.1.1 Introduction

With reference to Table 7-21, visual impacts may be caused by activities and infrastructure in all mine phases. The more significant activities and infrastructure are associated with the operational, decommissioning and closure phases when the mineralised waste facilities are in place and the open pit has been developed.

TABLE 7-21: VISUAL IMPACTS – LINK TO MINE PHASES AND ACTIVITIES/INFRASTRUCTURE

Construction	Operational	Decommissioning -	Closure
Foundations Trenches Stockpiles Scaffolding Cranes	Open pits Stockpiles Mineralised waste facilities Water dams Processing plant	Open pits Stockpiles Mineralised waste facilities Water dams Processing plant	Permanent mineralised waste facilities Permanent stockpiles Open pits

Construction	Operational	Decommissioning -	Closure
Borrow pits Roads Power lines Pipelines lights	Voids Trenches Buildings and equipment Pipelines Power lines Conveyors lights	Voids Trenches Scaffolding Cranes Piles of rubble Piles of scrap Pipelines Power lines Conveyors lights	

7.11.1.2 Assessment of impact

Severity

The severity of visual impacts is determined by assessing the change to the visual landscape as a result of mine related infrastructure and activities.

As discussed in Section 4.13, the visual landscape is determined by considering: landscape character, sense of place, aesthetic value, sensitivity of the visual resource and sensitive views. In this regard, the area in which Husab is situated is considered to have a significant visual landscape.

When considering the potential change to the visual landscape the key issues are: visual exposure, visual intrusion, and sensitivity of receptors. Each of these issues is discussed below.

Visual exposure is the extent to which mine infrastructure and activities will appear in the various views. It follows that the closer the infrastructure and activities, the greater the visual exposure. Most tourist related views will be from more than 7km away from the project infrastructure and therefore the exposure is considered to be moderate.

Visual intrusion is the extent to which the infrastructure and activities will contrast with the visual landscape and can/cannot be absorbed by the landscape. The visual intrusion of the proposed project is considered to be high, particularly at night.

Sensitivity of receptors relates to the way in which people will view the visual intrusion. In this regard, it is anticipated that tourist receptors will be sensitive but mine related receptors may not be sensitive.

Taken together, the unmitigated severity for all phases other than the construction phase is high and it is unlikely that this can be reduced with mitigation unless an alternative tourist attraction is established as a visual offset.

Duration

The duration is high in the unmitigated and mitigated scenarios because the main infrastructure components related to visual impacts (the mineralised waste facilities) will be long term in nature.

Spatial scale

By using a viewshed analysis tool the specialist determined that in both the day and the night, the infrastructure will be highly visible up to 7.5km away, moderately visible up to 15km away and insignificant further than that. This means that the main points of high visibility are centred around the Welwitschias (the Welwitschia camp and the plains). Although the Khan valley is within the distance for high visibility, the topography shields views to the proposed mine site. This is a medium spatial scale in both the mitigated and unmitigated scenarios.

Consequence

In both scenarios the consequence is high.

Probability

The probability of the visual impact occurring is high in both the mitigated and unmitigated scenarios.

Significance

The significance is high in the unmitigated and mitigated scenarios for all phases apart from the construction phase (where the significance is medium). The possibility of a visual offset may reduce this significance in future if such a possibility exists and if it is developed. Metago's confidence level is moderate to high for this significance rating.

7.11.1.3 Tabulated summary of the assessed cumulative impact – visual impact

Mitigation	Severity	Duration	Spatial Scale	Consequence	Probability of Occurrence	Significance
Unmitigated	**H**	**H**	**M**	**H**	**H**	**H**
Mitigated	**H**	**H**	**M**	**H**	**H**	**H-M**

7.11.1.4 Conceptual description of mitigation measures

Conceptual discussion of the mitigation measures is provided below and detailed in the Husab EMP (Appendix Q).

<u>Objective</u>

The objective of the measures is to limit visual impacts.

