

**Environmental Impact Assessment  
Proposed KUDU CCGT Power Plant  
at Uubvlei, near Oranjemund, Republic of Namibia**

**VOLUME 1 : FINAL ENVIRONMENTAL IMPACT REPORT**

Oranjemund



**Prepared by:**

CSIR: Environmentek  
P.O. Box 320  
Stellenbosch 7600  
Tel: + 27 21 888 2400  
Fax: + 27 21 888 2693  
Email: HFortuin@csir.co.za



**Prepared for:**

Namibia Power Corporation (Pty) Ltd  
P.O. Box 2864  
Windhoek, Namibia  
Tel: + 264 61 205 4111  
Fax: + 64 61 23 2805  
Email: John.Langford@nampower.com.na



Atlantic Ocean

Yacht Club

MAY 2005

CSIR Report No. ENV-S-C 2005 057

# REPORT CONTENTS

---

*Report Contents*

*Scope*

*Abbreviations and Acronyms Used*

*Units Used*

*Summary - Contents*

*Figures*

*Tables*

*Executive Summary*

<b>Chapter 1.</b>	INTRODUCTION
<b>Chapter 2.</b>	DESCRIPTION OF THE EIA PROCESS
<b>Chapter 3.</b>	PROJECT DESCRIPTION
<b>Chapter 4.</b>	PROJECT ALTERNATIVES
<b>Chapter 5.</b>	THE AFFECTED ENVIRONMENT
<b>Chapter 6.</b>	IMPACT DESCRIPTION AND ASSESSMENT
<b>Chapter 7.</b>	CONCLUSIONS AND RECOMMENDATIONS
<b>Chapter 8.</b>	REFERENCES

## APPENDICES

---

<i>Appendix A</i>	STAKEHOLDERS' LIST
<i>Appendix B</i>	BACKGROUND INFORMATION DOCUMENT
<i>Appendix C</i>	MINUTES OF MEETINGS
<i>Appendix D</i>	WORLD BANK (IFC) ENVIRONMENTAL AND SOCIAL REVIEW REQUIREMENTS

## SCOPE

<b>Title:</b>	Environmental impact assessment. Proposed Kudu CCGT Power Plant at Uubvlei, near Oranjemund, Republic of Namibia. Volume 1: Final Environmental Impact Report
<b>Date:</b>	May, 2005
<b>CSIR Report no:</b>	ENV-S-C 2005-057
<b>Prepared for:</b>	Namibia Power Corporation (Pty) Ltd P O Box 2864, WINDHOEK, Namibia
<b>Prepared by:</b>	CSIR-Environmentek, P O Box 320, STELLENBOSCH, 7599.
<b>Authors:</b>	Henri HG Fortuin
<b>Scope:</b>	<p>This Environmental Impact Report (EIR) forms part of the process of planning and decision making for the proposed Kudu CCGT power plant at Uubvlei, near Oranjemund, Namibia. Its purpose is to present the findings of the EIA process for review by stakeholders and Authorities. In particular, it will:</p> <ul style="list-style-type: none"><li>• Identify any interactions between the proposed CCGT power plant and the environment;</li><li>• Consider which of these aspects, if any, are likely to have a significant impact on the environment; and</li><li>• Recommend measures that will enhance any positive impact and avoid any adverse negative impact, and if the latter cannot be avoided, to reduce its impact and ensure adequate protection during construction and operation of the proposed CCGT power plant.</li></ul> <p>The EIR is part of a series of reports and information documents issued during the environmental impact assessment process.</p>
<b>Citation:</b>	CSIR (2005) Environmental Impact Assessment. Proposed Kudu CCGT Power Plant at Uubvlei, near Oranjemund, Republic of Namibia. Volume 1: Final Environmental Impact Report <i>CSIR Report ENV-S-C 2005-057</i> . Stellenbosch. 335 pp, including Executive Summary and Appendices. Prepared for Namibia Power Corporation (Pty) Ltd.
<b>Acknowledgements :</b>	Margaret van der Merwe, and John Langford, Gerson Rukata and David Mbidi (NamPower), Donal McKenna (ESBI), Peter Tarr (SAIEA), and Pat Morant (CSIR), the specialist scientists, and Magdel van der Merwe are thanked for their co-operation and support in the preparation of this report.

## ABBREVIATIONS AND ACRONYMS USED

<i>BTX</i>	Benzene, toluene, xylene
<i>CBD</i>	Convention on Biological Diversity
<i>CCGT</i>	Combined cycle gas turbine
<i>Cl</i>	Chlorine
<i>CO<sub>2</sub></i>	Carbon dioxide
<i>CSIR</i>	Council for Scientific and Industrial Research
<i>DWAF</i>	Department of Water Affairs and Forestry (South Africa)
<i>ELV</i>	Emission limit values
<i>EA</i>	Environmental assessment
<i>EIA</i>	Environmental impact assessment
<i>EIR</i>	Environmental impact report
<i>EMP</i>	Environmental management plan
<i>EMS</i>	Environmental management system
<i>GT</i>	Gas turbine
<i>HSRG</i>	Heat recovery steam generator
<i>I&amp;AP</i>	Interested and Affected Party
<i>IEM</i>	Integrated environmental management
<i>IFC</i>	International Finance Corporation
<i>IPCC</i>	Intergovernmental Panel on Climate Change
<i>MAI</i>	Mining Area One
<i>MAWRD</i>	Ministry of Agriculture, Water and Rural Development (Namibia)
<i>MET</i>	Ministry of Environment and Tourism (Namibia)
<i>MME</i>	Ministry of Mines and Energy (Namibia)
<i>MOU</i>	Memorandum of Understanding
<i>MW</i>	Megawatts
<i>NO<sub>x</sub></i>	Oxides of nitrogen
<i>NO<sub>2</sub></i>	Nitrogen dioxide
<i>OEM</i>	Original equipment manufacturer
<i>PEA</i>	Preliminary environmental assessment
<i>PM</i>	Particulate matter
<i>PM<sub>10</sub></i>	Particulate matter 10 microns or less
<i>SADC</i>	Southern African Development Community
<i>SAIEA</i>	Southern African Institute for Environmental Assessment
<i>SANS</i>	South African National Standard
<i>SAPP</i>	Southern African Power Pool
<i>SO<sub>2</sub></i>	Sulphur dioxide
<i>TSP</i>	Total suspended particulates
<i>US-EPA</i>	United States Environmental Protection Agency
<i>VOC</i>	Volatile organic compounds
<i>WHO</i>	World Health Organisation

## Units used

---

dBA	Power gain in decibels
dB (A)	Power gain in decibels
J/m <sup>2</sup> /day	Joules per square metre per day
mg/N m <sup>3</sup>	Milligrams per Normal cubic metre
µg/l, µg/ℓ	Micrograms per litre
µg l <sup>-1</sup> , µg ℓ <sup>-1</sup>	Micrograms per litre
Mm <sup>3</sup> /a	Million cubic metres per annum
m s <sup>-1</sup>	Metres per second
m <sup>3</sup> s <sup>-1</sup>	Cubic metres per second
ml l <sup>-1</sup> , ml ℓ <sup>-1</sup>	Millilitres per litre
µg/m <sup>3</sup>	Micrograms per cubic metre
M m <sup>3</sup> /a	Million cubic metres per annum
Psu	Practical salinity unit
ppm	Parts per million
‰	Parts per thousand
Δt	Difference in temperature

## EXECUTIVE SUMMARY - CONTENTS

<b>A.</b>	<b>INTRODUCTION</b>	<b>A-1</b>
A.1	The need for the proposed activity .....	A-1
A.2	Purpose for the proposed activity .....	A-1
A.3	Preliminary Environmental Assessment of the Kudu CCGT Power Plant.....	A-2
A.4	Environmental Impact Assessment of Kudu CCGT Power Plant at Site D, Oranjemund .....	A-2
A.5	Environmental Impact Assessment of Kudu CCGT Power Plant at Uubvlei, near Oranjemund A-5	
A.6	The purpose of the EIA process and this report.....	A-7
A.7	Comment on the draft EIR.....	A-7
<b>B.</b>	<b>THE EIA PROCESS</b>	<b>B-8</b>
B.1	Legal and policy requirements for EIA.....	B-8
B.2	Terms of Reference for the EIA.....	B-8
B.3	Financial institution requirements .....	B-9
B.4	Methodology for the EIA .....	B-10
B.5	Specialist studies .....	B-13
B.6	Integration and impact assessment.....	B-13
<b>C.</b>	<b>PROJECT DESCRIPTION</b>	<b>C-13</b>
C.1	Description of proposal .....	C-13
	<i>C.1.1 Introduction.....</i>	<i>C-13</i>
	<i>C.1.2 Description of Site .....</i>	<i>C-14</i>
	<i>C.1.3 Site Access and Security.....</i>	<i>C-17</i>
C.2	Plant Details.....	C-17
	<i>C.2.1 Plant Design and Layout.....</i>	<i>C-17</i>
	<i>C.2.2 Plant Components .....</i>	<i>C-18</i>
	<i>C.2.3 Power Generation Process.....</i>	<i>C-22</i>
	<i>C.2.4 Occasional Processes &amp; Activities.....</i>	<i>C-22</i>
	<i>C.2.5 Plant Efficiency .....</i>	<i>C-23</i>
C.3	Plant Enclosures.....	C-23
C.4	Unit Operations.....	C-24
C.5	Cooling Water .....	C-26
	<i>C.5.1 Systems Under Consideration .....</i>	<i>C-26</i>
	<i>C.5.2 Sources of Cooling Water .....</i>	<i>C-27</i>
C.6	Plant Operation.....	C-28
	<i>C.6.1 Running Regime .....</i>	<i>C-28</i>
	<i>C.6.2 Use of Resources .....</i>	<i>C-28</i>
C.7	Air Emissions .....	C-29
	<i>C.7.1 Main Air Emissions.....</i>	<i>C-29</i>
	<i>C.7.2 Auxiliary Boiler.....</i>	<i>C-31</i>
	<i>C.7.3 Minor/Fugitive Air Emissions .....</i>	<i>C-31</i>
C.8	Aqueous Discharges.....	C-32
	<i>C.8.1 Cooling Water Purge .....</i>	<i>C-32</i>
	<i>C.8.2 Low Volume Aqueous Discharges.....</i>	<i>C-32</i>

C.9	Noise and Vibration .....	C-34
C.10	Waste Management.....	C-35
C.11	Project Construction .....	C-36
	<i>C.11.1 Construction Site .....</i>	<i>C-36</i>
	<i>C.11.2 Environmental Factors.....</i>	<i>C-37</i>
C.12	Commissioning .....	C-38
C.13	Hazards and Safety .....	C-38
C.14	Decommissioning .....	C-39
C.15	Environmental Management Plan .....	C-39
	<i>C.15.1 Environmental management structure and responsibilities .....</i>	<i>C-39</i>
	<i>C.15.2 Environmental management of construction phase.....</i>	<i>C-40</i>
<b>D. PROJECT ALTERNATIVES</b> .....		<b>D-40</b>
D.1	No-project alternative.....	D-40
D.2	Activity alternatives .....	D-40
D.3	Process alternatives .....	D-41
D.4	Location alternatives.....	D-41
D.5	Process alternatives for cooling of a CCGT plant .....	D-44
<b>E. THE AFFECTED ENVIRONMENT</b> .....		<b>E-46</b>
E.1	Geology, topography and soils .....	E-47
E.2	Hydrology.....	E-47
E.3	Marine environment.....	E-47
E.4	Climate.....	E-48
E.5	Temperature .....	E-48
E.6	Precipitation .....	E-49
E.7	Wind.....	E-50
E.8	Humidity.....	E-50
E.9	Sunshine and cloudiness.....	E-51
E.10	Terrestrial Ecology.....	E-51
	<i>E.10.1 Vegetation.....</i>	<i>E-51</i>
	<i>E.10.2 Terrestrial Fauna .....</i>	<i>E-52</i>
E.11	Terrestrial Avifauna.....	E-53
E.12	Air quality .....	E-54
E.13	Noise.....	E-54
E.14	Archaeology.....	E-54
E.15	Orange River Transboundary Conservation Area .....	E-54
E.16	Population Centres .....	E-55
E.17	Communications .....	E-55
E.18	Tourism.....	E-56
<b>F. IMPACT DESCRIPTION AND ASSESSMENT</b> .....		<b>F-56</b>
F.1	Socio-economic assessment.....	F-58
	<i>F.1.1 Impact on the population, employment and social services .....</i>	<i>F-58</i>
	<i>F.1.2 Impact on infrastructure and urban services .....</i>	<i>F-58</i>
	<i>F.1.3 Impact on the economic structure and urban management .....</i>	<i>F-59</i>
	<i>F.1.4 World Bank requirements for assessment of socio-economic impacts.....</i>	<i>F-60</i>
F.2	Impact of noise on the receiving environment.....	F-60
	<i>F.2.1 World Bank requirements for assessment of noise impacts .....</i>	<i>F-61</i>

F.3	The vegetation on the site and its environs.....	F-61
	<i>F.3.1 World Bank requirements for assessment of impacts on vegetation.....</i>	<i>F-62</i>
F.4	Impact on terrestrial ecology and fauna, excluding birds.....	F-62
	<i>F.4.1 World Bank requirements for assessment of impacts on the terrestrial ecology.....</i>	<i>F-63</i>
F.5	Impact of air emissions.....	F-64
	<i>F.5.1 World Bank requirements for assessment of impacts from atmospheric emissions....</i>	<i>F-67</i>
F.6	Visual impact of the power plant.....	F-67
F.7	Impact of the purge water discharge.....	F-68
	<i>F.7.1 Water quality guidelines.....</i>	<i>F-73</i>
	<i>F.7.2 Summary of impacts.....</i>	<i>F-74</i>
<b>G. CONCLUSIONS AND RECOMMENDATIONS</b>		<b>G-77</b>
G.1	Introduction.....	G-77
G.2	Issues Affecting Oranjemund and its Environs.....	G-77
	<i>G.2.1 Socio-economic Issues.....</i>	<i>G-77</i>
	<i>G.2.2 Impact of Noise.....</i>	<i>G-78</i>
	<i>G.2.3 Air emissions.....</i>	<i>G-78</i>
	<i>G.2.4 Visual Impact.....</i>	<i>G-79</i>
G.3	Site-specific Issues.....	G-80
	<i>G.3.1 Terrestrial ecology.....</i>	<i>G-80</i>
	<i>G.3.2 Purge water discharge.....</i>	<i>G-80</i>
G.4	Conclusions.....	G-82
G.5	Recommendations.....	G-83
	<i>G.5.1 Environmental Management Plan.....</i>	<i>G-83</i>
	<i>G.5.2 Surf zone discharge: additional data.....</i>	<i>G-83</i>

## EXECUTIVE SUMMARY - FIGURES

Figure 1.	Location of Oranjemund and the Kudu Gas Field.....	A-3
Figure 2.	Site D, and other alternative sites in the Oranjemund area.....	A-4
Figure 3.	Location of the Uubvlei site, with Site D and the town of Oranjemund.....	A-6
Figure 4.	Integrated Environmental Management Procedure.....	B-12
Figure 5.	Location of the CCGT power station at Oranjemund. The gas to power the station will be sourced from the Kudu gas field (Kudu Block 2814A)......	C-15
Figure 6.	The location of the CCGT site at Uubvlei, near Oranjemund. ....	C-16
Figure 7.	The concept of the CCGT plant in diagrammatic format.....	C-18
Figure 8.	Plan view of layout of the 800 MW CCGT plant showing location for the second 800 MW plant.....	C-19
Figure 9.	Isometric view of layout of the 800 MW CCGT plant showing location for the second 800 MW plant.....	C-20
Figure 10.	Proposed route for heavy haulage from the Port of Lüderitz and Oranjemund. ....	C-21
Figure 11.	Semi-closed Evaporative Cooling System.....	C-26
Figure 12.	Make-up Water Cooling Tower System.....	C-27
Figure 13.	Location alternatives for the Kudu CCGT power plant.....	D-42
Figure 14.	Site alternatives for the CCGT power plant at Oranjemund.....	D-43
Figure 15.	Location of the Uubvlei site, with Site D and the town of Oranjemund.....	D-45



Figure 16. Wind rose for Alexander Bay for 2000 and 2001 ..... E-50

Figure 17. Map of Uubvlei area that shows the extent of land disturbed by diamond mining operations (hatching), and proposed situation of the power plant and associated activities. Boundaries of habitat zones are not indicated as these were not mapped at the site ..... E-52

Figure 18. Schematised behaviour of a typical negatively buoyant effluent plume such as the heated brine being considered in this study. .... F-71

Figure 19. Characterisation of the mixing processes in the near shore zone (after RSA DWAF, 2004b) ..... F-72

## EXECUTIVE SUMMARY - TABLES

---

Table 1. Environmental evaluation of proposed sites ..... A-2

Table 2. Summary Table of Alternatives Considered..... D-44

Table 3. Mean monthly and monthly extreme temperatures at Alexander Bay including average monthly rainfall and fog days ..... E-49

Table 4. Red Data Book bird species occurring between Port Nolloth and Lüderitz. .... E-53

Table 5. Emission scenarios modelled ..... F-64

Table 6. Compounds of potential concern and health endpoints. .... F-64

Table 7: Summary of stack parameters and emission rates per shaft for the Kudu CCGT power plant ..... F-65

Table 8. Summary of the pollutants assessed ..... F-66

Table 9. Characteristics of discharged cooling/purge waters from an evaporative cooling system... F-69

Table 10. Water quality guidelines for the discharge of a heated brine into the marine environment F-73

# EXECUTIVE SUMMARY

---

## A. Introduction

The vision of NamPower is to be “a leading energy company in Africa, which excels in customer service, people development and technological innovation”, and its mission is to “provide for the energy needs of our customers, fulfill the aspirations of our staff and satisfy the expectations of our stakeholders.” In pursuance of its vision to provide affordable and reliable electricity for the prosperity of Namibia and its people, NamPower joined the Southern African Power Pool (SAPP) to tap from the resources within the SADC Region.

Between 1985 and 2002, Namibia’s electricity demand grew at an average annual rate of 3.62 %, to 390 MW in 2004. Major demand increases took place from 2002 to 2004 and further major increases are expected if Namibia begins supplying Skorpion Mine near Rosh Pinah in 2011 or 2012.

NamPower projects that the maximum demand growth will continue at a rate of approximately 4.5%, resulting in a demand of approximately 550 MW by 2012. The assumed growth rate is in line with the country’s development objectives, which projects an average annual GDP growth of 6% from 2001 to 2030. This growth will be driven by growth in the agricultural and manufacturing sectors, which are expected to become highly export oriented in the future.

### *A.1 The need for the proposed activity*

At the present time, Namibia imports more than 50% of its annual energy needs from South Africa; rising domestic demand in South Africa and Namibia is expected to lead to a shortfall in continued supply of electricity to Namibia beyond 2007. The Kudu Power Project is one of the preferred options to address the predicted shortfall in electricity maximum demand by 2007, base load capacity by 2011, and growth in power demand in the region in the short-medium term. In addition to meeting NamPower’s projected demand, electricity generated by the Kudu CCGT plant will be exported to South Africa and other SADC countries to fulfill their own demands.

### *A.2 Purpose for the proposed activity*

The first phase of the Kudu Power Project will be the development of a nominal 800 MW combined cycle gas turbine (CCGT) power plant at Uubvlei near Oranjemund, to be commissioned in 2009 (Figure 1). The natural gas reserves within the Kudu Gas Field are sufficient for a nominal 800 MW power plant, operating for a minimum of 20 years, without the need for additional appraisal drilling. It is anticipated that, if additional gas reserves are proven after 2-3 years of gas production, and the demand for electricity warrants it, the second phase of the project, an additional nominal 800 MW CCGT power plant, will be commissioned in 2014.

The project is proceeding through well-defined phases, namely:

- feasibility studies that establish the technical feasibility, financial viability and the environmental acceptability of the project;
- final design and financial closure;
- construction;
- operation;
- decommissioning.

This EIA covers all aspects that relate to the construction, operation and decommissioning of the CCGT plant as far as the project has currently been defined. Decommissioning will be discussed in the Environmental Management Plan.

### ***A.3 Preliminary Environmental Assessment of the Kudu CCGT Power Plant***

A preliminary environmental assessment (PEA) for the Kudu CCGT Power Plant was conducted in 1998, and it looked at possible locations for the proposed power plant in the area around Oranjemund, shown in Figure 2. The results of such an environmental evaluation in the PEA, that correlated a low rank with a high environmental cost, are presented in Table 1.

**Table 1. Environmental evaluation of proposed sites**

<b>Rank</b>	<b>Scenario</b>	<b>Score</b>
1	Site D using saline water from well points	61
2	Site B with dry cooling	63a
3	Site D using sea water for evaporative cooling	71
4	Site D using sea water for once through cooling	73
5	Site A using sea water for once through cooling	78
6	Site B using sea water for evaporative cooling with discharge to the sea	89
7	Site B using river water for evaporative cooling with discharge to the river	97
8	Site B using river water for evaporative cooling with discharge to the sea	102

*a) This option involves very high capital expenditure.*

The PEA recommended strongly that Site D be the location for the new CCGT power plant, preferably using saline ground water for cooling.

### ***A.4 Environmental Impact Assessment of Kudu CCGT Power Plant at Site D, Oranjemund***

Nampower commissioned an EIA in 2004 to consider the construction, operation and decommissioning phases of a CCGT power plant at a site, known as Site D, about 2.5 km from the town of Oranjemund. A positive Record of Decision was issued by the Ministry of Environment and Tourism (MET), Government of Namibia, in January 2005.



Figure 1. Location of Oranjemund and the Kudu Gas Field

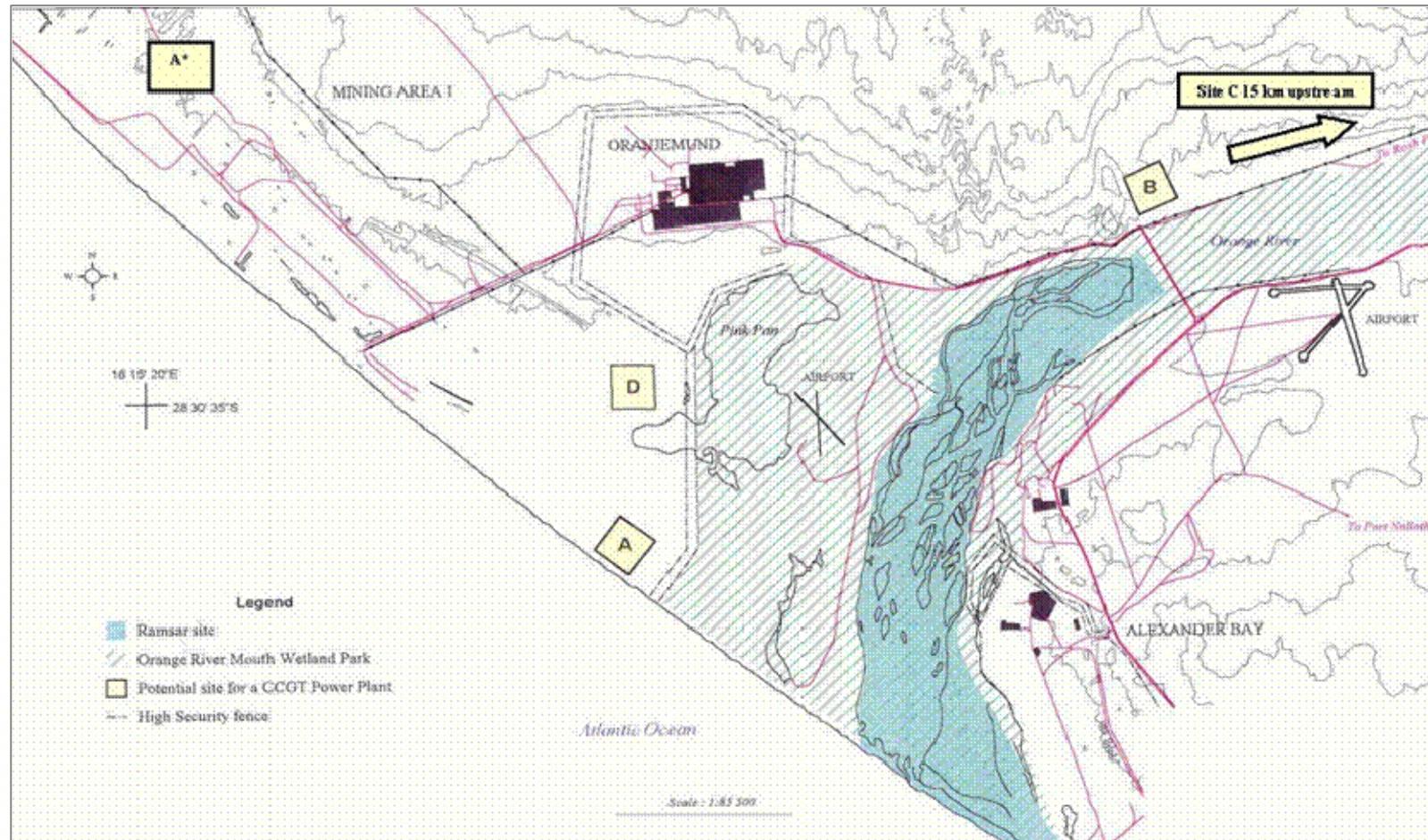


Figure 2. Site D, and other alternative sites in the Oranjemund area

### ***A.5 Environmental Impact Assessment of Kudu CCGT Power Plant at Uubvlei, near Oranjemund***

After the EIA for Site D at Oranjemund had been approved by MET, it was found that the routing of a gas pipeline from the gas platform to the proposed Site D was subject to severe constraints because of likely opportunity costs due to possible diamond lock-up offshore, and the inconvenience to ongoing mining activities.

A preliminary investigation by NamPower and Namdeb identified Uubvlei (Figure 3) as the most suitable alternative site, based on the following criteria:

- Cost implications;
- Already disturbed/mined-out area at the site (i.e., minimal impact on biodiversity and landscapes);
- Minimal interference with Namdeb mining operations;
- Availability of cooling water for the power plant;
- Good founding conditions for the power plant and landing site for the gas pipeline and seawater intake pipeline;
- Proximity to infrastructure and services;
- Minimal impact on mining reserves offshore;
- Suitability for transmission lines (interconnectivity).

Although this EIA will be an entirely new stand-alone document, it is envisaged that much of the information and analysis contained in the EIA for Site D will be valid for this Uubvlei EIA. This is because much of the background information is identical, and issues that relate to the functioning of the plant, emissions and other technical aspects, are unchanged.

However, there will be a number of new, site-specific issues that warrant new and additional work. These are:

- Description of the biophysical characteristics of Uubvlei site;
- Options for water abstraction for cooling given the differences between Uubvlei and Site D (i.e. from beach wells, ponds or directly from the ocean);
- Options for purge water discharge given the differences between Uubvlei and Site D (i.e. into ponds, onto the beach/intertidal zone, beyond the breakers);
- The suitability of existing facilities to accommodate the workforce during construction, and possibly operation;
- Options for supply of services for workers - water, electricity, recreation facilities, health services, catering, etc.;
- Options for waste management – industrial waste during construction, household waste, sewerage, hazardous waste;
- Maintenance of the road between Uubvlei and Oranjemund;
- Security issues and access to site;
- Interactions with Namdeb;
- Climate – implications for corrosion, dust control, etc.

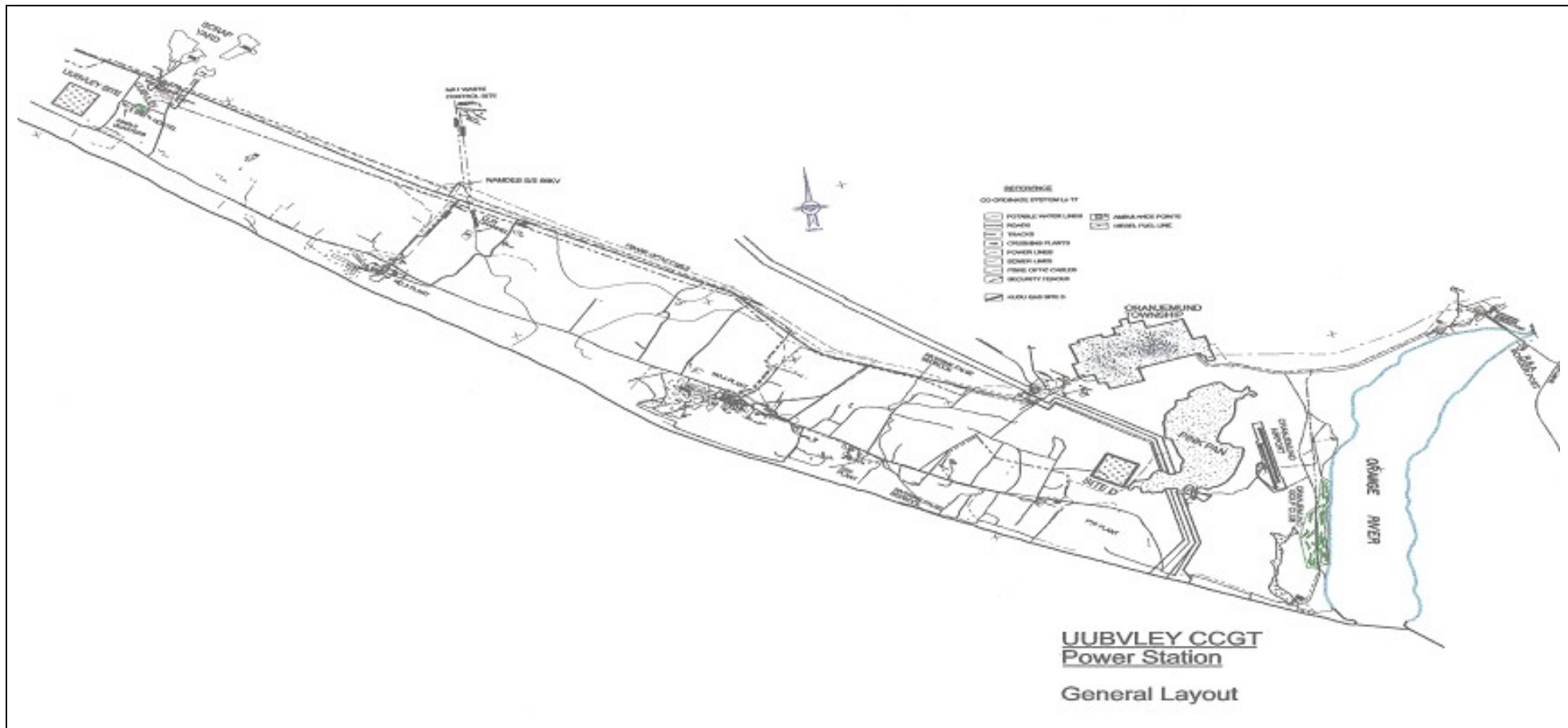


Figure 3. Location of the Uubvlei site, with Site D and the town of Oranjemund

Establishing the plant at Uubvlei will solve a number of the perceived drawbacks of Site D. These are:

- Visual distraction for Oranjemund residents;
- Impacts of noise;
- Pollution (specifically the impact of pollution on people);
- The danger to people of non-standard operating situations;
- Power lines in proximity to Oranjemund and bird flight paths (subject of a separate EIA);
- Negative interactions between power plant workers and the Oranjemund residents.

#### ***A.6 The purpose of the EIA process and this report***

The purpose of the EIA process is to:

- Identify any interactions between the proposed activity and the environment;
- Consider which of these aspects, if any, are likely to have a significant impact on the environment; and
- Recommend measures that will enhance any positive impact and avoid any adverse negative impact, and if the latter cannot be avoided, to reduce its impact and ensure adequate protection during construction and operation of the proposed activity.

This Environmental Impact Report (EIR) forms part of the process of planning and decision making for the proposed activity. The purpose of this EIR is to present the findings of the environmental impact assessment process for review by stakeholders and Authorities. It is the latest in a series of reports and information documents issued during the full EIA process.

#### ***A.7 Comment on the draft EIR***

As part of the EIA process, all Interested and Affected Parties were invited to provide comment on the Environmental Impact Report, from 2 May 2005 to 24 May 2005. No comments were received. A final revised Environmental Impact Report will be submitted to the Ministry for Environment and Tourism, Namibia, for consideration.

Comments were submitted to the following address:

Ms Stephanie Van Zyl  
Enviro Dynamics

Tel: +264 61 240300  
Fax: +264 61 240309

P O Box 20837, Windhoek, Namibia  
Email: [envirod@africaonline.com.na](mailto:envirod@africaonline.com.na)



## B. The EIA process

### *B.1 Legal and policy requirements for EIA*

The decision environment for the proposed activity is defined by the Constitution of Namibia, proposed and promulgated national statutes, and international conventions and treaties. These are dealt with in detail in Sections 2.1.1 to 2.1.4 of the main report, and they are:

- The Constitution of Namibia
- The Second National Development Plan of Namibia, 2001/2 – 2005/6, guided by Vision 2030.
- Environmental Assessment Policy
- Draft Wetland Policy of 2003
- The White Paper on National Water Policy for Namibia of 2000, together with the Draft Water Resources Management Bill
- The White Paper on Energy
- The National Environmental Health Policy
- Pollution Control and Waste Management Bill
- The Parks and Wildlife Management Bill of 2001
- Environmental Management and Assessment Bill
- Water Resources Management Act 24 of 2004
- Minerals (Prospecting and Mining) Act of 1992
- Forest Act 72 of 1968
- Sea Fisheries Act 29 of 1992
- Labour Act of 1992: Regulations for the Health and Safety of Employees at Work.
- The Diamond Act 13 of 1999
- The Public Health Act 36 of 1919 (as amended)
- General Health Regulations 121 of 14 October 1969 (as amended).
- Nature Conservation Ordinance 4 of 1975 (as amended 1996)
- Atmospheric Pollution Prevention Ordinance 11 of 1976
- The Stockholm Declaration on the Human Environment, Stockholm 1972
- Convention on Biological Diversity, Rio de Janeiro, 1992
- Convention on Wetlands of International Importance especially as Waterfowl Habitat (Ramsar Convention on Wetlands), Ramsar, 1971
- Protocol on Shared Watercourse Systems in the Southern African Development Community (SADC) region, Johannesburg 1995
- United Nations Framework Convention on Climate Change, Rio de Janeiro, 1992
- Kyoto Protocol, Kyoto, 1997
- International Convention for the Prevention of Pollution from Ships (MARPOL 73/78)
- 1989 Basel Convention on the Control of Transboundary Movements of Hazardous Wastes

### *B.2 Terms of Reference for the EIA*

The “Terms of Reference to Conduct an Environmental Assessment and Environmental Management Plan for the Proposed Kudu Combined Cycle Gas Turbine Power Plant at Uubvlei” were issued in March 2005, by NamPower.

The prime objective is to assess the suitability of Uubvlei for the location of the Kudu CCGT power plant in terms of biophysical, economic and social impacts.

Included in the tender is the requirement that the EIA study will cover all aspects relating to the construction and operation of the CCGT plant as far as the project has been currently defined. The EIA is required to consider at least the following aspects under construction, operating and decommissioning scenarios:

- Site clearance and fencing
- Bulk earthworks and civil
- Erection of structures and steel work
- All mechanical, electrical work
- All wet services installation
- Domestic water supply infrastructure
- Cooling water supply options and related infrastructure
- Effluent discharge infrastructure
- Solid and liquid waste disposal
- Air emissions under various operating scenarios
- Distillate fuel oil supply infrastructure
- Storm water and effluent control
- Road access infrastructure
- Housing (permanent and temporary)
- Presence of construction workforce and permanent workforce.

The EA Report will also have to conform to the relevant World Bank Guidelines for new thermal power plants, as well as the applicable Operational Directives.

Most of these issues were covered by the EIA done for site D and are applicable for Uubvlei. Additional issues are discussed in the section regarding specialist studies.

### ***B.3 Financial institution requirements***

The proposed Kudu CCGT Power Plant is envisaged as a private sector investment. The International Finance Corporation (IFC) focuses on investment in private sector projects, and therefore the requirements of the IFC are potentially relevant to this project. The applicable IFC requirements (and, where relevant, those of the World Bank Group) that might have implications for the proposed Kudu CCGT power plant are contained in:

- IFC Policies (including Environmental and Social Safeguard Policies)
- IFC Procedure for Environmental and Social Review of Projects
- IFC and World Bank Guidelines (including the World Bank's Pollution Prevention and Abatement Handbook)
- IFC Guidance Notes.

A summary of the main implications of these IFC requirements for the proposed Kudu CCGT power plant, are discussed in more detail in Appendix D. In terms of the IFC's project categories, the CCGT plant would be a Category A project, thus requiring a full Environmental Assessment.

#### ***B.4 Methodology for the EIA***

The methodology for the EIA is the environmental assessment procedure described in Namibia's Environmental Assessment Policy (1995). In terms of the policy, the Kudu Power Project (the proponent) is required to follow the Integrated Environmental Management (IEM) Procedure set out in Appendix A of the Policy (see Figure 4). In terms of this, the Develop Proposal Stage, or preliminary environmental assessment (PEA) is completed and submitted to the Ministry of Environment and Tourism (MET) for classification. If significant impacts are identified, the MET can request the Proponent to undertake a detailed environmental assessment. The key components of a preliminary environmental assessment (PEA) are to:

- Notify interested and affected parties (I&APs);
- Establish policy, legal and administrative requirements;
- Consult relevant ministries and I&APs;
- Identify issues and alternatives.

A PEA for the proposed power plant was undertaken in 1998. The next step in the IEM procedure is this environmental impact assessment (EIA) of the preferred site (Step 5 in Figure 4) and the compilation of an Environmental Management Plan (Step 8 in Figure 4).

A full EIA of a proposed CCGT power plant at Site D, Oranjemund, was conducted by the CSIR in collaboration with Enviro Dynamics in 2004. The study concluded that Site D as a location was the preferred technical, economic and environmental option. The EIA report was reviewed and a positive Record of Decision was issued by MET in January 2005.

Notwithstanding MET approval of Site D as the preferred site for the power plant, Nampower decided in February 2005 to investigate the possibility of locating the power station at Uubvlei, some 25 kilometres north of Oranjemund, and to commission another EIA for the construction, operation and decommissioning phases of the power station at Uubvlei. Although this second EIA is an entirely new stand-alone document, much of the information and analysis contained in the Site D EIA will be used in this EIA.

The purpose of an EIA is to provide information to stakeholders and decision makers as to whether the proposed activity will have a substantial detrimental effect on the environment. It provides an assessment of predicted positive and negative impacts of the proposed activity, to understand to what extent the activity will meet the goals of sustainable development. The EIA is being undertaken in three stages:

- Scoping
- Specialist studies
- Integration and impact assessment.

Namibia's Environmental Assessment Policy and the pending Environmental Management and Assessment Bill also require Public Consultation, in the form of scoping at the outset of the EIA, and integrated into the whole process. The consultation undertaken during this EIA built on the scoping exercise already undertaken during the PEA. However, it was considered important to allow for thorough participation once again, because 6 years have elapsed since the undertaking of the PEA, and new dimensions and stakeholders have come into play since then. The process comprised the following:

- Identification of key stakeholder groups - the stakeholder list is attached as Appendix A.
- Invitation and background information document (BID) - a copy of the BID is attached as Appendix B.
- Invitation - stakeholders were invited to a meeting in Oranjemund on 31 March 2005.
- Consultation meeting - held as follows (minutes of the meeting are attached as Appendix C):
  - Thursday, 31 March 2005, Oranjemund, School Auditorium
- Direct comments received - a few comments forms and e-mails were sent directly to Enviro Dynamics.
- Public Feedback
- Issues identified - these, which came from the public meeting, were grouped into the following broad categories:
  - Project design and implementation;
  - Uubvlei hostel accommodation;
  - Visual and noise impacts;
  - Security, access and transport;
  - Aviation safety;
  - Biophysical impacts;
- The Draft EIR was available for public comment during the period 2 May 2005 to 24 May 2005. The notification of the document availability, and due-date for comments was e-mailed and faxed to parties as relevant. NamPower further placed a notice in the press requesting comment on it. Printed copies of the Draft EIR will be made available in the Windhoek National Library, the Oranjemund Library and NamDeb in Oranjemund for comment.
- The document was also available on the NamPower website. Printed copies of the document and copies on compact disk were distributed to ministerial representatives on the Inter-ministerial Review Group (IRG).

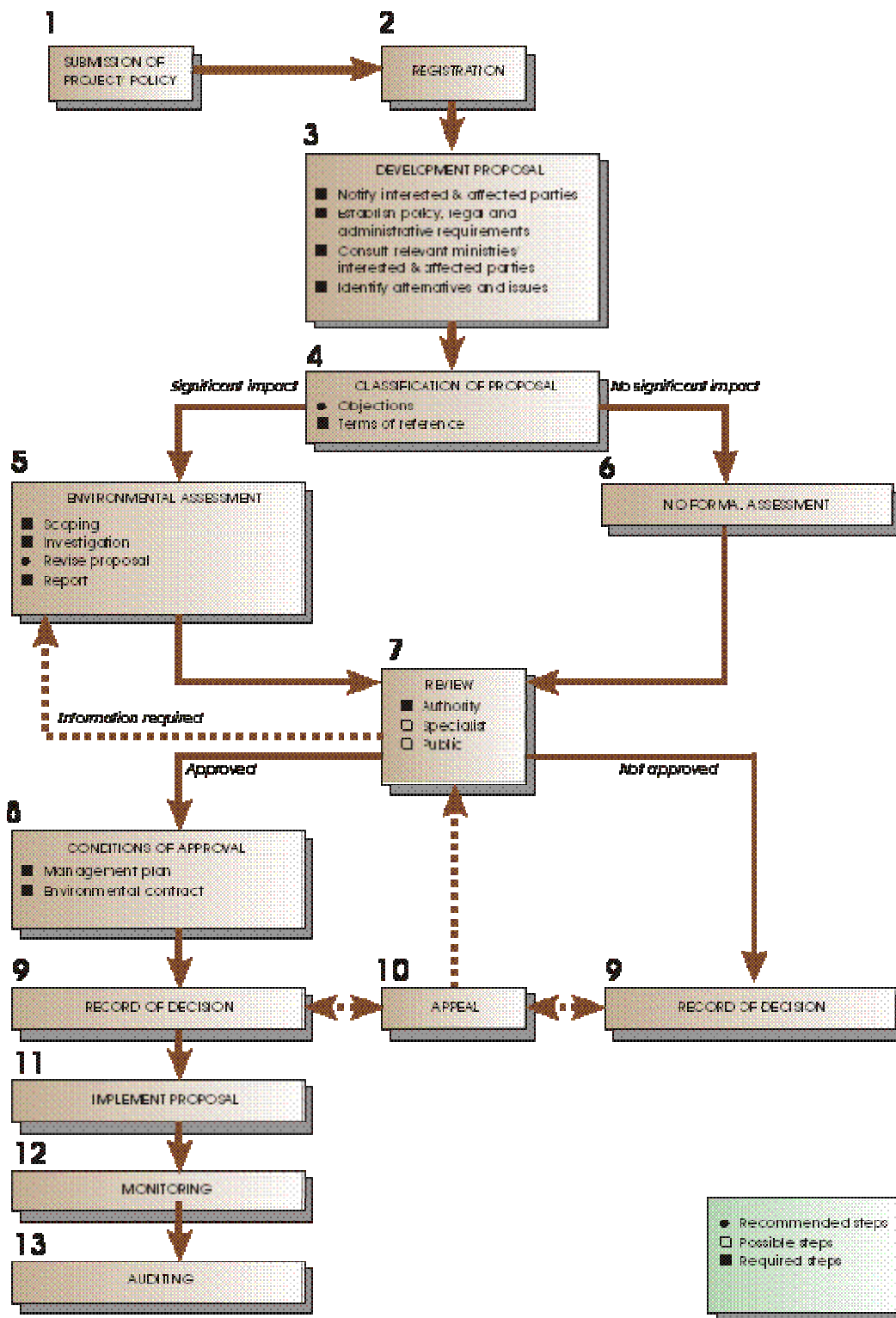


Figure 4. Integrated Environmental Management Procedure

### ***B.5 Specialist studies***

In the TOR for the EIA of the Uubvlei site, the following new, site specific issues that warrant additional work were commissioned for the Environmental Impact Assessment:

- Description of the biophysical characteristics of Uubvlei site;
- Options for water abstraction for cooling given the differences between Uubvlei and Site D (i.e. from beach wells, ponds or directly from the ocean);
- Options for purge water discharge given the differences between Uubvlei and Site D (i.e. into ponds, onto the beach/intertidal zone, beyond the breakers);
- The suitability of existing facilities to accommodate the workforce during construction, and possibly operation;
- Options for supply of services for workers - water, electricity, recreation facilities, health services, catering, etc.;
- Options for waste management – industrial waste during construction, household waste, sewerage, hazardous waste;
- Maintenance of the road between Uubvlei and Oranjemund;
- Security issues and access to site;
- Interactions with Namdeb;
- Climate – implications for corrosion, dust control, etc.