<u>Actions</u>

During construction, operation and decommissioning the following general principles apply:

- land disturbance will be limited to what is absolutely necessary;
- in the shaping of any structures that will remain after closure, harsh and angular structures will be avoided where possible and care should be taken to integrate these structures into the surrounding landscape. A professional landscape architect will be commissioned to assist with closure planning especially for the final landforms;
- all dust plume sources will be managed with dust suppressants to limit visual intrusion by dust;
- night lights will be used only where necessary and should be designed to illuminate only that which requires illumination. The use of standard high pole flood lights should be avoided where possible;
- litter will be prevented;
- In line with the SEA (SAIEA, 2010) recommendations, Swakop Uranium will investigate the possible alternative equivalent tourist sites (outside of the visual impact zone) for the Welwitschia related attractions. If such alternatives are identified, Swakop Uranium will contribute to the establishment of these alternative attraction sites and associated access routes as a form of visual impact offset.

Emergency situations

None identified.

7.12 SOCIO-ECONOMIC

The information in this section was sourced from the socio-economic specialist study in Appendix O (Metago Strategy4Good, 2010).

7.12.1 INTRODUCTION

In the broadest sense (see Table 7-22), the activities associated with the proposed Husab Project will have socio-economic impacts in all phases. Some of these are considered to be positive impacts and others are considered to be negative impacts. The separate groups of impacts are discussed below and must be read in the context of the baseline information included in Section 4.14. It must be noted that all impacts associated with the linear infrastructure are being separately assessed as part of the linear EIA report.

TABLE 7-22: SOCIO-ECONOMIC IMPACTS – LINK TO MINE PHASES AND ACTIVITIES

Construction	Operational	Decommissioning	Closure
Construction and initial operational activities Recruitment of contractors and workers	Operational activities Recruitment of contractors and workers	Decommissioning activities Recruitment of contractors and workers	Aftercare and maintenance activities

7.12.2 ISSUE: ECONOMIC (INCOME AND EMPLOYMENT) IMPACT

7.12.2.1 Assessment of impact

Severity

The establishment of the project is predicted to have a net positive impact on both the Erongo and the Namibian economy. In this regard, the following positive and negative points apply:

- The project will create a significant amount of wealth in the economy, not just in income, but also up-skilling of labour, improvement in roads, infrastructure and many other economic assets.
- At steady state mining, the project is likely to yield an annual regional economic value add (EVA) of R740.5 million, which will give a direct annual increase of 5.8% to the Erongo Economy and a 7.9% increase based on indirect and induced multipliers. However, by factoring in the initial investment, then the total positive impact could be as high as 10.7%.
- A key objective for economic development, not just in Namibia, but anywhere in the world, is job creation. The project will require the services of 4000 temporary construction workers. Given that these workers will move to other projects after the construction phase, this assessment focuses more on the 1200 permanent jobs created by the project. The total induced effect of these 1200 jobs is a potential 10.5 % decrease in the unemployed and the economically inactive population (after provision for leakage) in the Erongo region. In addition, with a local multiplier of 5, on half of the 1200 jobs (600 jobs is the minimum expected to be available to locals), this increases to a total of 3 000 local jobs that could be created for local inhabitants in Erongo.
- Government revenue could potentially increase by 2.6% nationally due to increase direct and indirect taxes emanating from the project investment.
- At steady state mining, the total exports in Namibia could increase by 10%, assuming no abnormal increases in the Namibian Base Exports.
- A further positive impact that mines have on local economies is the increase in local procurement and import substitution. This agglomeration impact has substantial positive impacts on a local economy.
- The impact on tourism is being quantified as part of the linear infrastructure EIA report. Qualitative information provided to date indicates that the net economic impact on tourism in the project's area of environmental influence (approximately 15km radius of the project site) will be negative, however, in the context of the broader Erongo region this is not expected to be severe in economic terms.
- The risk of unplanned mine closure through changes in the global economy and/or changes in the demand for uranium is a risk to the project both from an economic and social perspective.
- The eventual mine closure in the context of the Uranium Rush is an issue that can pose a risk to the region and needs to be addressed in a collective fashion.

In both unmitigated and mitigated scenarios the severity is highly positive.

Duration

In the normal course, the direct positive economic impacts associated with the mine will occur for the life of mine. After closure there may still be some positive impacts through maintenance and aftercare activities. Furthermore, the project would have contributed to the establishment of a critical economic mass and hence the benefits of wealth creation and a better skilled workforce are expected to continue beyond the life of mine. Quantitatively assessing the post closure impacts is not possible because there are a number of important unknown factors such as the general state of the future economy (local, national and world wide) and the future state of the mining sector in particular.

The negative impacts on the tourism sector may continue post closure or they may be improved post closure depending on the success of the Husab mine rehabilitation and closure plan in the context of the collective efforts of the other mines in the region.

Spatial scale

In both the unmitigated and mitigated scenarios, the impact will be felt both in the Erongo region and in other economic centres of Namibia such as Windhoek. With additional management, it may be possible to retain more of the benefit in the regional economy. The spatial scale is medium.

Consequence

In both the unmitigated and mitigated scenarios the consequence is high and positive.

Probability

In the normal course of economic activity the net positive impacts will definitely occur. With mitigation, the potential negative impacts on tourism are reduced. In addition, the negative impacts associated with planned and unplanned closure are limited.

Significance

In the unmitigated scenario, the significance of this potential impact is high positive. In the mitigated scenario, the significance is further increased. Metago's confidence level is high for this significance rating.

Tabulated summary of the assessed cumulative impact – economic

Mitigation	Severity	Duration	Spatial Scale	Consequence	Probability of Occurrence	Significance
Unmitigated	**H+**	**M-H**	**H**	**H+**	**H+**	**H+**
Mitigated	**H+**	**M-H**	**H**	**H+**	**H+**	**H+**

7.12.2.2 Conceptual description of mitigation measures

Conceptual discussion of the mitigation measures is provided below and detailed in the Husab EMP (Appendix Q).

Objective

The objective of the mitigation measures is to enhance the positive economic impacts and limit the negative economic impacts.

Actions

From the outset the mine will ensure that:

- it hires local people where possible,
- it procures local goods and services where possible,
- it implements a formal skills development programme,
- it incorporates economic considerations into its closure planning from the outset;
- that these closure planning considerations cover the skilling of employees for the downscaling, early closure and long term closure scenarios; and
- that these closure planning considerations cover the needs of tourism for the downscaling, early closure and long term closure scenarios.

The mine will engage with relevant people and entities in the tourism (and related conservation) sector to ensure that potential negative impacts from mining are managed in a way that the related impacts on tourism are acceptable. This engagement may be through new or existing collective structures and it will ideally also involve other mining and exploration companies that have the potential to negatively impact on tourism in the NNNP and WCRA. The findings and recommendations of the SEA (SAIEA, 2010) apply. In this regard, the mine will consider ways to contribute to the following:

- supporting regional conservation efforts,
- supporting public awareness campaigns about the desert and the NNNP and WCRA;
- establishing alternative roads to tourist attractions and/or establishing alternative tourist attractions;
- assisting relevant authorities with the maintenance of key infrastructure such as gravel roads in the NNNP that the mine utilises.

Moreover, In order to enhance the regional economic impacts, the mine will continue to consider ways to empower, support, train and use local/regional people for employment and local business for procurement. It will also consider other ways to enhance local economic development.

Emergency situations

None identified.

7.12.3 ISSUE: INWARD MIGRATION

7.12.3.1 Assessment of impact

Severity

There are a number of negative issues that can arise from inward migration of job seekers to urban areas (Walvis Bay, Swakopmund and Arandis in particular) in the Erongo region. While it is not possible to establish a defendable direct causal link between the proposed project and the regional phenomena of inward migration, it is reasonable to assume that inward migration will occur both directly and/or indirectly from regional economic development in general, and that Husab Project is a significant part of this development.

During the construction phase, it is expected that 4000 construction workers will have to be accommodated on site for the duration of this phase. This is a massive influx of people to the region, even though the contractors will endeavour to use as much local labour as possible.

At steady state mining (at Husab), a first order calculation shows that the Erongo population could increase by 3.8%. The estimated population of Erongo projected to 2010 is 118000 people and it is expected that 4500 people may move into the area as a result of employment at Husab and related industries.

The SEA (SAIEA, 2010) indicates that there is a housing shortage in the Erongo region, and house prices have increased dramatically in the last few years. There is thus a need for housing development to accommodate the influx of people. Based on the new jobs created, the influx of new workers, and the type of housing needs, it is estimate that there will be a need for at least 1440 additional stand alone houses in the residential areas of Arandis, Swakopmund and Walvis Bay.

The SEA (SAIEA, 2010) records that regional school facilities are not keeping pace with the growth of the Uranium Rush. As stated in the SEA, “The number of children in school in this region has doubled in the past fifteen years, from 13789 in 1993 to 28592 in 2009. Although four new schools have been opened in the past five years, bringing the total to 61, the Regional Education Directorate has typically coped with the situation by adding additional classrooms to existing schools. Currently, only one new school is planned (for Walvis Bay). Some schools at the coast now have enrolments in the range of 1000 to1500 learners.”