This study has built on existing specialist studies and used the same specialists that were involved in the environmental assessment for site D at Oranjemund.

### ***B.6 Integration and impact assessment***

The results of specialist studies have been integrated into this environmental impact report (EIR). Recommended mitigation measures for negative impacts and enhancement measures for positive impacts are also provided together with any monitoring required. These recommendations will form the core of the Environmental Management Plan (EMP) for design, construction and operation.

## **C. Project description**

### ***C.1 Description of proposal***

#### **C.1.1 Introduction**

The proposed development will comprise a combined cycle gas turbine (CCGT) power plant of nominal 800 MW capacity. Natural gas will be the main fuel for the plant. There will be associated connections to the electricity and gas grids.

The proposed project is the most environmentally benign form of electricity generation by thermal power plant. It has a very high efficiency and lower air emissions and cooling water requirements per unit of electricity generated than for conventional thermal plant. In particular, when firing on natural gas with low-NO<sub>x</sub> burners as planned, there are no significant emissions of NO<sub>x</sub> or SO<sub>2</sub> and emissions of carbon dioxide (CO<sub>2</sub>), which is the most significant greenhouse gas from the perspective of anthropogenic emissions to air, are over 50% lower than for conventional plant burning coal.

Where no constraints apply to gas availability, the CCGT technology chosen is accepted world-wide as the most suitable technology for a power plant of the size proposed.

### **C.1.2 Description of Site**

It is proposed that the Kudu CCGT Power Plant be located at Uubvlei near the town of Oranjemund, a small diamond mining town that is located near the mouth of the Orange River in the south-western corner of Namibia (see Figure 5). The Orange River forms the boundary between Namibia and South Africa. A feasibility study undertaken in 1997 identified Oranjemund as being the optimum location for a power plant; the proposed site is located about 25 km north of the town. The site currently comprises mined-out land and lies within a high security mining area operated by Namdeb.

It is proposed initially to construct a nominal 800 MW CCGT plant which will become operational in mid-2009. The plant will comprise two gas turbines, with one or two steam turbines. A further nominal 800 MW may be constructed later to commence power generation in about 2014 if the supply of gas is sufficient, and power demand in Namibia and in surrounding countries can be confirmed.

The area of the site is about 49 ha (700 m x 700 m), which is the area required to provide for construction staging and laydown (Figure 6).

The possible later development of the plant to 1600 MW capacity will take place within the confines of the currently designated site. All construction activities, e.g. concrete mixing, stockpiling of materials, will be conducted on already disturbed land immediately adjacent to the areas designated for the two 800 MW units.

The construction workforce, a maximum of 1 300 workers, will be accommodated near to the CCGT site. Either the existing mine hostel facilities at Uubvlei will be suitably upgraded for this purpose, or new temporary facilities will be constructed at the designated location adjacent to the CCGT site, on land that is already disturbed by mining (Figure 6) It should consist of housing, ablutions, canteen and kitchen, bulk food stores, cold and freezing facilities and both indoor and outdoor recreation facilities. It would require full electrical, water and sewage reticulation, streets with area lighting and a high security perimeter fence. These temporary facilities will be in use for about two and a half years, after which it would have to be removed completely. In the event that the second phase of the power plant is implemented, these accommodation facilities would be required for another two and a half years.

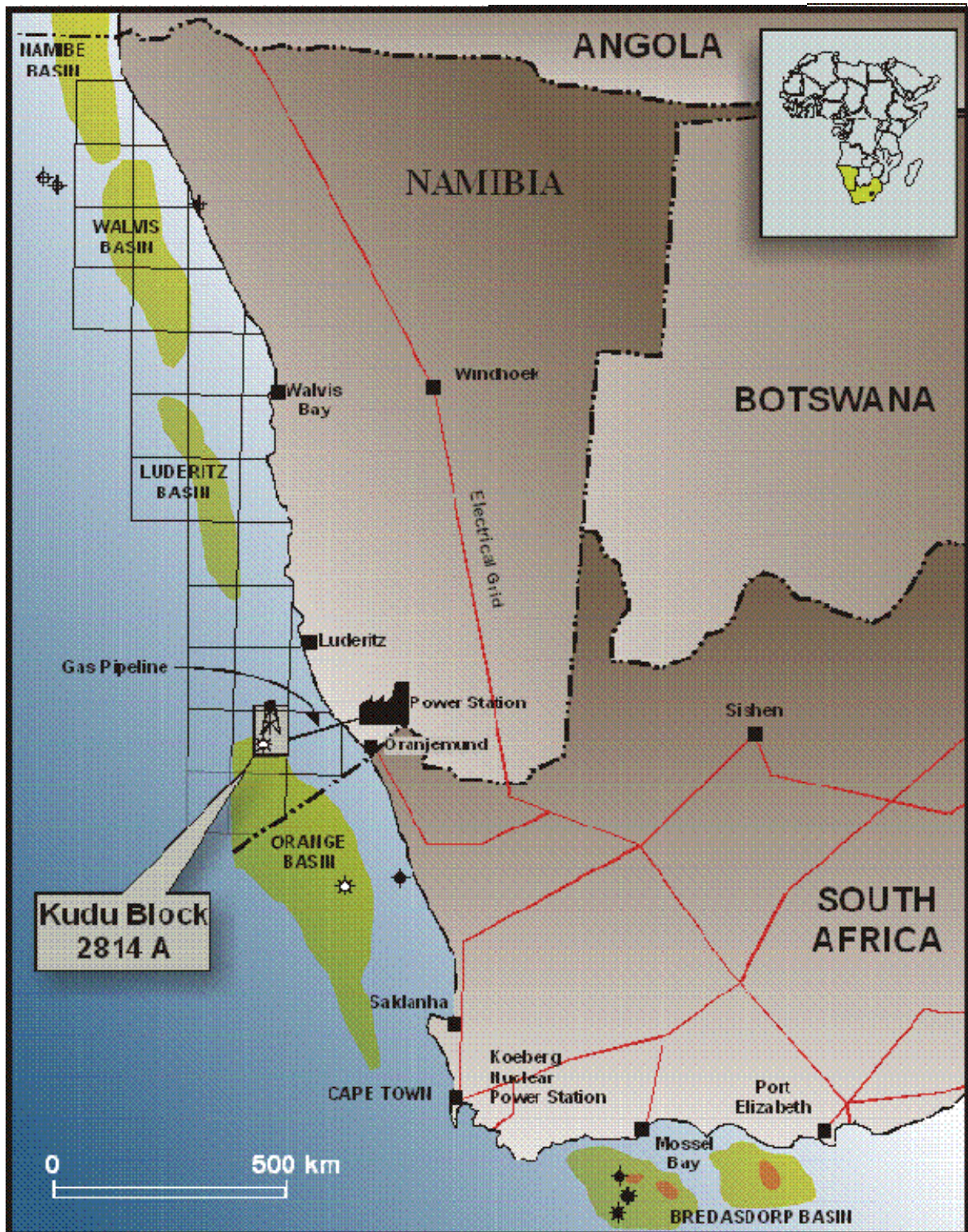
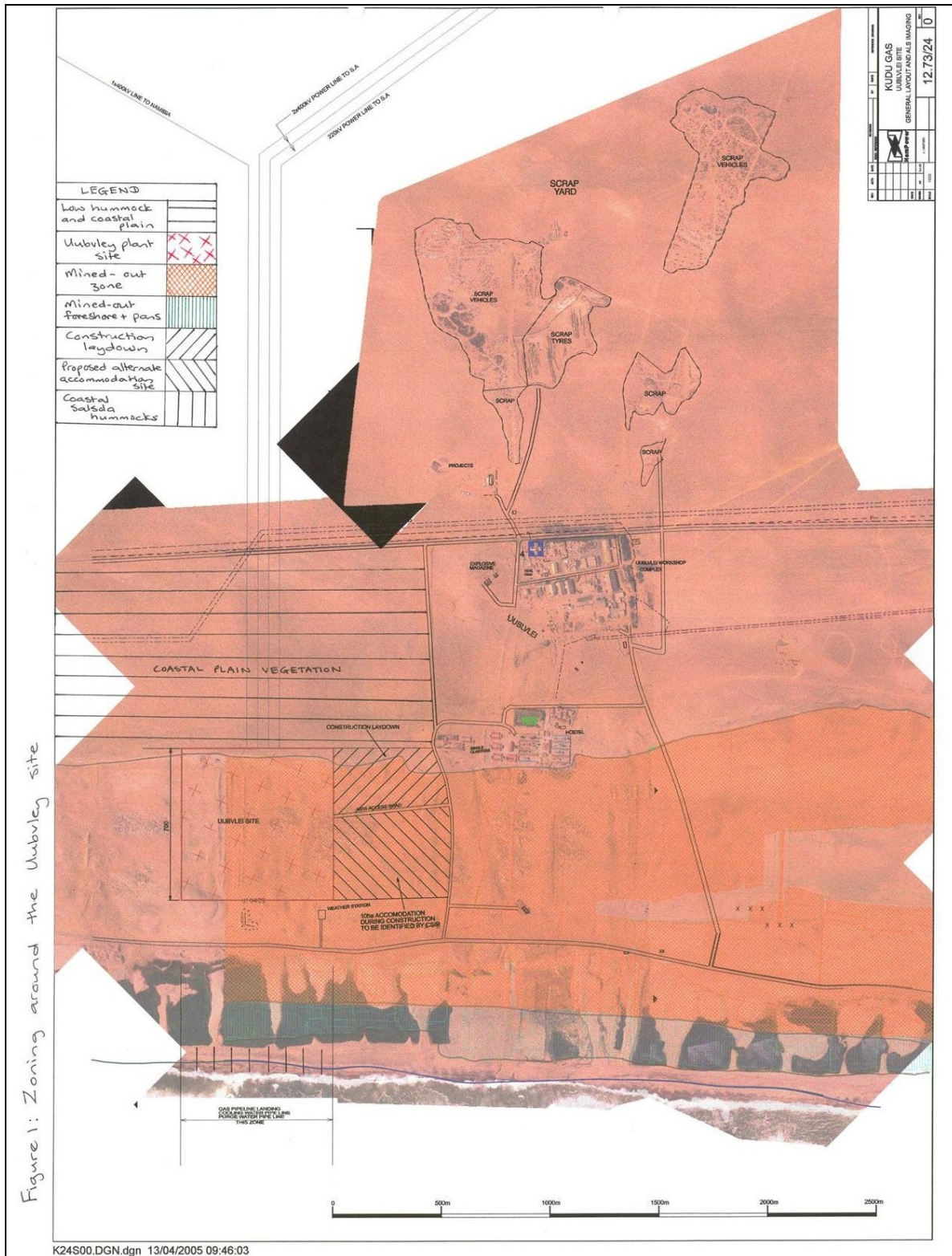


Figure 5. Location of the CCGT power station at Oranjemund. The gas to power the station will be sourced from the Kudu gas field (Kudu Block 2814A).





**Figure 6. The location of the CCGT site at Uubvlei, near Oranjemund.**

### C.1.3 Site Access and Security

It is anticipated that major components of the CCGT plant will be delivered from the Port of Lüderitz by means of haulage vehicles suitable for extra-heavy loads. A map of this route is provided in Figure 10.

The site currently lies within the MA1 high security area, which is surrounded by a double fence. The construction site and the construction workforce accommodation will be surrounded by normal industrial security fencing and provided with street lighting.

## C.2 Plant Details

### C.2.1 Plant Design and Layout

The combined cycle gas turbine power plant utilises the following process:

Two gas turbines burning either gas or liquid fuel drive two generators for electricity production. Exhaust gases from each gas turbine pass through a heat recovery steam generator (HRSG) to generate steam.

The steam generated in the two HRSGs drives a steam turbine which in turn drives a generator to produce further electrical energy.

The proposed plant will employ the most recently developed CCGT technology. A schematic of the process is shown in Figure 7.

Two configurations, which may be referred to as single-shaft and multi-shaft, are possible for the Kudu CCGT power plant. A single-shaft arrangement consists of a gas turbine, steam turbine and generator arranged on a single shaft or power train. There would be two such units at Kudu CCGT – see Figures 8 and 9 for plan and isometric views of a typical two single-shaft layout. The alternative multi-shaft option has two gas turbines and a steam turbine each with its own dedicated generator. For Kudu CCGT Power Plant the final choice between single-shaft and multi-shaft designs will be made on technical and economic grounds, following a competitive tender process.

The plant will be fired on natural gas with the possible provision of a back-up facility for firing on liquid fuel.

The rated capacity of the plant will initially be approximately 800 MW; this approximation arises from the nature of gas turbines. Sizes are particular to the design of individual manufacturers and it is not possible in an open international competition to specify the exact output without prejudice or favour to one manufacturer.

A gas conditioning plant with its associated slug catchers will be constructed adjacent to the CCGT power station. The purpose of the gas conditioning plant is to supply dry gas to the power plant, and to recover the monoethylene glycol (MEG) used to prevent the formation of methane hydrate in the pipeline from the offshore production platform. Gas and liquids from the pipeline are led into a slug catcher, which permits the separation of the gas from the condensate and water/monoethylene glycol (MEG) mixture. The slug catcher for Phase 1 will have a volume of

200 m<sup>3</sup>. The gas is dried and heated before passing through a fiscal meter and on into the power station. The condensate and water/MEG mixture is passed through a separator. The condensate is cooled and either stored for use as auxiliary fuel in the power station or sold. The water/MEG mixture is further treated in a regeneration unit which separates the MEG from the water. The MEG is returned to the platform via a piggyback pipeline.

## C.2.2 Plant Components

The principal components will include the following:

- Gas turbines
- HRSG with exhaust stack
- Steam turbine(s) and condenser(s)
- Water treatment plant and water storage facilities comprising bulk storage tanks
- Cooling water (CW) system
- Above-ground Gas Installation/piping to supply the plant
- Transformers
- High voltage electrical switchgear
- Fire protection system
- Administration/control building
- Auxiliary boiler and stack for plant start-up purposes

Depending on the choice of equipment, the following may also be provided:

- Gas compressor
- A by-pass stack for the gas turbines to allow them to operate in isolation from steam turbines
- Gas turbines or diesel generators for black start capability
- Liquid fuel storage facilities comprising bulk tanks

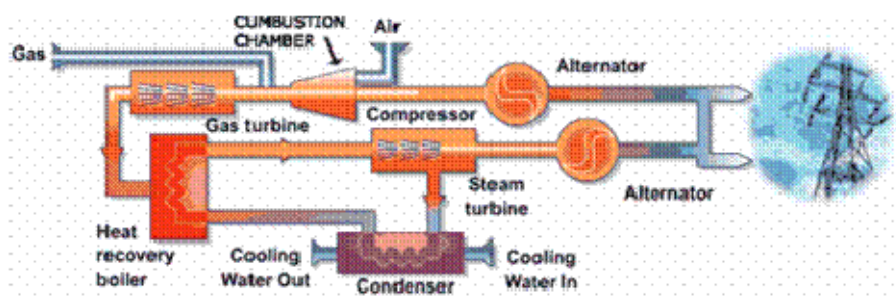


Figure 7. The concept of the CCGT plant in diagrammatic format.

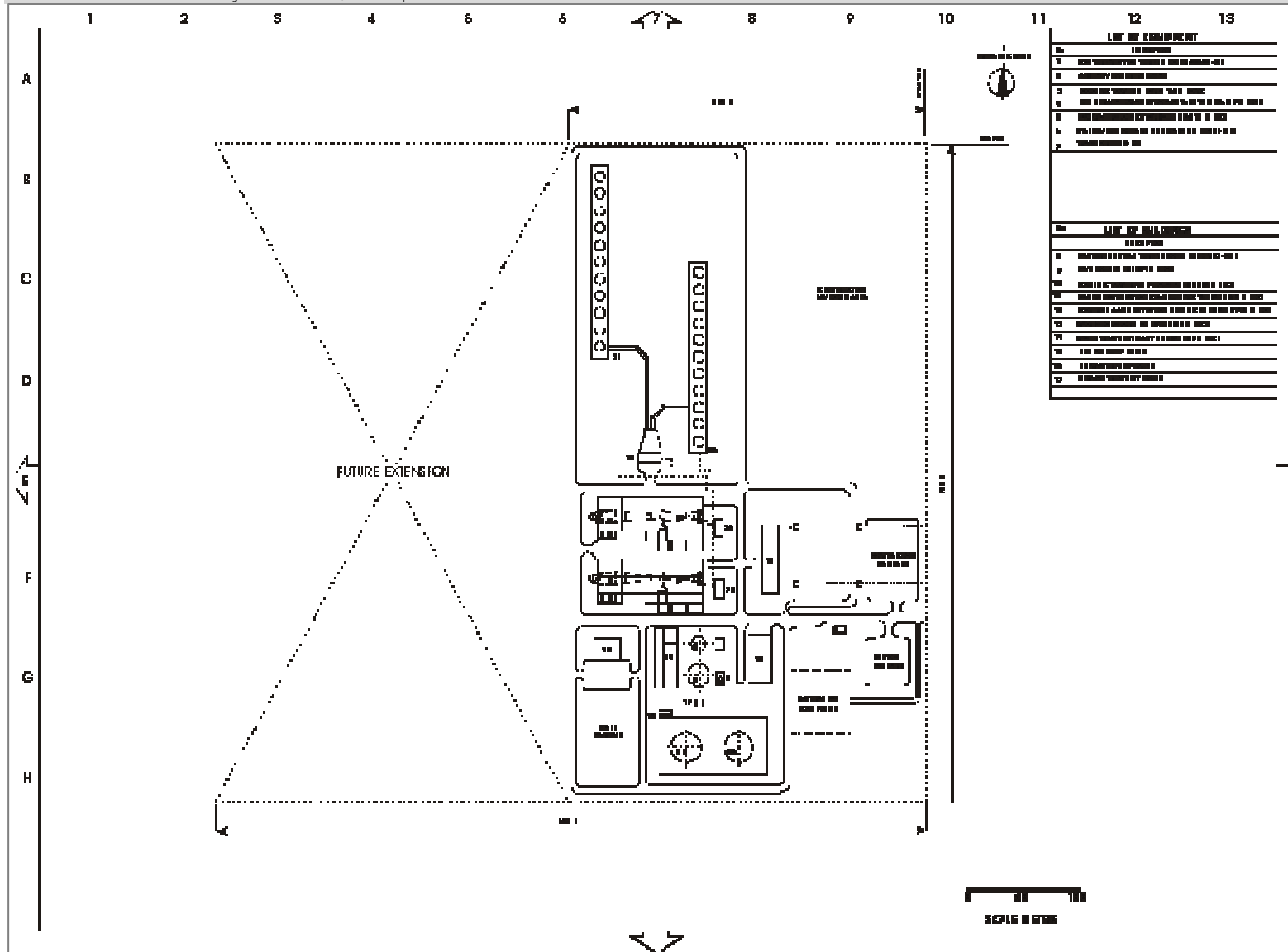
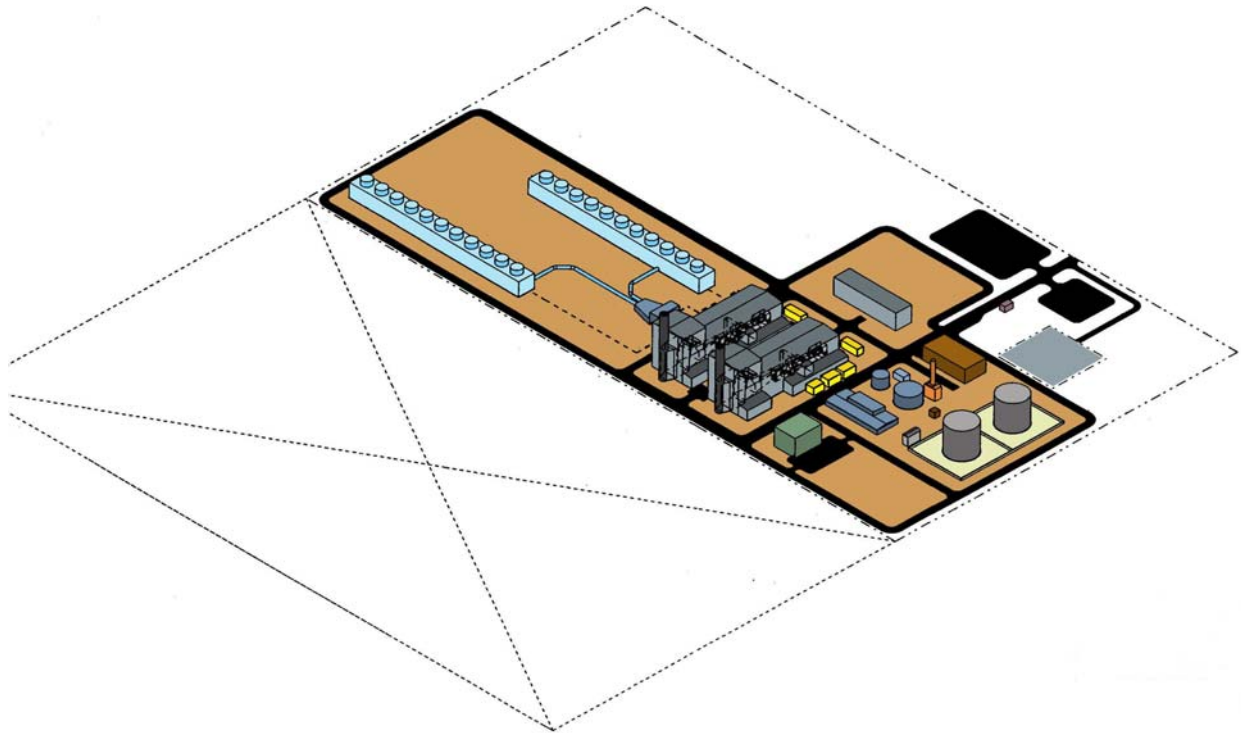


Figure 8. Plan view of layout of the 800 MW CCGT plant showing location for the second 800 MW plant.



**Figure 9. Isometric view of layout of the 800 MW CCGT plant showing location for the second 800 MW plant.**

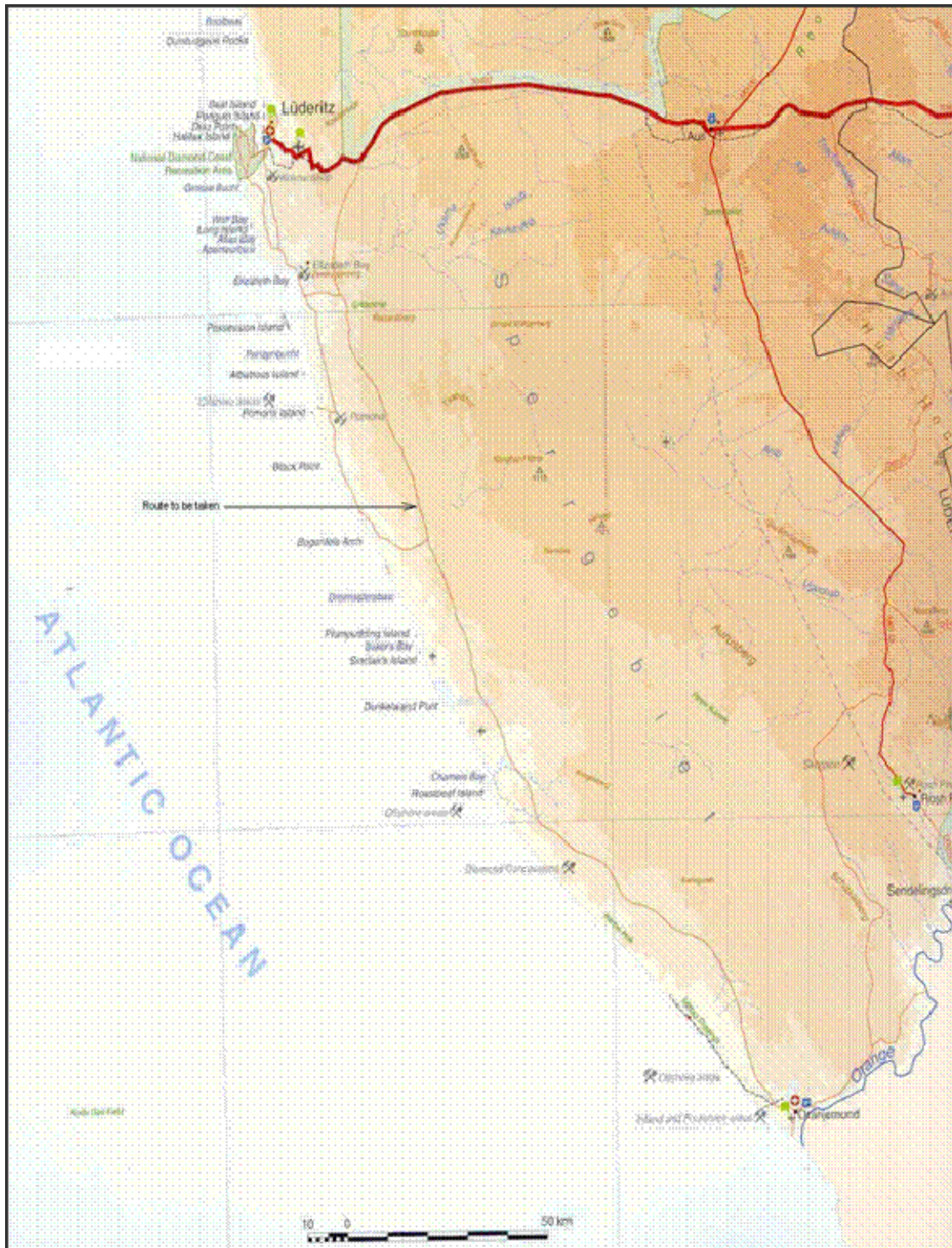


Figure 10. Proposed route for heavy haulage from the Port of Lüderitz and Oranjemund.

### C.2.3 Power Generation Process

A gas turbine is one in which the working substance is a gas rather than a condensable vapour, as in a steam turbine, or a liquid, as in a water turbine. The gas turbine itself consists of an air compressor, a combustion chamber, a turbine and an electricity generator coupled together. The air compressor, combustion turbine and electricity generator are all attached to one main shaft which rotates at high speed.

The air compressor takes in large quantities of air from the atmosphere and compresses it into the combustion chamber from where it flows through the turbine. Fuel is then injected into the combustion chamber and ignited. This addition of heat energy and combustion gases raises the temperature of the combined gases to over 1,300 °C and greatly increases the velocity of these gases through the turbine. The effect of this high velocity gas flow through the turbine drives both the air compressor to supply air and the electricity generator to produce the rated electrical power output. The expansion of the hot gases through the turbine and the extraction of mechanical work from them via the turbine reduces the temperature of the gases to approximately 600 °C.

Operation of a gas turbine as described above is referred to as open or simple cycle mode. However, it is possible to generate approximately 50% more electricity from the hot exhaust gases by diverting them through an HRSG (boiler) which extracts heat to make steam, which in turn drives a steam turbine. The temperature of the hot gases is reduced in this process to approximately 100 °C, but the heat recovery system does not in other respects alter the composition of the gases. They are discharged to the atmosphere via a stack on top of the HRSG.

Water for the HRSG is drawn from a suitable supply, is treated in a water treatment plant to achieve high purity and is then stored prior to use. The steam produced is supplied through inter-connecting pipework to the steam turbine and is then exhausted to the condenser. The steam turbine drives the electricity generator to produce the additional power output.

The electricity generated is fed to transformers where the voltage is stepped up for transmission via a local substation to the power grid.

Cooling water is used to condense the steam used in the steam turbine element of the combined cycle. The steam is condensed to hot water, which is then recirculated to the HRSG. The heat transferred to the cooling water must be released to the environment. There are a number of possible arrangements, which include direct seawater cooling and evaporative cooling in a cooling tower. It is also possible to dissipate heat from steam condensation to the air using an air cooled condenser. For evaporative systems losses in the cooling system are made up from supplies drawn from a suitable source.

### C.2.4 Occasional Processes & Activities

#### ***Bypass Mode***

The above description constitutes a full CCGT arrangement. Depending on the chosen plant configuration, it may also be possible to operate the gas turbine on its own, i.e. without passing the exhaust gases through the HRSG. In this mode the exhaust gases are directed to a bypass stack and are discharged to atmosphere without passing through the HRSG.

Operation in bypass mode is evidently less efficient than in full CCGT mode and it arises when the steam turbine is unavailable. This could arise during a steam turbine trip and during maintenance and at start-ups, where the steam conditions are initially unsuitable for the steam turbine.

Economic factors will determine whether the gas turbines at Kudu CCGT Power Plant will be equipped with bypass stacks.

#### ***Operation on Liquid Fuel***

Liquid fuel may be available for stand-by purposes. The necessity for an alternative fuel supply arises in part from the nature of gas supply which usually has some unavailability due to, for instance, maintenance work on the production platform. Faults may also arise in the supply system.

While natural gas may be unavailable for 10 – 15 days annually, up to half of these days are for scheduled outages that could be timed to coincide with the annual maintenance of at least one GT. In any case, continuous operation on fuel oil would be unlikely for cost reasons for the full duration of unavailability.

#### ***Black Start Capability***

Based on technical and economic studies, the Kudu CCGT Power Plant may be equipped with a facility to enable it to be started when isolated from the power grid, when no other sources of electricity are available. This is known as the black-start facility, and it would consist of one or two gas turbines or diesel generators with a capacity of up to 20 MW.

### **C.2.5 Plant Efficiency**

The plant will have an efficiency over its working life of about 55%. This means that 55% of the chemical energy contained within the fuel is converted into electrical energy. The plant will employ technology recognised as being the most advanced for power production on the scale proposed. The high overall efficiency will lead to lower specific emissions to the environment compared to any other form of conventional thermal plant.

Equivalent efficiencies in conventional thermal plants rarely reach 40%.

### ***C.3 Plant Enclosures***

The particular model of gas turbine to be installed will determine the overall size of the plant and its configuration and layout. The layout arises from the functional relationship of the main elements of the plant to associated ancillary plant and buildings.

The development will comprise the main structures as listed below. Exact dimensions of each element will become known only after contractor selection. The main structures associated with the development will be the gas turbine, bypass stack (if provided), HRSG with associated stack, steam turbine building, cooling towers and ancillary buildings.

- Enclosures to house the gas turbines – height approximately 25 m.
- Enclosure to house the steam turbine - height approximately 25 m.
- HRSG - height approximately 40 m.



- Cooling towers - height approximately 30 m.
- Auxiliary boiler - height approximately 12 m.
- Electrical Building to house switchgear enclosures - height approximately 12 m.
- Enclosure for Water Treatment Plant with chemical storage tanks - height approximately 12 m.
- Exhaust Stacks - height approximately 45 – 60 m for HRSGs, 45 m for by-pass stacks (if provided) and 45 m for auxiliary boiler.
- Water storage tanks for raw water, semi-treated and treated water - height approximately 20 m.
- Liquid fuel storage tanks (if provided) within a bunded area - height approximately 20 m.

Other components at lower elevations include the following:

- Workshops and Stores Building
- Control and Administration Building
- Generator, Unit and House Transformers
- Gas compound
- 400 kV Switchyard
- Fenced enclosure to house gas compressors (if provided)
- Black-start facility (if provided)

Some of these buildings may be combined or be subdivided depending on the final choice of plant.

The structural form of buildings will be conventional structural steel supported on reinforced concrete foundations. Steel columns will be fire protected as necessary. Floors will be concrete. Profiled fibre cement cladding will be used for external walls.

Roofs will be constructed of profiled fibre cement decking on purlins spanning between rafters and will be flat or shallow pitched. Buildings will have access gantries and walkways for access to plant and equipment. These will be constructed of stainless/galvanised steel open grating type flooring supported on steel beams and columns.

External personnel and escape doors will generally comprise metal flush doors and mild steel frames.

Stacks will be fabricated from painted insulated carbon steel. External finishes to all structures and components will be appropriate to the highly corrosive / abrasive environment encountered at the site.

#### **C.4 Unit Operations**

Brief descriptions of the principal individual unit operations are as follows:

### ***Gas Compressor (if provided)***

Depending on the plant selected and gas supply pressure, it may be necessary to compress the gas for supply to the gas turbine.

### ***Gas Turbine (GT)***

The GT will essentially comprise a multi-stage axial-flow compressor section with movable inlet guide vanes, a combustion chamber with several burners and a multi-stage axial-flow turbine section. Natural gas will be burned using air from the air compressor. The hot gas will pass through the turbine blades. Mechanical energy will be converted into electrical energy in the electrical generator coupled to the gas turbine. The exhaust gases will pass to the HRSG.

The gas turbine will be equipped with an intake air filtration system, a starting system, a lubrication system, a cooling system and other ancillary features.

### ***HRSG***

Exhaust gases from the gas turbine will be used to produce steam, which will feed a steam turbine. The cooled exhaust gases will then be emitted to atmosphere. The HRSG will be a multi-pressure type and will be equipped with a supplementary firing system to burn condensate that must be removed from the natural gas.

### ***Steam Turbine and Condenser***

The steam turbine will be of a multiple cylinder type suitable for direct coupling to a two-pole generator for power generation at 50Hz. The thermal energy of the steam generated by the HRSG will be converted to mechanical energy in order to drive a generator to produce electric power. The exhaust steam will flow out of the steam turbine to a condenser system.

### ***Boiler Water Treatment***

The steam-water cycle will be a closed-loop system with make-up supplied from the incoming water supply via an on-site water treatment plant where water for use in the HRSG will be treated to achieve a high purity. The water treatment process will consist of organic scavengers, and cation, anion and mixed bed ion-exchange. Regeneration of the ion-exchange resins will utilise sulphuric acid ( $H_2SO_4$ ) and caustic soda (NaOH).

Corrosion in the HRSG may be mainly caused by dissolved oxygen ( $O_2$ ) or carbon dioxide ( $CO_2$ ) in the feedwater. The feedwater must be pH controlled to prevent corrosion and it is desirable to use deaerated water. It is anticipated that feedwater will be dosed with ammonia ( $NH_3$ ), caustic soda (NaOH) or phosphate ( $Na_3PO_4$ ). In addition, an oxygen scavenging chemical, dilute hydrazine ( $N_2H_4$ ), may be required to achieve the required water quality by absorbing any traces of oxygen that get into the boiler.

### ***Electrical Transformer(s)***

The electricity generated will be fed to a generator transformer where the voltage will be stepped up. It will be an indoor, three phase unit and of the oil immersed design. It will be banded and blast protected with a deluge system for fire protection. Power will flow from this transformer to the electrical gas-insulated switchgear building, and thence to the power grid.

## C.5 Cooling Water

### C.5.1 Systems Under Consideration

Three potential cooling water system technologies have been considered for application at the CCGT site:

#### **Direct seawater cooling**

Direct seawater cooling entails cooling the steam turbine condensers by means of a once-through heat exchanger. The volumes required are large (ca. 50 000 m<sup>3</sup>/hour) and the discharged water would be about 10°C hotter than the intake sea water. Direct seawater cooling is the most efficient method to condense exhaust steam. The distance of the CCGT site from the shore and the dynamic nature of the shoreline as a consequence of both natural processes and mining operations mean that this option is unlikely to be implemented. However, there is at least one potential site further north in MA1 where direct seawater cooling potentially could be a viable option.

#### **Evaporative cooling**

Evaporative cooling using induced draught cooling towers incorporates a semi-closed water circulation system (see Figure 11). The cooling system includes a large storage capacity (approximately 50,000 m<sup>3</sup>) into which make-up water is introduced at a rate of 2 000 m<sup>3</sup>/hour. Sea water will be used as make-up, described in Figure 12 below. Approximately 700 m<sup>3</sup>/hour is lost through evaporation and a further 1 300 m<sup>3</sup>/hour is purged from the system to maintain the dissolved solids of the reservoir at acceptable levels. The temperature of the discharged purge water will depend upon the prevailing atmospheric conditions but an increase of 10°C above ambient is unlikely to be exceeded. The salinity of the purge water is expected to be about 50-55‰, i.e., a brine, as opposed to a salinity of 35‰ m/m in normal seawater.

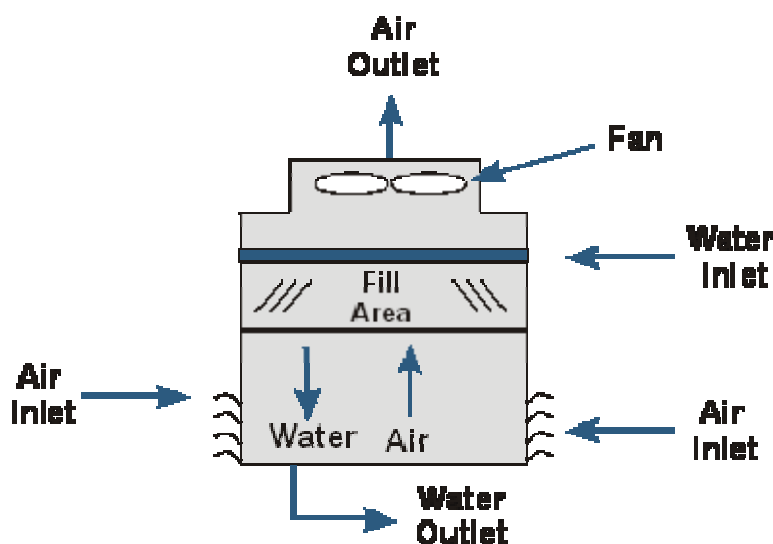


Figure 11. Semi-closed Evaporative Cooling System

Because the water is predominantly recirculated within the cooling water system it requires treatment to prevent deterioration of the plant components. Treatment will be by injection of a biocide, possibly sodium hypochlorite (NaOCl), at very low concentrations.

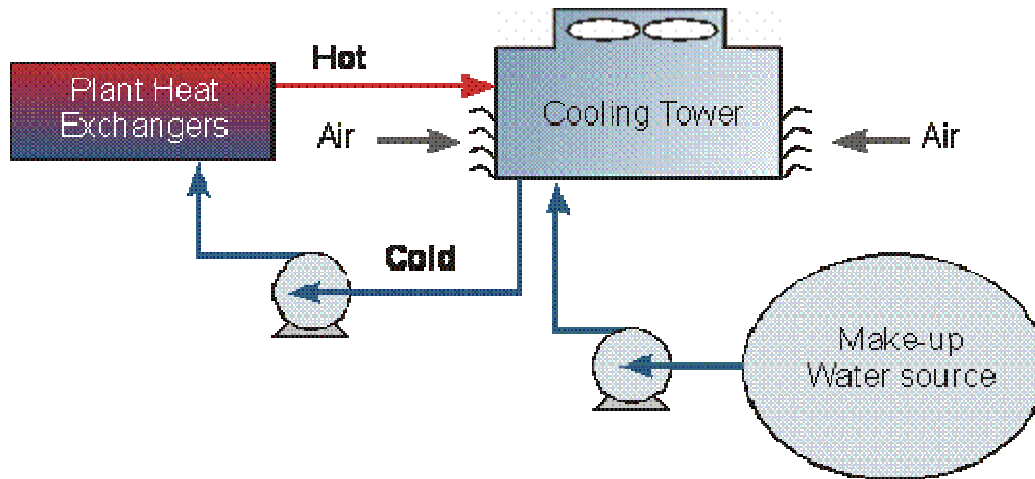


Figure 12. Make-up Water Cooling Tower System

### ***Dry Cooling***

In a direct dry cooling system the exhaust steam is channelled directly to a radiator-type fin-tubed heat exchanger. The steam's latent heat is transferred to the metal surface of the finned tube. Air to cool the fins is forced across the heat exchanger by electrically driven fans.

While both systems are under consideration, because of the lower overall efficiency of air cooled systems, the preference for Kudu CCGT power plant is for an evaporative system, subject to the availability of a suitable supply of make-up water and the long-term reliability of that supply.

## **C.5.2 Sources of Cooling Water**

Potential sources of make-up water for evaporative cooling are as follows:

### ***Direct Extraction from the Sea***

Sourcing of water from the sea would require a pipeline extending seaward of the surf zone, in order to extract relatively sediment-free water. Locating the water intake beyond the depth in which significant sand movement occurs is required. Based on existing bathymetric and wave climate data, this indicates that the intake be located at 15 m or more below sea level. Allowing for a potential 300 m progradation of the shoreline as a result of mining operations, the intake pipeline will extend 1 400 m from the present shoreline. This distance is believed to be adequate for the greatest beach accretion predicted under various potential future mining scenarios. It is envisaged that the intake ports be situated 2 m above the seabed to avoid intake of sediments suspended near the bottom.

### ***Extraction from Mining Ponds***

The existing mining ponds, which are associated with Namdeb's diamond mining operations, are a potential source of make-up water. The ponds are close to the power plant site and are free of

suspended sediment. Potential future mining scenarios and their impacts on overall stability and reliability of the ponds, together with the long-term availability of the necessary quantity of make-up water, are under detailed investigation.