The situation presented for schooling is echoed with respect to health services; and hence, this too becomes an impact that Husab has to consider. Regional health statistics are scant but based on national statistics, Namibia has too few doctors and it under-spends on essential health services.

Xenophobic tension can occur where people fear that immigrants are taking their services and jobs, and ultimately reducing their quality of life. As people without jobs immigrate into an area, the average GGP per capita reduces in the short term if job creation is not correlated to population growth, meaning poverty increases.

In this context, in-migration may cause severe infrastructural and social cohesion challenges and the following negative social issues arise:

- inability of the existing infrastructure to cope with growth demands,
- development of informal settlements;
- increase in crime;
- spread of diseases such as HIV/AIDS and tuberculosis and related deaths;
- economic disempowerment of local population, especially vulnerable groups as the general price level of the region rises, especially housing.

In the unmitigated scenario, the inward migration issue is predicted to have a cumulative high severity. In the mitigated scenario, the inward migration severity may reduce, but the challenge is significant because it will involve a focussed and combined effort from the commercial and government sectors.

Duration

In the normal course, social impacts associated with the project will occur for the life of mine. However, issues associated with inward migration take on a life of their own and are likely to extend long after mine closure. This applies in both the mitigated and unmitigated scenarios.

Spatial scale

In both the unmitigated and mitigated scenarios, the impacts of inward migration will be felt mainly in the Erongo region. The spatial scale is medium.

Consequence

In the unmitigated scenario the consequence associated with inward migration is high. This may reduce in the mitigated scenario if the severity is reduced through management interventions.

Probability

In the unmitigated scenario the impact is definite. In the mitigated scenario this probability may be reduced but the challenge is significant and it involves multiple parties across different sectors in the public and private domain.

Significance

In the unmitigated scenario, the significance of this potential impact is high. In the mitigated scenario, the significance may be reduced but there remains a question around the chances of succeeding with the mitigation measures. Metago's confidence level is high for this significance rating.

Tabulated summary of the assessed cumulative inward migration impact

Mitigation	Severity	Duration	Spatial Scale	Consequence	Probability of Occurrence	Significance
Unmitigated	**H**	**H**	**M**	**H**	**H**	**H**
Mitigated	**M-H**	**H**	**M**	**M-H**	**M-H**	**M- H**

7.12.3.2 Conceptual description of mitigation measures

Conceptual discussion of the mitigation measures is provided below and detailed in the Husab EMP (Appendix Q).

Objective

The objective of the mitigation measures is to limit the impacts associated with inward migration.

Actions

The mine will collaborate with local and regional government and other entities in the commercial sector to identify and implement interventions that may assist with the prevention of inward migration and/or the prevention of the associated negative impacts. The findings and recommendations of the SEA (SAIEA, 2010) apply. In this regard the mine will:

- Focus social investment on community infrastructure, education, housing, sanitation services and/or health.
- Focus this investment in the proclaimed towns that already exist in the region (mainly Arandis, Swakopmund and Walvis Bay).
- Ensure that its workers have access to formal serviced houses.
- Collaborate with local authorities to prevent the increase in crime and informal settlement development.

Emergency situations

None identified.

7.12.4 ISSUE: SOCIAL LINK BETWEEN THE MINE AND THE COMMUNITY

7.12.4.1 Assessment of impact

Severity

The establishment of the Husab Mine can directly and indirectly impact on people both in the workplace and in the context of worker families and communities. In this regard, there is a link between issues at the community of the workplace and the community of the residential place. These issues include: radiation exposure management, health, education and training.

In the unmitigated scenario, if workplace learning is not transferred to the home and the broader community, then their influence will be limited to the workplace only which means that the proposed project may indirectly have a negative impact on people at the home and in the receiving communities. This is a low to medium severity.

In the mitigated scenario, the severity can be reduced to low and possibly even turned into a positive.

Duration

The impacts are likely to be restricted to the life of mine. This is a medium duration.

Spatial scale

In both the unmitigated and mitigated scenarios, the impacts will be felt in the workplace and in the communities in which the Husab employees reside. This is a medium spatial scale.

Consequence

The consequence in the unmitigated scenario is low to medium negative, but this can become a positive consequence with mitigation.