### ***Extraction from Beach Wells***

A beach well is a conduit by which groundwater can be extracted from aquifers in coastal environments. The well itself is generally a hole that intercepts the aquifer at some depth below the site surface, and is usually lined during, or immediately after, excavation, so as to prevent collapse. Well efficiency is influenced by clogging, and deformation of the aquifer due to excessive extraction, poor well field management or inappropriate design. Indeed, while water extracted from beach wells generally appears free of sediment, the significant maintenance of pumping equipment used in previously operating well-fields suggests that finer grained particles still enters from the aquifer. Often set back from the shoreline to prevent inundation during storm events, beach wells positioned adjacent to existing seawalls often derive most of their water via the mining ponds and not the sea. As such, management practices within the ponds have a direct influence on their yield and efficiency.

## ***C.6 Plant Operation***

### **C.6.1 Running Regime**

It is expected that the plant will operate at base load, i.e. continuous operation, 24 hours per day, 365 days per year and will be staffed on a shift basis for plant operation. An average annual load factor of circa. 92% is initially expected for the plant with the non-operational balance of hours being downtime for maintenance.

Best practice internationally would involve an operational workforce of 30 – 40 staff. Non-core activities such as security, grounds maintenance, etc. may increase this number to about 50.

Plant overhauls, during which workforce numbers will increase temporarily, may initially occur at intervals of about six years.

Normal operation of the plant will be as a combined cycle power station fuelled with natural gas. It is envisaged that the plant will operate in open cycle mode in exceptional circumstances (if a by-pass stack is provided).

Start-ups fall into two categories, namely cold start and warm start. A warm start occurs after a short outage. A cold start occurs less frequently, usually after a lengthy outage, such as for plant overhaul.

### **C.6.2 Use of Resources**

The principal materials used will be as follows:

#### ***Natural Gas***

The primary fuel for the Kudu CCGT Power Project will be natural gas. The maximum demand for gas for an 800 MW capacity plant is equivalent to about 3.5 million m<sup>3</sup>/day. Natural gas will be delivered to the power plant via a gas pipeline from the offshore gas field and an on-shore conditioning plant.

### **Water**

Water for use in the HRSG will be stored in bulk storage tanks filled by the supply from the water treatment plant. The maximum quantity for use for the HRSGs will be approximately 70 m<sup>3</sup>/hr and average use will be approximately 20 m<sup>3</sup>/hour. This storage will also serve as the supply for fire-fighting purposes and for water injection for NO<sub>x</sub> control when firing on liquid fuel (if capability is provided). Water injection during firing on liquid fuel would result in additional consumption of up to 180 m<sup>3</sup>/hr of water.

### **Bulk Chemicals**

Regeneration of ion exchange resins used in water treatment will be by caustic soda (NaOH) and either sulphuric acid (H<sub>2</sub>SO<sub>4</sub>) or hydrochloric acid (HCl). These will be stored on site in bunded storage tanks. Smaller stocks will be held of ammonia (NH<sub>3</sub>) for control of pH and hydrazine (N<sub>2</sub>H<sub>4</sub>) or equivalent for control of dissolved oxygen (O<sub>2</sub>) levels of the water in the HRSGs.

### **Electricity**

Kudu CCGT will produce its own electricity for auxiliary plant and during normal operation its electricity demand from the grid will be zero. At times when the power plant is not operational the grid will supply the plant with a small amount of power for start-up, lighting and other minor services.

### **Liquid Fuel**

If liquid fuel is provided for use as stand-by fuel, it will be delivered by road and stored in bulk storage tanks. The nominal liquid fuel storage capacity will be sufficient for about 8 days of operation at base load (approximately 17 kg/s for each GT).

## **C.7 Air Emissions**

### **C.7.1 Main Air Emissions**

The main fuel for Kudu CCGT will be natural gas, which contains a mixture of gases, with methane (CH<sub>4</sub>) predominating. The main products of combustion released to atmosphere will be carbon dioxide (CO<sub>2</sub>), water vapour (H<sub>2</sub>O) and small quantities of oxides of nitrogen (NO<sub>x</sub>). The latter is due predominantly to the high temperature oxidation of atmospheric nitrogen with a contribution of fuel bound nitrogen. NO<sub>x</sub> composition is estimated to comprise ~ 95% nitric oxide (NO) and ~ 5% nitrogen dioxide (NO<sub>2</sub>).

In addition, use of liquid fuel for standby, if provided for when natural gas is unavailable, will give rise to sulphur dioxide (SO<sub>2</sub>) emissions due to its sulphur content. With on-site storage limited to approximately 8-days supply, a maximum load factor of 2-3% on liquid fuel is expected.

Emissions of particulates are considered to be negligible for natural gas and liquid fuel because of the efficient burnout and low ash content in the GT. The maximum emission rate for PM<sub>10</sub> will be in the order of 1-2 g/s (4-8 kg/hr) when operating on natural gas and 5 g/s (19 kg/h) when the plant is firing on liquid fuel. These emission rates are very low and include the condensable particulate fraction in the exhaust gas. In addition, emissions of carbon monoxide (CO) and hydrocarbons are also normally very low with significant levels emitted only during periods of incomplete combustion / low-temperature operation at start-up. Nearly all the fuel carbon (>99.5%) is converted to CO<sub>2</sub> during the combustion process when firing on gas or liquid fuel and so the amount of CO formed is very low.

The plant will be equipped with dry low-NO<sub>x</sub> burners for operation on natural gas. If provision is made for firing on liquid fuel, water injection will be used for NO<sub>x</sub> suppression. This involves the addition of demineralised water from the water treatment plant to the combustion chamber. This reduces the temperature of combustion and so reduces the formation of thermal oxides of nitrogen. One GT manufacturer is now offering no water injection but compliance at up to 60% load with recognised industry standards for ELVs on liquid fuel without water injection. This could be an attractive option for Kudu CCGT Power Plant where water is scarce.

With the type of plant expected to be offered by the manufacturers, typical emissions concentrations for NO<sub>x</sub> in combined cycle mode that are regarded as appropriate for new plant are as follows:

- Natural gas: 50 mg/Nm<sup>3</sup> with provision for higher concentrations for efficiencies of > 55%
- Liquid fuel: 120 mg/Nm<sup>3</sup>

The above fully meet emission limit values (ELVs) of the World Bank guidelines for NO<sub>2</sub> (125 mg/Nm<sup>3</sup> for gas firing and 165 mg/Nm<sup>3</sup> for liquid fuel firing).

The approximate annual tonnages of NO<sub>x</sub> (expressed as NO<sub>2</sub>), SO<sub>2</sub> (assuming 0.3% S in liquid fuel) and CO<sub>2</sub> that will arise, based on 95% overall load factor for the initial 800 MW development are as follows:

Operation	Oxides of Nitrogen (NO <sub>x</sub> )	Sulphur Dioxide (SO <sub>2</sub> )	Carbon Dioxide (CO <sub>2</sub> )
100% Gas:	1,450 t	Negligible	2 365 Gg
97% Gas / 3% Liquid Fuel:	1,500 t	185 t	2,365 Gg

Emission rates for SO<sub>2</sub> from gas turbines are commonly not regulated as concentrations are determined by the fuel characteristics rather than plant performance.

If a bypass stack is provided, in addition to combined cycle mode, it will be possible to operate the plant in open cycle mode. The maximum mass emission rate from the plant will be the same regardless of the mode of operation. However, the thermal buoyancy and therefore the dispersion of the flue gas emission is enhanced for open cycle operation due to the higher discharge temperature of the exhaust gases. Hence, only the ground level concentrations of air emissions resulting from combined cycle operation are considered.

The proposed ELVs for NO<sub>2</sub> apply to operation at greater than 60% load and exclude start-up and shut-down periods. Emission concentration will normally be higher below this load level because the dry low-NO<sub>x</sub> burner system does not operate at low load. Owing to the very high efficiency of this type of plant it will normally operate at full load with very infrequent occurrence of start-up and shut-down. Operation at reduced load will be confined to starting and stopping transitions. Since these periods will be infrequent and of short duration, they are not relevant to the consideration of air quality impacts.

### **C.7.2 Auxiliary Boiler**

An auxiliary steam boiler, with a rating of about 7 t of steam/hr, may be provided for start-up of the HRSGs and this unit will have a single stack.

Outside of routine testing, operation of the auxiliary boiler will be restricted to about 1-2 hours for plant starting and this is unlikely to occur more than once per month during normal plant operation. This boiler will operate on natural gas with a firing rate of about 500 kg/hr. It may also operate on liquid fuel, if provision is made, with a firing rate of 550 kg/hr.

Emissions of NO<sub>x</sub> and SO<sub>2</sub> are estimated to be very low and under 0.5 g/s. These rates are about 2% of the emissions from the HRSG exhaust stack. Furthermore, due to the limited period of operation of the auxiliary boiler during the year, the emissions will be insignificant in terms of those arising during operation of the CCGT. Because the auxiliary boiler does not operate while the CCGT is on load, cumulative emissions do not arise.

### **C.7.3 Minor/Fugitive Air Emissions**

Minor air emissions from the power plant will include the following:

#### ***Cooling Towers***

Water vapour arising from the evaporation of water within the cooling system will lead to a visible plume.

#### ***HRSG***

Steam will be discharged to atmosphere at various stages through safety valves under certain process fault conditions and through HRSG vents and drains during HRSG start-up. HRSG blowdown also leads to some steam release. These emissions will be of short duration and will have no significant impact.

#### ***Natural Gas***

Purging of gas pipelines and the gas compressor (if provided) will lead to venting of natural gas to the atmosphere. The emissions will be of short duration and will have no significant impact.

#### ***Diesel Generator***

A diesel generator may be provided for black-start capability. With infrequent use, other than for testing, emissions will not be significant.

#### ***Storage Tanks***

Storage tanks used for bulk storage of chemicals, liquid fuel (if provided) and condensate extracted from the gas will be vented to the atmosphere. During any transfers of liquid fuel and/or gas condensate to and from road tankers, some venting may take place. The volumes of resulting gaseous emissions will be very low and will have no significant impact.

#### ***Lube Oil Vents***

An oil mist will be released by the lubricating oil vents on the gas turbines and steam turbines. A demister will be installed to minimise these emissions.



### **Ventilation**

Various parts of the plant will be provided with positive ventilation. The volumes of resulting emissions will be very low and will have no significant impact.

### **Odours**

None of the air emissions from the proposed plant will give rise to odours external to the site.

### **Gas conditioning plant**

It is provisionally expected that on average a maximum of 120 cubic metres of liquids, mainly water, will have to be removed from the maximum 140 MMscfd gas required by the power plant. The liquids are separated into two distinct phases: a water/MEG mixture and condensate. A small amount of gas which will be used as probably in the MEG regenerator is liberated in this process. Following the separation step the condensate is cooled and stabilized at atmospheric pressure before being stored in bunded atmospheric tanks. The stabilization process produces also a small amount of gas, which will be used as fuel for e.g. the flare pilot light. The water will be boiled off and turned into steam. The MEG will be cooled and sent to atmospheric bunded storage tanks. The bunding should be able to contain the content of the storage tanks plus water from typically a one in ten year rainfall event. The MEG/water mixture sent to the boiler contains a small amount of aromatic components namely benzene, toluene and xylene (BTX). These aromatics also will be boiled off in the process and fed to an enclosed combustion unit where complete combustion to CO<sub>2</sub> and water takes place. The contribution to the overall atmospheric emissions from the power plant will, therefore, be negligible.

## **C.8 Aqueous Discharges**

### **C.8.1 Cooling Water Purge**

The use of an evaporative cooling system will lead to discharge of cooling water purge. With the sea water make-up for a 800 MW nominal capacity plant amounting to 2 000 m<sup>3</sup>/hour and evaporation accounting for 700 m<sup>3</sup>/hour, a discharge of 1 300 m<sup>3</sup>/hour will arise.

The evaporation of water within the system leads to concentration of dissolved solids and in the case of seawater make-up leads to increased salinity of the residual water. The constant discharge and make-up allows for control of water quality.

The addition of a biocide in low concentration to control biofouling is the only alteration in the quality of the make-up water as the accumulation of impurities in the system is simply the concentrations of constituents such as dissolved solids that were already present.

It is envisaged that the pipeline for the cooling water purge discharge will follow the same route as the pipeline for the incoming make-up water. The terminal point for the discharge is not yet determined and its selection will be based on a number of factors that include avoidance of interference with and from future mining operations and recirculation of cooling water.

### **C.8.2 Low Volume Aqueous Discharges**

In addition to the cooling water purge discharge, there will be a number of low volume aqueous discharges associated with operation of the power plant. On the basis of assessing a worst-case scenario, it is assumed that these will discharge to the aquatic environment. At a practical level, it

is envisaged that these will either be recovered for use in landscape maintenance at the plant or discharged to the cooling tower basin to minimise the required cooling water make-up.

Discharges that will arise frequently comprise treated water treatment plant effluents and treated sewage effluent. Less frequent discharges will include HRSG blowdowns (ultra pure water). The volume and frequency of surface water drainage will be rainfall dependent. Other infrequent discharges may arise from time to time associated with, for instance, compressor cleaning.

#### ***Water Treatment Plant Effluent***

The incoming water supply will be treated to achieve a high level of purity and then stored prior to its use in the HRSG. Regeneration of the ion-exchange resins will be by sulphuric acid ( $H_2SO_4$ ) and caustic soda (NaOH), leading to alternate acidic and alkaline waste streams. Effluent will be neutralised prior to discharge which is expected to last up to one hour daily with a flow rate of up to 7 kg/s.

#### ***Sewage Effluent***

Sewage effluent will be treated in a sewage treatment plant to achieve a quality standard of 30 mg/l for suspended solids and 20 mg/l for biological oxygen demand (BOD). The volume of treated effluent is estimated at a maximum of approximately 4 m<sup>3</sup>/day. This is based on the system serving up to approximately 50 permanent employees, although the shift nature of operations means that not all of these employees will be present on each day.

#### ***HRSG Blowdown***

The water in the HRSG will be blown down intermittently to remove accumulation of impurities. This blowdown water will be discharged to a tank to reduce pressure prior to entering station drains before discharge. The average volume of the discharge will be approximately 150 m<sup>3</sup>/day. This heated water may contain traces of hydrazine ( $N_2H_4$ ), sodium phosphate ( $Na_3PO_4$ ), caustic soda (NaOH) and ammonia ( $NH_3$ ). However, the concentrations will be low and the discharge is essentially of ultra-pure water.

#### ***Surface Water Drainage***

Drainage arising from paved surfaces within the power plant site, such as the turbine floor and maintenance areas, and from controlled discharges from bunds to bulk storage tanks, will be discharged to the cooling water system following passage through an appropriate oil interceptor.

#### ***Plant Cleaning***

Water washing of the gas side of the HRSG tubes may be carried out to remove deposits, which mostly comprise carbonaceous material, that build up and reduce plant efficiency. Minimal deposits would be expected with natural gas being used as the principal fuel and washing may arise only on a few occasions over the life of the plant. Wash-water will be discharged following treatment to isolate and remove suspended particles.

#### ***GT Compressor Washing***

A few times each year each of the gas turbine compressors will be washed off-load. The high-frequency washing medium will be a solution of environmentally benign surfactants in pure water. The wash water will be treated and discharged to the cooling tower basin.

#### ***HRSG Storage Solutions***

Two methods may be used to protect an HRSG when it is out of use for an extended period and these are referred to as dry storage and wet storage. Dry storage, which is the preferred method,

will comprise circulation of dry air or the use of the inert gas nitrogen (N<sub>2</sub>). There are no resulting discharges. Wet storage may use a solution of hydrazine (N<sub>2</sub>H<sub>4</sub>) and ammonia (NH<sub>3</sub>). The resulting discharges, should they arise, will be either sent for disposal by an appropriate waste contractor or else suitably treated prior to release.

### ***HRSG Acid Cleaning***

Acid washes during the life of the plant are carried out at intervals of roughly 8 - 10 years, depending on many factors such as large-scale replacement of HRSG tubes, severe on-load corrosion, or excessive magnetite or deposit build-up. The resulting effluents will be taken off-site for safe treatment/disposal at environmentally licensed facilities.

### ***Water from gas conditioning plant***

The ongoing design studies of the gas conditioning plant strongly suggest that all water separated from the gas will be turned into vapour and that there will be no effluent discharges from the gas conditioning plant, except occasional small quantities of storm water discharges. Nevertheless the discharge of a nominal 5 m<sup>3</sup> metres of water, at a temperature of 40°C and containing trace amounts of dissolved hydrocarbons (≤10 ppm max) have been considered. This water can be co-discharged with the cooling purge water (31 200 cubic metres per day), with negligible effect on the receiving environment. Due to the nature of the process adopted, the oil content of the condensed water will be well within permitted international standards for disposal of such water, i.e., any oil content will be less than 10 mg/litre which is well within the international Marpol 93/96 standards. If co-disposed with the power plant purge water the concentration of free and dissolved hydrocarbons will be less than 0.0016 ppm.

## ***C.9 Noise and Vibration***

The main potential sources of noise from the plant, mitigation of which will be an integral feature of the plant design, will be as follows:

### ***Gas Turbines***

High noise levels originate in the air inlet and flue gas exhaust. Strong pure tonal components are associated with the inlet, while the exhaust results in high levels of low-frequency noise. Specially designed silencers are provided to control such noise emissions to acceptable levels. The gas turbine itself will be housed in an acoustic enclosure.

### ***HRSG***

Venting of steam will occur during HRSG start-up and blowdowns. This is routinely controlled by suitable silencers. Boiler safety valves may be tested on an annual basis for insurance certification. Outside of such testing, operation of safety valves will occur for very short periods under process fault conditions. They will be fitted with silencers but will be audible outside the plant. Owing to their safety function, it is not possible to totally abate noise from such high temperature/high volume sources.

### ***Cooling Towers***

Noise from evaporative cooling towers arises from mechanical equipment and predominantly from falling water. Areas of noise breakout include the air inlet to the fill medium, fan outlets and the casing. Cooling towers comprise a series of point sources and cooling tower noise is very directional. Silencing will be effected by optimum orientation of towers, splash attenuation mats, low speed gearboxes and noise baffles as necessary.

### **Steam Turbine**

The steam turbine, together with a range of auxiliary plant, much of which contains rotating or reciprocating machines, is a source of noise. This is attenuated by acoustic lagging and enclosure and by the acoustic design of the turbine house.

### **Gas Release**

When it is required to purge the gas pipelines and gas compressor (if provided), gas will be vented to the atmosphere. This will last for a short period and may result in slightly increased noise levels. It may occur up to ten times annually.

### **Transformers**

Fans on generator and other large transformers are provided for cooling purposes. The transformers themselves may emit noise at multiples of the power line frequency (50 Hz) but are treated to minimise noise emission and will be inaudible at the site boundary.

### **Traffic**

Road traffic associated with plant operations will normally consist of the movement of a relatively small number of station personnel to and from the site together with maintenance and servicing activities. Routine delivery of consumables will not lead to significant additional traffic. Operation on liquid fuel (if provided) could involve significant transportation over short periods.

The plant will not give rise to significant vibrations.

## **C.10 Waste Management**

Waste generated in the operational phase will include the following:

### **Air Filters**

Filters on air intakes will require changing periodically.

### **HRSG Washing**

Insoluble and precipitated materials from treatment of HRSG wash water.

### **Gas Turbine Washing**

Intermittent liquid effluent arising from off-line washing with surfactant solution of the air compressor.

### **General Cleaning**

Rags, etc. arising in maintenance and cleaning operations.

### **Lamps/Batteries**

Lighting units replaced as required.

### **Metal Waste**

Waste comprising scrap metal.

### **Oil Interceptors**

Oily sludge from cleaning of oil interceptors.

### **Waste Oils**

Waste oils arising from maintenance activities.

### **Water Treatment**

Spent ion exchange resins.

### **Auxiliary Cooling Water**

Drainage solution containing an anti-freeze and possible corrosion inhibitors.

### **Packaging Waste**

Timber, cardboard, plastic etc.

In order to avoid risk of contamination, all waste will be segregated into hazardous and non-hazardous waste and removed off site for appropriate treatment/disposal at recognised facilities.

## **C.11 Project Construction**

### **C.11.1 Construction Site**

#### **Principle construction activities**

The principal activities associated with the construction of the CCGT power plant include:

- Erection of accommodation for the workforce, temporary site office, workshops and fuel storage tanks.
- Provision of site services (roads, electricity, water, sanitation, etc.).
- Clearance of construction site.
- Excavation and piling.
- Erection of the power house and installation of machinery.
- Construction of the cooling system.
- Electrical installation.
- Laying of the gas pipeline and construction of the gas treatment plant (this will be the responsibility of Energy Africa and its contractors).

#### **Duration and Phasing**

It is envisaged that construction work will commence in late-2006 and that commissioning of the plant will be completed in mid-2009. Development of a second 800 MW unit would extend the construction period.

The construction period of less than three years compares favourably with a conventional thermal plant which may take up to seven years to complete and with a nuclear plant which may take even longer.

#### **Employment**

The average number of persons employed during construction is expected to be in the order of 600 with numbers peaking at approximately 1 300.

#### **Works Safety**

Works will be carried out by an experienced contractor using appropriate and established safe methods of construction. All requirements arising from statutory obligations regarding health and safety will be met in full.

The contractor will be required to ensure that all workers receive appropriate safety training and are equipped with appropriate personal protective equipment.

Appropriate medical first-aid facilities will be provided at the site and at the workforce accommodation.

#### **Works Method Statement**

The contractor will be required to prepare and implement a detailed Works Method Statement and Management Plan to address managing the environmental impacts associated with the construction of the plant in line with nationally and internationally recognised best practices.

All construction will be carried out under the supervision of Consulting Engineers with appropriate experience.

#### **Site Facilities and Accommodation**

A suitably surfaced contractor's laydown area will be developed at the site. Standard pre-fabricated structures will be provided for office accommodation.

If the present hostel facilities at Uubvlei are not utilized, a 10 ha area will be designated for provision of temporary accommodation for the workforce. It is envisaged that standard pre-fabricated structures would be used for all components of the accommodation, i.e. sleeping quarters, washing facilities, canteen, laundry, etc. The accommodation will include appropriate recreation facilities.

All necessary infrastructure facilities, such as water supply, electricity, waste disposal and sewage treatment, will be provided for the workforce accommodation and the construction site.

All temporary facilities will be fully removed upon project completion and the respective areas will be rehabilitated.

### **C.11.2 Environmental Factors**

Environmental impacts during project construction will be as follows:

#### **Traffic**

Construction of the project will require delivery of materials, plant and equipment, and construction personnel to the site. However, the volume of additional traffic will be within the capacity of the existing road network and will not cause a disturbance.

#### **Noise**

Noise during construction will predominantly arise from on-site construction plant, with earthmoving and concreting usually being the noisiest construction activities. A further significant potential source of noise is piling of foundations. If piling works become necessary, they will be restricted to daytime hours.

#### **Air**

Some site preparation and construction activities are a potential source of local dust emissions. To prevent dust becoming a nuisance during the construction phase, dust suppression will be used within the site.

### **Waste**

Construction waste will be generated. All relevant regulations and best practice relating to waste management will be fully met.

Any damage caused to local infrastructure or facilities as a result of the construction works will be repaired.

### **C.12 Commissioning**

Plant commissioning will follow completion of the plant construction phase. Emissions particular to the commissioning phase will include the following:

#### **Noise**

On a small number of occasions during commissioning there will be additional noise for short periods. Commissioning will involve a steam blow through the HRSGs and pipework to purge them, with the steam being exhausted to atmosphere. These once-off occurrences can lead to high noise levels. These blow out activities will be scheduled to occur during daytime hours only.

#### **Waste**

Water-side cleaning of the HRSG tubes is carried out during commissioning to remove deposits of metals and other impurities on the tubes' surfaces. This work will be undertaken by specialist contractors and will involve the use of acids, alkalis and proprietary chemicals. The process effluents will be taken off-site by the contractor for safe treatment/disposal at environmentally licensed facilities.

Commissioning will generally involve setting up and testing the equipment to ensure that it is fully functional and that all technical, environmental and safety requirements have been met.

### **C.13 Hazards and Safety**

The basic technology to be employed in the project is well understood and has been used successfully in many equivalent projects elsewhere. The main potential hazards that are associated with the proposal arise from the storage of quantities of combustible material, storage of small volumes of chemicals, presence of high voltage equipment and use of high-pressure steam.

The measures taken to mitigate against their occurrence comprise passive and active systems. The main passive safety measures to be incorporated in plant design are as follows:

- The development of plant layout to minimise risk outside the site from accidents which may occur on it and the use of non-combustible and fire-resistant building materials.
- The incorporation of adequate emergency response access and means of escape.
- The provision of continuous gas monitoring systems, construction of bunding to storage tanks for fuels and chemicals, and installation of smoke detectors
- The venting of air/gas accumulations and protection of ignition sources from damage.

The active hazard protection measures relate to the provision of emergency fire fighting facilities, including automatic/manually operated deluge systems for the areas of the plant most at risk, a hydrant system and in-house procedures specifically developed in recognition of potential hazards.

The project will be designed with adequate fire protection/detection systems, which will be consistent with the requirements of internationally recognised best practice and compliant with all relevant statutory requirements.

The most serious potential emergency situations at the proposed plants are well known. Documented emergency procedures, taking account of the plant's management structure and physical layout will be established. The contents will address the following:

- Oil spill risk control procedures.
- Chemical spill control procedures.

Prior to start-up, a comprehensive set of operating procedures will be drawn up for operation of the plant and all operatives will be fully trained. Any potential emergency situations associated with the proposed development will be managed under the emergency response procedures that will be put in place at the plant.

Personnel welfare and safety on site will be of primary importance to the Owner, who is committed to ensuring that facilities are as safe and healthy as possible to work in. Staff will be trained to operate and maintain plant to a high degree of proficiency and will be capable of dealing with any emergency on the site, including fire.

#### ***C.14 Decommissioning***

When the supply of gas from the Kudu gas field is exhausted the CCGT power plant at Uubvlei will be decommissioned, the plant demolished and the site rehabilitated.

#### ***C.15 Environmental Management Plan***

##### **C.15.1 Environmental management structure and responsibilities**

A formal Environmental Management System (EMS) will be developed. The system will be fully documented and meet the requirements of the international standard for Environmental Management Systems ISO 14001 - Specification with guidance for use.

A member of the plant's management team will be assigned the task of Health, Safety and Environmental (HSE) Manager. Duties in the environmental area, being additional to other duties, will include:

- Establishing the plant's environmental policy.
- Initiating environmental programmes encompassing all plant activities that help to achieve the targets and goals of the policy.
- Drawing up documented procedures and instructions for each plant group.
- Operating a yearly review of policy, objectives and programmes in conjunction with the plant manager.
- Developing and drawing up budgets for specific environmental targets and goals on a yearly basis.
- Preparing a yearly report on environmental performance.
- Maintaining a base of documentation for the environmental management system.
- Maintaining a register of records and measurements carried out.
- Identifying training needs of plant staff. The most important function would be monitoring, control and optimisation of the wastewater streams and other emissions.



### C.15.2 Environmental management of construction phase

The environmental management plan will include a major section designed to ensure that the environmental, health and safety aspects of all construction activities meet the required standards. The contractor and subcontractors will be required to implement plans for the management of:

- Site
- Dust
- Water Use
- Materials Handling and Storage
- Fire Control and Emergency Procedures
- Leak and Spill
- Solid Waste
- Wastewater
- Transportation
- Noise

## D. Project alternatives

As part of the planning for this project, NamPower has considered activity alternatives, location alternatives and process alternatives. Activity alternatives include policies, plans and programmes that address the project need, but which require variations in the fundamental nature of the project. Location alternatives are geographically separate or located in close proximity to one another, and include different sites or layouts. Process alternatives are variations in the technology or aspects of technology to be used.

### *D.1 No-project alternative*

A customer such as power generation is needed to commercialise development of the Kudu gas field as a Namibian resource. Such exploitation of the Kudu gas field would be utilizing the natural capital of Namibia for the well-being of its people, as well as diversifying its economy and maximizing a comparative advantage. The Kudu gas field may become a “stranded asset” if the proposed power plant is not built and operated, and the opportunity to convert natural capital into wealth for the people of Namibia would be lost.

### *D.2 Activity alternatives*

NamPower wants to reduce its dependence on South Africa for electricity supply while meeting electricity demand in Namibia and exporting electricity to the regional market; currently about half of Namibia’s electricity is sourced through imports from South Africa. Although this electricity is purchased at very low prices from Eskom, tariffs are low due to structural characteristics of the energy supply industry in South Africa.

NamPower, in its generation investment plan (Nampower, 2002), considered a range of alternatives for increasing electricity supply in Namibia. Namibia’s energy resource inventory includes hydropower, natural gas and renewable energy in the form of biomass, wind and solar energy. Of these, hydropower and natural gas are deemed to be the most feasible large-scale resources in a country in which over 90 % of the rural population do not have access to grid electricity. The process alternatives discussed below are those which utilize the natural capital of Namibia, and exclude alternatives based on imported coal and fossil fuels. Namibia already has

the Van Eck coal fired thermal power station in Windhoek and a diesel powered station at Walvis Bay. However, the cost of fuel delivered at Windhoek is becoming excessive, and Namibia is looking to building its economy by basing it on its own natural resources.

### *D.3 Process alternatives*

Process alternatives investigated by Nampower were the following:

- Hydropower
- Natural gas from sources external to Namibia
- Biomass Power
- Wind power
- Solar Power
- Nuclear Power
- Natural gas for a CCGT plant

### *D.4 Location alternatives*

In addition to the Uubvlei site that is the subject of this EIA, seven location alternatives were originally considered in a 1997 feasibility study for a CCGT plant in Namibia, all of which were deemed to be technically and environmentally viable, shown Figure 13. Three sites were at Lüderitz, three at Oranjemund, and one at Keetmanshoop (NamPower, undated).

The criteria for evaluating the locations were:

- Environmental impact,
- Cost of gas supply pipeline link and transmission integration,
- Strategic position in relation to potential future gas pipeline link to Cape Town,
- Availability of cooling water for the turbines,
- Founding conditions for the plant (bedrock) and
- Operating efficiency.

Four sites were evaluated during the extensive lead up period to this EIA; these were examined by Nampower (Nampower, undated), and their locations are shown in Figure 14.

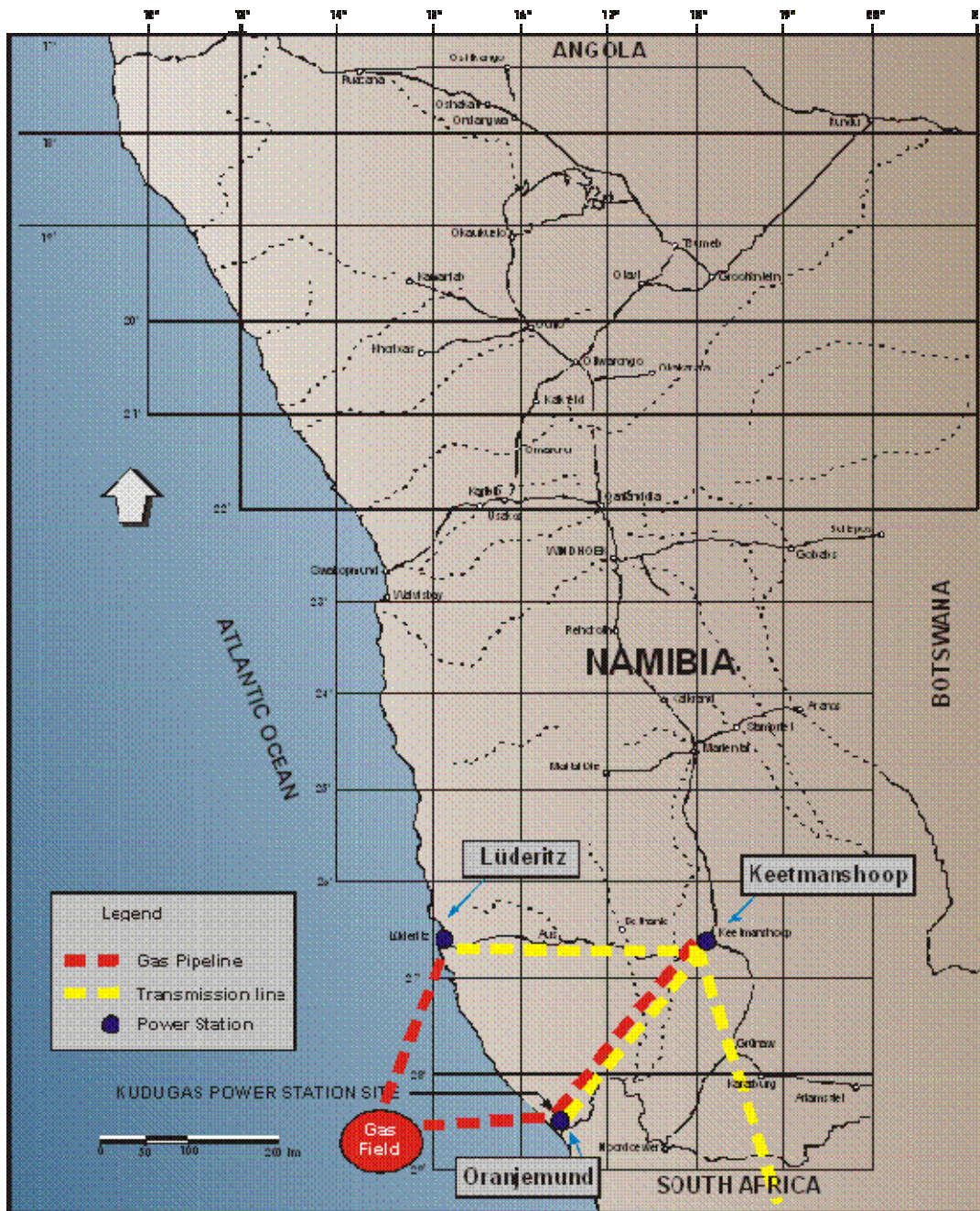
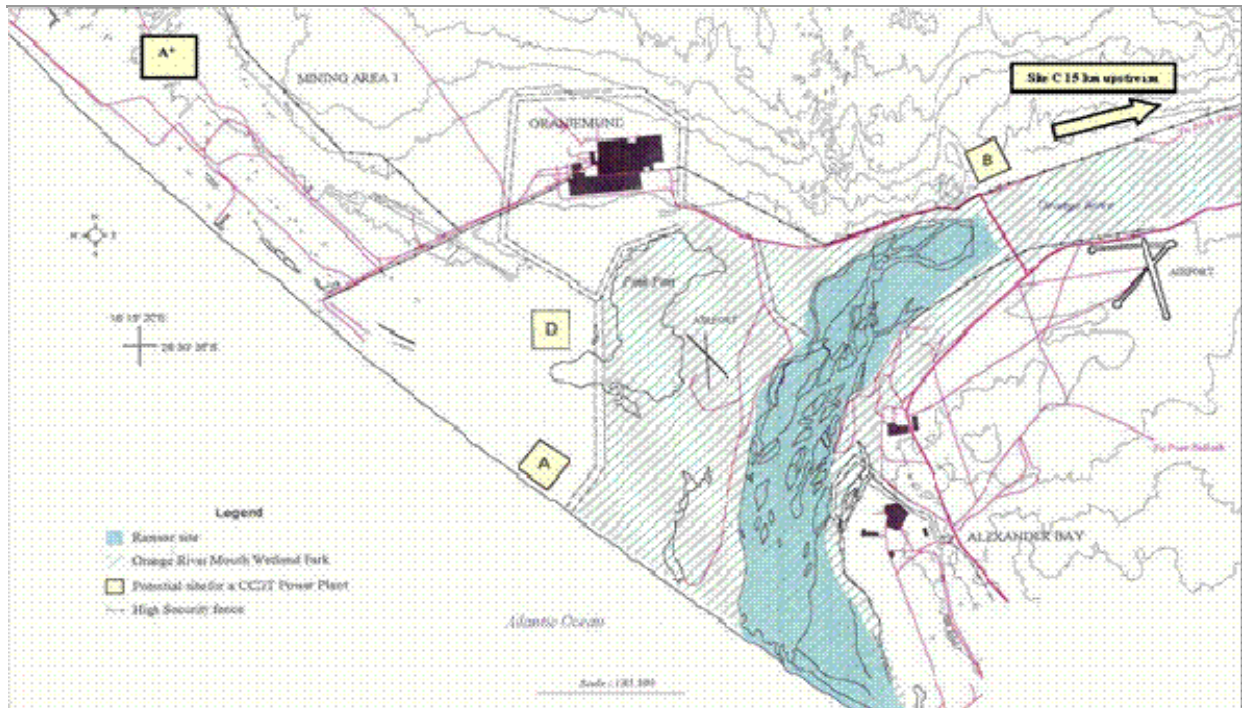


Figure 13. Location alternatives for the Kudu CCGT power plant



Source: NamPower

**Figure 14. Site alternatives for the CCGT power plant at Oranjemund**

Site D was one of the three sites included in the Preliminary Environmental Assessment (Walmsley Environmental Consultants, 1998). Based on the evaluation, NamPower made a decision that Site D is the preferred alternative and should be the principal alternative considered in the EIA, stating that Site D performed best against the evaluation criteria suggested by the KDT (NamPower, undated). An EIA for Site D was completed in 2004.

After the EIA for Site D at Oranjemund had been approved by MET, it was found that the routing of a gas pipeline from the gas platform to the proposed Site D was subject to severe constraints because of likely opportunity costs due to possible diamond lock-up offshore, and inconvenience it would impose on mining activities.

A preliminary investigation by NamPower and Namdeb identified Uubvlei (Figure 15) as the most suitable alternative site to Site D at Oranjemund, based on the following criteria:

- Cost implications;
- Already disturbed/mined-out area at the site (i.e., minimal impact on biodiversity and landscapes);
- Minimal interference with Namdeb mining operations;
- Availability of cooling water for the power plant;
- Good founding conditions for the power plant and landing site for the gas pipeline and seawater intake pipeline;
- Proximity to infrastructure and services;
- Minimal impact on mining reserves offshore;
- Suitability for transmission lines (interconnectivity).

### D.5 Process alternatives for cooling of a CCGT plant

Two alternatives for cooling of the CCGT plant at the site are the use of direct seawater cooling and the preferred alternative of forced draught cooling towers with seawater make up from beach wells. Although direct seawater cooling might well be the cheapest option at this site, further consideration will need to consider its interaction with Namdeb's nearby mining operations (NamPower, undated; Walmsley Environmental Consultants, 1998).

Major reasons for elimination of the various activity, process and location alternatives are given in Table 2.

**Table 2. Summary Table of Alternatives Considered**

<b>Alternative</b>	<b>Major reason for consideration as an alternative</b>
<b>Activity alternatives</b>	
Increase importation of energy from South Africa	Importation agreement with Eskom due to expire in 2006; terms of subsequent agreements likely to be different and more costly
Natural gas in Namibia	Activity alternative being considered in the EIA
<b>Process alternatives</b>	
Additional hydropower from the Kunene River	Lag time to bring electricity production on line (commissioning date 2014)
Wind energy from various sites	Costs prohibitive without international donor funding and/or carbon offset benefits; too small and non-commercialised.
<b>Process alternatives for cooling of a CCGT plant</b>	
Direct seawater cooling	Inlet structure could interfere with Namdeb's long-term plans; siltation levels at intakes; uneconomical and technically difficult.
Forced draught cooling towers with seawater make up from beach wells	Process alternative being considered in the EIA
<b>Location alternatives</b>	
Keetmanshoop (Site A)	Decreased plant performance due to altitude and lack of an adequate cooling water source; expensive gas pipelines.
Lüderitz (Sites A, B and C)	Increased construction costs associated with distance from gas source
Oranjemund Site A*	Poor founding conditions, unsheltered, remoteness of site with access difficulties in MA1
Oranjemund Site B	Visual and noise impact on Orange River Mouth Ramsar site; legal and ecological sensitivity of effluent discharge to the Orange River; constrained access to the site; inadequacy of water supply from the river for cooling tower make-up.
Oranjemund Site C	Distance from the source in the gas field; situated in a moving dune field.
Oranjemund Site D	Approved by MET. Routing of a gas pipeline from the gas platform to the site was subject to severe constraints.
Uubvlei	Location alternative being considered in the EIA

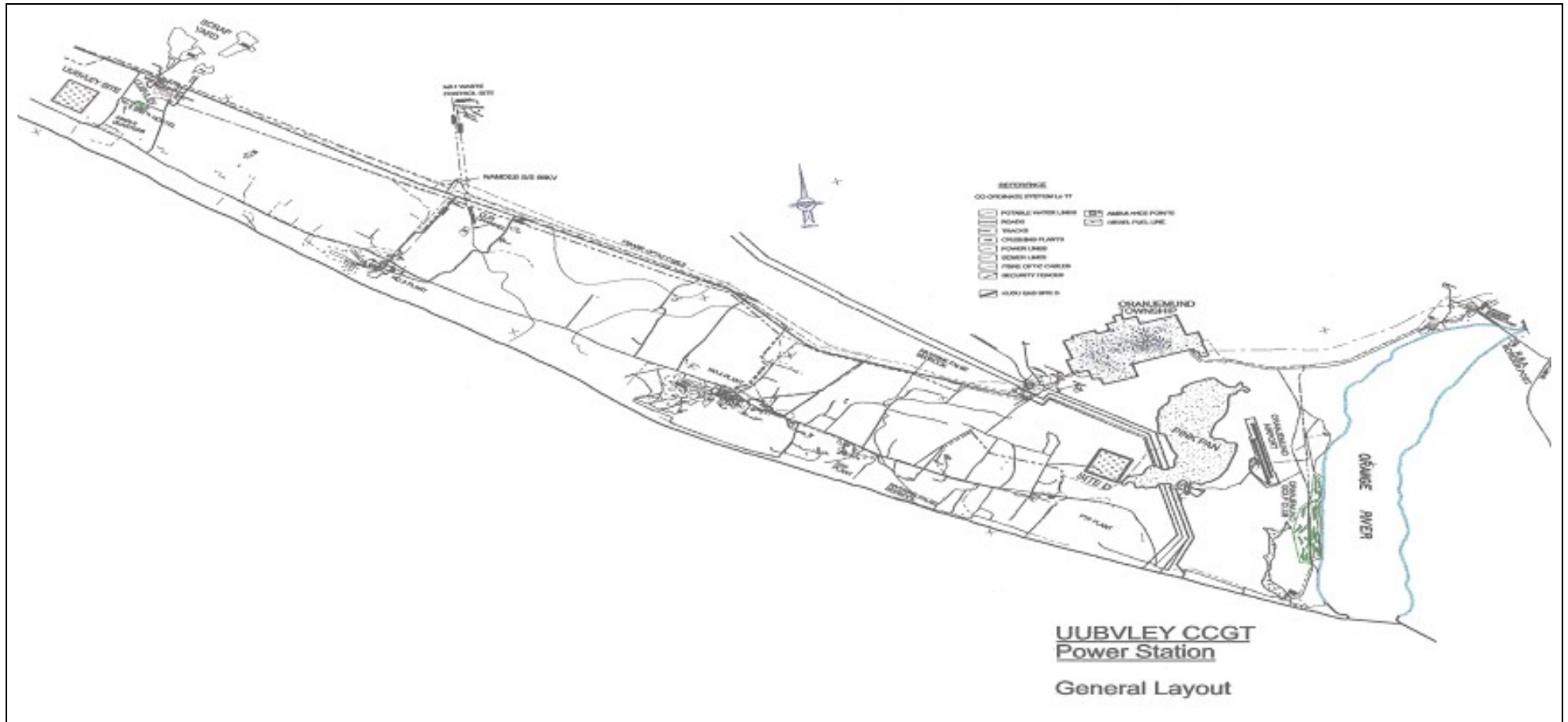


Figure 15. Location of the Uubvlei site, with Site D and the town of Oranjemund

The net thermal efficiency of the Kudu power project, depending on the gas turbine selected, is currently projected to be around 57% at site conditions and to average around 56% over a 20 year operating life. Natural gas, the fuel used in CCGTs, possesses a much lower carbon-content than coal and petroleum and in comparison produces lesser emissions of CO<sub>2</sub> and NO<sub>x</sub> (Blakemore *et al.*, 2001).