Probability

The probability of the impacts occurring is considered to be medium in both the mitigated and unmitigated scenarios.

Significance

In the unmitigated scenario, the significance of this potential impact is low to medium negative. In the mitigated scenario, the significance may at best be turned into a medium positive. Metago's confidence level is high for this significance rating.

Tabulated summary of the assessed cumulative impacts – link between mine and communities

Mitigation	Severity	Duration	Spatial Scale	Consequence	Probability of Occurrence	Significance
unmitigated	**L - M**	**M-H**	**M**	**L - M**	**M**	**L- M**
mitigated	**L- to L+**	**M**	**M**	**L- to L+**	**M**	**L- to M+**

7.12.4.2 Conceptual description of mitigation measures

Conceptual discussion of the mitigation measures is provided below and detailed in the Husab EMP (Appendix Q).

Objective

The objective of the management measures is to reduce impacts associated with the link between the mine and the communities.

Actions

Specific actions include the following:

- implement a stakeholder communication and engagement strategy. The key components of which are: maintaining an inclusive comprehensive stakeholder database that recognises both internal and external stakeholders, encouraging meaningful and transparent communication and information sharing, ongoing monitoring to ensure that the strategy is up to date, and follow up auditing;
- develop a formal complaints (grievance) procedure that incorporates measures for receiving, responding, tracking and recording complaints and grievances from both internal and external stakeholders;
- maintain an employee profile that can assist with both managing impacts and informing the mine's closure plan – for both long term planned closure and for unplanned premature downscaling or closure;
- develop worker radiation, HIV/AIDS and tuberculosis programmes that can be extended to contractors and service providers, and into the communities where Husab workers reside;
- ensure formal home ownership and discourage informal housing for employees and contractors; and
- extend employee education programmes on social and health issues into interest communities.

Emergency situations

None identified.

8 KEY ASSUMPTIONS, UNCERTAINTIES AND LIMITATIONS

Assumptions, uncertainties and limitations have been discussed throughout the EIA report and in the various specialist studies. The more significant of these are included below.

8.1 ENVIRONMENTAL ASSESSMENT LIMIT

The EIA focused on third parties only and did not assess health and safety impacts on workers because the assumption was made that these aspects are separately regulated by health and safety legislation, policies and standards, and that Husab will adhere to these.

The EIA does not cover any potential future expansions. If planned, these will be addressed in a separate EIA that will consider the cumulative impacts of the original mine plus any impacts associated with the potential future expansions.

Given the practicalities of planning and coordination with parastatal organisations such as NamPower and NamWater, all of the off site linear infrastructure components (although considered as part of the mining project during the scoping phase of this EIA) are being assessed in a separate report that will follow on from the distribution of this EIA report.

8.2 PREDICTIVE MODELS IN GENERAL

All predictive models are only as accurate as the input data provided to the modellers. If any of the input data is found to be inaccurate or is not applicable because of project design changes that occur over time, then the model predictions will be less accurate.

8.3 GEOCHEMISTRY

In the absence of kinetic laboratory test results and a more complete set of waste rock samples, the geochemical analysis and conclusions have adopted a precautionary approach. Given this, liners have been recommended for the mineralised waste facilities. If further test work modifies the analysis and conclusions then it may be possible to change the liner requirements for the mineralised waste facilities.

8.4 GEOLOGY

Not applicable.

8.5 TOPOGRAPHY

Not applicable.

8.6 SOILS AND LAND CAPABILITY

There is uncertainty about the possibility of reinstating and/or creating two specific soil features. These include the surface crust that has been identified on the plains and the less permeable calcrete layer that is situated below the topsoil horizon. Both of these features are considered to be important from a moisture retention perspective and the surface crust has the added role of erosion prevention. Ongoing pilot tests will be conducted by Swakop Uranium to determine if there are effective means of creating similar features.

8.7 BIODIVERSITY

There is still a measure of debate about the water source that sustains the Welwitschia plants that are situated to the south of the proposed project site. As a start, most specialists agree that these plants do not rely on fog for water. There is more information in support of the theory that these plants rely on surface water run-off that seeps into the shallow sand zones beneath the topsoil. There is less information in support of the theory that these plants have deep roots that tap into deep ground water resources in the bedrock. This issue requires additional research. To this end, a Welwitschia working group has been established.