The combination of using natural gas as a fuel and employing CCGT technology in a power station ultimately reduces CO<sub>2</sub> by 50% per unit of generated power (Blakemore *et al.*, 1998). There will be no emissions of dust or particulates during the normal operation of the plant (Energy Management News, 2002). The main atmospheric emissions of concern from the proposed power station will be oxides of nitrogen. However, according to Blakemore *et al.* (2001) a Combined Cycle Gas Turbine Stations will produce an 81% reduction of NO<sub>x</sub> per unit of power to that generated by an equivalent coal-fired plant.

The environmental performance of combined cycle gas turbines and other natural gas-fired combustion system are also significantly better than coal-fired boilers. These include low emissions of particulate matter, sulfur oxides, volatile organic compounds, and hazardous organic and inorganic compounds.

The IPCC, in their Workgroup III Third Assessment Report, issued in Accra in 2001, stated that

*At least up to 2020, energy supply and conversion will remain dominated by relatively cheap and abundant fossil fuels. Natural gas, where transmission is economically feasible, will play an important role in emission reduction together with conversion efficiency improvement and greater use of CCGT and cogeneration plants.*

Emission reductions have a market value, even though there is no current regulatory program mandating them, but their value should be taken into consideration when evaluating the environmental advantages and financial feasibility of CCGT technology. In terms of the Kyoto Protocol and the Clean Development Mechanism, markets for greenhouse gas emission credits will develop, and there will be opportunities for Namibia to benefit not only from the application of this technology in utilising its natural resources at the Kudu gas field, but also from such markets in emissions credits.

## E. The Affected Environment

Following the discovery of rich ore deposits on the north bank of the Orange River, south of Lüderitzbucht, the town of Oranjemund was founded in 1936. It lies within Diamond Area 1, where public access is strictly controlled. The land is owned by the State, but all the infrastructure and assets in Oranjemund are currently owned by Namdeb. In mid 2003, the Namibian Cabinet resolved to alienate unreserved state land in preparation for the future proclamation of Oranjemund as an independent town. Though the structure plan and site layout are currently being finalised, the plan excludes the site proposed for the power plant. There is the intention to set up an independent town management company to run the town on a commercial, municipal basis until proclamation.

### ***E.1 Geology, topography and soils***

Oranjemund and its surrounds are located on rocks of the Gariiep Belt, which is a sequence of sediments and volcanics that accumulated in a basin on rocks of the Namaqua Mobile Belt, Orange River Group, Vioolsdrift Suite and the Richtersveld Intrusive Complex.

The topography between Oranjemund and the coast is low-lying and flat, but the sand dunes rise up gently towards the interior to the north and east of town. The main topographic features are the rocky outcrop of Swartkop, 73 metres above mean sea level, the mobile dunes east of town and the shallow Orange River valley.

The soils of the desert are poorly developed, but some alluvial soils occur on the southern bank of the Orange River further upstream, where crops are cultivated. There is no agriculture or agricultural potential at Site D, the proposed site for the CCGT power plant, and it has been mined previously by Namdeb.

### ***E.2 Hydrology***

The Orange River is the only perennial fresh water source along the coast for 370 km to the south and 1350 km to the north. This, together with the variety of habitats, makes it extremely important for wetland birds, especially migrants along a very inhospitable coast. Because of its international importance as a waterfowl habitat, it has been listed as a Ramsar Site by both Namibia and South Africa. In recent years the decreasing flows at the mouth have been a concern and special water allocations have been requested from the Permanent Water Commission for the Orange River (PWC), in order to maintain ecological functioning of the Ramsar wetlands.

The total natural or virgin flow of the Orange River at the mouth used to be 10 670 Mm<sup>3</sup>/a, but this had decreased by 50% to 5 340 Mm<sup>3</sup>/a by 1991 due to construction of several dams and interbasin transfer schemes upstream. A feature of the Orange River is its periodic, massive floods. Major floods occur every 8-10 years on average, but upstream regulation has resulted in fewer smaller floods. The most recent flood was in 1988, and the discharge was the largest since 1921 when systematic flow recording began (Swart *et al*, 1990). The March 1988 flood probably had an exceedance discharge value of between 100 and 200 years. The water quality in the river is generally good, but is characterised by a high silt load, especially after a major flood. Such floods introduce large amounts of terrigenous material into the nearshore region. Bremner *et al* (1990) showed that the mud belt off the Orange River expanded in width immediately following the flood. There are indications that the water quality is becoming increasingly saline due to high evaporation and irrigation return flows.

Oranjemund obtains its domestic water supply from ground water in an old palaeo-channel of the Orange River just upstream of the town. The coastal zone is underlain by both saline and fresh water shallow aquifers. The former is recharged constantly by the sea and the latter by the river, especially during when the river is in high flow.

### ***E.3 Marine environment***

The coast of Namibia is one of the most hostile in the world. It is characterised by large swells and breakers, the strong, northward-flowing Benguela current, less strong counter currents and gale-force winds. It is also a corrosive and abrasive environment.



Natural processes that impact severely on the coastal ecosystem include high sediment loads from the Orange River (Bremner et al., 1990) and major floods causing mortality of intertidal organisms as a result of severely reduced salinity (Branch et al., 1990). The nearshore ecosystem also has been affected by the movement inshore of water having a low dissolved oxygen content (Bailey et al., 1985; Bailey, 1991).

Surface currents are mainly wind driven and flow to the north-west (Shillington, et al., 1990). Current measurements made in a water depth of approximately 20 m some 5 km north of the proposed discharge location indicated mean current speeds of approximately 0.1 m.s<sup>-1</sup> (summer) to 0.2 m.s<sup>-1</sup> (spring) with a standard deviation of > 0.1 m.s<sup>-1</sup>. Peak current speed measured were of the order of 0.4 m.s<sup>-1</sup> to 0.6 m.s<sup>-1</sup> (CSIR, 1997a, 2002). These data show frequent current reversals but a long term mean current residual of approximately 0.04 m.s<sup>-1</sup> in an approximate north-west (alongshore) direction.

Typically wave-driven flows dominate in the surfzone (characteristically 150m to 250 m wide), with influence of waves on currents extending out to the base of the wave effect (~40 m, Rogers, 1979). The influence of wave-driven flows extend beyond the surfzone in the form of rip currents.

The salinity of upwelled waters in this region is typically 34.8 to 34.85 psu while the waters reaching the surface during upwelling typically contain about 5 ml.l<sup>-1</sup> of dissolved oxygen (Chapman and Shannon, 1985).

In the early 1960s the Marine Diamond Corporation was established to mine diamonds from the sea using specially-equipped suction dredgers. De Beers Marine is applying this concept to fossil shorelines in deep water where robot-controlled suction equipment is deployed. A number of other mining companies, contracted to Namdeb, operate closer to the coast using similar techniques.

The effect of the diamond mining activity is that hardly any of the coast between Lüderitz and the Olifants River has been left undisturbed. Active mines include Elizabeth Bay (Namdeb), Oranjemund (Namdeb), Alexander Bay (Alexkor) and Kleinzee (CDM, Namaqualand).

#### *E.4 Climate*

Winds and weather in the region are controlled by the interaction of the south Atlantic anticyclone, the northward-flowing and cold Benguela Current (with associated upwelling), eastward moving mid-latitude cyclones and the atmosphere pressure field over the subcontinent (Kamstra, 1985). Semi-permanent temperature inversion is caused by warm, dry air mass overlapping the cool air mass above the ocean, and is ideal for the formation of fog and low stratus cloud. Although located in a desert, cool, foggy conditions occur most mornings and strong southerly winds are a distinct feature of the afternoons. Temperatures along the coastal strip are modified by the cold ocean, but rise sharply inland.

The area is arid with rainfall mostly restricted to the winter months. Very hot, dry and dusty conditions occur occasionally in winter when there are offshore (north-easterly) berg winds.

#### *E.5 Temperature*

At the Orange River mouth average sea surface temperatures in winter are 12 – 13°C, spring 13 – 14°C, summer 14 – 15°C and autumn 13 – 14°C (Boyd and Agenbag, 1985). Because of oceanic influences, temperatures are moderate compared with much of Namibia. Average

temperatures in Alexander Bay are mild throughout the year with slightly cooler temperatures in winter. The average daily maximum temperature in summer is 23.5° C with extremes exceeding 40° C. In winter the average maximum temperature is 20.8° C with extremes in the region of 35°C. Annual average 08h00 and 14h00 relative humidity levels are 84% and 53% respectively. Monthly averages and extreme temperatures from the South African Weather Service (SAWS) 27-year climate record (SAWB, 1990) are presented in Table 3.

**Table 3. Mean monthly and monthly extreme temperatures at Alexander Bay including average monthly rainfall and fog days**

Month	Temperature (°C)			Rainfall (mm)	Fog Days
	Average	Maximum	Minimum		
Jan	19.8	24.4	15.1	1	4.0
Feb	19.6	24.1	15.1	3	6.5
Mar	19.2	24.3	14.2	2	10.5
Apr	18.2	23.8	12.6	4	12.6
May	17.0	23.2	10.7	4	11.3
Jun	15.7	21.6	9.8	9	8.0
Jul	14.9	21.0	8.8	5	9.4
Aug	14.7	20.5	8.9	7	8.2
Sep	15.5	20.9	10.1	3	5.7
Oct	16.6	21.7	11.5	5	3.7
Nov	17.9	22.8	13.0	1	4.6
Dec	18.9	23.5	14.4	2	4.3
Annual	17.3	22.6	12.0	46	89

## E.6 Precipitation

The region is characterized by extreme aridity. The rainfall varies from about 15 mm at the coast to about 200 mm at the escarpment; the influence of topography is evident in the steep gradients of the isohyets at the escarpment itself. Rains come in winter and summer, with rainfall averaging 51 mm per annum, and coastal fog an important factor for the moisture regime of many organisms. Alexander Bay receives an annual average rainfall of 46 mm. The majority of the rain falls in the winter months, however the area receives very limited annual rainfall with no month exceeding 10mm on average. Mean monthly rainfall totals from the SAWS 27-year climate record (SAWB, 1990) are presented in Table 3 above.

Fog is the most distinctive feature of the coastal climate of the Namib. It is usually considered to be a hazard since it reduces visibility and may contribute to weathering and mineral breakdown. On the other hand, it is a significant source of moisture for desert animals and plants. The fog lies close to the coast extending about 20 nautical miles (~35 km) seawards (Olivier, 1992, 1995). Within a 15 - 20 nautical mile zone offshore, fog frequency may be as high or even higher than at coastal stations. This fog is usually quite dense, visibility less than 300 m, and appears as a thick bank hugging the shore.

The coast from Elizabeth Bay northwards (including Lüderitz) and from Chameis Bay south to Port Nolloth experiences an average of 50 fog days per annum. Between Elizabeth and Chameis bays a lower fog frequency occurs, namely 25 fog days per year. Fog precipitation often exceeds rainfall and is considerably more reliable. At Swakopmund 130 mm of fog precipitation was measured in 1958 - seven times the mean annual rainfall. In the Central Namib, fog precipitation

averages 34 mm/year at the coast. Unfortunately there are no fog precipitation data for the study area.

Alexander Bay has on average 89 days of fog per year. Most fog is in the late summer and early autumn; they complement the very limited rainfall that occur in the area and help to sustain the arid vegetation. Mean monthly fog days from the SAWS 26-year climate record (SAWB, 1990) are presented in Table 3 above.

### E.7 Wind

In the coastal environment, the wind regime hampers the operation of equipment which must be protected from sandblasting. The strong winds coupled with the low precipitation creates an extremely harsh environment for plants and animals which adopt various strategies to avoid these extreme conditions.

The prevailing winds in Alexander Bay are predominantly southerly, associated with strong anti-cyclonic circulation in the southern Atlantic Ocean (Figure 16). The annual frequency of occurrence of southerly winds is approximately 30%. The average annual wind speed is 4.6 m/s and the station experienced calm conditions for only 5.8% of the observation period. The other dominant wind patterns are on-shore (west / south-westerly) and off-shore (easterly). On-shore winds tend to be stronger than the off-shore winds and this can be attributed to the cold Benguela current that flows up the west coast of southern Africa.

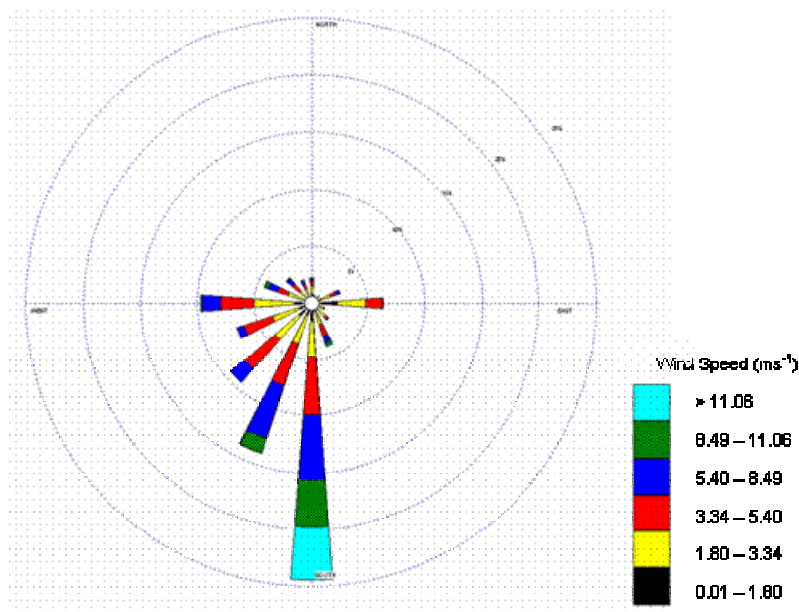


Figure 16. Wind rose for Alexander Bay for 2000 and 2001

### E.8 Humidity

Relative humidity (RH) is strongly influenced by distance from the sea. The mean annual humidity falls sharply towards the interior from around 85% at the coast. Periods of very low RH (<10%) are rare and occur when winter easterly berg winds blow. Very high evaporation rates are recorded during such episodes.

### ***E.9 Sunshine and cloudiness***

Low stratus and stratocumulus clouds are often formed during the early morning hours (02h00 – 04h00) when onshore breezes blow over the upwelling zone. These clouds may be advected inland, intersecting the rising land to produce fog. The amount of cloud cover is thus highest at night but decreases consistently from 08h00 through midday to 20h00. The incoming radiation experienced on the Namaqualand coast, as measured at Alexander Bay, is one of the highest values recorded for a coastal region in the world.

### ***E.10 Terrestrial Ecology***

The ecology of most of the desert is undisturbed, because Diamond Area 1 has been closed to the public since 1908 and mining activities were confined to the coastal strip and the Orange River valley. Parts of the area at Uubvlei are already greatly disturbed by diamond-mining activities and by scrap-heaps of metal, old equipment and used tyres, but there are also areas that are relatively unspoilt within Mining Area 1 (MA1). Figure 17 shows the distribution of existing natural habitats and disturbed areas around the CCGT site.

#### **E.10.1 Vegetation**

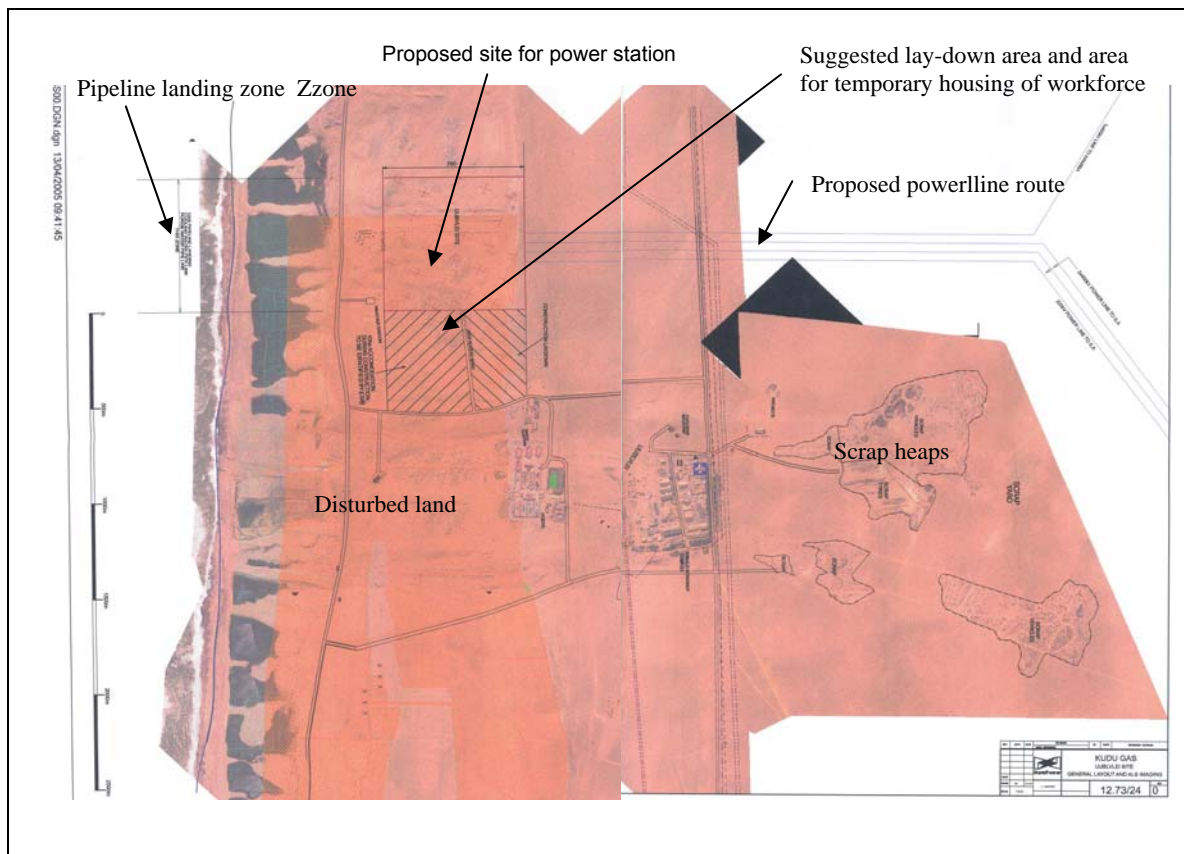
The proposed CCGT site is in a very disturbed mining area where nobody resides permanently. Apart from the mine hostels south-south-east of it, the closest areas to the site where people reside are Oranjemund, approximately 25 km to the south-east, and Alexander Bay, some 7 km further south-east. Due to mining activities, vegetation in most of the mining area that is designated for construction of the plant itself, as well as the new access road, possible accommodation site and the construction laydown area (Figure 17) is very sparse and in a disturbed state. The existing vegetation, dominated by *Brownanthus arenosus*, *Eberlanzia sedoides*, *Zygophyllum clavatum*, *Lycium tetrandrum* and *Salsola* sp., has re-established itself naturally since the area was mined-out approximately two decades ago. Similar reestablishment of these species may be anticipated over the long term. Although *B. arenosus* is near-endemic, and *E. sedoides* is an endemic and protected species, they are relatively common along a considerable stretch of the coastal plains, and have already shown their propensity for re-establishing themselves naturally once disturbance ceases.

The zone that will be affected by the pipelines to and from the sea is similarly disturbed. The mined-out foreshore and ponds habitat is an unnatural habitat as a result of previous mining, and is already extensively compromised to such an extent that none of the proposed construction would compromise it any further. The coastal *Salsola* hummocks occur reasonably frequently further north and south along the Namibian coast where similar conditions prevail. *S. nollothensis* is not of conservation concern at present.

The exit zone of the powerlines to Namibia and South Africa east of the proposed CCGT site comprises a largely undisturbed coastal plain. The vegetation in this area is dominated by low-growing succulents, including *B. arenosus*, *B. marlothii*, *Stoeberia beetzii*, *Othonna furcata* and *Sarcocaulon patersonii*. In addition, *Cephalophyllum ebracteatum* is quite common, as is *Asparagus capensis*, and both *Crassula atropurpurea* var. *cultriformis* and *Juttadinteria deserticola* occur occasionally. *Tridentea pachyrrhiza* a near-endemic, protected species with a very restricted distribution was found (collectors number CM 2682, live plant collection NBRI). With the exception of the last-mentioned species, this assemblage of species is typical of the coastal plains, but less diverse areas of sandy hummocks dominated by the grass *Cladoraphis*

*cyperoides* intervene occasionally towards the western sections. Most of the plant species observed in the study area are found in similar habitats along the coast of the southern Namib, but several of the species are endemics, and/or protected and *J. deserticola* and *T pachyrrhiza* are thought to occur at a very low density throughout their ranges.

Several more species of conservation concern have been recorded in this area previously, although they were not seen during a survey conducted during March 2005. These include the endemic red data species *Tromotriche aperta* and *Euphorbia cibdela*, as well as *Stapelia garipeensis*, a protected species.



**Figure 17. Map of Uubvlei area that shows the extent of land disturbed by diamond mining operations (hatching), and proposed situation of the power plant and associated activities. Boundaries of habitat zones are not indicated as these were not mapped at the site**

The ecology of most of the desert is undisturbed, because Diamond Area 1 has been closed to the public since 1908 and mining activities were confined to the coastal strip and the Orange River valley. However, the terrestrial ecology around Oranjemund has been disturbed considerably by mining activities, urban development and mine infrastructure, leading to the almost complete eradication of some habitat types which were formerly extensive, but are now isolated populations of endemic species.

### E.10.2 Terrestrial Fauna

The terrestrial fauna of the study area from the Orange River mouth to the proposed CCGT site is adapted to a harsh environment with low rainfall and, inland of the fog belt, high summer

temperatures. In adopting strategies to survive in these conditions, many of the species are cryptic or nocturnal or have extended dormant periods and only emerge under optimum conditions.

**Low hummocks and coastal plains.** Areas disturbed by earlier mining have vegetation areas that are sparser than normal, and presumably similarly for fauna. During mining, the soil in these areas has been excavated, sieved and dumped back, and some re-establishment of plants has subsequently taken place. Recolonisation by invertebrates and small vertebrate animals has probably also taken place, but the extent of this has not been ascertained. Where this habitat has not been disturbed by mining, it supports an interesting array of plant species and is home to some specialised fauna. Lichens are an important feature in this habitat, growing on hummocks of *Salsola* and *Brownanthus*. Lichens in general in Namibia are poorly known, and this area even less because of the restrictions of Diamond Area 1 (Wessels 1994), so it is not known if any species are endemic to a limited area here, or are of any conservation significance for other reasons.

As in much of the Namib, most of the ecological action by fauna in this area is carried out by small animals that can shelter from the harsh conditions of strong winds and meagre rainfall, and that can take advantage of the moisture provided by fog. The snake *Bitis schneideri* exists largely in the area that is or has been mined out in the course of diamond mining by Namdeb. It is known to exist in two colour morphs, dark and pale, and these may be separate species. Thus the conservation status for this possible species complex is raised.

No mammals of conservation significance occur in this area.

**Coastal hummock habitat.** The foreshore area near the CCGT site has been completely mined out, leaving little of the original vegetation and fauna. It is assumed to support species-poor remnants of the original vegetation and animals, namely hummocks around *Salsola* bushes, and fauna similar to the low hummock habitat immediately inland.

### E.11 Terrestrial Avifauna

The terrestrial avifauna of the study area is adapted to a harsh environment with low rainfall. The Chestnutbanded Plover frequents salt pans and nests on and around them. The Damara Tern nests in dune slacks and on exposed gravel plains. The marine and coastal species listed in Table 4 plus the Black-necked Grebe, use the mining ponds for feeding and roosting. Barlow's Lark is near endemic to the Sperrgebiet.

**Table 4. Red Data Book bird species occurring between Port Nolloth and Lüderitz.**

Species	Status
<b>Marine and Coastal species:</b>	
African Penguin <i>Spheniscus demersus</i>	Vulnerable
White Pelican <i>Pelecanus onocrotalus</i>	Near-threatened
Cape Gannet <i>Morus capensis</i>	Vulnerable
Cape Cormorant <i>Phalacrocorax capensis</i>	Near-threatened
Bank Cormorant <i>Phalacrocorax neglectus</i>	Vulnerable
Crowned Cormorant <i>Phalacrocorax coronatus</i>	Near-threatened
Greater Flamingo <i>Phoenicopterus ruber</i>	Near-threatened
Lesser Flamingo <i>Phoenicopterus minor</i>	Near-threatened

Chestnutbanded Plover	<i>Charadrius pallidus</i>	Near-threatened
Caspian Tern	<i>Sterna caspia</i>	Near-threatened
Damara Tern	<i>Sterna balaenarum</i>	Endangered
<b>Terrestrial species:</b>		
Kori Bustard	<i>Ardeotis kori</i>	Vulnerable
Ludwig's Bustard	<i>Neotis ludwigii</i>	Vulnerable
African Black Oystercatche	<i>Haematopus moquini</i>	Near-threatened
Martial Eagle	<i>Polemaetus bellicosus</i>	Vulnerable
Barlow's Lark	<i>Certhilauda barlowi</i>	Near-threatened

### *E.12 Air quality*

The ambient air quality of Uubvlei is generally good, although dust storms do occur on a regular basis, particularly in the winter when easterly off-shore winds are more common. Visibility along the coast is often reduced as a result of the frequent fog and salt spray. As such, the only pollutant of concern would be particulate matter, which has more of a nuisance value than human health impact except in the case of fine particulate matter that can enter the respiratory system. Other sources of air pollution in the study area would be limited to activities associated with diamond mining along the coastline, but their impact is minimal on the area where the CCGT site is. There is currently no ambient air quality monitoring in the study area.

### *E.13 Noise*

Ambient noise would be generated by wind, thundering waves and occasionally, mining activities, air traffic and vehicle movements. The power plant will operate continuously over a 24-hour period, and the major potential impact of noise would be during evening and night-time when man-made noise at any location is at a minimum, and when people expect to rest in quiet surroundings. The noise impact study for the EIA of the CCGT site at Oranjemund, (CSIR, 2004) reported that the increase in operational ambient noise levels can be mitigated so that they conform to international guidelines.

### *E.14 Archaeology*

A full archaeological survey was undertaken over the southern part of Mining Area 1 (which includes the CCGT site) prior to mining. Since the CCGT site has since been mined out, there are no archaeological concerns on the site *per se*. Depending on their various locations, however, the access routes, the gas pipeline, the power line and construction camps could easily put the archaeological record at risk if they are not evaluated as an integral part of the final EIA and EMP.

### *E.15 Orange River Transboundary Conservation Area*

A proposed network of protected areas includes the Orange River Mouth Transboundary Ramsar Site, the Richtersveld - Ai-Ais Transfrontier Park, the Richtersveld Community-based Conservancy and the Sperrgebiet. In Namibia, the Sperrgebiet is a protected area. The Ai-Ais-Richtersveld Transfrontier Conservation Park spans some of the most spectacular scenery of the arid and desert environments in southern Africa. It is bisected by the Orange River, and it comprises the Ai-Ais Hot Springs Game Park in Namibia and the Richtersveld National Park in South Africa.

In recognition of its exceptional ecological significance, the Orange River Mouth was designated a Wetland of International Importance in terms of the Ramsar Convention by both the South African and Namibian governments in 1991 and 1995 respectively.

About 500 ha of the ~2000 ha reserve is within Namibia, and extremely vulnerable because it is at the terminal end of a watershed which is susceptible to pollution and drying up due to over-abstraction of groundwater. In general terms the wetland can be described as a delta type river mouth with a braided channel system during low flow months. The Ramsar site comprises sand banks or channel bars covered with pioneer vegetation, a tidal basin, a narrow floodplain, pans, the river mouth, and a salt-marsh on the south bank of the river mouth.

### *E.16 Population Centres*

The nearest towns to the CCGT site are Oranjemund 25 km away from it, the diamond mining settlement of Alexander Bay on the South African side of the Orange River and Rosh Pinah, about 50 km to the north-east, which is a settlement serving two mines. Because it is a closed security town, no informal settlement has been allowed to develop around Oranjemund; according to the 2001 Housing and Population Census, Oranjemund has a population of 4451. These census figures are at variance with Namdeb estimates of 10 000. Population estimates of between 6000 and 9000, of whom 60% are males, can be assumed for planning purposes.

Oranjemund lies within Diamond Area 1, but outside Mining Area 1 (MA1), a roughly 3km band from the Orange River mouth to Chameis Bay, with strict controls on access. Though the land is owned by the State, infrastructure and assets are owned by Namdeb. The government of Namibia intends to for Oranjemund to become a municipality, and a structure plan and site layout are being finalized in preparation for this.

Excellent schooling facilities are available in town for primary and pre-primary education. High schooling is only available at Alexander Bay or at boarding schools in Namibia and South Africa. Namdeb delivers social services to the community in the form of individual casework, family counselling and community development projects. The town of Oranjemund offers social services and facilities at a level usually only found in much bigger towns. These include health facilities, schools, a technical college, a crèche, a public library, parks, recreation facilities and sports fields. Although Oranjemund remains a “closed” town, it nevertheless has developed a viable commercial service and industrial sector. There are more than 30 social and recreation clubs in Oranjemund, including horse riding, yachting, golf, soccer, tennis, youth clubs and gymnasiums. Namdeb equips and maintains all clubs and children’s’ playgrounds. Staff work with parents to co-ordinate youth activities. Oranjemund has always rated itself as a highly safe and secure town for its residents with an exceptionally low crime rate. This is partly due to the isolated nature of the town and its small size, but mostly because of the security measures which are implemented around the diamond industry.

### *E.17 Communications*

By road, Oranjemund is accessible from three different directions:

- A gravel road along the north bank of the Orange River from Rosh Pinah in the east;
- A security gravel road from the Lüderitz-Aus road in the south; and,
- From South Africa via the Ernst Oppenheimer bridge seven kilometers south-east of Oranjemund.



The southern security road runs through the Sperrgebiet and is planned to be the route used to transport the main combined cycle power plant components from Lüderitz. The road from Aus via Rosh Pinah will be upgraded and tarred. Oranjemund is connected to Alexander Bay and thence to Port Nolloth via a recently tarred road. The single-lane Oppenheimer Bridge spans the Orange River some 9 km from its mouth. Port Nolloth is connected to the extensive South African highway network through Steinkopf and Springbok. There is an airport at both Oranjemund and Alexander Bay. Lüderitz and Oranjemund are served by a regular Air Namibia service which connects them to Windhoek and Cape Town. Alexander Bay is served charter services. There is no regular air service to Port Nolloth.

Oranjemund has an automatic telephone exchange and full cellphone reception. All four centres, Lüderitz, Oranjemund, Alexander Bay and Port Nolloth are connected to their respective national (mainly microwave) telephone networks that are fully connected to the global system.

### *E.18 Tourism*

The once restricted diamond mining area, the Sperrgebiet, will be proclaimed a national park by the Namibian government. The Sperrgebiet is one of the world's 25 top globally recognised biodiversity hotspots for fauna and flora, and offers unique scenery ideal for high quality, low impact tourism. The area has been identified as a priority area for conservation in the Succulent Karoo Ecosystem Plan (SKEP), a 20-year strategy that now guides conservation action in this hotspot. The strategy was developed and is being implemented with support from the Critical Ecosystem Partnership Fund (CEPF) and Conservation International's Global Conservation Fund.

Tourism throughout Namibia has developed into an extremely important growth industry. Tourists to Namibia wish to experience wide open, unspoilt places. If implemented properly and sustainably, the development of tourism in the Sperrgebiet can stimulate the economy of southern Namibia by bolstering the economies of towns such as Rosh Pinah and Lüderitz, and serve as a gateway to the Lüderitz waterfront

## F. Impact description and assessment

Potential impacts of the proposed activity on the environment are described and assessed in this Chapter, by applying the criteria in Box 1.

### **Box 1: Assessment of potential impacts**

The significance of potential impacts should be described as follows:

- **Low:** Where the impact will not have an influence on the decision, nor is it critical for it be accommodated in the project design
- **Medium:** Where it could have an influence on the decision unless it is mitigated, and would require modification of the project design;
- **High:** Where it would influence the decision regardless of any possible mitigation, with possible 'no-go' implication for the project.

The assessment of impacts should be based on the following criteria:

- **Nature of impact** - this appraises the type of effect a proposed activity would have on the environment and should include "what will be affected and how?"
- **Extent** - this should indicate whether the impact will be local and limited to the

immediate area of the activity (the site or the servitude corridor); limited to within 5km of the development; or whether it will have an impact regionally, nationally or even internationally.

- **Duration** - this indicates what the lifetime of the impact will be, whether short term (0 - 5 years), medium (5 - 15 years), long term (>15 years, but where the impacts will cease after the operation life of the activity), or permanent.
- **Intensity** – this establishes whether the impact is destructive or benign, and described as low (where no environmental functions and processes are affected), medium (where the affected environment is altered and continues to function, but in a modified manner) or high (where environmental functions and processes are altered to the extent that they temporarily or permanently cease).
- **Probability** - this describes the likelihood of the impact actually occurring, indicated as improbable (possibility very low), probable (distinct possibility), highly probable (most likely) or definite (impact will occur regardless of prevention measures).

*Note: the descriptions provided for extent, duration, intensity and probability should be reviewed by each specialist, and adapted if necessary.*

The status of the impacts and degree of confidence with respect to the assessment of the significance, must be stated as follows:

- **Status of the impact:** A description of whether the impact will be positive (a benefit), negative (a cost), or neutral.
- **Degree of confidence in predictions:** This is based on the availability of information and specialist knowledge.

Other aspects to be taken into consideration in the specialist studies:

- Impacts should be described both before and after the proposed mitigation and management measures have been implemented.
- All impacts should be evaluated for the full life cycle of the proposed development, including design, construction, operation and decommissioning.
- The impact evaluation should take into consideration the cumulative effects associated with this and other facilities that are either developed, or are in the process of being developed in the region.
- The specialist studies must attempt to quantify the magnitude of potential impacts (direct and cumulative effects) and outline the rationale used. Where appropriate, national standards are to be used as a measure of the level of impact.
- All relevant legislation and permit requirements must be identified and the permit application process discussed.

#### **Mitigation and monitoring**

- Where negative impacts are identified, specialists should set mitigation objectives (i.e. ways of reducing negative impacts), and recommend attainable mitigation actions. Where no mitigation is feasible, this should be stated and the reasons given. Where positive impacts are identified actions to enhance the benefit must also be recommended.
- The specialists should set quantifiable standards for measuring the effectiveness of mitigation and enhancement. In addition, specialists should recommend monitoring, and review programmes to assess the effectiveness of mitigation.

## **F.1 Socio-economic assessment**

### **F.1.1 Impact on the population, employment and social services**

The main concerns by the public raised during the 1998 PEA, the 2004 EIA and the present EIA were the following:

- Construction: Increase in crime; integration of old and new residents; stress on community facilities and services; stress on recreation facilities; urban management; increased squatting at Rosh Pinah.
- Operations: Impact of retrenched workers; health risks from hazardous by-products.
- Decommissioning: Impact of retrenched workers and urban management.

Practically all of the social impacts identified are significant only during the three year construction period. Of the five social impacts identified, none fall into the category of high significance and/or high intensity. One is considered to have medium significance and/or intensity. This means that it could have sufficient influence on the environment to affect project design or require alternative mitigation. This is:

- Stress on existing health systems (negative impact)

The remaining four social impacts are rated as having either a medium-low intensity or a low significance. This means that the impact will not have an influence on the project design. Helpful mitigations may be implemented but are not essential. These are:

- Impact on occupational health (negative impact)
- Stress due to increased crime and alcohol related violence (negative impact)
- Stress on education, social and recreation facilities (negative impact)
- Employment opportunities for retrenched Namdeb workers (positive impact)

The estimated life of the plant is more than 20 years. However, this could be extended by several years if the second phase is commissioned. All five of the social impacts identified are rated as having either a low intensity or low significance.

### **F.1.2 Impact on infrastructure and urban services**

Only two concerns were raised by the public during both the 1998 PEA and the 2004 EIA, that relate to infrastructure and urban services. These were:

- The creation of a housing shortage due to the influx of new urban residents; and,
- The impact of increased traffic on road safety.

During the March 2005 public meeting, concerns were raised about the possible use of the Uubvlei hostel and single quarters as accommodation for the plant construction workers. The standard of these facilities have fallen into decline in recent years and are no longer considered fit for extended worker habitation. Nampower would have to ensure that these facilities are improved and upgraded to make them suitable for occupation for a further 3 to 6 years.

Three urban infrastructure impacts are identified. These are all linked to the construction phase of the project only and concern the impact of the 600 – 1300 temporary workers on the town's housing and its sewage disposal system, and also concern the impact of additional traffic moving through the town.

Two impacts are identified during the construction phase which fall into the category of medium or medium/low significance with medium intensity. This means that they could have sufficient influence on the environment to affect the project design or require alternative mitigation. These are:

- Increased urban road traffic (negative impact)
- Impact on Namdeb's housing stock (negative impact)

There are no impacts of high significance and / or high intensity.

Once the plant is operational, a permanent force of 60 - 70 technical and management staff will be employed. It has already been agreed that they will be accommodated in Oranjemund in family houses to be constructed at a site already earmarked in the western sector of town.

There are no impacts of high/medium significance and/or high/medium intensity.

Two urban infrastructure impacts are rated as having low intensity and low significance. This means that the impact will not have an influence on the project design. Helpful mitigations may be implemented but are not essential. These are:

- Impact on the Town's Housing Stock (negative impact)
- Impact on the Town's Reticulated Services (negative impact)

### **F.1.3 Impact on the economic structure and urban management**

During the 1998 meetings held for the PEA, three main concerns were raised concerning economic impact on the town. These were:

- Potential impact of the plant on existing diamond mining operations;
- Economic benefits to the town; and
- Impacts on the future of tourism.

Additional concerns and issues raised during the 2004 meetings were:

- Negative impact on the town's viability and management after decommissioning;
- Economic benefits and problems to Rosh Pinah;
- Economic spin-offs, e.g., in tourism and agriculture;
- Need for financial contributions (e.g., a trust fund) to mitigate decommissioning impacts.

Five main economic and urban management impacts are identified. Four are linked to both the construction and operation phase of the Kudu CCGT project, and one is relevant to the operation phase only. The five impacts identified are:

- Impact on Namdeb mining operations;
- Macro-economic spin-offs from the operation of the plant;
- Local economic spin-offs;
- Impact on local governance; and,
- Impact of informal employment speculators (squatters).

Three impacts fall into the category of medium/high impact and/or significance and are therefore considered to have sufficient influence on the environment to affect the project design or require alternative mitigation. These are:

- Local economic spin-offs (positive impact);
- Impact of Informal Employment Speculators (negative impact), and
- Impact on local governance (neutral impact).

The socio-economic impact of the Kudu CCGT project on Namdeb's overall terrestrial and coastal mining operations was evaluated to be of low significance and low impact.

The socio-economic impact on Namdeb mining operations was again deemed to be of low significance and low impact during the operational phase. Similarly, the impact of the power plant operations on local governance is considered to be of low significance and low impact.

Three impacts scored medium or high impact and / or significance within the operation period and one after decommissioning. These were:

- Macro-economic spin-offs (positive impact);
- Local economic spin-offs (positive impact); and,
- Impact of Informal Employment Speculators (negative impact), and
- Impact of decommissioning (negative impact).

#### **F.1.4 World Bank requirements for assessment of socio-economic impacts**

Operational Directive 4.01 of the World Bank requires that impacts of development and other socio-cultural aspects on the receiving socio-economic environment be assessed. In particular, the effects of secondary growth of settlements and infrastructure on the environment must be properly controlled.

If the recommendations proposed for enhancement and mitigation of impacts on the socio-economic environment are implemented by the project proponent, then the project will comply with World Bank requirements as stipulated in Operational Directive 4.01.

#### ***F.2 Impact of noise on the receiving environment***

During construction, noise is caused by the operation of diesel powered earth moving and construction equipment, such as bulldozers, front end loaders, scrapers, excavators, concrete mixers as well as haulage and other kinds of trucks. These noise emissions have a characteristic low frequency content that is not readily attenuated by atmospheric absorption and can often be heard over long distances. However, because there have been mining activities for a very long time, these noise sources are not new in this environment. General construction activities, such as metalworking often have a broadband or high frequency character and are quickly attenuated by atmospheric absorption and soft ground conditions while travelling from the source to the receiver.

During the operational phase, noise is generated by the gas turbine units. The process involves the compression of air by high speed rotating machines, the combustion of gas and propulsion of generators and emission of high speed and high temperature exhaust gasses. They are, therefore, inherently noisy processes and can produce particularly disturbing single frequency noise components related to the blade passing frequency of the turbines. The noisiest sources on these units are the air intakes and exhausts. Noise is also caused by ancillary equipment, such as oil pumps and the two banks of cooling fans.

### F.2.1 World Bank requirements for assessment of noise impacts

In terms of World Bank guidelines, noise abatement measures must achieve either the levels given below, or a maximum increase in background levels of 3 decibels (measured on the A scale) [dB(A)]. Measurements must be taken at noise receptors located outside the project property boundary.

Location Category	Maximum allowable log equivalent (hourly measurements), in dB(A)	
	Day Time (07h00 – 22h00)	Night Time (22h00 – 07h00)
Residential Institutional, Educational	55	45
Commercial/Industrial	70	70

The impact of noise on construction workers at the CCGT site will be controlled by statutory occupational health regulations. Because Oranjemund is 25 km away, and up-wind of the CCGT site, both construction and operational noise will not be heard in Oranjemund.

### F.3 The vegetation on the site and its environs

Mining has already severely disturbed the CCGT site, to the extent that there is sparse vegetation on the site itself, as well as north and south of it throughout the mined-out area. This makes it an ideal site from a conservation point of view.

Stabilised hummock vegetation is found to the south-east of the site. It is probably the original vegetation type at the site, because pockets of it may still be seen in the surrounding yet-to-be-mined areas within Mining Area 1. Diversity here is higher than that on the low hummocks, with two protected species, *Othonna furcata* and *Eberlanzia sedoides* (which is also endemic) occurring. Neither these species, nor the assemblage of species found, is rare or threatened in Namibia. Nevertheless, the presence of two protected species makes it essential that any unnecessary damage to the area be avoided.

There is an area of coastal hummock vegetation west of the CCGT site, south of the ponds in Mining Area 1. This type of habitat has already been compromised by mining to a certain extent, but occurs reasonably frequently further north along the Namibian coast where similar conditions prevail.

Impacts such as clearing for roads and other structures on any remaining pristine or less disturbed hummock vegetation in the direct surrounds of the CCGT site should be minimized in the hope of later natural recolonisation of the habitat.

In regard to the low hummock vegetation, where there will probably be a new access road, routes (preferably a single route) should be identified and demarcated before construction activities commence, in order to minimize disturbance. The environmental management plan should provide for the prohibition of new tracks being made, where the surface of the original track has become corrugated.

In regard to the construction camp, provision should be made for waste disposal. The contractors should be responsible for compliance by their workforce to all rules concerning the management of waste. It is recommended that, in order to conserve the remaining pocket of stabilized hummock vegetation, collateral damage such as unnecessary tracks and turning-points during

the construction phase be prevented through careful planning of road routes and control of staff. If sufficient control is exercised, later recolonisation of damaged areas by these plants (as can already be seen within the mining area) may be expected, reducing long-term defacement and will permit the re-establishment of reasonably natural habitats and ecosystems. For the coastal hummock vegetation, beyond prevention of unnecessary collateral damage, no mitigation measures are suggested.

### F.3.1 World Bank requirements for assessment of impacts on vegetation

Section 95(l) of the Constitution of Namibia, and Article 14 of the Convention on Biological Diversity require that important ecosystems and biodiversity be maintained, and that impacts be avoided/minimized. The World Bank Operational Policy 4.04; *Natural Habitats* also recommends that rehabilitation be considered, particularly in the case of natural habitats. Its section 3 states that:

*“the Bank promotes and supports natural habitat conservation and improved land use by financing projects designed to integrate into nation and regional development the conservation of natural habitats and the maintenance of ecological functions. Furthermore, the Bank promotes the rehabilitation of degraded natural habitats”.*

These requirements will be met if the recommended mitigation measures for impacts of the remaining hummock vegetation are implemented.

### F.4 Impact on terrestrial ecology and fauna

Parts of the area at Uubvlei in Mining Area 1 (MA1) are already greatly disturbed by diamond-mining activities and by scrap-heaps of metal, old equipment and used tyres, but there are also areas that are relatively unspoilt within MA1.

On the fauna side, most of the ecological action in this area, like in much of the Namib, is carried out by small animals than can shelter from the harsh conditions of strong winds and meagre rainfall, and that can take advantage of the moisture provided by fog.

Extraction of seawater from beach wells, and discharge of effluent in the sea, are not expected to have any impact on the terrestrial fauna. Pipelines for these purposes will traverse disturbed land lying between the shore and the power station, so they will also have negligible impact.

Construction activities, most particularly clearing of the surface where the power station and associated structures will be built, and making access roads, could raise clouds of dust. This effect will be short-lived, and will probably not increase dust levels significantly more than the area already experiences from mining activities. Plants, lichens and animals that inhabit this area are probably frequently exposed to strong sand-laden winds, so there will be no difference for them.

B. schneideri snakes in the area that are directly impacted by the project should be collected and possibly relocated to an area of similar habitat that is not disturbed, nearby. This would involve some fieldwork to locate and catch the reptiles by specialists who could start a captive breeding programme to help clarify the taxonomic status of the different morphs, as well as to build up numbers of this/these species.

For any atmospheric pollutants, strong winds at the coast, experienced on an almost daily basis, will disperse them so that there is no hazardous buildup.

Waste disposal facilities should be used for disposal of building wastes as well as domestic wastes produced in the living areas of construction staff. This will prevent litter blowing around and contaminating surrounding areas. The Windhoek hazardous waste disposal facility at Kupferberg is available for any hazardous waste generated during construction and operation.

Construction activities should not be allowed to spill over into undisturbed low hummock habitat, as this can quickly spread and destroy a much wider area of this kind of hummock vegetation and its associated fauna. Roads for vehicles should be clearly demarcated and drivers instructed to keep strictly to these tracks only.

If it is unavoidable to extend activities onto undisturbed land, then rehabilitation procedures, as recommended and carried out by Namdeb, should be done. This involves preparation before construction begins, by moving plants and as much of their surrounding substrate as possible, from areas that will be excavated to others where they are safe.

Safety guidelines implemented by Namdeb for sourcing of their fuel need to be assessed for appropriateness and to develop measures that can be applied to Nampower. Namibia has an oil-spill contingency plan that is coordinated by the Emergency Response Unit in the Ministry of Works, Transport and Communication. Nampower and its contractors should familiarize itself with steps to avoid an oil-spill accident and what to do in the event of such an accident.

All biota in the immediately affected area of the low hummock habitat would be threatened as a result of an oil spill, but, assuming it was confined to a small area, the overall impact would be small. Namibia has an oil-spill contingency plan that is coordinated by the Emergency Response Unit in the Ministry of Works, Transport and Communication. Nampower and its contractors should familiarize itself with steps to avoid an oil-spill accident and what to do in the event of such an accident.

#### **F.4.1 World Bank requirements for assessment of impacts on the terrestrial ecology**

The proposed site for the CCGT site has been degraded by mining operations. However, there are likely to be impacts to the ecology from both the construction and operational phases of the project. As previously mentioned, Section 95(1) of the Constitution of Namibia, Article 14 of the Convention on Biological Diversity, and the World Bank Operational Policy 4.04 (OP 4.04), *Natural Habitats*, require that important ecosystems and biodiversity be maintained, with impacts avoided/minimized. Section 1 of OP 4.04 states that

*“The conservation of natural habitats, like other measures that protect and enhance the environment, is essential for long-term sustainable development. The Bank therefore supports the protection, maintenance, and rehabilitation of natural habitats and their functions... The Bank supports, and expects borrowers to apply, a precautionary approach to natural resource management to ensure opportunities for environmentally sustainable development”*

These requirements will be met if the recommended mitigation and monitoring measures are implemented.



### F.5 Impact of air emissions

The proposed plant is likely to have negligible transboundary effects on air quality.

A double capacity CCGT plant will result in an 82% increase in the global greenhouse gas emissions from Namibia, based on 1994 figures. While this figure indicates a large increase the overall emissions of CO<sub>2</sub> remain insignificant in global terms.

Emissions from the gas conditioning plant are negligible.

The air quality study was undertaken to address the generation and subsequent dispersion of air pollution from the proposed power plant at Uubvlei near Oranjemund. Air dispersion modelling was undertaken using the US-EPA approved CALPUFF suite of models, to predict ambient air pollution concentrations and deposition rates. Four development scenarios were modelled i.e., nominal 800 MW oil fired, nominal 800 MW gas fired, nominal 1600 MW oil fired and nominal 1600 MW gas fired.

Emission scenarios modeled are described in Table 5.

**Table 5. Emission scenarios modelled**

Scenario	Sources	Pollutants To Be Modelled
<b>Construction</b>	Roads and construction site	Particulates
<b>800 MW generating capacity: Normal operations</b>		
<b>Gas cycle only</b>	CCGT power station	NO <sub>x</sub>
<b>Fuel oil cycle only</b>	CCGT power station	SO <sub>2</sub> , NO <sub>x</sub> , Particulates
<b>1600 MW generating capacity: Normal operations</b>		
<b>Gas cycle only</b>	CCGT power station	NO <sub>x</sub>
<b>Fuel Oil cycle only</b>	CCGT power station	SO <sub>2</sub> , NO <sub>x</sub> , Particulates

Pollutants of concern for this study are the major ones typically emitted from combined cycle gas turbine power production operations. These are listed in Table 6. Quantitative health risk assessments were required only for SO<sub>2</sub>, NO<sub>x</sub> and PM. Other pollutants were considered in a qualitative manner.

**Table 6. Compounds of potential concern and health endpoints.**

Medium	Compounds of potential concern	Health endpoint
Air	Sulphur Dioxide (SO <sub>2</sub> )	Broncho-constriction
	Oxides of Nitrogen (NO <sub>x</sub> )	Increased risk of respiratory infection
	Particulate Matter (PM)	Respiratory, cardiovascular effects

A network of uniformly spaced receptor points, 1 km apart, was used, covering a 25 km by 25 km study area of approximately 625 km<sup>2</sup>, centred on the proposed CCGT site at Uubvlei. The selection criteria for receptor points were:

- Geographical spread around the proposed development.
- Location of human settlements where exposure is most likely to occur in order to protect the most sensitive individuals.
- Location of areas with natural vegetation and cultivated lands.

- Location of recreational and tourist areas.

The study only considered air pollution from the proposed power plant. The limitation of this approach is that urban air pollution sources such as motor vehicle emissions are not considered, neither are emissions from the local diamond mining industry. The impact of air pollution per se is therefore not considered quantitatively but an assumption is made that indoor and outdoor air pollution concentrations are similar. It is important to note that maximum 1-hour and 24-hour concentrations are used in the risk assessment. The results therefore do not present ranges, but rather the worst-case scenario.

Stone and Webster (1998) assessed the option of using fuel oil as a standby fuel in the case of failure of the gas supply. The natural gas supply to the plant would have a 96% guaranteed availability, representing an annual downtime of 14.6 days, but the maximum continuous gas supply interruption is specified as 5 – 7 days. The standby liquid fuel consumption by the power station was estimated to be a maximum of 3 100 m<sup>3</sup>/day (Stone and Webster, 1998). Based on this fuel consumption a summary of the emissions from the oil fired stacks are provided in Table 7 below. Mitigation measures employed would be dry low NO<sub>x</sub> burners for gas-fired operation and water injection for liquid fuel operation.

**Table 7: Summary of stack parameters and emission rates per shaft for the Kudu CCGT power plant**

Parameter	Fuel Gas Stack	Fuel Oil Stack NO <sub>x</sub> mitigation
Emission Temperature	361.2 K	373.2 K
Emission Exit Velocity	21.5 m/s	21.5 m/s
Stack Height	60 m	60 m
Stack Diameter:	6.4 m	6.4 m
Emission Rate – NO <sub>x</sub>	30.28 g/s	21.53 g/s
Emission Rate – SO <sub>2</sub>	0.0 g/s	168.99 g/s
Emission Rate – PM	0.0 g/s	4.31 g/s

The air pollutants identified as important in terms of potential damage to vegetation in the study area were NO<sub>x</sub>. The potential impacts of NO<sub>x</sub> on vegetation in the study area is based on published data on effects of atmospheric pollutants on vegetation, the results of air dispersion modelling for NO<sub>x</sub> emissions from the proposed Kudu CCGT Power Station and the specialist studies on vegetation (Burke, 1998; Mannheimer, 2004) in the area. It must be noted that that existing data on impacts of air pollution are essentially based on observations and experimental evidence for industrialised northern hemisphere countries. Information of potential impacts on local flora is very poorly documented, both in terms of field and laboratory investigations (Olbrich and van Tienhoven, 1998). Thus caution must be exercised in extrapolating published information to the current situation that is being assessed.

A summary of the pollutants assessed in this study is presented in Table 8.

**Table 8. Summary of the pollutants assessed**

Pollutant	Modelled	Health Risk Assessment	Qualitative Assessment
PM	Yes	Yes	No
SO <sub>2</sub>	Yes	Yes	No
NO <sub>x</sub>	Yes	Yes	No
CO <sub>2</sub>	No	No	Yes
CO	No	No	Yes
Dust	No	No	Yes

The overall assessment on the impact of the proposed development on vegetation indicates that the significance of impacts are low based on pollutant loads and the distribution of the vegetation types on a regional (Namibian coast) scale. Assessment of the data did not indicate any fatal flaws.

The health risk assessment was based on the worst case scenario as specified above at the receptor points. This conservative approach means that if the risk to human health is found to be low, then the chance of an adverse impact on health is minimal and even sensitive individuals will not be affected by the emissions from the proposed plant. The World Health Organisation (WHO) guidelines for NO<sub>x</sub>, World Bank standard and the proposed new ambient air quality standards for South Africa were used for the assessment. For the air quality assessment, Isopleth maps were drawn to reflect annual average, 24-hour maximum and 1-hour maximum concentrations, where model outputs for annual periods represented the actual predicted average for 2 years of meteorological data. The 24-hour and 1-hour maxima represented the worst-case scenario, as the highest concentration modelled at each receptor point. For the isopleth maps the maximum value modelled at each grid point at any time in the year was used to calculate the isopleths. In reality no such day or hour is likely to occur but provides an indication as to the potential worst-case scenario.

Risks were evaluated for a child of 10 years and an adult of between 18 - 65+ years of age at the Uubvlei CCGT site.

Based on the results of the dispersion modelling and risk assessments the following conclusions may be drawn:

- For the main pollutants of concern no acute or chronic health effects are expected in any healthy or sensitive individuals from the emissions of the proposed CCGT power station.
- Dust generated during the construction phase, particularly after the early excavation period may have a nuisance impact beyond the immediate region under windy conditions. Management measures to minimize or mitigate the impact must be implemented.
- The proposed development will not have a significant impact on the surrounding vegetation.

Based on a comprehensive air quality modelling exercise, using the best available input data, and risk assessments, it is apparent that impacts from emissions from the proposed Kudu CCGT power plant are limited to the immediate area surrounding the plant, they will however persist for the lifetime of the plant, but the intensity of the impacts are low, with and without mitigation.

### F.5.1 World Bank requirements for assessment of impacts from atmospheric emissions

The only way in which the performance of any dispersion model can be evaluated is based on the availability of monitored data in the area where the model is being applied. There are currently no monitored data of ambient concentrations of NO<sub>x</sub>, or any other air pollutant in the Oranjemund area. The dispersion model can therefore not be tested or evaluated.

It is recommended that an ambient air quality monitoring programme must be established following the commissioning of the plant. This could initially be achieved through a passive monitoring network and the results from this survey could inform future monitoring at the site. Once a reasonable data record is established it can be used to evaluate past and future modelling exercises.

The information supplied by the manufacturer and the predictions from the dispersion model do, however, indicate that the proposed power plant will comply with World Bank requirements.

### F.6 Visual impact of the power plant

The sources of visual impact are the following:

- The power plant, and particularly the 4 stacks, which reach up to 50m in height, would be visible on the skyline from most viewpoints in the open desert landscape.
- The plume from the power plant would extend some distance above and beyond the power station, and would therefore also be noticeable from a distance.
- Flaring from the gas conditioning plant. Gas flaring at the gas processing plant will occur in emergency cases only, to blow down the gas pressure in the plant and/or pipeline, and would last for hours only. Should such an emergency happen at night, there would be a temporary visual impact. The pilot of the flare has no visible effect.
- The lighting from the power plant, including red navigation lights on the tall stacks, which would be visible at night.

Visibility is largely determined by topography (viewsheds), by the elevation and distance of the observer, and by foreground buildings or trees which may obscure sightlines. The degree of visibility in a flat landscape is determined largely by distance, although silhouette effects against the skyline also play a role. Degrees of visibility can be described as:

- Highly visible - Dominant within the observer's viewframe (± 0 to 1km);
- Clearly visible - Clearly noticeable within the observer's viewframe (1 to 2km)
- Moderately visible - Recognisable feature within observer's viewframe (2 to 4km)
- Marginally visible - Not particularly noticeable within observer's viewframe (4 to 6km)
- Hardly visible - Practically not visible unless pointed out to observer (6km+)

The proposed CCGT power plant will not be visible from Oranjemund, and there is thus no visual impact on the town. However, the future development of the Sperrgebiet will be accompanied by an increase in tourist numbers, though it is not known how visible the power plant will be to any likely travel routes. To minimize any potential negative visual impacts on a desired Sperrgebiet experience, the following guidelines are recommended:

- Limit the visual effect of buildings scattered in the landscape;
- Use muted colours for building finishes to reduce light reflection and resulting visual prominence of structures. Light blue-grey colours will tend to be less visible when seen against the sky.
- Outdoor lighting, where required, must be as unobtrusive as possible

### F.7 Impact of the purge water discharge

Discharges of purge water offshore of the surf zone and into the surf zone were assessed. International best practice is not to discharge into “sensitive” environments and the recently drafted South African Operational Policy for the disposal of land-derived water containing waste to the marine environment (RSA DWAF, 2004b), and a review of international best practise and international trends in marine waste disposal policy, suggests that the surf-zone in general should be considered a sensitive environment. The option of shoreline discharge into the surf zone, nevertheless, was fully assessed as a potential marine disposal option.

World Bank requirements for the discharge of purge water are that effluents comply with the conditions in the table below.

Parameter	World Bank Guidelines <sup>a</sup>
<b>Zone of impact / mixing zone</b>	100 m radius from point of discharge for temperature
<b>Temperature</b>	< 3° C above ambient at the edge of the zone where initial mixing and dilution take place. Where the zone is not defined, use 100 meters from the point of discharge when there are no sensitive aquatic ecosystems within this distance.
<b>Salinity</b>	-
<b>Residual Chlorine</b>	0.2mg/l at point of discharge prior to dilution <sup>b</sup> .

- The World Bank guidelines are based on maximum permissible concentrations at the point of discharge and do not explicitly take into account the receiving environment, *i.e.* no cognisance is taken of the fact of the differences in transport and fate of pollutants between, for example, a surfzone, estuary or coastal embayment with poor flushing characteristics and an open and exposed coastline. It is for this reason that we include in this study other generally accepted Water Quality guidelines that take the nature of the receiving environment into account.
- “Chlorine shocking” may be preferable in certain circumstances. This involves using high chlorine levels for a few seconds rather than a continuous low-level release. The maximum value is 2 mg/l for up to 2 hours, not to be repeated more frequently than once in 24 hours, with a 24-hour average of 0.2 mg. l<sup>-1</sup>. (The same limits would apply to bromine and fluorine.)

For the 800 MW nominal capacity gas-fired combined cycle power station under consideration, the characteristics of the proposed cooling technology are an evaporative cooling system having the following characteristics:

- Abstraction rate of 2 000 m<sup>3</sup>/hr (~ 0.56 m<sup>3</sup>/s)
- Discharge rate of 1 300 m<sup>3</sup>/hr (~ 0.36 m<sup>3</sup>/s)
- Water return will contain a trace of chlorine of 0.1 mg/l NAO Cl, but can be de-chlorinated at a cost premium.
- Temperature rise in discharge waters of approximately 10°C relative to intake seawater temperature (*i.e.* ΔT=10°C) or approximately 5°C relative to wet bulb temperature (*pers comm.*, John Jenkins, ESKOM).

- Salinity rise of approximately 1.5 x the salinity at the intake, i.e. a discharge salinity of approximately 55 psu.

This implies discharge temperatures ranging from as little as 16°C to 22°C (wet bulb temperature + 5°C) to 32°C to 35°C (ambient water temperature +10°C) for the evaporative cooling option. Should the capacity of the plant be increased to nominal 1600 MW, the characteristics of the effluent discharges will remain the same, however the volumes discharges will approximately double in magnitude. The effluent discharged will be a dense effluent having roughly the characteristics as listed in Table 9. Other effluents that could possibly be discharged together with the heated brine waters are:

- boiler blowdown
- gas turbine blade cleaning effluent
- drainage from processes in the plant and surface water drainage
- steam generator chemical cleaning effluent
- other effluent and drainage discharges
- sewage treatment plant effluent
- BTEX (benzene, toluene, ethylbenzene and xylene), from the gas conditioning plant.

These include various chemical compounds either associated with the exploitation and transport of the Kudu gas itself, or with power generation.

**Table 9. Characteristics of discharged cooling/purge waters from an evaporative cooling system.**

Variable	Ambient conditions (approximate)	Increase above ambient	Approximate discharge characteristics
Seawater temperature	Seawater temperature: Winter: 12 – 13°C Spring: 13 - 14°C Summer: 14 - 15°C Autumn: 13 - 14°C	$\Delta T = +10^\circ\text{C}$ above ambient seawater temperature	T = 22 - 25°C under typical conditions, but T = 33,5 - 34,5°C under extreme conditions)
	Mean daily wet bulb air temperature at Alexander Bay range between 11 and 17°C with variability in the means at 0800B, 14:00 B and 20:00 B ranging between 8 and 18°C.	or $\Delta T = +5^\circ\text{C}$ above wet bulb air temperature	or T = +16°C – 22°C under typical conditions, but +12°C – 25°C under more extreme conditions
Salinity	34.8 to 34.85 psu	Approximately +20 psu (brine concentration factor = 1.5) <sup>*1</sup>	S = 55 psu
Biocide (free chlorine)	none	0.1mg/1 NAO CL <sup>*2</sup>	0.1mg/1 NAO CL

\*1 The brine concentration value is a function of the purge quantity, which in principle can be manipulated according to environmental requirements. Increasing the purge water will however result in increased thermal impacts and an increased discharge of biocides (as well as increased costs associated with these increased volumes to be pumped and associated chlorination requirements.)

\*2 Typically a sodium hypochlorite (NaOCl) solution is pumped directly into the cooling system inlet by a controlled injection system, so as to maintain a residual level of 0.1mg/l NaOCl (or free chlorine) at the cooling water outlet from the condensing plant. De-chlorination of the effluent is possible for an evaporative cooling system but at an increased operational cost.

The discharge location needs to be such that it does not stir up sediments that could be drawn into the intake. Similarly the discharge needs to be located such that there is no significant re-circulation of heated brine from the discharge into the intake. Possible discharge locations include:

- Discharge inshore of the intake but beyond the surfzone
- Discharge offshore of the intake but beyond the surfzone, and
- Surfzone discharge

For the discharges beyond the surf zone, to avoid the intake of excessive sediment, the seawater intake is assumed to be located at a water depth of approximately 15 m. Over the life-time of the project it is expected that the shoreline will prograde by up to 300 m.

In terms of existing and potential future marine discharge policy and legislation (e.g. RSA DWAF, 2004a) and the likely migration of the shoreline at the discharge location due to mining operations in the region, a discharge location at the shoreline or in the surf zone is an option that needs to be carefully considered both in terms of environmental and engineering constraints.

For both of the offshore discharge options a single port diffuser, directed upwards at 60 degrees to the horizontal and is located approximately 1 m above the sea bed, is assumed. The discharge velocities from the single port range between  $0.9 \text{ m.s}^{-1}$  and  $5 \text{ m.s}^{-1}$ . (The higher discharge velocity is typical of higher volume once-through hot water discharges)

For the shoreline discharge, the discharge is assumed to occur at the shoreline. The exact location of the discharge relative to the moving (accreting) shoreline is unknown as is the engineering design of such a discharge. For the purposes of this assessment a discharge at the shoreline has been assumed at all times, *i.e.* the discharge point moves with the accretion of the coastline.

The discharge will add heat, brine (elevated salinity) and residual biocide (free chlorine) to the natural environment. The heat and elevated salinities in the heated brine will directly modify the physical characteristics of the seawater in the vicinity of the discharge whilst the heat, brine, biocide and potential co-discharges can all negatively affect the biota. To determine the scale of their effect here first order estimates of the impact area both offshore and in the surf-zone are provided.

### ***Discharge beyond the surfzone***

For the pipeline discharges offshore of the surfzone, the potential changes in the marine environment have been assessed by using a predictive modelling approach, using the CORMIX mixing zone expert system which comprises a software system for the prediction and design of aqueous toxic or conventional pollutant discharges into diverse water bodies developed for the United States Environmental Protection Agency (U.S. EPA) by the Cornell University during the period 1985-1995 (Jirka *et al.*, 1996). The CORMIX system is applicable to all types of ambient water bodies, including small streams, large rivers, lakes, reservoirs, estuaries and coastal waters. The model is a steady-state model providing distributions of conservative pollutants and non-conservative pollutants with a specific allowance being made for heated effluents. However, a limitation of the model is that it assumes an infinite receiving body of water and consequently does not take into account the potential build-up of pollutants. Where the potential for such build-up in, for example, temperature exists due to poor flushing, the results provided by the model will

not be conservative. This is a potential concern for discharges into a surfzone, coastal embayments and similar enclosed semi-enclosed or enclosed bodies of water embayments and similar enclosed semi-enclosed or enclosed bodies of water, however this is unlikely to be of concern along an open and energetic coastline as being considered here. Nevertheless, presentation of the modelling results has erred on the side of caution.

The heated brine being discharged comprises a dense effluent. It is anticipated to have a temperature of 24°C (+10°C above the ambient seawater temperature of 14°C), a salinity of 55 psu (for a brine concentration factor of approximately 1.5) and a density of 1038.9 kg/m<sup>3</sup>. The ambient seawater density is approximately 1026 kg/m<sup>3</sup>. To ensure adequate dilution in the near field the port is configured to discharge at an angle of 60° above horizontal. A negatively buoyant discharge, when jetted into the water column almost vertically will rise up to a maximum height in the water column. Depending on the discharge velocity, the effluent plume may reach the surface. In shallow water the effluent may be mixed throughout the water column. These behaviours are represented schematically in Figure 18.

In Figure 18 the effluent plume rises to a maximum rise height in the water column and then settles back to the seabed and continues to spread due to buoyancy spreading and advection. For the purposes of this study, the extent of the “footprint” of the effluent is given as contours of maximum temperature or salinity rise or concentration of biocide at any location within the water column. In general the effluent is trapped on or near the bottom thus the impacts are expected to be greatest at or near the seabed.

From the study, the approach used was conservative, as it is assumed that there is no heat loss to the atmosphere and that there is no modification of the free chlorine concentration by organic material in the receiving waters.

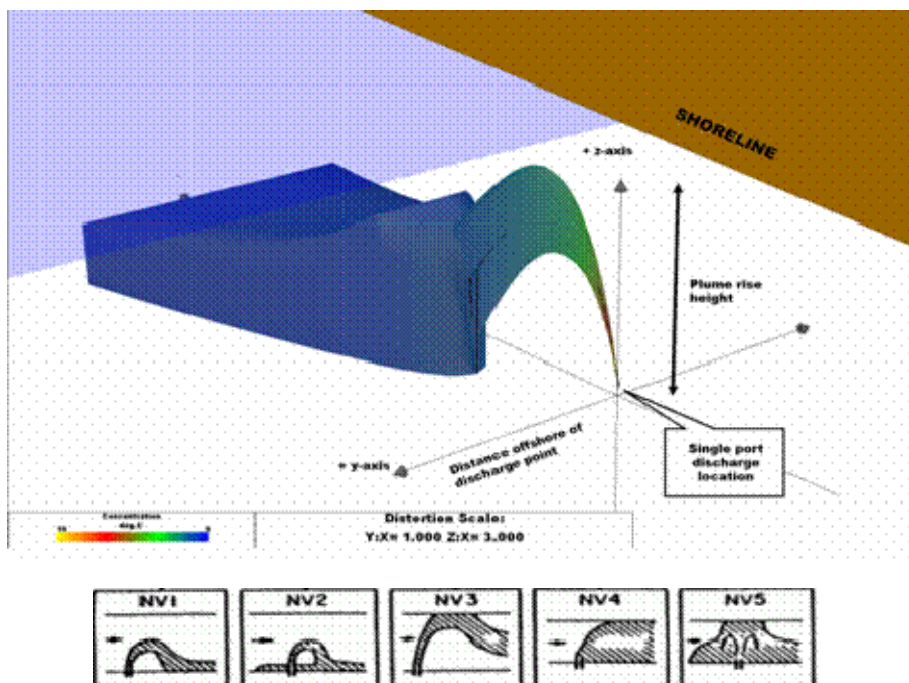


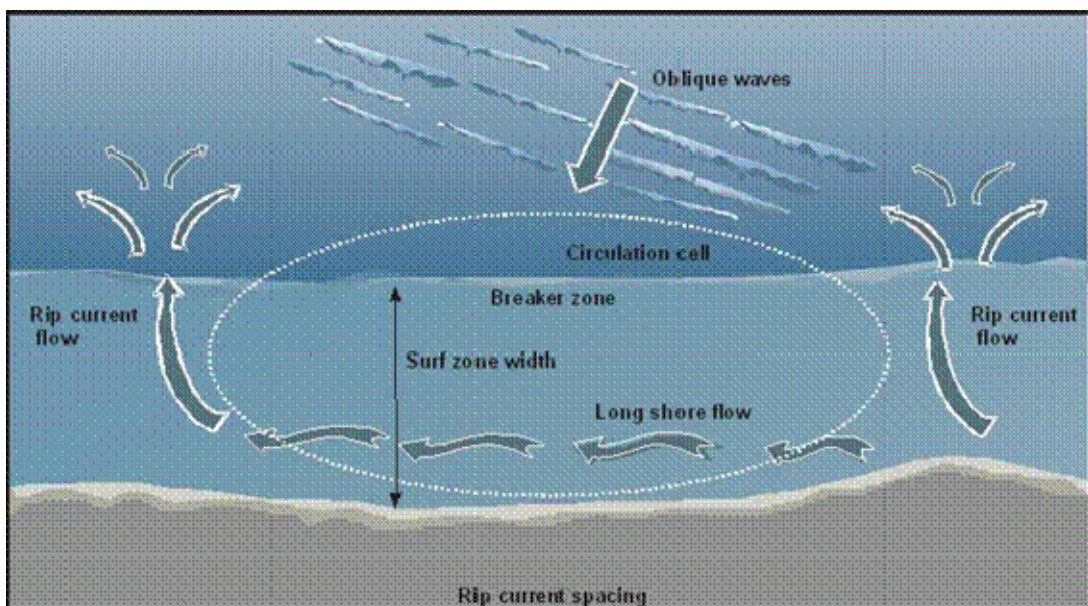
Figure 18. Schematised behaviour of a typical negatively buoyant effluent plume such as the heated brine being considered in this study.



### **Discharge into the surfzone**

Wave-driven flows predominate in the surf zone where dispersion of pollutants is rapid *within* the surf zone due to the vigorous mixing processes and strong longshore and cross-shelf transports.

In terms of dispersion of pollutants the surf zone is relatively isolated from the waters further offshore. Pollutants in the surf-zone are rapidly mixed across the surf-zone and then transported for long distances alongshore with relatively little dilution of the pollutant. Most of the exchange between the surf zone and the offshore waters occurs due to rip currents that transport surf zone waters further offshore (Figure 19). Some of the water mixed beyond the surf zone may be transported back into the surf zone with the next set of waves. This will reduce the effective dispersion of a pollutant. While high wave conditions often result in rapid dispersion within the surf zone and rapid alongshore dispersion of the pollutant, observations indicate a higher degree of re-entrainment of pollutant dispersed into the offshore zone thus effectively reducing the overall pollutant dispersion within the surfzone. Nearshore circulation is highly complex. At times there is meandering alongshore flow, and other times the flow is straight and uniform. Some periods exhibit clear indications of rip currents, others not. The prediction of the fate of a waste field in this highly variable, non-linear surf zone regime is difficult and not easy to provide quantitative answers on the degree of mixing or transport which can be expected, even for a specific day. During field exercises in False Bay (South Africa), the behaviour of a waste field changed drastically within hours (meandering of the flow, change in direction along the shore, change of rip currents, etc.) without observable changes of the weather or sea state (RSA DWAF, 2004b).



**Figure 19. Characterisation of the mixing processes in the near shore zone  
(after RSA DWAF, 2004b)**

Other than highly sophisticated and potentially costly modelling studies, no real robust methods exist to quantify in a simple manner mixing in the surf zone and between the surf zone and offshore waters.

The pollution “footprints” have been assessed using two analytical methods and by referring to existing observations along the South African coastline. The assessment has been undertaken

for a range of representative wave conditions; it is intended that these wave conditions encompass both typical and extreme conditions.

The analytical methods used are those of:

- Inman *et al.* (1971) that explicitly handles mixing in the surf-zone,
- CORMIX that has been utilized to assess mixing in a highly schematized surfzone.

### F.7.1 Water quality guidelines

The water quality guidelines of potential relevance and the associated required dilutions of the effluent to meet the most stringent of these target values are listed in Table 10 below.

**Table 10. Water quality guidelines for the discharge of a heated brine into the marine environment**

Parameter	SA Water Quality Guidelines (DWAf, 1995)	World Bank Guidelines	International Water Quality Guidelines	Maximum required dilutions
Zone of impact / mixing zone	To be kept to a minimum, the acceptable dimensions of this zone informed by the EIA and requirements of licensing authorities, based on scientific evidence.	100 m radius from point of discharge for temperature	-	
Temperature	< 1°C above ambient seawater temperature	< 3°C above ambient at the edge of the zone where initial mixing and dilution take place. Where the zone is not defined, use 100 meters from the point of discharge when there are no sensitive aquatic ecosystems within this distance.	Mean temperature of sea water in receiving environment not to exceed 80%ile temperature value to be obtained from the seasonal distribution of temperature from a reference site (ANZECC, 2000)	10
Salinity	33 – 36 psu, however intertidal species may tolerate 40 psu or more	-	< 5% change in salinity from ambient/background (ANZECC, 2000)	20
Residual Chlorine	no guideline, however deleterious effects recorded for concentrations as low as 2 – 20 µg.l <sup>-1</sup>	0.2mg/l at point of discharge prior to dilution <sup>a</sup> .	3 µg Cl/l measured as total residual chlorine (low reliability trigger value at 95% protection level, to be used only as an indicative interim working level) (ANZECC, 2000)	5 to 50

Parameter	SA Water Quality Guidelines (DWAf, 1995)	World Bank Guidelines	International Water Quality Guidelines	Maximum required dilutions
			7.5 µg/l (4 day average) 13 µg/l (1 h average) (not to be exceeded more than once every three years) (EPA, 1986)	

a. "Chlorine shocking" may be preferable in certain circumstances. This involves using high chlorine levels for a few seconds rather than a continuous low-level release. The maximum value is 2 mg/l for up to 2 hours, not to be repeated more frequently than once in 24 hours, with a 24-hour average of 0.2 mg. l<sup>-1</sup>. (The same limits would apply to bromine and fluorine.)

## F.7.2 Summary of impacts

The results for the modeling of these discharges indicate that whether target values for water quality are met is very much dependent on the design of the discharge, i.e. discharge velocities, number and configuration of ports, etc. Through careful engineering design the potential "footprint" of the heated brine effluent can be limited to the minimum footprints indicated. With appropriate design and implementation of mitigation measures, it is expected that all co-discharges will comply the relevant water quality guidelines. However, it is not possible to assess potential synergistic effects of the co-discharges. The water waste streams should be managed to the relevant water quality guidelines before discharge.

### Offshore discharge located offshore of the intake

#### ***For a pipeline discharge beyond the surf zone and offshore of the intake, from a 800 MW nominal capacity power plant:***

For a well-designed outfall (port exit velocity  $\geq 1,8 \text{ m}\cdot\text{s}^{-1}$ ) in a water depth of 15 m, there is compliance with the chosen water quality guidelines as follows:

- Increase in seawater temperature - within a 20 m radius of the discharge location;
- Increase in seawater salinity - within a 70 m radius ;
- Free chlorine - within a 70 m radius of the discharge location;
- Free chlorine for the most stringent water quality guideline - within 360 m downstream of the discharge location and offshore distance of approximately 120 m.

#### ***For a pipeline discharge beyond the surf zone and offshore of the intake, from a 1 600 MW nominal capacity power plant:***

For a well-designed outfall (port exit velocity  $\geq 1,8 \text{ m}\cdot\text{s}^{-1}$ ) in a water depth of 15 m, there is compliance with the chosen water quality guidelines as follows:

- Increase in seawater temperature - within a 20 m radius of the discharge location;
- Increase in seawater salinity – alongshore distance of 315 m and 120 m offshore from discharge location;
- Increase in seawater salinity for the most stringent water quality guideline, with  $5 \text{ m}\cdot\text{s}^{-1}$  discharge velocity 25 m from discharge location;
- Free chlorine - alongshore distance of 325 m and 140 m offshore from discharge location;

- Free chlorine for the most stringent water quality guideline, with  $5 \text{ m.s}^{-1}$  discharge velocity - within 30 m alongshore and 250 m cross-shore of discharge location

#### **Offshore discharge located inshore of the intake**

##### ***For a pipeline discharge beyond the surf zone and inshore of the intake, from a 800 MW nominal capacity power plant:***

For a well-designed outfall (port exit velocity  $\geq 1,8 \text{ m.s}^{-1}$ ) in a water depth of 15 m, there is compliance with the chosen water quality guidelines as follows:

- Increase in seawater temperature - within a 20 m radius of the discharge location;
- Increase in seawater salinity - within a 70 m radius ;
- Free chlorine - within a 70 m radius of the discharge location;
- Free chlorine for the most stringent water quality guideline - within 360 m downstream of the discharge location and offshore distance of approximately 120 m.

##### ***For a pipeline discharge beyond the surf zone and inshore of the intake, from a 1 600 MW nominal capacity power plant:***

For a well-designed outfall (port exit velocity  $\geq 1,8 \text{ m.s}^{-1}$ ) in a water depth of 15 m, there is compliance with the chosen water quality guidelines as follows:

- Increase in seawater temperature - within a 20 m radius of the discharge location;
- Increase in seawater salinity – alongshore distance of 315 m and 120 m offshore from discharge location;
- Increase in seawater salinity for the most stringent water quality guideline, with  $5 \text{ m.s}^{-1}$  discharge velocity 25 m from discharge location;
- Free chlorine - alongshore distance of 325 m and 140 m offshore from discharge location;
- Free chlorine for the most stringent water quality guideline, with  $5 \text{ m.s}^{-1}$  discharge velocity - within 30 m alongshore and 250 m cross-shore of discharge location

For a pipeline discharge either offshore or inshore of the intake point, all potential environmental impacts as assessed in this study are considered to be of low significance, however the impacts increase on moving inshore, i.e. shortening the discharge pipeline length.

For all environmental conditions assessed for an offshore pipeline discharge, there is compliance with the World Bank Water Quality guidelines for temperature and biocides, and with international guidelines on aromatic hydrocarbons. No World Bank Water Quality guideline could be located for salinity, however the impacts are assessed to be low based on other Water Quality guidelines deemed to be of relevance (e.g. RSA DWAF, 1995).

However, it should be noted that:

- The model results are strongly dependent on the assumed currents in the ambient waters and are also strongly dependent on the detailed design of the discharge (e.g. on port discharge velocity).

#### **Shoreline discharge into the surfzone**

The “footprint” of an effluent plume discharged into the surf-zone is thus somewhat more extensive than for either of the other two offshore pipeline discharge options.

***For a pipeline discharge into the surf zone, from a 800 MW nominal capacity power plant:***

There is exceedance of chosen water quality guidelines as follows:

- Increase in seawater temperature - alongshore distance of 150 m and 80 m to 620 m offshore from discharge location, World Bank Water Quality guidelines;
- Increase in seawater temperature - alongshore distance of 250 m and 80 m to 620 m offshore from discharge location, South African Water Quality guidelines;
- Increase in seawater salinity – 200 m – 500 m downstream and 80 m to 620 m offshore from discharge location, South African Water Quality guidelines.

***For a pipeline discharge into the surf zone, from a 1 600 MW nominal capacity power plant:***

There is exceedance of chosen water quality guidelines as follows:

- Increase in seawater temperature - alongshore distance of 300 m and 80 m to 620 m offshore from discharge location, World Bank Water Quality guidelines;
- Increase in seawater temperature - alongshore distance of 600 m and 80 m to 620 m offshore from discharge location, South African Water Quality guidelines;
- Increase in seawater salinity – 400 m to 800 m downstream and 80 m to 620 m offshore from discharge location, South African Water Quality guidelines;

For a discharge into the surf zone, all potential environmental impacts assessed are considered to be of low significance, except for:

- The potential impacts of elevated salinity on physiological function of larval fish and invertebrates;
- Impacts due to biocides associated with a larger and more persistent plume in the surf zone;
- Elevated temperatures and salinity acting as a barrier for the movement of the larvae of fishes and invertebrates that are transported by the littoral drift;
- Potential impacts on the cueing effects that guides larval/juvenile fish to nursery areas such as the Orange River estuary.

There is considerable uncertainty as to the significance of these impacts. Because of the uncertainty of the impacts, the sensitivity of marine biota and the likely extent and persistence of the biocide plume, the precautionary principle requires that these potential impacts be considered to be of medium significance or greater until proven otherwise.

There is a possibility that the larvae of a variety of species, including those of the commercially important rock lobster *Jasus lalandii*, could be transported by the longshore drift. In this case the heated brine could act as a barrier to their dispersal. The scale of the impacts is somewhat uncertain but are expected to be proportional to the plume extent (estimated 200 to 500 m for a salinity of 40 psu).

The cumulative effect of elevated salinity and temperature, and of co-discharges, on the larval and juvenile stages of fish and invertebrates is not known, but could well be greater than the sum of the individual impacts. For example, on the southern Namibian coastline shallow, nearshore reef regions are thought to be important as recruitment habitats for rock lobsters. Furthermore, the population often becomes concentrated in very shallow waters in response to low oxygen

concentrations near the seabed. The effect of an effluent plume discharged into the surf-zone could thus have far-reaching effects on the commercial fishery for this species. Because of the uncertainty of the impacts, the likely sensitivity of marine biota to elevated salinities, and the spatial extent and likely persistence of the plume in the surf-zone, the precautionary principle requires that the potential impacts be considered to be of medium significance or greater.

## G. Conclusions and Recommendations

### G.1 Introduction

When, in 2004, the Kudu gas-to-electricity project was re-activated in response to the urgent requirement that Namibia's future electricity needs be ensured, NamPower decided that the focus of its planning would be on Site D, the selection of which was the outcome of the preliminary environmental assessment (PEA) completed in 1998. However, consideration of Namdeb's operational requirements over the medium term has led to Nampower investigating a new site at Uubvlei, about 25 kilometres north of Oranjemund. Thus the EIA, commenced in March 2005, was required to address the potential impacts of a combined cycle gas turbine (CCGT) electricity generating plant at Uubvlei and its environs.

The EIA addresses issues raised in the original PEA, those identified during stakeholder consultation meetings held in June 2004 and March 2005, and issues raised by Namdeb staff in their official capacity. Essentially the issues fall into two main groups:

- Those primarily identified by the stakeholders or interested and affected parties (I&APs) which mainly concerned the impact on Oranjemund and its environs; and
- Issues specific to the CCGT site itself.

### G.2 Issues Affecting Oranjemund and its Environs

#### G.2.1 Socio-economic Issues

The introduction of a large "foreign" workforce (up to 1 300 personnel at the peak of construction activities) into the closed community of Oranjemund gave rise to a number of concerns of a socio-economic nature.