Not enough information is available on the Husab Sand Lizard to fully understand the incremental (Husab) and cumulative impacts (all mines) on this species which has an extremely restricted range (estimated to be between Valencia, Langer Heinrich and Rössing Mines) and a direct competitive relationship with the Western Sand Lizard in adjacent ranges. So while it appears as if the proposed Husab Project infrastructure will not significantly impact the preferred habitat of the Husab Sand Lizard, the potentially endangered status of the species together with the lack of understanding of cumulative impacts, raises a significant unanswered concern. This issue requires additional research. To this end, a study proposal has been requested and received by Husab.

8.8 RADIOLOGICAL

Although NECSA commenced with a baseline data gathering programme in the second half of 2009, the full data set (particularly for radon gas) was not available at the time that the public risk assessment report (NECSA 2010) was compiled. This is not expected to have any material impact on the report findings, but the baseline data and related understanding of pre project radiological conditions will be more complete when a full year of data is available.

8.9 SURFACE WATER

Not applicable.

8.10 GROUNDWATER

Not applicable.

8.11 AIR

The baseline data for PM10 is not definitive and even though there is a fairly good correlation between the predicted and measured background concentrations (SAIEA, 2010) additional work is required to firmly quantify the situation. Given this, the cumulative impact assessment for PM10 cannot be considered absolute and it is subject to confirmation by ongoing PM10 monitoring.

The air specialist made use of a dispersion model to predict spatial air quality concentrations for the construction and operational phases. Given that the activities during decommissioning are similar to construction the model findings for construction are considered applicable to decommissioning. Modelling of the closure phase is only possible when the final closure plan is documented, but it is expected that impacts at closure will not be worse than the operational phase.

8.12 ARCHAEOLOGY

Not applicable.

8.13 NOISE

Not applicable.

8.14 BLASTING

Not applicable.

8.15 VISUAL

Although it has been recommended that Swakop Uranium considers assisting with the development of alternative tourist attractions for the current Welwitschia related attractions to the south of the proposed project site, it is not yet clear whether such alternatives exist outside of the visual impact zone.

8.16 SOCIO-ECONOMIC

Not applicable.

9 ENVIRONMENTAL IMPACT STATEMENT & CONCLUSION

The cumulative assessment (incremental contribution of the Husab Project plus existing baseline conditions) of the proposed Husab Project presents the potential for significant positive economic impacts and significant negative environmental and social impacts. In this context, Swakop Uranium will be required to follow a two-pronged approach to managing its impacts. The first 'prong' is the management of its incremental impacts, and the second 'prong' is working collectively with other mines, the Chamber of Mines, non-government organisations, industry and government to tackle the regional strategic issues that have been identified and detailed in the Central Namib Uranium Rush Strategic Environmental Assessment.

Swakop Uranium will go a long way to mitigating the potential negative impacts by committing to apply the findings of the cumulative assessment and related mitigation objectives and actions to its project. However, some of these potential negative impacts will remain as high negative residual impacts even with mitigation. The most significant impacts in this regard are: impacts from the physical destruction and general disturbance of biodiversity, impacts from particulate matter related air pollution, impacts on sense of place and the related impacts on the tourism industry, and inward migration related impacts on the already stressed regional infrastructure and services (housing, education, health care, sanitation, power and water supply). In the case of people related impacts, the assessment focused on third parties only and did not assess health and safety impacts on workers because the assumption was made that these aspects are separately regulated by health and safety legislation, policies and standards.

It follows that there will be people that oppose the project development on the grounds of the negative environmental and social impacts, but there will also be people that support the project on the grounds of the positive economic impacts. Ultimately, the decision makers will be required to prioritise either the positive economic impacts or the negative environmental and social impacts.

A tabulated summary of the impact assessment is provided in Table 9-1.

TABLE 9-1: SUMMARY OF POTENTIAL CUMULATIVE IMPACTS ASSOCIATED WITH THE PROPOSED HUSAB PROJECT

Section	Potential impact	Significance of the impact (the ratings are negative unless otherwise specified)	
		Unmitigated	Mitigated
Topography	Injury to people and animals form hazardous excavations and infrastructure	**High**	**Medium**
Soils and land capability	Loss of soil resources from pollution	**High**	**Low**
	Loss of soil resources from physical disturbance	**High**	**Medium to High**
Biodiversity	Physical destruction of biodiversity from clearing land and placing infrastructure	**High**	**High**