##### G.2.1.1 Impact on the Central Business Area

There was a concern that the town could become unpleasantly crowded when large numbers of construction workers are present e.g. on Saturday mornings. However, since the workers will be housed 25 kilometres away from the town, this concern can be mitigated by devising a transport schedule from Uubvlei to Oranjemund that smooths out the surges in influx over the periods of concern.

##### G.2.1.2 Impact on Recreational Facilities

It has been proposed that at least two soccer fields be laid out next to the workers' accommodation to allow for informal football games to be played. It is likely that these fields will satisfy much of the need for recreational facilities. However, in the event that this does not satisfy all the workers, recreational facilities in Oranjemund can be requested to open their doors to the temporary workers for the duration of the construction of the power plant.

### **G.2.1.3 Impact on Roads and Traffic**

#### Construction Vehicles

Construction vehicles will not be permitted in the residential and central business areas of the town.

#### Private vehicles

Since the workers will be housed 25 kilometres away, use of their private vehicles will not add significantly to the traffic in town, except in the vicinity of the shopping centre for the short periods when they visit town to do their shopping.

### **G.2.1.4 Impact on Security**

Whenever a large number of "foreign" people join a community there is a concern that crime such as theft and assaults (at bars) will increase. However, since the workers will not be housed close to the town, the opportunities for such incidents can be regulated through the transport arrangements used to ferry the workers from the Uubvlei site

## **G.2.2 Impact of Noise**

Since the power plant will be 25 kilometres away from Oranjemund, noise from both its construction and operation will not have an impact on the town

### **G.2.2.1 Impact of Construction Noise**

A variety of noise sources will be present during construction. The one factor that they will have in common is that they will not be individually constant i.e. they will rise and fall depending on the particular activity being conducted. Those impacted by such noise at the CCGT site will be the construction workers themselves, who are protected from excessive noise levels by regulations under the Labour Act of 1992:

### **G.2.2.2 Impact of Power Station Operational Noise**

Unlike the noise generated by construction, that which is produced while the power plant is operating will be constant. As with the noise generated by construction, the impact of this noise on workers will also be regulated by the Labour Act of 1992.

## **G.2.3 Air emissions**

The air quality study was undertaken to address the generation and subsequent dispersion of air pollution from the proposed power plant. Pollutants of concern selected for this study were those major pollutants typically emitted from combined cycle gas turbine power production operations; quantitative health risk assessments were done for SO<sub>2</sub>, NO<sub>x</sub> and particulate matter (PM). The main atmospheric emissions of concern from the proposed power station will be the oxides of nitrogen.

The World Health Organisation (WHO) guidelines for NO<sub>x</sub>, World Bank standard and the proposed new ambient air quality standards for South Africa were used for the assessment of impacts on human health. Risks were evaluated for a child of 10 years and an adult of between 18-65+ years of age at the CCGT site only. Maximum average annual and 1-hour ambient concentrations for NO<sub>x</sub> from No.2 fuel oil and, as well as those for gas fired scenarios were

modelled, and hazard quotients based on these results were mostly below the safety margin of 1 for the acute and chronic NO<sub>2</sub> exposure scenarios at the CCGT site. The health risk assessment for SO<sub>2</sub> exposure scenarios showed that it would be unlikely for any individual to develop adverse health effects due to SO<sub>2</sub> exposure at the modelled concentrations. However, for 1-hour SO<sub>2</sub> concentrations from the oil stack at double capacity, individuals at the site are at risk. Concentrations modelled for total suspended particulate matter (TSP) from the oil stack after NO<sub>2</sub> mitigation were all well below international and proposed South African guidelines

Comprehensive air quality modelling and risk assessments showed that impacts from emissions from the proposed Kudu CCGT power station are limited to the immediate area surrounding the plant, they will however persist for the lifetime of the plant, but the intensity of the impact are low, with and without mitigation.

NO<sub>x</sub> was identified as important in terms of potential damage to vegetation in the study area. The modelling of NO<sub>x</sub> emissions indicated that levels would be well below those that would indicate potential for impact. However, confidence levels for the assessment were low due to lack of data on effects that may occur in the specialised vegetation that is characteristic of the study area. However, the overall assessment of the impact of the proposed development on vegetation indicates that the significance of impacts are low based on pollutant loads and the distribution of the vegetation types on a regional (Namibian coast) scale. Assessment of the data did not indicate any fatal flaws.

Emissions from the proposed Kudu CCGT power plant will conform to the emission requirements of the World Bank when operating under natural gas and No. 2 fuel oil. Emissions from the gas conditioning plant will be negligible.

#### **G.2.4 Visual Impact**

Consideration needs to be given to whether the large power plant structure, with its associated cooling towers and the plume emanating from them, and the power transmission lines would have a significant visual impact on the ambience of the future Sperrgebiet national park.

##### **G.2.4.1 Visual Impact of the Power Plant**

The power plant, located at the CCGT site, would not be visually intrusive from more than about 7 kilometres away. In addition, the power plant can be painted so that it blends into the surrounding landscape. In clear weather conditions, i.e. approximately 200 days per year, the plume is visually intrusive, and resembles a small cloud around the cooling towers. However, once people understand that it is water vapour being emitted, and not smoke or chemical emissions, the significance of the plume's visual impact decreases.

##### **G.2.4.2 Visual Impact of Power Transmission Lines**

A separate EIA has been undertaken for the power transmission lines, and it will address any concerns about their visual impact.



### **G.3 Site-specific Issues**

#### **G.3.1 Terrestrial ecology**

The proposed site of the power plant is in the previously mined area, where land is already disturbed. Construction here will have little further impact on the vegetation and flora.

Any of the other structures that will be associated with the power plant buildings, access roads, a materials lay-down area, and possible temporary accommodation for the construction workforce, should be situated on disturbed land immediately south of and adjacent to the power station site. Due to the possible presence of amphibians and reptiles of conservation concern, and the trend of gradual reduction of their habitat, all activities should be confined (as far as possible) to areas that are already disturbed. They should not be situated on undisturbed land.

Impacts on particularly low hummock and coastal plain vegetation type may be expected during construction and operational phases. In order to minimize disturbance, routes (preferably a single route) and turning points, should be identified and demarcated before construction activities commence and the making of new tracks due to corrugations should be strictly prohibited. Impacts such as clearing for roads and other structures on any remaining pristine or less disturbed hummock vegetation in the direct surrounds of the CCGT site should be minimized in the hope of later recolonisation of the habitat. If sufficient control is exercised, later natural recolonisation of damaged areas (as may already be seen within the mining area) may be expected, which will reduce long-term defacement and enable the natural restoration of the environment.

Dust raised by construction activities will probably not increase dust levels significantly more than the area already experiences from mining activities. Plants, lichens and animals that inhabit this area are frequently exposed to strong sand-laden winds. Dust suppression should, however, be practised for the new construction. In regard to oil spill accidents, contractors must be familiar with steps to avoid such accidents, and what to do in the event it happens.

The impact of operations on the affected area will need to be monitored. It is suggested that plants and lichens in the affected area and in a 'control' area be individually marked and monitored regularly to assess this.

The mined-out foreshore zone and ponds habitat is an unnatural habitat, and has already been extensively compromised, to such an extent that none of the proposed construction would compromise it any further. Beyond prevention of unnecessary collateral damage, no mitigation measures are suggested for this area.

#### **G.3.2 Purge water discharge**

The investigation of the purge water discharge showed that, with proper design criteria, the proposed pipeline discharge beyond the surf-zone from the power plant will comply with World Bank guidelines for effluent disposal in terms of temperature and biocides. No World Bank Water Quality guideline could be located for salinity; however the impacts are assessed to be low based on other Water Quality guidelines deemed to be of relevance (e.g. RSA DWAF, 1995).

The potential impacts on biological communities by an effluent discharge will vary depending on the type of cooling water system installed, the position of the discharge pipeline, and the design of the diffuser. The impacts are the greatest for scenarios where a reduced seawater temperature rise in the effluent of 5°C is assumed (i.e. evaporative cooling system). Although the thermal impacts are somewhat reduced, the effluent is more dense, resulting in more limited mixing of the effluent with the receiving waters. This reduced mixing results in a slightly larger thermal plume "footprint" within which the guidelines for biocides are exceeded. Consequently there is a greater impact by the biocides in the effluent discharged into the marine environment.

Although the impacts are greater for a 1 600 MW nominal capacity power plant, the impacts associated with the discharge beyond the surf-zone of a heated brine from both a 800 MW and 1600 MW power plant are considered to be of low significance. However, the impacts increase on moving inshore, i.e., shortening the discharge pipe length.

The alongshore dimensions of the spatial area of the plume that exceeds the various Water Quality guidelines is substantially greater for a shoreline discharge into the surf zone than those for an offshore pipeline discharge. This is primarily due to the surf-zone trapping that occurs, resulting the extensive spreading of the plume alongshore.

Based on the World Bank Water Quality guideline of not exceeding a 3°C temperature rise beyond a 100m radius, there is marginal non-compliance for the shoreline discharge option for a 800MW power plant. For a 1600 MW power plant the non-compliance is more extensive; however a 3°C is not exceeded beyond a radius of 300 m. There is compliance, by default, with the World Bank guideline for biocides, i.e. the concentrations at the point of discharge are below the World Bank guidelines.

For a shoreline discharge, at maximum temperature condition, biota may suffer mortality but are expected to have a fast recovery rate. The significance of the potential salinity impacts on beach and surfzone benthic communities is considered to be low, however the impacts of elevated salinity on physiological function of larval fish and invertebrates is uncertain. Based on the precautionary principle these impacts presently should be considered to be of medium significance until shown otherwise.

The plume extent for biocides is significantly more extensive for a shoreline discharge than for a pipeline discharge offshore of the surfzone and based on the sensitivity of marine biota and the likely extent of the biocide plume, the potential impact of this co-discharge on the marine biota in the surfzone should be considered to be of medium significance. The impacts due to biocides can be mitigated by de-chlorination if required but at a significant cost. The cumulative effect of elevated salinity and temperature, and of co-discharged substances on the larval stages is not known but could well be greater than the sum of the individual impacts

Elevated salinities and temperatures in the surfzone may have a significant barrier effect on larvae of fishes and invertebrates that are transported by the littoral drift. The extent and significance of this impact is highly uncertain. Elevated salinities and temperatures in the surfzone also may have a significant impact of the cueing effect that guides larval/juvenile fish to nursery areas such as the Orange River estuary. The extent of impact is highly uncertain.

The exact nature and quantity of the oily water waste streams are relatively uncertain, however they should be able to be managed to comply with the relevant water quality guidelines before discharge. With appropriate design of the discharge and mitigation measures, the discharges from the gas conditioning plant and the HRSG effluent are expected to meet water quality

guidelines at the point of discharge or in close proximity (< 20 m) of the discharge. It should be noted that substances with the lowest tainting thresholds, should these substances be present in the gas conditioning plant effluent, may result in tainting of flesh in marine biota. However, this will only be within a conservatively estimated of approximately 500 m of the discharge, possibly 1 km at the most for the proposed optimal discharge of the gas conditioning plant effluent as proposed.

For a shoreline discharge into the surf-zone, all potential environmental impacts as assessed in this study are considered to be of low significance, except for:

- The potential impacts of elevated salinity on physiological function of larval fish and invertebrates.
- Impacts due to biocides associated with a larger and more persistent plume in the surf-zone.
- Elevated temperatures and salinity acting as a barrier for the movement of the larvae of fishes and invertebrates that are transported by the littoral drift.
- Potential impacts on the cueing effects that guide larval/juvenile fish to nursery areas such as the Orange River estuary.

There is considerable uncertainty in the significance of these impacts. Based on this uncertainty, the lack of information on the sensitivity of marine biota and the likely extent and persistence of the plume, the precautionary principle requires that these potential impacts be considered of medium significance or greater until proven otherwise.

At present, the southern limit of the southern rock lobster fishing grounds are approximately 11 km north of the proposed discharge location. Although substantial extension of these grounds further southwards is considered unlikely due to the scarcity of suitable fishing reefs south of Mittag (MFMR, Lüderitz, pers. comm.), this possibility cannot be excluded. It is therefore recommended to liaise with the rock lobster fishing industry on this issue to avoid potential confrontation in the future. Given that it is possible for BTEX compounds to taint rock lobster flesh (with potentially serious consequences for the rock lobster export market), the importance of strict compliance with the most stringent guidelines for the discharge of hydrocarbons is emphasized.

#### **G.4 Conclusions**

The environmental impact assessment focused on the CCGT site and addressed potential impacts in terms of those which might have an effect on the CCGT site and its environs, those which might have an effect on the marine environment, and any spillover socio-economic impacts on the town of Oranjemund.

The EIA confirms the following factors that favour Uubvlei as the preferred site for the proposed CCGT power plant:

- Socio-economic and biophysical impacts on Oranjemund and its environs:
  - The power plant will not be a visual distraction for Oranjemund residents, nor for any proposed tourist route;
  - The power plant will not interfere with any aircraft flight paths;
  - Both construction and operational noise from the power plant will have no impact on the town of Oranjemund;

- Air pollution from both the power plant and gas conditioning plant will have no impact on the town of Oranjemund, nor on any workers properly protected under occupational health regulations; and,
- Uubvlei is not within walking distance of the town. The social impact of the workforce is more of a spillover effect, and it can be regulated and mitigated through judicious transport arrangements from Uubvlei to Oranjemund.
- Issues specific to the CCGT site itself:
  - Since the CCGT site and its environs have already been extensively disturbed by mining operations, its impact on the terrestrial and marine ecology and archaeology is low;
  - Air pollution from both the power plant and gas conditioning plant will have no impact on the ecology of the site;
  - For the purge water discharge, the two offshore discharge options both meet World Bank water quality guidelines for effluent disposal. The shoreline discharge into the surf zone, however, requires further investigation in terms of its impact on larval and juvenile fishes and larval invertebrates which may use the littoral drift as a transport/dispersal mechanism. This is of concern as a result of the proximity of the Orange River Estuary which services as a nursery for a number of marine fish species. However, information from such an investigation may allow for even this option to be adopted.

## ***G.5 Recommendations***

### **G.5.1 Environmental Management Plan**

An Environmental Management Plan (EMP) will be prepared to address the management of all the impacts arising from the construction and operation phases of the CCGT power plant life cycle. It is recommended that the substance of this EMP be communicated to all the contractors and their workers and to the residents of Oranjemund. In particular, the procedures to be followed when non-compliance with the requirements of the EMP is identified must be communicated clearly to all concerned.

### **G.5.2 Surf zone discharge: additional data**

#### **G.5.2.1 Plankton survey**

It is recommended that, before a surf zone purge water discharge is adopted, a survey of the surf zone ichthyoplankton and zooplankton be undertaken. Monthly sampling for a full year should be done in order to determine the importance of the surf zone to the larvae and the juveniles of fishes and invertebrates as a transport and dispersal system and whether the brine plume would act as a barrier to such movements.

#### **G.5.2.2 Toxicity study**

Toxicological studies of the effect of the residual biocide on selected larval candidates in elevated temperature and salinity conditions should be undertaken in order to determine whether the brine plume will be toxic (lethal and/or sub-lethal effects) to the larvae and juveniles of invertebrates and fishes.

## CONTENTS

---

1. INTRODUCTION.....	1-1
1.1 Background to the EIA .....	1-1
1.1.1 The project proponent, Nampower.....	1-1
1.1.2 Namibia's electricity demand.....	1-1
1.2 The need for the proposed activity.....	1-2
1.3 Purpose for the proposed activity .....	1-2
1.4 The Kudu Power Project .....	1-3
1.5 The location for the proposed CCGT power plant .....	1-4
1.6 History of Environmental Assessments for the CCGT and Gas Field .....	1-5
1.6.1 Preliminary Environmental Assessment of the of the Kudu CCGT Power Plant.....	1-5
1.6.2 Other Gas Field EIAs.....	1-8
1.6.3 Environmental Impact Assessment of Kudu CCGT Power Plant at Site D, Oranjemund .....	1-8
1.7 Environmental Impact Assessment of Kudu CCGT Power Plant at Uubvlei, near Oranjemund	1-9
1.8 The purpose of the EIA process and this report .....	1-10
1.9 Comment on the draft EIR .....	1-10
1.10 Structure of this report.....	1-12

## FIGURES

---

Figure 1.1:	Location of Uubvlei, Oranjemund and the Kudu Gas Field .....	1-4
Figure 1.2:	Site D, and other alternative sites in the Oranjemund area.....	1-7
Figure 1.3:	Location of the Uubvlei site, with Site D and the town of Oranjemund.....	1-11

## TABLES

---

Table 1.2:	Environmental evaluation of proposed sites in the PEA .....	1-6
------------	---	-----

# 1. Introduction

## 1.1 Background to the EIA

### 1.1.1 The project proponent, Nampower

The South West Africa Water and Electricity Corporation (SWAWEK) was formed on 19 December 1964 as a private and fully affiliated company of the Industrial Development Corporation of the RSA with its prime objectives, utilising the waters of the Kunene River for the generation of electric power and to distribute it throughout the country. Over the next 15 years to 1979 it developed the following:

- A power station just north of Windhoek where four generators of 30 MW capacity each were installed with "dry-cooling",
- 220 kV transmission lines to south of Omaruru, westwards to Swakopmund and Walvis Bay and one northwards to supply Otjiwarongo, Tsumeb and Grootfontein. An interim diesel power station named Paratus with 4 x 6 MW generating units at Walvis Bay to absorb peak demands. Later, a gas turbine of 22 MVA was added, pushing the total capacity up to 46 MVA.

In July 1996, SWAWEK changed its name to Namibia Power Corporation (Pty) Ltd (NamPower). Its vision is to be "a leading energy company in Africa, which excels in customer service, people development and technological innovation", and its mission is to "provide for the energy needs of our customers, fulfill the aspirations of our staff and satisfy the expectations of our stakeholders." It has adopted the principles of transparency, accountability and confidentiality, and has adopted and conforms to the principles of the King II Report on corporate governance. Its group values are customer focus, teamwork, accountability, employee empowerment and integrity, and it is committed to:

- Providing value added service to customers.
- Making electricity available to many households in Namibia.
- Appropriate development strategies.
- Having affordable and competitive tariffs in the region.
- Having a productive workforce.
- Adhering to safety measures in all operations.
- Having technically reliable, modern and state of the art technology and equipment.

Where it was traditionally responsible for the generation, transmission and distribution of electricity as a bulk supplier, the Energy Act of 2000 in Namibia required that NamPower reposition itself to meet the challenges of competition. In terms of the Act, the vertically integrated company had to ring fence its core business activities, and give other players in the electricity supply industry (ESI) the opportunity to enter the Namibian market. NamPower is now a commercially stronger, technically and technologically more innovative, and customer-oriented company.

In pursuance of its vision to provide affordable and reliable electricity for the prosperity of Namibia and its people, Nampower joined the Southern African Power Pool (SAPP) to tap from the resources within the SADC Region.

### 1.1.2 Namibia's electricity demand

Between 1985 and 2002, Namibia's electricity demand grew at an average annual rate of 3.62 %, to 390 MW in 2004. Major demand increases took place from 2002 to 2004 and further major increases are expected if Namibia begins supplying Skorpion Mine near Rosh Pinah in 2011 or 2012.

NamPower projects that the maximum demand growth will continue at a rate of approximately 4.5%, resulting in a demand of approximately 550 MW by 2012. The assumed growth rate is in line with the country's development objectives, which projects an average annual GDP growth of 6% from 2001 to 2030. This growth will be driven by growth in the agricultural and manufacturing sectors, which are expected to become highly export oriented in the future.

Namibia has the Van Eck coal fired thermal power station in Windhoek with 120 MW installed capacity, the 24 MW Paratus diesel powered station at Walvis Bay, and a 249 MW hydro-electric power station at Ruacana. This gives the country a total installed generation capacity of 393 MW. The hydro-electric power station at Ruacana is Namibia's main power generating source. Because the excessive cost of fuel delivered at Windhoek makes the production of electricity at the Van Eck thermal power stations uneconomic, it, and the Paratus diesel unit at Walvis Bay, are used to provide backup services to the system.

### ***1.2 The need for the proposed activity***

Since power generation at Ruacana is dependent on the highly variable water flow in the Kunene River, its annual power generation is also variable. This has a major impact on NamPower's ability to supply the demand from its own generation facilities and the bulk of the demand has to be imported from elsewhere in the SADC region. At the present time, Namibia imports more than 50% of its annual energy needs from South Africa; rising domestic demand in South Africa and Namibia is expected to lead to a shortfall in continued supply of electricity to Namibia beyond 2007.

The Kudu Power Project is one of the preferred options to address the predicted shortfall in electricity maximum demand by 2007, base load capacity by 2011, and growth in power demand in the region in the short-medium term. In addition to meeting NamPower's projected demand, electricity generated by the Kudu CCGT power plant will be exported to South Africa and other SADC countries to fulfill their own demands.

### ***1.3 Purpose for the proposed activity***

The first phase of the Kudu Power Project will be the development of a nominal 800 MW combined cycle gas turbine (CCGT) power plant at Uubvlei, to be commissioned in 2009. The natural gas reserves within the Kudu Gas Field are sufficient for a nominal 800 MW power plant, operating for a minimum of 20 years, without the need for additional appraisal drilling. It is anticipated that, if additional gas reserves are proven after 2-3 years of gas production, and the demand for electricity warrants it, the second phase of the project, an additional nominal 800 MW CCGT power plant, will be commissioned in 2014.

The project is proceeding through well-defined phases, namely:

- feasibility studies that establish the technical feasibility, financial viability and the environmental acceptability of the project;
- final design and financial closure;
- construction;
- operation;
- decommissioning.

This EIA covers all aspects that relate to the construction, operation and decommissioning of the CCGT plant as far as the project has currently been defined. Decommissioning will be discussed in the Environmental Management Plan.

#### ***1.4 The Kudu Gas to Power Project***

The Kudu Gas Field was discovered in 1974 by Chevron/ SOEKOR; a further two wells drilled in 1987 and 1988 confirmed the potential of the discovery. After Namibia's independence in 1990, the State-owned NAMCOR issued licences for the exploration of a number of blocks on the continental shelf of Namibia. Shell Exploration and Production Namibia B.V. (SEPN) and Energy Africa Kudu Ltd (then Engen (Kudu) Ltd) were awarded the licence to explore and develop Licence Area 2814A, the block that contained the Kudu gas discovery., with SEPN as the operator. In 1996 Energy Africa divested two thirds of its holding to Texaco whereupon the equity share of the companies in the Kudu Joint Venture became SEPN – 75%, Energy Africa – 10% and Texaco – 15%. Subsequently Chevron took over Texaco and became an equity holder as ChevronTexaco.

During late 1993, a 1 600 km 2-D and 300 km<sup>2</sup> 3-D seismic survey were both completed. This was followed by the drilling of the Kudu-4 well in the second half of 1996, which confirmed that the Kudu Gas Discovery was commercially exploitable. A further 400 km of 2-D and 400 km<sup>2</sup> of 3-D seismic surveys were completed between the end of 1996 and the beginning of 1997.

SEPN and Energy Africa applied for the Declaration of a Petroleum Field on 6 May 1997. In November 1997 a Memorandum of Understanding (MOU) was signed between SEPN and its partners, NamPower and ESKOM to promote the construction of a nominal 800MW combined-cycle gas turbine (CCGT) power station at Oranjemund, known as the Kudu Power Project (KPP). National Power, a UK-based independent power producer, joined the consortium later. The project included a first phase development of the gas field to be followed by a second phase for the export of gas to South Africa. A feasibility study conducted by independent consultants demonstrated the commercial viability of the development, but Eskom, the planned purchaser of the excess power generated over Namibia's needs, were of the opinion that the timing was premature and the cost too high. As a result the MoU was allowed to lapse at the end of 1998.

A new commercialisation strategy for the Kudu Gas Field comprised the development of a smaller power station in Oranjemund (400 MW – the OPP) in parallel with the development of a large power station in the Western Cape (1 600 MW – the CPP). This was termed the integrated project because it combined the fuel demand of the two power stations so that the offshore gas field infrastructure could be integrated into a single development rather than two separate developments. This brought with it economies of scale. In 2000 an independent feasibility study clearly demonstrated the commercial viability of a 1 200 – 2 000 MW gas fired power station in the Western Cape as the cheapest next new generation option for South Africa within the targeted time window (2005 – 2008). However, a phased development of the Kudu gas field has been adopted as a more appropriate strategy, with significant cost reductions that enable an 800 MW gas fired power plant near Oranjemund to meet commercial viability criteria in its own right.

The Kudu Gas to Power Project encompasses three main developments:

- 1) The development of the gas field, and the construction of a pipeline to the power plant and gas conditioning plant adjacent to the power plant;
- 2) The construction and operation of the power plant itself; and,
- 3) Construction of power lines from the power station to feed into the Namibian and South African power grids.

The upstream development, i.e. gas field, pipeline and gas conditioning plant, as well as the outgoing power lines are the subjects of separate environmental impact assessments. The relationship between the various components of the overall Kudu gas-to-power project and their respective impacts will be documented following the completion of the separate EIAs. However, impacts associated with construction and operation of the onshore gas conditioning plants, insofar as these are cumulative to impacts related to the power plant, are also considered in this EIA. The upstream developer remains responsible for the mitigation of impacts related to the gas conditioning plant.



### 1.5 The location for the proposed CCGT power plant

Studies commissioned by Nampower in 1997 identified Oranjemund as the best location for a power plant. It is a small diamond mining town currently owned by Namdeb Corporation, situated near the mouth of the Orange River in the south-western corner of Namibia. The Orange River forms the boundary between Namibia to the north and South Africa to the south.

Nampower commissioned an EIA in 2004 to consider the construction, operation and decommissioning phases of a CCGT power plant at a site, known as Site D, about 2.5 km from the town of Oranjemund. A positive Record of Decision was issued by the Ministry of Environment and Tourism (MET), Government of Namibia, in January 2005. Notwithstanding this MET approval of Site D as the preferred site for the proposed CCGT power plant, Nampower decided in February 2005 to investigate the possibility of locating the power station at an alternate site, namely, Uubvlei, some 25 kilometres north of Oranjemund, and to commission another EIA for the construction, operation and decommissioning phases of the proposed power plant at this site (Figure 1.1).

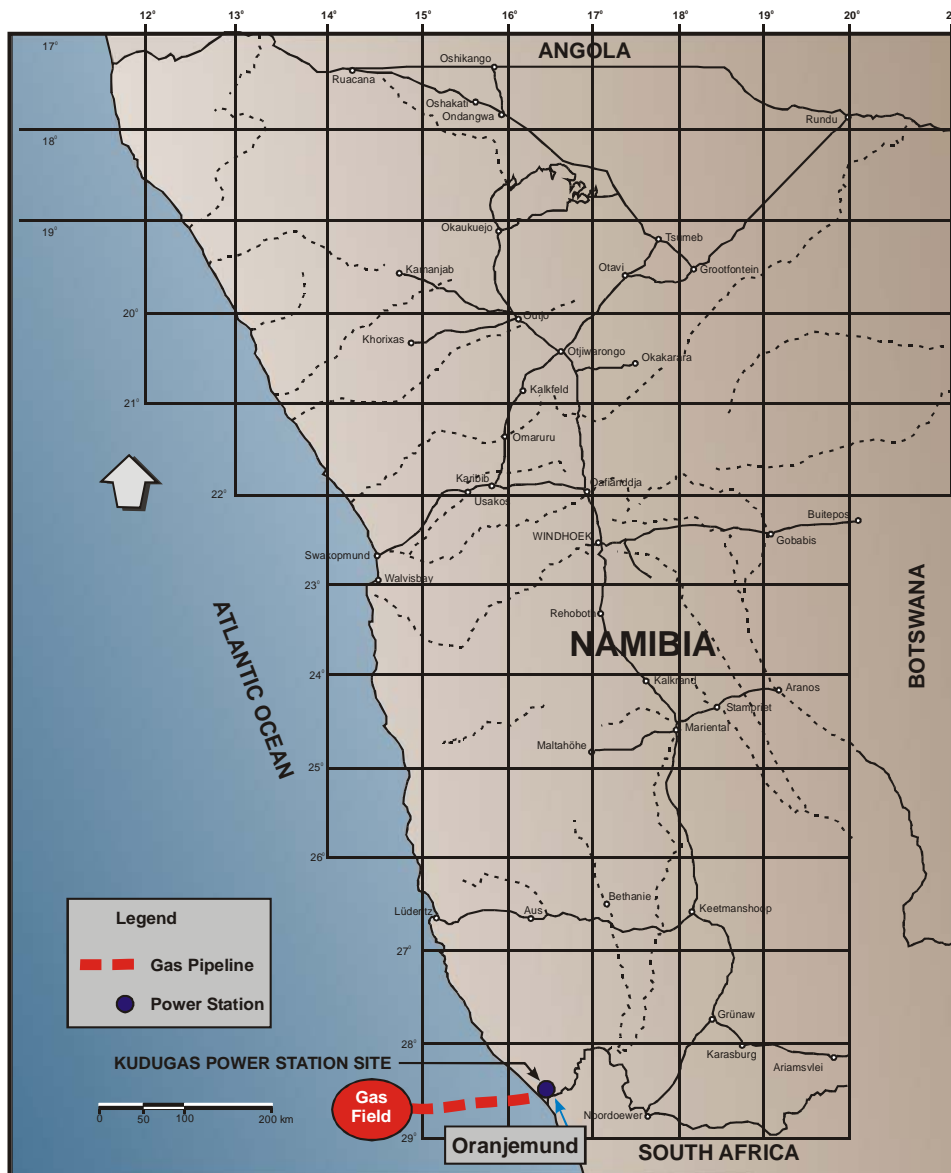


Figure 1.1: Location of Uubvlei, Oranjemund and the Kudu Gas Field

## ***1.6 History of Environmental Assessments for the CCGT and Gas Field***

### **1.6.1 Preliminary Environmental Assessment of the Kudu CCGT Power Plant**

A preliminary environmental assessment for the Kudu CCGT Power Plant was conducted by Walmsley Environmental Consultants in 1998. As part of the Scoping phase, all stakeholders and interested and affected parties were contacted through information letters and the media, inviting them to attend public hearing meetings held in Windhoek on 10 February 1998, Alexander Bay on 11 February 1998, and Oranjemund also on 11 February 1998. The purpose of Scoping was to provide the public, authorities and the environmental project team with the opportunity to identify environmental issues. All concerns and issues raised at the meetings were captured, and the meeting reports were included in the final PEA Report. One hundred and five people in total attended the meetings, and the PEA focused on Sites A, B, and D proposed as locations for the power plant (Figure 1.2).

The main aims and objectives of the Preliminary Environmental Assessment (PEA) were to:

- Identify the main issues relating to each proposed site for the CCGT Power Plant at Oranjemund;
- Analyse the issues and impacts in the local, regional, national and international context;
- Prevent or minimise negative impacts through rational planning and design according to the principles of Best Available Technology Not Entailing Excessive Cost (BATNEEC);
- Maximise the benefits of the project wherever technically and economically possible and practical;
- Identify and allow for the impact of the environment on the project i.e. environmental constraints;
- Liaise closely with the other environmental studies (gas in/power out);
- Provide input to the Techno-Economic study;
- Determine the legal position and compliance of the project in relation to prevailing and anticipated Namibian and South African Environmental Policies and Legislation;
- Comply with the World Bank Guidelines for Environmental Assessment of Energy and Industrial Projects, as well as with other International Protocols e.g. the Ramsar Convention and Helsinki Rules;
- Ensure that the Interested and Affected Parties (I&APs) are brought into the decision-making process;
- Identify a preferred site for the power station in Oranjemund from an environmental perspective, taking into account, *inter alia*, the need for future plant expansion, mineral rights, water abstraction and disposal, visibility, air emissions, noise, aesthetics, prevailing climatic conditions, the biotic environment, ground water resources, soil capability, archaeological and historical considerations, socio-economics etc.

#### **1.6.1.1 Key Issues in the PEA**

This PEA identified seventy-two possible scenarios by adding together all the scenarios for construction and operation, using a preference ranking that associated increasing environmental cost with the control and mitigation measures that may be required to prevent or minimise impacts. The range of options was reduced to eight when filtered through the following assumptions:

- The construction work force will be accommodated on site;
- The high security fence is moved; and,
- The cumulative impacts of gas-fired and diesel-fired operation are added together.

The results of such an environmental evaluation in the PEA, that correlated a low rank with a high environmental cost, are presented in Table 1.2.

**Table 1.2: Environmental evaluation of proposed sites in the PEA**

Rank	Scenario	Score
1	Site D using saline water from well points	61
2	Site B with dry cooling	63 <sup>a</sup>
3	Site D using sea water for evaporative cooling	71
4	Site D using sea water for once through cooling	73
5	Site A using sea water for once through cooling	78
6	Site B using sea water for evaporative cooling with discharge to the sea	89
7	Site B using river water for evaporative cooling with discharge to the river	97
8	Site B using river water for evaporative cooling with discharge to the sea	102

*a) This option involves very high capital expenditure.*

The PEA recommended strongly that Site D be the location for the new CCGT power plant, preferably using saline ground water for cooling. The same preference would apply for Uubvlei. Of its recommendations for additional studies, the following pertain to the Uubvlei site:

- Detailed study of cooling water potential to supply power plant;
- Archaeological and palaeontological surveys with ongoing monitoring during site clearance activities, only if the areas had not been mined first
- A full EIA based on the information from the new specialist studies;
- A full EMP for the full construction and operational phases of the project.

#### **1.6.1.2 SAIEA review of the PEA**

The Southern African Institute for Environmental Assessment (SAIEA) reviewed the PEA, and graded it as containing most of the information relevant for the project, but makes it clear that additional studies will be required once a full EIA is conducted and that these should be seen in the context of site conditions having changed considerably since 1998.

Since alternatives were not dealt with in any detail, the reviewer recommended a good analysis of alternatives in the EIA, with an explanation for why the current project is considered the best option. In addition, the full EIA needs to provide an accurate update of the latest plans, including the preferred technological options, such as cooling and stack height. This would include the selection of the site, and a good explanation of why this site was chosen above other sites. The EIA should also focus on the preferred method of seawater abstraction and the scenario for discharge.

The PEA was not really able to address cumulative impacts fully, because the project was not yet well defined. A key concern was the fact that there are 3 separate EIAs for a single project. The location of the power plant has a significant bearing on the pipeline route (on land) and the power line route.

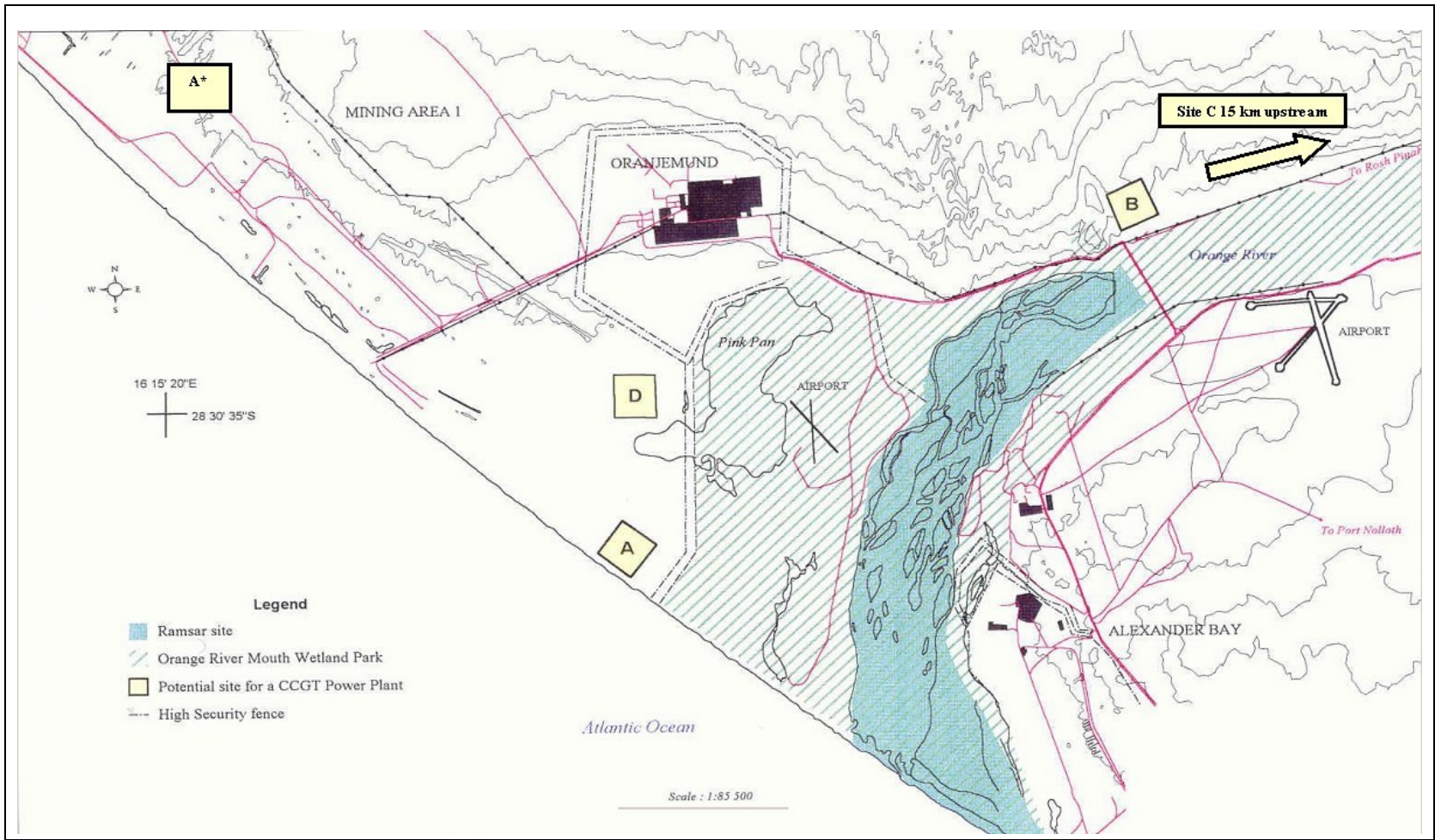


Figure 1.2: Site D, and other alternative sites in the Oranjemund area

## **1.6.2 Other Gas Field EIAs**

### **1.6.2.1 1998 Gas field development EIA**

The objective of the Kudu Gas Field Development Project is to provide gas to the proposed Combined Cycle Gas Turbine (CCGT) power station planned to be located at Oranjemund. The terrestrial component of the gas field development, the gas conditioning plant, will be located immediately adjacent to the CCGT. In 1998 while separate EIAs were prepared for the upstream and downstream components it was decided to combine the scoping exercises for the two projects. Three combined public meetings were held: in Windhoek, Oranjemund and in Alexander Bay, South Africa. In addition for the Kudu Gas Field Development Project alone, an Interministerial Review Group Meeting in Windhoek, and a scoping meeting in Lüderitz were held.

Following the five public meetings work on the original upstream EIA progressed until October 1998 when, because of the failure of the parties involved in the development of the power station (SEPN, NamPower, Eskom and National Power) to agree on the way forward, the work was suspended.

### **1.6.2.2 2001 Revision of the 1998 EIA**

When the project was re-activated in 2001 it was decided, by both SEPN and the Ministry of Environment and Tourism, that because more than three years had elapsed since the EIA for the Kudu Gas Field Project was initiated, it was necessary to provide the interested and affected parties (I&APs) with the opportunity to review the questions and concerns raised at the scoping meetings held in February 1998. This was undertaken by means of an information leaflet and reply-paid response form being distributed to all I&APs during May 2001. In 2002 SEPN embarked on a major investigation to support the development of the Kudu gas field in the expectation that the Kudu-6 and Kudu-7 wells would confirm the presence of additional major quantities of gas for an alternative Floating Natural Liquified Gas project. The 2001 EIA was complemented by field studies on the benthos and oceanography. When the exploration wells failed to confirm the expected gas SEPN relinquished their concession.

### **1.6.2.3 2004 Revision and update of the EIA**

The re-activation of the Kudu Gas Field Development Project with Energy Africa as the operator has resulted in revision and update the 2001 Kudu upstream EIA. Since there has been no significant change in the project design it was decided with the approval of the Interministerial Review Group not to initiate a new round of scoping. A public information meeting was, however, held in Lüderitz to inform the Lüderitz based fishing industry and users of the port facilities of the planned activities.

## **1.6.3 Environmental Impact Assessment of Kudu CCGT Power Plant at Site D, Oranjemund**

The PEA recommended strongly that Site D near Oranjemund be the location for the new CCGT power plant, preferably using saline ground water for cooling. Seawater-cooling options were also found to be environmentally acceptable, on condition that the following additional studies are done:

- Detailed noise modelling by an approved expert in CCGT power plants;
- More detailed climatic study, especially wind direction, atmospheric stability and fog to determine the impact on the Oranjemund town;
- Insect survey of Pink Pan;
- Detailed study of cooling water potential to supply power plant;
- Archaeological and palaeontological surveys with ongoing monitoring during site clearance activities, only if the areas had not been mined first, as Site D area would be mined out by Namdeb by the end of March 2004 and would be heavily impacted as a consequence.
- A visual assessment from various vantage points;

- A full EIA based on the information from the new specialist studies;
- A full EMP for the full construction and operational phases of the project.

In their review of the PEA, the major concern of the Ministry of Environment and Tourism (MET) centred around the location of the site 2.5 km from the town, and the noise, light, dust, acid deposition, visual intrusion and safety/security during construction and operation of the power plant that might have some impact on the population of Oranjemund. The environmental impacts of these concerns were investigated in the EIA that was conducted in 2004.

### **1.7 Environmental Impact Assessment of Kudu CCGT Power Plant at Uubvlei, near Oranjemund**

After the EIA for Site D at Oranjemund had been approved by MET, it was found that the routing of a gas pipeline from the gas platform to the proposed Site D was subject to severe constraints because of likely opportunity costs due to possible diamond lock-up offshore, and the inconvenience to ongoing mining activities.

A preliminary investigation by NamPower and Namdeb identified Uubvlei (Figure 1.3) as the most suitable alternative site, based on the following criteria:

- Cost implications;
- Already disturbed/mined-out area at the site (i.e., minimal impact on biodiversity and landscapes);
- Minimal interference with Namdeb mining operations;
- Availability of cooling water for the power plant;
- Good founding conditions for the power plant and landing site for the gas pipeline and seawater intake pipeline;
- Proximity to infrastructure and services;
- Minimal impact on mining reserves offshore;
- Suitability for transmission lines (interconnectivity).

Although this EIA will be an entirely new stand-alone document, it is envisaged that much of the information and analysis contained in the EIA for Site D will be valid for this Uubvlei EIA. This is because much of the background information is identical, and issues that relate to the functioning of the plant, emissions and other technical aspects, are unchanged.

However, there will be a number of new, site-specific issues that warrant new and additional work. These are:

- Description of the biophysical characteristics of Uubvlei site;
- Options for water abstraction for cooling given the differences between Uubvlei and Site D (i.e. from beach wells, ponds or directly from the ocean);
- Options for purge water discharge given the differences between Uubvlei and Site D (i.e. into ponds, onto the beach/intertidal zone, beyond the breakers);
- The suitability of existing facilities to accommodate the workforce during construction, and possibly operation;
- Options for supply of services for workers - water, electricity, recreation facilities, health services, catering, etc.;
- Options for waste management – industrial waste during construction, household waste, sewerage, hazardous waste;
- Maintenance of the road between Uubvlei and Oranjemund;
- Security issues and access to site;
- Interactions with Namdeb;
- Climate – implications for corrosion, dust control, etc.

Establishing the plant at Uubvlei will solve a number of the perceived drawbacks of Site D. These are:

- Visual distraction for Oranjemund residents;
- Impacts of noise;
- Pollution (specifically the impact of pollution on people);
- The danger to people of non-standard operating situations;
- Power lines in proximity to Oranjemund and bird flight paths (subject of a separate EIA);
- Negative interactions between power plant workers and the Oranjemund residents.

### ***1.8 The purpose of the EIA process and this report***

The purpose of the EIA process is to:

- Identify any interactions between the proposed activity and the environment;
- Consider which of these aspects, if any, are likely to have a significant impact on the environment; and
- Recommend measures that will enhance any positive impact and avoid any adverse negative impact, and if the latter cannot be avoided, to reduce its impact and ensure adequate protection during construction and operation of the proposed activity.

This Environmental Impact Report (EIR) forms part of the process of planning and decision making for the proposed activity. The purpose of this EIR is to present the findings of the environmental impact assessment process for review by stakeholders and Authorities. It is the latest in a series of reports and information documents issued during the full EIA process.

### ***1.9 Comment on the draft EIR***

As part of the EIA process, all Interested and Affected Parties were invited to provide comment on the Environmental Impact Report. The comments period for this report was from 2 May 2005 to 24 May 2005. No comments were received. The final revised Environmental Impact Report will be submitted to the Ministry for Environment and Tourism, Namibia, for consideration.

Comments were submitted to the following address:

**Ms Stephanie Van Zyl**  
**Enviro Dynamics**

**Tel: +264 61 240300**  
**Fax: +264 61 240309**

**P O Box 20837, Windhoek, Namibia**  
**Email: [envirod@africaonline.com.na](mailto:envirod@africaonline.com.na)**

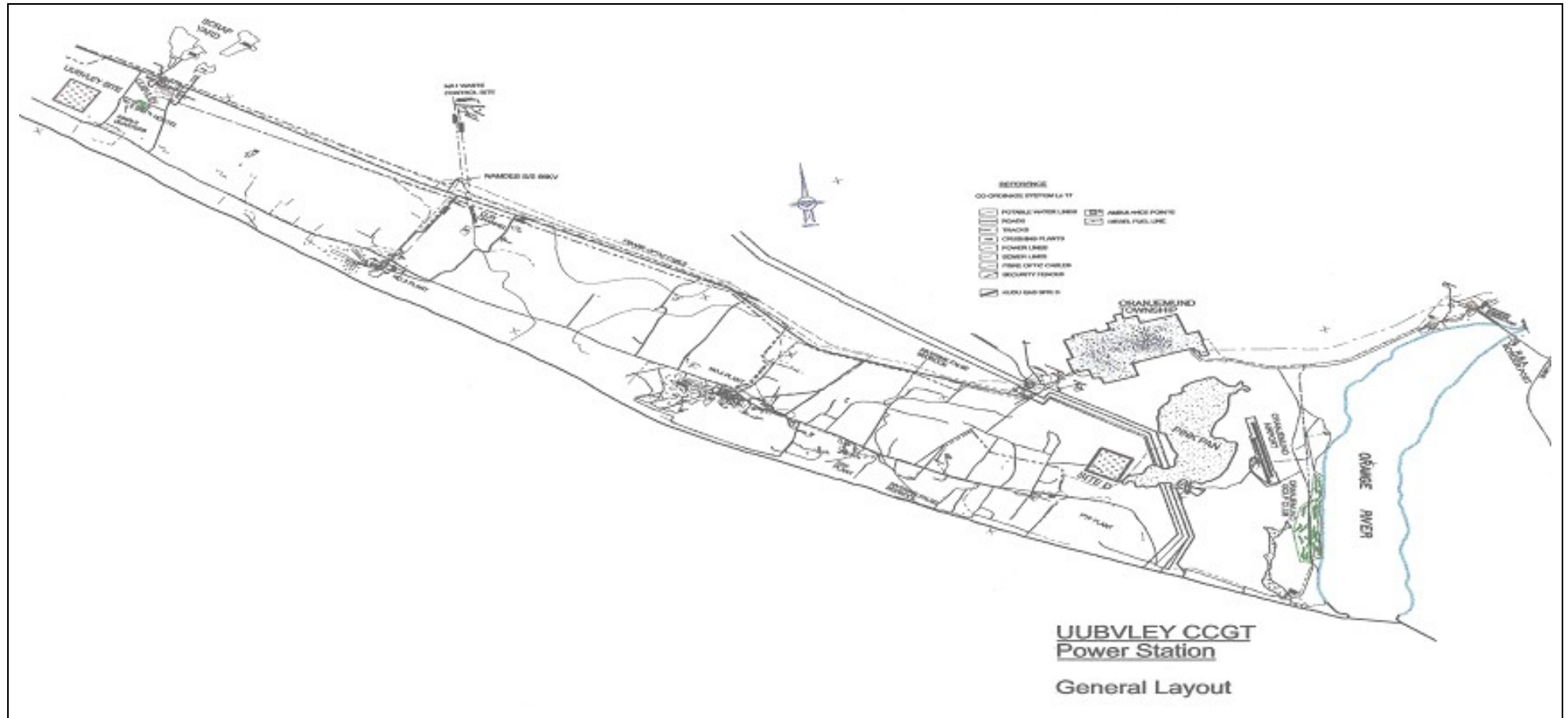


Figure 1.3: Location of the Uubvlei site, with Site D and the town of Oranjemund



### ***1.10 Structure of this report***

The first chapter has provided an introduction to the proposal put forward by Nampower, and the process undertaken thus far. Chapter 2 will outline the legislation, policy and regulations that are relevant to the proposed project. It will describe the methods used in the EIA, including scoping, specialist studies, integration and assessment, and the implementation phase. A project description is provided in Chapter 3, and project alternatives in Chapter 4. The affected environment is described in Chapter 5, while Chapter 6 provides the assessment of key issues. The potential impacts relating to each key issue are described, mitigation measures are proposed and a summary table for each key issue provides a synthesis of the potential impacts and impact significance at each site. Chapter 7 provides a summary of impacts and proposed mitigation measures, and recommendations for decision-making. Literature references are provided in Chapter 8.

## CONTENTS

---

2. DESCRIPTION OF THE EIA PROCESS .....	2-1
2.1 Legal and policy requirements for EIA .....	2-1
2.1.1 <i>The Constitution of Namibia</i> .....	2-1
2.1.2 <i>National Policies</i> .....	2-1
2.1.3 <i>National legislation</i> .....	2-3
2.1.4 <i>International Conventions and Protocols</i> .....	2-8
2.2 Terms of Reference for the EIA .....	2-12
2.3 Financial institution requirements .....	2-13
2.4 Methodology for the EIA .....	2-14
2.4.1 <i>Scoping</i> .....	2-15
2.4.2 <i>Issues identified</i> .....	2-18
2.4.3 <i>Specialist studies</i> .....	2-19
2.4.4 <i>Integration and impact assessment</i> .....	2-20
2.4.5 <i>Public review of the draft environmental impact report</i> .....	2-20

## FIGURES

---

Figure 2.1: Integrated Environmental Management Procedure .....	2-16
---	------

## 2. Description of the EIA process

### 2.1 Legal and policy requirements for EIA

The statutory decision making environment for the proposed activity is defined by the Constitution of Namibia, proposed and promulgated statutes, and international conventions and treaties. These are dealt with in detail in Appendix D, and they are briefly discussed in this section.

#### 2.1.1 The Constitution of Namibia

Since the gas from the Kudu gas field is a natural resource, its utilisation has to comply with Section 95(l) of the Constitution, which provides for the

*“maintenance of ecosystems, essential ecological processes and biological diversity of Namibia and [utilize] living natural resources on a sustainable basis for the benefit of all Namibians, both present and future ...”*

In addition, Article 91(c) of the Constitution defines the functions of an Ombudsman, of whom it is

*“the duty to investigate complaints concerning the over-utilisation of living natural resources, the irrational exploitation of non-renewable resources, the degradation and destruction of ecosystems and failure to protect the beauty and character of Namibia ...”*

#### 2.1.2 National Policies

##### 2.1.2.1 The Second National Development Plan of Namibia, 2001/2 – 2005/6, guided by Vision 2030.

The Kudu CCGT power plant project must be aligned with Vision 2030, which embraces sustainable development, and states that

*“The nation shall develop its natural capital for the benefit of its social, economic and ecological well-being by adopting strategies that: promote the sustainable, equitable and efficient use of natural resources; maximize Namibia’s comparative advantages; and reduce all inappropriate use of resources. However, natural resources alone cannot sustain Namibia’s long-term development, and the nation must diversify its economy and livelihood strategies.”*

##### 2.1.2.2 Environmental Assessment Policy

The Cabinet of the government of Namibia approved the Environmental Assessment (EA) Policy in August 1994, and this EIA is being undertaken in accordance with its procedure described in Figure 2.1. This EA policy provides that all policies, projects and programmes should be subjected to EA procedures, regardless of where these originate. These procedures must aim for a high degree of public participation, and consider the environmental costs and benefits of projects proposed. Policies, areas and activities which may have significant environmental effects are specified, and provision will be made to include other activities that may adversely affect biodiversity, archaeology and the social environment in Namibia. In line with IUCN guidelines, EAs are conducted at an early phase of project development, allowing for identification and avoidance of adverse impacts.

##### 2.1.2.3 Draft Wetland Policy of 2003

Oranjemund and the proposed project are next to the Orange River wetland. Legislation that will guide the management of wetlands will be the Water Resources Management Bill, Environmental Management and Assessment Bill and the Parks and Wildlife Management Bill. Other important legislation and policies are the Water Resources Management Act 24 of 2004, National Water Policy of 2000, Water Supply and Sanitation Policy of 1993, Water Corporation Act 12 of 1997, Aquaculture Act 18 of 2002 and the Inland Fisheries Resources Act 1 of 2003.

The vision of the Wetland Policy of 2003 aims to integrate sustainable management into decision-making at all levels by stating that

*Namibia shall manage national and shared wetlands wisely by protecting their biodiversity, vital ecological functions and life support systems for the current and future benefit of people's welfare, livelihoods and socio-economic development.*

The objectives of the policy are to:

- Protect and conserve wetland diversity and ecosystem functioning without compromising human needs.
- Promote the integration of wetland management into other sector policies.
- Recognise and fulfil Namibia's international and regional obligations concerning wetlands, including those laid down in the Ramsar convention and the SADC protocol on Shared Water Systems.

#### **2.1.2.4 The White Paper on National Water Policy for Namibia of 2000**

The sourcing of cooling water must conform with the new policy framework that redresses the inefficient water management regime based on the current former Water Act of 1956. Government policy in regard to water resource development, utilisation, management, and protection addresses:

- Ownership
- Equity
- Promotion of development
- Economic value
- Awareness and Participation
- Openness and transparency
- Decentralisation
- Ecosystem values and sustainability
- Integrated management and planning
- Clarity of institutional roles and accountability.
- Capacity building
- Shared watercourses

#### **2.1.2.5 The White Paper on Energy**

The White Paper on Energy embodies a new, comprehensive energy policy aimed at achieving security of supply, social upliftment, effective governance, investment and growth, economic competitiveness, economic efficiency and sustainability. Policies will, amongst others, affect supply that includes upstream and downstream oil and gas.

The White Paper clarifies an accepted policy framework for upstream oil and gas which seeks to optimise possible national benefits while achieving the necessary balance of interests to attract investment. It identifies the different roles and functions of industry participants, and lays out the basic legal and fiscal criteria. Licensing requirements will include the need for separate accounting for the different operations of gas production, transmission, distribution and marketing, allowance for third party access and the application of fair and reasonable tariffs.

Through this EIA, the Kudu CCGT project is aligned with the energy policy goal of sustainability that will be promoted through the requirement for environmental impact assessments and project evaluation methodologies which incorporate environmental externalities.

### 2.1.2.6 The National Environmental Health Policy

Throughout the construction, implementation and decommissioning phases, the Kudu CCGT project must be guided the aim of the Policy, which includes the following:

- Facilitate the improvement of the living and working environments of all Namibians, through pro-active preventative means, health education and promotion and control of environmental health standards and risks that could result in ill-health; and
- Ensure provision of a pro-active and accessible integrated and co-ordinated environmental health services at national, regional, district and local levels.

### 2.1.3 National legislation

Both proposed legislation, i.e., Bills, and promulgated legislation such as Acts and Regulations are discussed in this section.

#### 2.1.3.1 Draft Pollution Control and Waste Management Bill of 1999

A draft version of the Pollution Control and Waste Management Bill of 1999 has amalgamated a variety of Acts and Ordinances that provide protection for particular species, resources or components of the environment. These include, but are not limited to, the Nature Conservation Ordinance No.4 of 1975, the Sea Fisheries Act 29 of 1992, the Sea Birds and Seals Protection Act 46 of 1973, Seashore Ordinance No. 37 of 1958, Hazardous Substances Ordinance No. 14 of 1974 and amendments, and the Atmospheric Pollution Prevention Ordinance No. 11 of 1976. All construction, disturbance, effluent and pollution resulting from the Kudu Power Project will be required to be in strict accordance with the regulations outlined in the Pollution Control and Waste Management Bill.

This Bill deals mainly with the protection of particular species, resources of components of the environment. Various sections, of relevance for the project, are described below.

#### ***Air Pollution***

- the co-ordination and monitoring of Namibia's air quality, through reference to air quality objectives that will be drawn up once the Bill is promulgated.
- An air pollution licence will be required for the discharge of pollutants to the air, subject to air pollution objectives that are set, standards, treatment processes, the contents of an environmental assessment, and an air pollution action plan that stipulates the best possible means for reducing and preventing the discharge of pollutants to the air.

#### ***Water Pollution***

- Water quality monitoring will be co-ordinated by an Agency, in terms of water quality objectives and activities liable to cause water pollution.
- Regulations under this pending law will include limits for discharges of pollutants to water and land from fixed and mobile sources, water quality objectives, standards for the pre-treatment or purification of pollutants, and procedures required for compliance with any standards. It will also prescribe offences and water quality action areas and the restriction of polluting activities in these areas, as well as require application for water pollution licences to be accompanied by an environmental assessment report, and offences.

#### ***Integrated pollution control***

- Processes creating a risk of pollution to more than one environmental medium, e.g., air and water, may be subject to specific regulations that adopt an integrated approach to pollution and licencing. These prescribed processes shall be subject to an Integrated Pollution Control Licence.

### **Noise, Dust and Odour Pollution**

- Local authorities or a separate agency created to deal with dust, noise and odour will have the power to issue an abatement notice for activities causing a nuisance. The activity may be stopped, or conditions determined for mitigatory or other measures to reduce the nuisance to acceptable levels.
- Regulations may come into force under this Act that set standards for noise, dust and odour emissions, and product or process standards that have a bearing on noise, dust and odour pollution.

### **Waste Management**

- The production, collection, sorting, recovering, treatment, storage, disposal and general management of waste shall be covered under this Act.

### **Hazardous substances**

- The Bill further makes provision for regulations that establish standards and other requirements in relation to hazardous substances.

### **Accident Prevention Policies**

- The Bill makes provision for the enforcement of regulations that require a person in possession of specified hazardous substances or products containing hazardous substances or any person carrying on an activity involving significant risk of harm to human health or the environment, to take measures to limit the risk of accidents occurring as a result of those substances or activities.

When this Act comes into force, it shall repeal the following:

- The entire Atmospheric Pollution Prevention Ordinance No 11 of 1976
- The entire Hazardous Substances Ordinance No 14 of 1974; and
- Section 21 of the Water Act of 1956

#### **2.1.3.2 The Parks and Wildlife Management Bill of 2001**

This new legislation is still in its draft stage, but will eventually replace the existing Nature Conservation Ordinance No. 4 of 1975, with amendments. The Bill provides for the declaration of protected areas and steps to be taken before declaration.

The Ministry of Environment and Tourism intends to declare the Sperrgebiet as a protected area under this pending legislation, meaning that all activities within the area will be subject to the provisions of the Act when it comes into force. The Uubvlei site falls into Zone 6, a Managed Resource Protected Area that is managed mainly for the sustainable use of natural ecosystems in the long term,

#### **2.1.3.3 Draft Environmental Management and Assessment Bill of 2002**

Drafting of the Environmental Management and Assessment Bill started in 1996, with a highly consultative approach. A sixth draft of the Bill had been negotiated with stakeholders by December 1998, but the Bill has not yet been passed by Parliament. The main reason for delay is a lack of consensus over who should administer the legislation: an Environmental Commissioner within the Ministry for Environment and Tourism, or an environment agency outside of Government, but still funded by it. The Bill provides a practical framework within which to administer EIAs in Namibia. Schedule 1 specifies a list of over 30 activities that require an EIA, broadly grouped as follows:

- Construction and related activities that include roads, dams, factories, pipelines and other infrastructure;
- Land-use planning and development activities that include rezoning and land-use changes;
- Resource extraction, manipulation, conservation and related activities, such as mining and water abstraction; and,
- Other activities such as pest-control programmes.

The Bill also requires public comment and hearings, in addition to the normal consultation with interested and affected parties during an EIA, and the provision for external review by the Commissioner and an *ad hoc* committee of experts, where required, at the proponent's expense.

Also included is a provision that respects the rights and knowledge of indigenous peoples. Namibia has not to date signed the Convention on Indigenous Peoples' Rights.

#### **2.1.3.4 The Water Resources Management Act 24 of 2004**

This Act is administered by the Department of Water Affairs, Ministry of Agriculture, Water and Rural Development (MAWRD), and came into operation on 8 December 2004. It repeals the Water Act of 1956, and provides for the management, development, protection, conservation, and use of water resources; the establishment of the Water Advisory Council, Basin Management Committees, water point user associations and local water user associations and their committees, the Water Regulatory Board and Water Tribunal, and incidental matters.

The objective of the Act is to ensure that Namibia's water resources are managed, developed, protected, conserved and used in ways which are consistent with or conducive to fundamental principles set out in section 3 of the Act. The functions of the Minister are to:

- Determine water resources management policies; conduct water resources management planning;
- Participate in consultations and negotiations regarding shared water resources;
- Ensure adequate supply of water for domestic use; and
- Develop and implement efficient water management practices contemplated in section 75 of the Act.

The fundamental principles set out in section 3 are:

- Equitable access to water resources by every citizen, in support of a healthy and productive life;
- Access by every citizen, within a reasonable distance from their place of abode, to a quantity of water sufficient to maintain life, health and productive activities;
- Essentiality of water in life, and safe drinking water a basic human right;
- Harmonisation of human needs with environmental ecosystems and the species that depend upon them, while recognising that those ecosystems must be protected to the maximum extent;
- Integrated planning and management of surface and underground water resources, in ways which incorporate the planning process, economic, environmental and social dimensions;
- Openness and transparency, by making available water resources information accessible to the public;
- Management of water resources so as to promote sustainable development; recognition of the economic value of water resources and of the need for their development to be cost-effective;
- Furthering a process of human resources development and building of competency in water resources decision-making;
- Facilitating and encouraging awareness programmes and participation of interested persons in decision-making;
- Consistency of water resources decisions with firm and specific mandates from Government that separate policy making from operational and regulatory roles;
- Prevention of water pollution, and the polluter's duty of care and liability to make good;
- Meeting Namibia's international obligations and promoting respect for Namibia's rights with regard to internationally shared water resources and, in particular, to the abstraction of water for beneficial use and the discharge of polluting effluents; and

- Regional diversity and decentralisation to the lowest possible level of government consistent with available capacity at such level.

Other sections of the Act that are relevant for the project are described below. It is not clear how the provisions on effluent quality will be co-ordinated with measures on water pollution that are specified in the proposed Pollution Control and Waste Management Bill.

#### ***Licence to abstract and use water***

Water may only be abstracted or used in accordance with a licence issued under this Act. This includes the abstraction of brackish or marine water for any purpose. Subject to sections 40 and 41 of the Act, a licence may be granted for a term not exceeding five years. Amongst others, the application for a licence must include:

- The proposed rate and volume of the abstraction;
- The proposed timing of the abstraction;
- A description of any waterworks necessary to accomplish the proposed abstraction;
- A description of the proposed treatment that will be given to the abstracted water, including any chemicals proposed to be applied to the water;
- A description of the volume, rate and chemical composition of any effluent or return flow resulting from application of the abstracted water to beneficial use;
- A description of the location that any such effluent or return flow is expected to enter a water resource.

#### ***Combined licence to abstract and use water and to discharge effluent***

A combined licence to abstract and use water and to discharge effluent may be issued.

#### ***Borehole drilling, mining and other operations***

A person who proposes to drill a new borehole, or to improve any existing borehole, for any purpose other than exploring for groundwater must:

- Inform the Minister of such proposal;
- Furnish the Minister with such data and information as the Minister may require in connection with such borehole drilling or improvement; and
- Take such measures as may be required by the Minister for conserving and protecting groundwater.

#### ***No discharge of effluent without permit***

Discharge of any effluent directly, or indirectly to any water resource on or under the ground, including through a borehole, or construction of any effluent treatment facility or disposal site above any aquifer, must be in compliance with a permit issued under section 60 of the Act. The application for a permit must include information on any land, water resource, or environmentally sensitive area to which the discharged effluent will flow, directly or indirectly. This includes discharge from a sewer. In terms of section 59, the Minister require the applicant to conduct an assessment of the impact of the proposed effluent discharge or the proposed effluent treatment facility or disposal site upon the environment, including owners and occupiers of land and water resources, including ground water, in the vicinity of the proposed effluent discharge or construction of effluent treatment facility or disposal site.

#### ***Standards of effluent quality***

The Minister, after consultation with competent authorities, may prescribe minimum standards of effluent quality with which effluent discharges must comply.

#### **2.1.3.5 Forest Act 72 of 1968**

Although plants are regulated by the Nature Conservation Ordinance, trees and forests are controlled under two separate laws, the Forest Act (72 of 1968) and the Preservation of Trees and Forests Ordinance (37 of 1952). Both are administered by the MET's Directorate of Forestry.



The Forest Act aims to protect forests, prevent fires, and regulate trade in and removal of useful forest products.

The proposed site for the power plant is degraded due to mining, and this Act would probably not be applied.

#### **2.1.3.6 Minerals (Prospecting and Mining) Act of 1992**

This Act enables the Ministry of Mining to control the reconnaissance, prospecting and mining of all categories of minerals in Namibia. This is done through a Minerals Board, established in terms of the Act, responsible for maintaining policy in terms of which the provisions of the Act are to be implemented. Applications for prospecting, reconnaissance and mining work is made to the Ministry in terms of this Act.

#### **2.1.3.7 Sea Fisheries Act 29 of 1992**

The Sea Fisheries Act provides for marine environmental conservation as well as the orderly exploitation, conservation and promotion of certain marine resources to the benefit of all Namibians, present and future. It deals mainly with:

- Dumping at sea;
- Discharge of wastes in marine reserves;
- Disturbance of rock bolsters, marine invertebrates or aquatic plants;
- Prohibited areas for catching/disturbing fish, aquatic plants or disturbing/damaging seabed.

#### **2.1.3.8 Labour Act of 1992: Regulations for the Health and Safety of Employees at Work.**

- The Regulations relating to Health and Safety at the Workplace in terms of the Labour Act 6 of 1992 came into force on 31 July 1997. These regulations prescribe conditions at the workplace, and *inter alia* deal with the following:
  - Welfare and facilities at work-places, including lighting, floor space, ventilation, sanitary and washing facilities, usage and storage of volatile flammable substances, fire precautions, etc.
  - Safety of machinery;
  - Hazardous Substances including precautionary measures related to their transport, labelling, storage, and handling. Exposure limits, monitoring requirements, and record keeping are also covered.
  - Physical hazards including noise, vibration, ionising radiation, non-ionizing radiation, thermal requirements, illumination, windows and ventilation.
  - Requirements for protective equipment
  - Emergency arrangements
  - Construction safety
  - Electrical safety

#### **2.1.3.9 The Diamond Act 13 of 1999**

This Act came into operation on 1 April 2000. Section 52 deals with Restricted Areas, where approved persons must enter with the required permit. Restricted Areas are declared as such by the Minister in the Government Gazette, and include areas where on- or offshore mining or related activities take place.

The Diamond Regulations in terms of the Act make provision for security check procedures for persons wishing to enter Restricted Areas, and security plans which must be submitted by licence holders, such as NamDeb.

### **2.1.3.10 The Public Health Act 36 of 1919 (as amended)**

Chapter VIII deals with the control of nuisances, which include:

- “...any factory or trade premises not kept in a cleanly state and free of offensive smells.....and not ventilated so as to destroy or render harmless and inoffensive as far as practical any gases, vapours, dust or other impurities generated”.
- “...any chimney sending forth smoke in such a quantity or in such a manner as to be offensive or injurious or dangerous to health”.

### **2.1.3.11 General Health Regulations 121 of 14 October 1969 (as amended).**

Section 13 generally deals with standards for the provision of sanitary facilities at the workplace and at public places, as follows:

- Section 13 (1) prescribes that for factories, at least one latrine per 20 persons employed in or on the premises shall be provided, where the waterborne sewerage is provided.
- According to section 13 (10), latrine accommodation has to be provided for the workforce employed on a construction site.
- Section 16 requires that approval be obtained for the construction of sewerage works in or near a town area. The application is made to the applicable local authority.
- Section 17 deals with the control of discharges of infectious, noxious or hazardous substances into a water supply or underground water resource.

### **2.1.3.12 Nature Conservation Ordinance 4 of 1975 (as amended 1996)**

The Nature Conservation Ordinance deals with *in situ* and *ex situ* conservation by providing for the declaration of protected habitats as national parks and reserves, and for the protection of scheduled species wherever they occur. It regulates hunting and harvesting, possession of, and trade in listed species.

### **2.1.3.13 Atmospheric Pollution Prevention Ordinance 11 of 1976**

The Atmospheric Pollution Prevention Ordinance provision on air pollution is administered by the Namibian Ministry of Health. In terms of Section 5 any person carrying on a “scheduled process” within a “controlled area” has to obtain a registration certificate from the administering authority, in this case the Department of Health. The Act lists 72 processes in Schedule 2; of relevance for the project are the sections on power stations (29), producer gas works (33) and gas and coke works (24). According to Sections 5 and 6 of the Ordinance, the premises in which such scheduled process will be conducted must be registered and a registration certificate (air pollution permit) obtained.

## **2.1.4 International Conventions and Protocols**

Namibia is signatory to the international conventions and protocols described below. Key aspects of these protocols and conventions that are relevant to the proposed project, are summarized.

### **2.1.4.1 The Stockholm Declaration on the Human Environment, Stockholm 1972**

The United Nations Conference on the Human Environment, which led to the Stockholm Declaration on 16 June 1972, aimed to provide “a common outlook and common principles to inspire and guide the peoples of the world in the preservation and enhancement of the human environment” (UNEP, 1972). Namibia adopted the Stockholm Declaration on the Human Environment on 28th August 1996, and the following principles are most relevant for the project:

- Principle 21: States have, in accordance with the Charter of the United Nations and the principles of international law, the sovereign right to exploit their own resources pursuant to their own environmental policies, and the responsibility to ensure that activities within their jurisdiction or control do not cause damage to the environment of other States or of areas beyond the limits of national jurisdiction.
- Principle 22: States shall cooperate to develop further the international law regarding liability and compensation for the victims of pollution and other environmental damage caused by activities within the jurisdiction or control of such states to areas beyond their jurisdiction.

#### **2.1.4.2 Convention on Biological Diversity, Rio de Janeiro, 1992**

Namibia signed the Convention on Biological Diversity (CBD) on 12 June 1992 in Rio de Janeiro, at the United Nations Conference on Environment and Development, and ratified it on 18 March 1997. Namibia is accordingly now obliged under international law to ensure that its domestic legislation conforms with the CBD's objectives and obligations. Its Constitution explicitly refers to biodiversity, providing that in the interests of the welfare of the people, the State shall adopt policies aimed at maintaining ecosystems, ecological processes and biodiversity for the benefit of present and future generations (Article 95(I)).

Of relevance for the project, are these Articles from the CBD:

- Article 1 outlines the framework within which action must be taken, and demands that implementation and further development of the CBD conform to these objectives. In this way, it will help ensure that balanced decisions are taken, and that where interpretations diverge, conflicts are resolved amicably.
- Article 6 (a) requires the development of national strategies, plans or programmes for the conservation and sustainable use of biological diversity, or adapting existing strategies, plans or programmes for this purpose, while Article 6 (b) sets out the need for integration, as far as possible and as appropriate, of the conservation and sustainable use of biological diversity into relevant sectoral or cross-sectoral plans, programmes and policies.
- Article 14 requires each contracting party to carry out environmental impact assessments (EAs) of projects that are likely to adversely affect biological diversity. It further requires that the EA be aimed at avoiding or minimising such effects and, where appropriate, allow for public participation in the assessment.
- Article 14.1 (d) provides that, where there is imminent or grave danger or damage to biological diversity within areas under jurisdiction of other States or in areas beyond the limits of national jurisdiction, that such potentially affected States be notified immediately of such danger or damage, and action initiated to prevent or minimize such danger or damage.

#### **2.1.4.3 Convention on Wetlands of International Importance especially as Waterfowl Habitat (Ramsar Convention on Wetlands), Ramsar, 1971**

The Convention on Wetlands, signed in Ramsar, Iran, in 1971, is an intergovernmental treaty which provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources. It is based on the consideration of the "fundamental ecological functions of wetlands as regulators of water regimes and as habitats supporting a characteristic flora and fauna, especially waterfowl" (UNESCO, 1994). Countries signatory to the Convention recognize that "wetlands constitute a resource of great economic, cultural, scientific, and recreational value, the loss of which would be irreparable". Through the protection of wetlands, the Convention aims "to stem the progressive encroachment on and loss of wetlands now and in the future". As waterfowl may transcend international frontiers during their seasonal migrations, the Convention recognizes that they should be regarded as an international resource.

The Orange River Mouth was designated a Wetland of International Importance 23 August 1995. In terms of Article 3.2, this makes Namibia responsible for ensuring that the Government is informed at the earliest possible time if the ecological character of the Orange River Mouth wetland is likely to change as the result of technological developments, pollution or other human interference. Namibia is responsible for communicating information on such changes, without delay, to the International Union for the Conservation of Nature and Natural Resources (IUCN).

Article 4.2 of the Convention stipulates that if Namibia, in its urgent national interest, restricts the boundaries of a wetland included in the List, it should as far as possible compensate for any loss of wetland resources, and in particular it should create additional nature reserves for waterfowl and for the protection, either in the same area or elsewhere, of an adequate portion of the original habitat.

#### **2.1.4.4 Protocol on Shared Watercourse Systems in the Southern African Development Community (SADC) region, Johannesburg 1995**

The Republic of Namibia is signatory to the Protocol on Shared Watercourse Systems in the Southern African Development Community (SADC) region, agreed to in Johannesburg on 28 August 1995. This Protocol is based on the conviction of “the need for coordinated and environmentally sound development of the resources of shared watercourse systems in the SADC region in order to support sustainable socio-economic development” (SADC, 1995).

Article 3 of the Protocol calls for the establishment of River Basin Management Institutions for shared watercourse systems. The functions of the River Basin Management Institution are fulfilled by the Permanent Water Commission which was formally agreed between the Government of the Republic of Namibia and the Government of the Republic of South Africa on 14 September 1992 (International Water Law Project, 2004). The Commission was established “to act as technical adviser to the two Parties on matters relating to the development and utilisation of water resources of common interest to the Parties”.

#### **2.1.4.5 United Nations Framework Convention on Climate Change, Rio de Janeiro, 1992**

The United Nations Framework Convention on Climate Change was concluded in Rio de Janeiro in June 1992. The objective of the Convention and subsequent related legal instruments (such as the Kyoto Protocol) is “the stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a time-frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner” (United Nations, 1992).

Namibia signed the Convention on 12 June 1992, ratified it on 16 May 1995 and it entered into force in Namibia on 14 August 1995.

#### **2.1.4.6 Kyoto Protocol, Kyoto, 1997**

The objective of the Kyoto Protocol is to stabilize and reduce greenhouse gas emissions, mitigate climate change, and promote sustainable development in line with the objectives of the United Nations Framework Convention for Climate Change. The Protocol commits 38 industrialised countries (Annex 1 countries) to cut their emissions of greenhouse gases between 2008 to 2012 to levels that are 5.2 per cent below 1990 levels, and makes provision for innovative mechanisms to achieve emission reduction targets (UNFCCC, 1997). This includes the Clean Development Mechanism, which assists developing country Parties that do not currently have emission reduction targets (such as Namibia), to contribute to the objectives of the United Nations Framework Convention for Climate Change with technological and financial support from Parties that have emission reduction targets.

Namibia acceded to the Kyoto Protocol on 4 September 2003, meaning that it has accepted the offer or the opportunity to become a party to the Kyoto Protocol. Amongst other things, in terms of Article 10 (c), all Parties to the Protocol are required to cooperate in the promotion of effective modalities for the

development, application and diffusion of, and take all practical steps to promote, facilitate and finance, as appropriate, the transfer of, or access to, environmentally sound technologies, know-how, practices and processes pertinent to climate change, in particular to developing countries.

The Protocol has not yet entered into force.

#### **2.1.4.7 International Convention for the Prevention of Pollution from Ships (MARPOL 73/78)**

This Convention is applicable for considering the cumulative effects of the power plant and onshore gas conditioning plant.

#### **2.1.4.8 Transboundary Pollution**

The 1989 Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal aims to do the following:

- Reduce transboundary movements of hazardous waste to a minimum;
- Ensure that hazardous wastes should be treated and disposed of as close as possible to their source of generation; and,
- Minimise hazardous waste generation at source.

It defines "waste" in Article 2 as

*Substances or objects which are disposed of or are intended to be disposed of or are required to be disposed of by the provisions of national law.*

However, this definition is open to interpretation and dispute, as scrap metal and wastes are inputs for production in several countries, especially developing countries. In regard to hazardous waste, the Basel Convention is still seeking to define the specific matter that constitutes hazardous waste, and has constituted a Technical Working Group to look into this matter. Certainly, emissions from the proposed power plant would fall into the definition of "waste", and its transboundary movement would need to be examined in the light of this Convention.

Principle 22 of the 1972 Stockholm Declaration on Human Rights provides that States shall cooperate to develop further the international law regarding liability and compensation for the victims of pollution and other environmental damage caused by activities within the jurisdiction or control of such states to areas beyond their jurisdiction. A principle of international environmental customary law was expressed in 1941, the Trail Smelter Arbitration US v Canada (1938 and 1941), where it was ruled that *'...under the principles of international law, as well as of the law of the United States, no State has the right to use or permit the use of its territory in such a manner as to cause injury by fumes in or to the territory of another or the properties or persons therein, when the case is of serious consequence and the injury is established by clear and convincing evidence'*.

In terms of international customary law, Namibia has an obligation to ensure that the activities of the power plant do not result in injury to persons or property across the border and it could be liable if this does occur. Legal obligations and potential liability arises at two levels:

- In international law the actions of private citizens can be imputed to the governments of their respective countries, as in the case of the Trail Smelter. The Namibian government would accordingly have rights and responsibilities to the South African government, and could be liable.
- In domestic law private legal persons, for example, farmers on the Orange River would have legal rights which could be enforced against Nampower, in the domestic courts of Namibia.

## 2.2 Terms of Reference for the EIA

The “Terms of Reference to Conduct an Environmental Assessment and Environmental Management Plan for the Proposed Kudu Combined Cycle Gas Turbine Power Plant at Uubvlei were issued in March 2005, by NamPower,

The prime objective is to assess the suitability of Uubvlei for the location of the power plant in terms of biophysical, economic and social impacts.

Included in the tender is the requirement that the EIA study will cover all aspects relating to the construction and operation of the CCGT plant as far as the project has been defined. The EIA is required to consider at least the following aspects under construction, operating and decommissioning scenarios:

- Site clearance and fencing
- Bulk earthworks and civil
- Erection of structures and steel work
- All mechanical, electrical work
- All wet services installation
- Domestic water supply infrastructure
- Cooling water supply options and related infrastructure
- Effluent discharge infrastructure
- Solid and liquid waste disposal
- Air emissions under various operating scenarios
- Distillate fuel oil supply infrastructure
- Storm water and effluent control
- Road access infrastructure
- Housing (permanent and temporary)
- Presence of construction workforce and permanent workforce.

Most of these issues were covered by the EIA done for site D and are applicable for Uubvlei. Additional issues are discussed in the section regarding specialist studies.

The EA Report will also have to conform to the relevant World Bank Guidelines for new thermal power plants, as well as the applicable Operational Directives.

The study does not cover the upstream components of the development, i.e., the gas field, pipelines from the gas field and gas conditioning plant adjacent to the power plant, nor the construction of the transmission power lines from the power plant, with exception of the cumulative impacts of the gas conditioning plant adjacent to the power plant. These components are subject to separate EIAs. This study will include:

- Consultation with all interested and affected parties and stakeholders to solicit their input regarding this development, and feed this information into the EIA process;
- Describing the receiving environment, including all relevant bio-physical and socio-economic components;
- Considering alternatives to the project;
- Considering alternatives within the project;
- Assessing the potential impacts of the power plant on the receiving environment during all phases, and different scenarios, including construction, normal operating conditions, maintenance, decommissioning and closure
- Compiling a bankable EA report, in accordance with World Bank (IFC) guidelines; and
- Compiling an Environmental Management Plan for the control of the residual impacts

- Building on and confirming work done in the PEA and the EIA for Site D at Oranjemund.

### 2.3 Financial institution requirements

The proposed Kudu CCGT Power Plant is envisaged as a private sector investment. The International Finance Corporation (IFC) focuses on investment in private sector projects, and therefore the requirements of the IFC are potentially relevant to this project. The applicable IFC requirements (and, where relevant, those of the World Bank Group) that might have implications for the Kudu Power Plant are contained in:

- IFC Policies (including Environmental and Social Safeguard Policies)
- IFC Procedure for Environmental and Social Review of Projects
- IFC and World Bank Guidelines (including the World Bank's *Pollution Prevention and Abatement Handbook*)
- IFC Guidance Notes.

This section presents a summary of the main implications of these IFC requirements for the Kudu Power Plant, which are discussed in more detail in Appendix D. In terms of the IFC's project categories, the Power Plant would be a **Category A project**, thus requiring a full Environmental Assessment.

Timing of IFC involvement in a project can vary significantly. IFC's initial involvement in a project normally occurs after a feasibility study has been completed (i.e. after site selection, preliminary design work, etc.). In the case of the Kudu CCGT Power Plant, the EIA and EMP are being completed prior to potential IFC involvement. Given this background, the following potential implications of IFC requirements for the Power Plant are identified:

1. **Operational Policy (OP) 4.01** specifies the requirements for Environmental Assessment. The current EIA and EMP for the Power Plant are being prepared according to Namibian legislation (and international best practice) prior to any IFC involvement. However, the IFC may require revision to the EIA and the EMP, as discussed below.
2. The IFC's **Procedure for Environmental and Social Review of Projects** (IFC, December 1998) includes the project evaluation cycle followed by the IFC when investigating potential financing of a project. In order to satisfy this procedure, the IFC may require revision of the EIA and EMP to meet their specified report formats, terminology and certain additional content requirements. Given that the EIA has been conducted according to international best practice, it is not expected that the IFC will require substantial additions to the EIA and EMP. However, they require reworking of existing documents and inclusion of some additional information (eg. cost estimates for each mitigation, management and monitoring action) in order to meet their requirements. If the IFC is a potential investor, it is recommended that the project proponent confirm with the IFC as soon as possible the extent of additional requirements. Revisions to the EIA, due to IFC requirements, may require further approval by the Namibian authorities to ensure they agree with any revisions.
3. The World Bank Group's **Pollution Prevention and Abatement Handbook** applies to all projects directly financed by IFC. The *Thermal Power Guidelines for New Plants* are directly relevant to the project. These guidelines specify thresholds or maximum emissions levels for all fossil fuel-based thermal power plants with a capacity of 50 or more megawatts of electricity (MWe) that use coal, fuel, oil or natural gas. Levels are specified for atmospheric emissions, liquid waste, solid waste and noise.
4. The IFC's **Guidance Note A** provides a Checklist of potential issues that should be addressed in an EIA. These appear to be adequately covered in the Kudu Power Plant EIA, except for two items:

- a) **Major hazards:** The IFC requires that all projects which involve dangerous materials in sufficient quantities to represent a significant hazard with the potential for an incident of major consequence, are required to complete a major hazard assessment and establish formal management processes. Furthermore, **Guidance Note E** provides an outline of the requirements for **a Project Specific Major Hazard Assessment**.
  - b) **Restoration and rehabilitation of disturbed land** – a comprehensive plan is required for future rehabilitation and restoration after the life of the project.
5. **Guidance Note C** provides the outline for an **Environmental Action Plan (EAP)**. The EIR and EMP for the Kudu Power Plant includes these items, except that an Environmental Action Plan (EAP) is not presented in the stand-alone format specifically required by the IFC. The EAP is essentially a management plan that contains the mitigation, monitoring and implementation measures to reduce or eliminate significant adverse environmental and social impacts. It needs to be updated regularly by the project sponsor/proponent.
6. **Guidance Note F** provides guidance for the preparation of a **Public Consultation and Disclosure Plan (PCDP)**. It is expected that the existing stakeholder engagement process undertaken for the EIA in terms of Namibia's Environmental Assessment Policy is adequate to meet the IFC requirements for work done to date. However, IFC may require that information from this process be packaged in a way that meets their requirements. This would need to be clarified with the IFC, should they be a potential lender. The project proponent needs to take cognisance of the IFC's requirements for ongoing consultation during the construction and operation phases.

## 2.4 Methodology for the EIA

The methodology used for the EIA is the Integrated Environmental Management Procedure (IEM) as presented in Namibia's Environmental Assessment Policy (1995).

In terms of this Policy, the Kudu Power Project (the proponent) is required to follow the Integrated Environmental Management (IEM) Procedure set out in Appendix A of the Policy (see Fig 2.1). In terms of this, the Develop Proposal Stage, or preliminary environmental assessment (PEA) is completed and submitted to the Ministry of Environment and Tourism (MET) for classification. If significant impacts are identified, the MET can request the Proponent to undertake a detailed environmental assessment. In terms of the IEM Procedure, the key components of a preliminary environmental assessment (PEA) are to:

- Notify interested and affected parties (I&APs);
- Establish policy, legal and administrative requirements;
- Consult relevant ministries and I&APs;
- Identify issues and alternatives.