Section	Potential impact	Significance of the impact (the ratings are negative unless otherwise specified)	
		Unmitigated	Mitigated
	Loss of biodiversity from the reduction of water resources as an ecological driver	**High**	**Low**
	General disturbance of biodiversity through a range of aspects including dust, noise, vibration, pollution, lighting, power lines, water dams, poaching, and vehicle movement.	**High**	**Medium to High**
Radiological – direct radiation	Direct physical exposure to radiation from on site sources	**Medium to Low**	**Low**
Surface water	Pollution of surface water – radiological and non-radiological	**Medium**	**Low**
Groundwater	Water abstraction impacts on third party users	**Low**	**Low**
	Groundwater contamination– non radiological	**Low**	**Low**
Air quality	Air pollution – non radiological	**High**	**High**
	Air pollution – radiological and related secondary pathways	**Low**	**Low**
Noise	Noise pollution in the context of sensitive receptors within the Namib Naukluft National Park	**Medium to Low**	**Medium to low**
Blasting	Blast injury to third parties or damage to structures	**Medium**	**Medium to Low**
Archaeology	Damage to archaeological sites and landscapes	**High**	**Medium**
Visual impacts	Visual impact from sensitive views within the Namib Naukluft National Park	**High**	**Medium to High**
Socio-economic impacts	Cumulative economic impact including the positive impacts on regional and national economies and the potential negative regional impacts on tourism	**High+**	**High+**
	Inward migration of job seekers that may add stress to the current regional infrastructure and service deficiencies, lead to poor living conditions, increased crime and accelerated spread of disease in urban areas.	**High**	**Medium to High**
	Link between the mine and communities. Related issues include radiation exposure management, health, education and training	**Low to Medium**	**Low to Medium +**

B Stobart, EAPSA
(Project Manager)

A Pheiffer, PrSciNat
(Project Reviewer)

J Goeller
(Project Assistant)

Metago Environmental Engineers (Pty) Ltd

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Strategic Environmental Assessment for the central Namib Uranium Rush. Ministry of Mines and Energy, Windhoek, Republic of Namibia. SAIEA (August) 2010.

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Visual Impact Assessment for the Proposed Swakop Uranium Husab Project, Swakopmund, Namibia. 1104/E08J. Newtown Landscape Architects cc (NLA), September 2010

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APPENDIX A – PROJECT TEAM CURRICULUM VITAE

APPENDIX B – INFORMATION SHARING RECORD

Correspondence with MET distributing the BID

Correspondence with IAPs distributing the BID

Photos of site notices

Newspaper adverts

Scoping meeting minutes

Summary letter to IAPs with Scoping terms of reference

Letter from MET

EIA summary letter to IAPs

Minutes of EIA review meetings

Review comments from external reviewer and IAPs

APPENDIX C – IAP DATABASE

APPENDIX D – ISSUES TABLE

APPENDIX E – GEOCHEMISTRY

APPENDIX F – SOILS AND LAND CAPABILITY

APPENDIX G – BIODIVERSITY

APPENDIX H – RADIOLOGICAL

APPENDIX I - SURFACE WATER

APPENDIX J – GROUNDWATER

Aquaterra

BIWAC

DD science

APPENDIX K - AIR QUALITY

APPENDIX L – NOISE

APPENDIX M – ARCHAEOLOGY

APPENDIX N – VISUAL

APPENDIX O – SOCIO ECONOMIC

APPENDIX P - MINERALISED WASTE MITIGATION

APPENDIX Q - HUSAB EMP

Metago Environmental Engineers (Pty) Ltd
Consulting Engineers and Scientists

RECORD OF REPORT DISTRIBUTION

Project Number:	M009-03
Title:	ENVIRONMENTAL IMPACT ASSESSMENT REPORT FOR THE PROPOSED HUSAB MINE
Report Number:	2
Proponent:	Swakop Uranium (Pty) Limited

Name	Entity	Copy No.	Date issued	Issuer
Aune Andreas	MME	1	Oct 2010	BS
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Salomon April	National Heritage Council of Namibia	4	Oct 2010	BS
Felix Musukubili	Ministry of Labour and Social Welfare	5	Oct 2010	BS
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C/o reference librarian	Arandis public library	14	Oct 2010	BS
Reception	Swakop Uranium Office (Swakopmund and Windhoek)	15,16	Oct 2010	BS
Michele Kilbourn Louw	Swakop Uranium	17	Oct 2010	BS
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