The PEA for the proposed Kudu CCGT power plant was undertaken in 1998. The next step in the IEM procedure process is this environmental impact assessment (EIA) of the preferred site (Step 5 in Fig 2.1) and the compilation of an Environmental Management Plan (Step 8 in Fig 2.1).

A full EIA of a proposed CCGT power plant at Site D, Oranjemund, was conducted by the CSIR in collaboration with Enviro Dynamics in 2004. The study concluded that Site D as a location was the preferred technical, economic and environmental option. The EIA report was reviewed and a positive Record of Decision was issued by MET in January 2005.

Notwithstanding MET approval of Site D as the preferred site for the power plant, Nampower decided in February 2005 to investigate the possibility of locating the power station at Uubvlei, some 25 kilometres north of Oranjemund, and to commission another EIA for the construction, operation and decommissioning phases of the power station at Uubvlei. Although this second EIA is an entirely new



stand-alone document, much of the information and analysis contained in the Site D EIA will be used in this EIA.

The purpose of an EIA is to provide information to stakeholders and decision makers as to whether the proposed activity will have a substantial detrimental effect on the environment. It provides an assessment of predicted positive and negative impacts of the proposed activity, to understand to what extent the activity will meet the goals of sustainable development. The EIA is undertaken in three stages:

- Scoping
- Specialist studies
- Integration and impact assessment

Each of these stages is discussed in detail below:

### 2.4.1 Scoping

Scoping provides the opportunity for stakeholders to contribute to the process, and focuses on identifying, and reaching closure, on the key issues to be addressed in the EIA. For all Category A projects, World Bank Guidelines on Environmental Assessment (Operational Procedure 4.01), require Public Consultation during the EA process. Project-affected groups and NGOs need to be consulted about the project's environmental aspects and the EIA needs to consider their views during the process. Relevant material should be provided in a timely manner before consultation and in a form and language that are understandable and accessible to the groups being consulted.

Namibia's Environmental Assessment Policy and the pending Environmental Management Act also require Public Consultation, in the form of scoping at the outset of the EIA, integrated throughout the process.

The consultation undertaken during this EIA built on the scoping exercise already undertaken during the PEA and the EIA for Site D at Oranjemund. Much of the background information for Uubvlei is identical to that for Site D; and, apart from a few differences, issues relating to the functioning of the plant, emissions and other technical aspects are unchanged.

#### 2.4.1.1 Identification of key stakeholder groups

Because of its fast-track nature, NamPower agreed to prepare the stakeholders' list for the EIA of Site D. Upon appointment, the EIA team added this list to their own database. The same stakeholder list was used for this EIA of the Uubvlei site, attached as Appendix A.

The key stakeholder groups may be summarised as follows:

- Applicable Ministries including the Ministries of Mines and Energy, Environment and Tourism, Trade and Industry, Roads, Transport and Communication, and Health and Social services;
- Regional and local government structures including Regional Government, and the town management structures of Oranjemund, Rosh Pinah and Alexander Bay;
- Relevant South African authorities, including Northern Cape Nature Conservation, Department of Minerals and Energy and Provincial Government;
- The management and applicable personnel of Namdeb, and of mines in the vicinity, including Kumba Resources (Rosh Pinah), NamZinc (Scorpion), and Alexcor (Alexander Bay);
- Parastatals, including Telecom and NamWater;
- NGOs;
- Business; and
- Members of the general public.

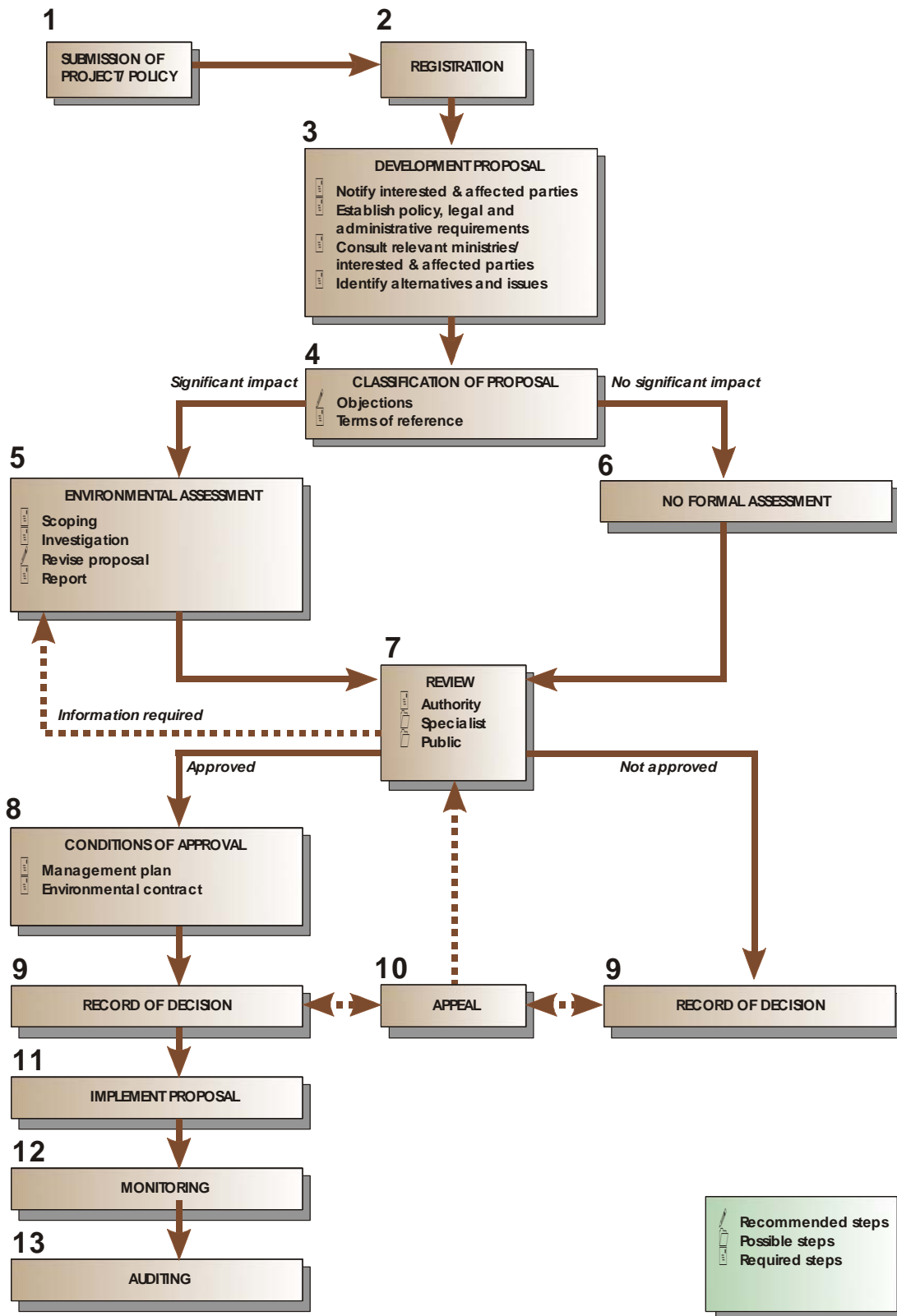


Figure 2.1: Integrated Environmental Management Procedure

#### **2.4.1.2 Invitation and background information document (BID)**

A Background Information Document was prepared, that included:

- A brief background to NamPower's decision to include Uubvlei as a possible alternative site for the Kudu Gas CCGT Power Plant
- Reasons why the Uubvlei site would probably be the most suitable alternative;
- Additional studies needed; and
- The role of the public and stakeholders in the study, namely, to participate throughout the process using the given communication channels.,

This document was distributed electronically to all on the Stakeholders list, inviting comments and input to the study.

A copy of the BID is attached as Appendix B.

#### **2.4.1.3 Invitation**

Stakeholders were invited by email to a public meeting held in Oranjemund on 31 March 2005. Namdeb staff in Oranjemund assisted with distributing the invitation through their Intranet.

The stakeholders' list attached as Appendix A shows how each person or organisation was invited to the meeting.

#### **2.4.1.4 Consultation meetings**

Having built on an extensive public consultation process for Site D, it was decided that one consultation meeting for the directly affected community in Oranjemund would be adequate. Stakeholders in Windhoek could provide comment by electronically responding to the Background Information Document.

The local consultation meeting was held on Thursday, 31 March 2005 at the School Auditorium, Oranjemund

Eighteen people completed the attendance register. The majority of those attending, namely 11, were from Namdeb; five were from the Mineworkers Union of Namibia, one from NCCI and one from the Oranjemund Flying Club.

#### **2.4.1.5 Method for participation at the meetings**

During the opening and introduction of the meeting NamPower stressed the fact that they are committed to solid public consultation and to hear the opinions of the Oranjemund community.

A project overview followed for the power station as well as the power lines, within which respectively a technical presentation and details of the EIA process followed. Issues compiled from the public meetings for Site D were shared, and all participated to adapt list for Uubvlei site. Some issues relevant to Site D no longer of concern for Uubvlei, were eliminated from the list, and new ones added. The minutes of the meeting are attached as Appendix C.

#### **2.4.1.6 Direct comments received**

Comments forms and e-mails are directly to Enviro Dynamics. The only e-mails received were of a few Oranjemund residents who welcome the possible shift to Uubvlei. The issues contained in them are integrated in the section detailing the identified issues, below.

### 2.4.1.7 Public Feedback

An important component of the public consultation process is to ensure that interested and affected parties are kept abreast of the process, and that information is fed back to them at appropriate times during the study. In this study, this objective was achieved as follows:

- In all invitations, the background document, mails sent, etc. people were invited to follow progress of the study by making contact with the public consultation manager at any time throughout the process. Contact details were emphasised during the public meeting.
- Progress on the study and all relevant documents produced are placed on NamPower's website and stakeholders welcomed to track progress of the study by visiting the site on the Internet.
- Minutes of public meetings are placed on the website and sent to participants of the meetings.
- An update report is sent to the entire stakeholder list.
- The summary of the outcome of the EIA will be distributed to the entire stakeholder list.

### 2.4.2 Issues identified

The list of key issues that emanated from the public meeting, to be considered during the EIA, included the following categories:

- Project design and implementation
- Uubvlei hostel accommodation
- Visual and noise impacts
- Security, access and transport
- Aviation Safety
- Biophysical impacts

The full list of issues is contained in the minutes of the public meeting, Appendix C.

Key comments and responses are reported below:

#### 2.4.2.1 Project design and implementation

**COMMENTS:** *What is the rationale for the possible shift from site D to Uubvlei?*

**RESPONSE:** *There was some opposition to the power station being located at Site D, because of concerns around noise, visual impacts and pollution. This opposition was submitted in the form of a petition which has been recorded in the previous EIA report for Site D. NamPower has not made the decision to abandon site D yet, and if Uubvlei is selected as the preferred alternative to site D, public opposition will likely not be the main justification. Technical and economic considerations would also be considered. The public meeting noted that opposition to Site D was not unanimous within the Oranjemund community.*

**COMMENT:** *It seems that the medical fraternity at Oranjemund is welcoming the additional work that will be created by the Kudu Project.*

#### 2.4.2.2 Uubvlei hostel accommodation

**COMMENT:** *Namdeb is phasing out the use of the hostel at Uubvlei, one of the factors being its apparent declining suitability as decent accommodation. Will the facilities be of an appropriate*

*standard to house workers?*

**RESPONSE:** This point is noted in the terms of reference for the EIA study. The Contractor will decide whether to use and revamp the existing facilities or to build new ones. Appropriate standards will be specified to ensure that whatever accommodation is provided will comply with these standards.

#### 2.4.2.3 Visual and noise impacts

**COMMENTS:** Although it is recognized that Uubvlei is an industrial site and will thus not be part of a future tourism route, the plant should blend in as much as possible with the surroundings, e.g., through appropriate paint colour. Uubvlei is far removed from town to cause any nuisance to Oranjemund residents in terms of noise. Noise levels inside the plant need to conform to international health and safety standards.

**RESPONSE:** Points noted. International health and safety standards should apply.

#### 2.4.2.4 Security, access and transport

**COMMENT:** How will security and access be addressed, given that the plant lies within the Mining Area? From where will goods be transported to site and how will this affect existing traffic movements in town?

**RESPONSE:** These issues are a high priority for NamPower, and will be fully considered. The MD of Namdeb gave the assurance that Namdeb interests would need to be protected and that a mutually acceptable solution would be sought. The EIA will address road access and the impact on existing traffic.

#### 2.4.2.5 Aviation Safety

**COMMENT:** The aviation fraternity of Oranjemund strongly welcomes the possible shift of the site to Uubvlei; it poses a substantial lower risk to aircraft than Site D. Risks caused by lowered visibility in smoke plumes, power lines, and smoke stacks would virtually be eliminated.

**RESPONSE:** The point is taken.

#### 2.4.2.6 Biophysical impacts

**COMMENT:** New studies are needed to determine the impacts on fauna and flora for Uubvlei site.

**RESPONSE:** These aspects are included in the Terms of Reference for the EIA, and new studies are indeed being undertaken.

### 2.4.3 Specialist studies

In the TOR for the Uubvlei site, the following new, site specific issues that warrant additional work were commissioned for the Environmental Impact Assessment:

- Description of the biophysical characteristics of Uubvlei site;
- Options for water abstraction for cooling given the differences between Uubvlei and Site D (i.e. from beach wells, ponds or directly from the ocean);
- Options for purge water discharge given the differences between Uubvlei and Site D (i.e. into ponds, onto the beach/intertidal zone, beyond the breakers);
- The suitability of existing facilities to accommodate the workforce during construction, and possibly operation;
- Options for supply of services for workers - water, electricity, recreation facilities, health services, catering, etc.;
- Options for waste management – industrial waste during construction, household waste, sewerage, hazardous waste;

- Maintenance of the road between Uubvlei and Oranjemund;
- Security issues and access to site;
- Interactions with Namdeb;
- Climate – implications for corrosion, dust control, etc.

This study has built on existing specialist studies and used the same specialists that were involved in the environmental assessment for site D at Oranjemund. The CSIR core project team is made up of Henri Fortuin (Project Leader) and Pat Morant (Project Manager), both of whom worked on the EIA for the CCGT power plant site at Site D, Oranjemund. Pat Morant has also completed the “upstream” EIA for the Kudu power project.

*Table 1: Specialist studies*

<b>Specialist study</b>	<b>Specialists and their affiliation</b>
Discharge of cooling water to the marine environment	Mr R van Ballegooyen, CSIR
Atmospheric emissions	Mr Greg Scott, Environmentek, CSIR
Vegetation	Ms C Manheimer, Independent
Mammals, reptiles and amphibians	Mr J Pallett, DRFN
Archaeology	Dr D Noli, Independent
Socio-economic assessment	Mr T Rudd, Enviro Dynamics
Site services and infrastructure	Mr V Fischer-Buder, Consulting Services Africa

The assessment criteria shown in Box 6.1 were applied in the specialist studies that assessed the impacts likely to result from the construction and operation of the Kudu CCGT power plant.

#### **2.4.4 Integration and impact assessment**

The results of the specialist studies are integrated into this environmental impact report (EIR). Recommended mitigation measures for negative impacts and enhancement measures for positive impacts are also provided together with any monitoring required. These recommendations will form the core of the Environmental Management Plan (EMP) for design, construction and operation.

#### **2.4.5 Public review of the draft environmental impact report**

The Draft EIR was made available for public comment during the period 2 May 2005 to 24 May 2005.

The notification of the document availability, and due-date for comments were e-mailed and faxed to relevant parties. NamPower further placed a notice in the press requesting comment on it. Printed copies of the Draft EIR were made available in the Windhoek National Library, the Oranjemund Library and NamDeb in Oranjemund for comment.

The document was also available on the NamPower website. The Executive Summary of the document was e-mailed to key stakeholders on the I&AP list who had access to the Internet. Printed copies of the document and copies on compact disk were distributed to ministerial representatives on the Inter-ministerial Review Group (IRG).

No comments were received on the Draft EIR. This final revised EIR will be submitted to the Ministry of Environment and Tourism, for a decision on whether the proposed project should be approved.

# CONTENTS

3. PROJECT DESCRIPTION .....	3-1
3.1 Introduction .....	3-1
3.1.1 <i>Description of Proposal</i> .....	3-1
3.1.2 <i>Description of Site</i> .....	3-1
3.1.3 <i>Site Access and Security</i> .....	3-4
3.2 Plant Details .....	3-5
3.2.1 <i>Plant Design and Layout</i> .....	3-5
3.2.2 <i>Plant Components</i> .....	3-6
3.2.3 <i>Power Generation Process</i> .....	3-10
3.2.4 <i>Occasional Processes &amp; Activities</i> .....	3-10
3.2.5 <i>Plant Efficiency</i> .....	3-11
3.3 Plant Enclosures .....	3-11
3.4 Unit Operations .....	3-12
3.5 Cooling Water .....	3-13
3.5.1 <i>Systems Under Consideration</i> .....	3-13
3.5.2 <i>Sources of Cooling Water</i> .....	3-15
3.6 Plant Operation .....	3-15
3.6.1 <i>Running Regime</i> .....	3-15
3.6.2 <i>Use of Resources</i> .....	3-16
3.7 Air Emissions .....	3-16
3.7.1 <i>Main Air Emissions</i> .....	3-16
3.7.2 <i>Auxiliary Boiler</i> .....	3-18
3.7.3 <i>Minor/Fugitive Air Emissions</i> .....	3-18
3.8 Aqueous Discharges .....	3-20
3.8.1 <i>Cooling Water Purge</i> .....	3-20
3.8.2 <i>Low Volume Aqueous Discharges</i> .....	3-21
3.9 Noise and Vibration .....	3-22
3.10 Waste Management .....	3-23
3.11 Project Construction .....	3-24
3.11.1 <i>Construction Site</i> .....	3-24
3.11.2 <i>Environmental Factors</i> .....	3-26
3.12 Commissioning .....	3-26
3.13 Hazards and Safety .....	3-27
3.14 Decommissioning .....	3-27
3.15 Environmental Management Plan .....	3-28
3.15.1 <i>Environmental management structure and responsibilities</i> .....	3-28
3.15.2 <i>Environmental management of construction phase</i> .....	3-28

## FIGURES

---

Figure 3.1:	Location of the CCGT power plant Uubvlei, near Oranjemund. The gas to power the plant will be sourced from the Kudu gas field (Kudu Block 2814A).....	3-2
Figure 3.2:	The location of the CCGT site, including the gas conditioning plant, at Uubvlei, near Oranjemund. ....	3-3
Figure 3.3:	Proposed route for heavy haulage from the Port of Lüderitz and Oranjemund.....	3-4
Figure 3.4:	Plan view of layout of the 800 MW CCGT plant showing location for the second 800 MW plant. ....	3-7
Figure 3.5:	Isometric view of layout of the 800 MW CCGT plant showing location for the second 800 MW plant. ....	3-8
Figure 3.6:	The concept of the CCGT plant in diagrammatic format. ....	3-8
Figure 3.7:	Main components of onshore Gas Conditioning Plant .....	3-9
Figure 3.8:	Semi-closed Evaporative Cooling System.....	3-14
Figure 3.9:	Make-up Water Cooling Tower System.....	3-14



## 3. Project Description

### 3.1 Introduction

#### 3.1.1 Description of Proposal

The proposed development will comprise a combined cycle gas turbine (CCGT) power plant of nominal 800 MW capacity. Natural gas will be the main fuel for the plant. There will be associated connections to the electricity and gas grids.

The proposed project will generate the most environmentally benign form of electricity by thermal power plants. It has a very high efficiency and lower air emissions and cooling water requirements per unit of electricity generated than for conventional thermal plants. In particular, when firing on natural gas with low-NO<sub>x</sub> burners as planned, there are no significant emissions of NO<sub>x</sub> or SO<sub>2</sub> and emissions of carbon dioxide (CO<sub>2</sub>), the most significant greenhouse gas from the perspective of anthropogenic emissions to the atmosphere, are over 50% lower than for conventional plants that burn coal.

Where no constraints apply to gas availability, the CCGT technology is accepted world-wide as the most suitable technology for a power plant of the size proposed.

#### 3.1.2 Description of Site

The Kudu CCGT Power Plant will be located at Uubvlei near the town of Oranjemund, a small diamond mining town that is located near the mouth of the Orange River in the south-western corner of Namibia (see Figure 3.1). The Orange River forms the boundary between Namibia and South Africa. A feasibility study undertaken in 1997 identified Oranjemund as being the optimum location for a power plant; the proposed site is located about 25 km north of the town. The site currently comprises mined-out land and lies within a high security mining area operated by Namdeb.

It is proposed initially to construct a nominal 800 MW CCGT plant which will become operational in mid-2009. The plant will comprise two gas turbines, with one or two steam turbines. A further nominal 800 MW may be constructed later to commence power generation in about 2014 if the supply of gas is sufficient, and power demand in Namibia and in surrounding countries can be confirmed.

The area of the site is about 49 ha (700 m x 700 m), which is the area required to provide for construction staging and laydown (Figure 3.2).

The possible later development of the plant to 1 600 MW capacity will take place within the confines of the currently designated site. All construction activities, e.g. concrete mixing, stockpiling of materials, will be conducted on already disturbed land immediately adjacent to the areas designated for the two 800 MW units.

The construction workforce, a maximum of 1 300 workers, will be accommodated near to the CCGT site. Either the existing mine hostel facilities at Uubvlei will be suitably upgraded for this purpose, or new temporary facilities will be constructed at the designated location adjacent to the CCGT site, on land that is already disturbed by mining (Figure 3.2) It should consist of housing, ablutions, canteen and kitchen, bulk food stores, cold and freezing facilities and both indoor and outdoor recreation facilities. It would require full electrical, water and sewage reticulation, streets with area lighting and a high security perimeter fence. These temporary facilities will be in use for about two and a half years, after which it would have to be removed completely. In the event that the second phase of the power plant is implemented, these accommodation facilities would be required for another two and a half years.

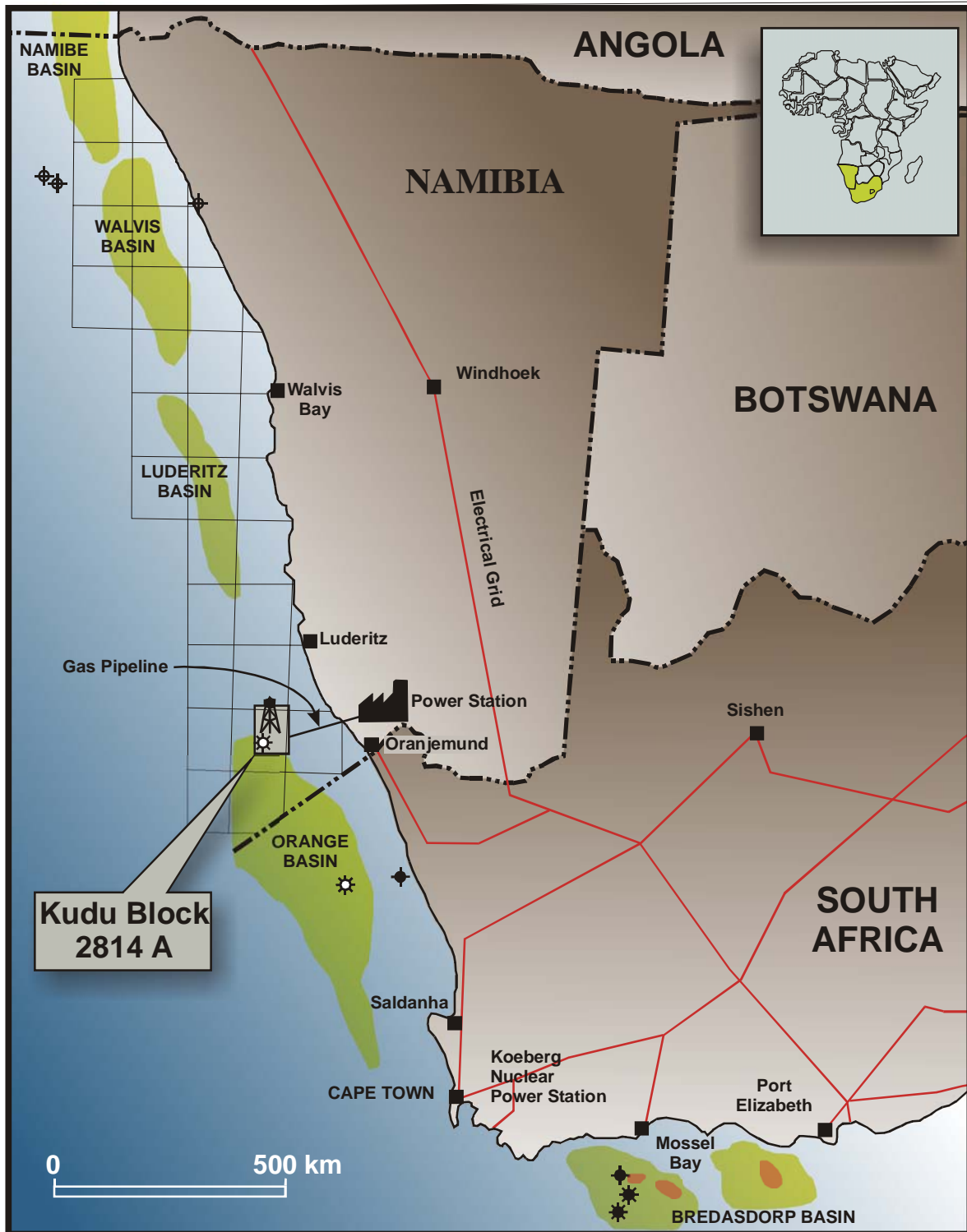


Figure 3.1: Location of the CCGT power plant Uubvlei, near Oranjemund. The gas to power the plant will be sourced from the Kudu gas field (Kudu Block 2814A).



### 3.1.3 Site Access and Security

It is anticipated that major components of the CCGT plant will be delivered from the Port of Lüderitz by means of haulage vehicles suitable for extra-heavy loads. A map of this route is provided in Figure 3.3.

The site currently lies within the MA1 high security area, which is surrounded by a double fence. The construction site and the construction workforce accommodation will be surrounded by normal industrial security fencing and provided with street lighting.



Figure 3.3: Proposed route for heavy haulage from the Port of Lüderitz and Oranjemund.

## 3.2 Plant Details

### 3.2.1 Plant Design and Layout

The combined cycle gas turbine power plant utilises the following process:

- Two gas turbines burning either gas or liquid fuel drive two generators for electricity production.
- Exhaust gases from each gas turbine pass through a heat recovery steam generator (HRSG) to generate steam.
- The steam generated in the two HRSGs drives a steam turbine which in turn drives a generator to produce further electrical energy.

Two configurations, which may be referred to as single-shaft and multi-shaft, are possible for the Kudu CCGT Power Plant. A single-shaft arrangement consists of a gas turbine, steam turbine and generator arranged on a single shaft or power train. There would be two such units at Kudu CCGT – see Figures 3.4 and 3.5 for plan and isometric views of a typical two single-shaft layout. The alternative multi-shaft option has two gas turbines and a steam turbine each with its own dedicated generator. For Kudu CCGT Power Plant the final choice between single-shaft and multi-shaft designs will be made on technical and economic grounds, following a competitive tender process.

The plant will be fired on natural gas with the possible provision of a back-up facility for firing on liquid fuel.

The proposed plant will employ the most recently developed CCGT technology. A schematic of the process is shown in Figure 3.6.

The rated capacity of the plant will initially be approximately 800 MW; this approximation arises from the nature of gas turbines. Sizes are particular to the design of individual manufacturers and it is not possible in an open international competition to specify the exact output without prejudice or favour to one manufacturer.

A gas conditioning plant with its associated slug catchers will be constructed adjacent to the CCGT power station. The key components of the gas conditioning plant are presented schematically in Figure 3.7. The purpose of the gas conditioning plant is to supply dry gas to the power plant, and to recover the monoethylene glycol (MEG) used to prevent the formation of methane hydrate in the pipeline from the offshore production platform. The gas is dried and heated before passing through a fiscal meter and on into the power station.

Gas and liquids from the pipeline are led into a slug catcher, which is a bottle able to store large quantities of liquid and permits the separation of the gas from the condensate and water/monoethylene glycol (MEG) mixture. When the gas flow rate in a multi phase pipeline is increased there is a temporary but significant increase in liquid production. This liquid arrives as a “slug” hence the term “slug catcher”. The slug catcher for Phase 1 will have a volume of 200 m<sup>3</sup>.

The liquids in the slug catcher are drained, heated and separated into two distinct phases: a water/MEG mixture and condensate. A small amount of gas which will be used as fuel probably in the MEG regenerator(s) is liberated in this process. Following this separation step the condensate is cooled and stabilised at atmospheric pressure before being stored in banded atmospheric tanks. The volume of condensate to be stored is still to be decided but it will probably be of the order of 25,000 bbls contained in a small banded tank farm. The stabilisation process also produces a small amount of gas, which will be used as fuel. The MEG/water mixture requires separation and this will be achieved by distillation. The water will be boiled off and turned into steam. The MEG will be cooled

and sent to atmospheric bunded storage tanks. The bunding should be able to contain the content of the storage tank(s) plus water from typically a one in ten year rainfall event. The MEG/water mixture sent to the boiler contains a small amount of aromatic components, namely benzene, toluene and xylene (BTX). These aromatics also will be boiled off in the process and burnt in an enclosed combustion chamber.

A range of utility systems will support the conditioning plant. Power will be drawn from the local grid. There will be an unobtrusive plant flare to facilitate plant or pipeline gas pressure blowdown.

### 3.2.2 Plant Components

The principal components will include the following:

- Gas turbines
- HRSG with exhaust stack
- Steam turbine(s) and condenser(s)
- Water treatment plant and water storage facilities comprising bulk storage tanks
- Cooling water (CW) system
- Above-ground Gas Installation/piping to supply the plant
- Transformers
- High voltage electrical switchgear
- Fire protection system
- Administration/control building
- Auxiliary boiler and stack for plant start-up purposes

Depending on the choice of equipment, the following may also be provided:

- Gas compressor
- A by-pass stack for the gas turbines to allow them to operate in isolation from steam turbines
- Gas turbines or diesel generators for black start capability
- Liquid fuel storage facilities comprising bulk tanks

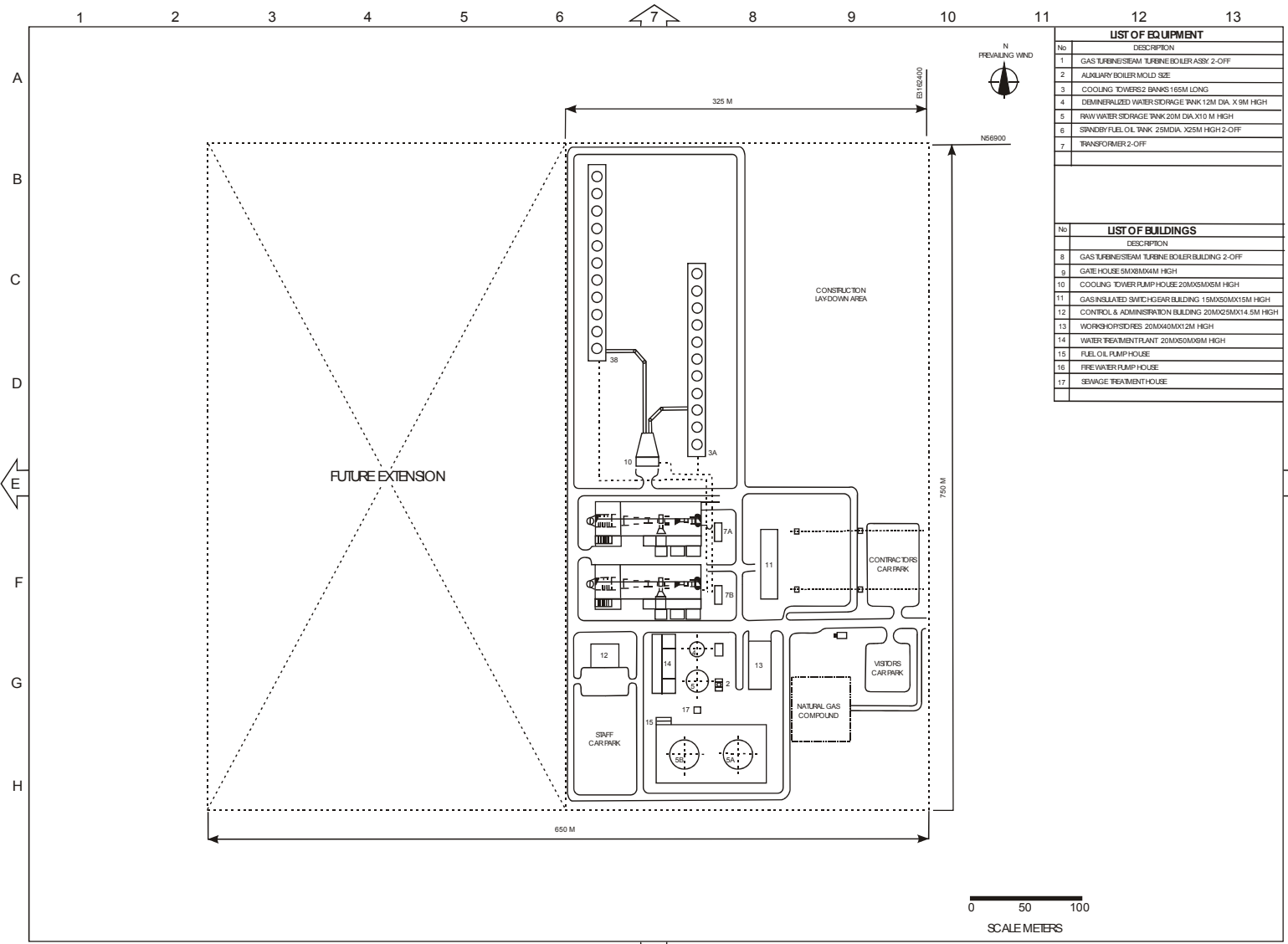


Figure 3.4: Plan view of layout of the 800 MW CCGT plant showing location for the second 800 MW plant.

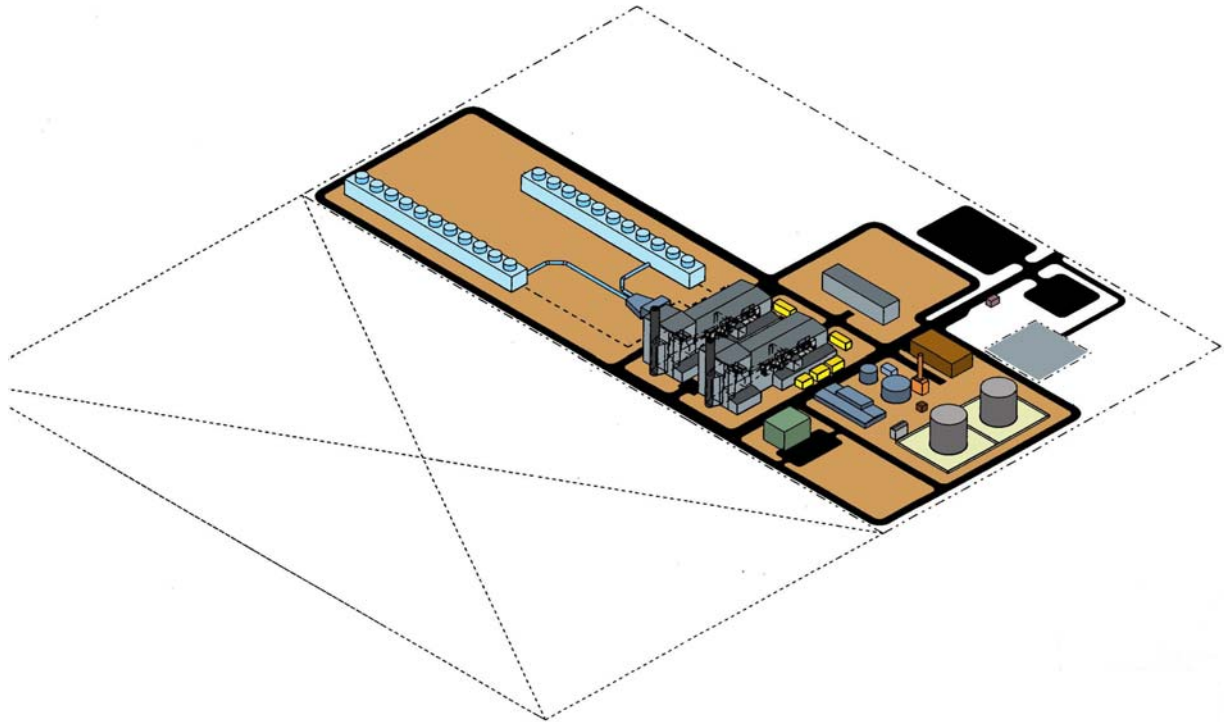


Figure 3.5: Isometric view of layout of the 800 MW CCGT plant showing location for the second 800 MW plant.

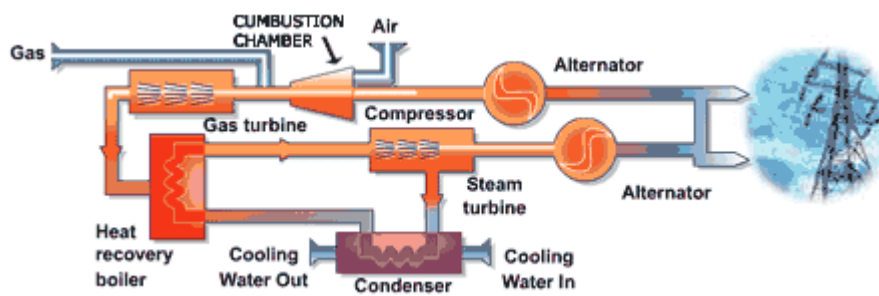


Figure 3.6: The concept of the CCGT plant in diagrammatic format.





### 3.2.3 Power Generation Process

A gas turbine is one in which the working substance is a gas rather than a condensable vapour, as in a steam turbine, or a liquid, as in a water turbine. The gas turbine itself consists of an air compressor, a combustion chamber, a turbine and an electricity generator coupled together. The air compressor, combustion turbine and electricity generator are all attached to one main shaft which rotates at high speed.

The air compressor takes in large quantities of air from the atmosphere and compresses it into the combustion chamber from where it flows through the turbine. Fuel is then injected into the combustion chamber and ignited. This addition of heat energy and combustion gases raises the temperature of the combined gases to over 1 300 °C and greatly increases the velocity of these gases through the turbine. The effect of this high velocity gas flow through the turbine drives both the air compressor to supply air and the electricity generator to produce the rated electrical power output. The expansion of the hot gases through the turbine and the extraction of mechanical work from them via the turbine reduces the temperature of the gases to approximately 600 °C.

Operation of a gas turbine as described above is referred to as open or simple cycle mode. However, it is possible to generate approximately 50% more electricity from the hot exhaust gases by diverting them through an HRSG (boiler) which extracts heat to make steam, which in turn drives a steam turbine. The temperature of the hot gases is reduced in this process to approximately 100 °C, but the heat recovery system does not in other respects alter the composition of the gases. They are discharged to the atmosphere via a stack on top of the HRSG.

Water for the HRSG is drawn from a suitable supply, is treated in a water treatment plant to achieve high purity and is then stored prior to use. The steam produced is supplied through inter-connecting pipework to the steam turbine and is then exhausted to the condenser. The steam turbine drives the electricity generator to produce the additional power output.

The electricity generated is fed to transformers where the voltage is stepped up for transmission via a local substation to the power grid.

Cooling water is used to condense the steam used in the steam turbine element of the combined cycle. The steam is condensed to hot water, which is then recirculated to the HRSG. The heat transferred to the cooling water must be released to the environment. There are a number of possible arrangements, which include direct seawater cooling and evaporative cooling in a cooling tower. It is also possible to dissipate heat from steam condensation to the air using an air cooled condenser. For evaporative systems losses in the cooling system are made up from supplies drawn from a suitable source.

### 3.2.4 Occasional Processes & Activities

#### ***Bypass Mode***

The description given above constitutes a full CCGT arrangement. Depending on the chosen plant configuration, it may also be possible to operate the gas turbine on its own, i.e. without passing the exhaust gases through the HRSG. In this mode the exhaust gases are directed to a bypass stack and are discharged to atmosphere without passing through the HRSG.

Operation in bypass mode is evidently less efficient than in full CCGT mode and it arises when the steam turbine is unavailable. This could arise during a steam turbine trip and during maintenance and at start-ups, where the steam conditions are initially unsuitable for the steam turbine.

Economic factors will determine whether the gas turbines at Kudu CCGT Power Plant will be equipped with bypass stacks.

### ***Operation on Liquid Fuel***

Liquid fuel may be available for stand-by purposes. The necessity for an alternative fuel supply arises in part from the nature of gas supply which usually has some unavailability due to, for instance, maintenance work on the production platform. Faults may also arise in the supply system.

While natural gas may be unavailable for 10 – 15 days annually, up to half of these days are for scheduled outages that could be timed to coincide with the annual maintenance of at least one gas turbine. In any case, for cost reasons continuous operation on fuel oil would be unlikely for the full duration of unavailability.

### ***Black Start Capability***

Based on technical and economic studies, the Kudu CCGT Power Plant may be equipped with a facility to enable it to be started when isolated from the power grid, when no other sources of electricity are available. This is known as the black-start facility, and it would consist of one or two gas turbines or diesel generators with a capacity of up to 20 MW.

## **3.2.5 Plant Efficiency**

The net thermal efficiency of the Kudu power project, depending on the gas turbine selected, is currently projected to be around 57% at site conditions and to average around 56% over a 20 year operating life. This means that 56% of the chemical energy contained within the fuel is converted into electrical energy. The plant will employ technology recognised as being the most advanced for power production on the scale proposed. The high overall efficiency will lead to lower specific emissions to the environment compared to any other form of conventional thermal plant.

Equivalent efficiencies in conventional thermal plants rarely reach 40%.

## **3.3 Plant Enclosures**

The particular model of gas turbine to be installed will determine the overall size of the plant and its configuration and layout. The layout arises from the functional relationship of the main elements of the plant to associated ancillary plant and buildings.

The development will comprise the main structures as listed below. Exact dimensions of each element will become known only after contractor selection. The main structures associated with the development will be the gas turbine, bypass stack (if provided), HRSG with associated stack, steam turbine building, cooling towers and ancillary buildings.

- Enclosures to house the gas turbines – height approximately 25 m.
- Enclosure to house the steam turbine - height approximately 25 m.
- HRSG - height approximately 40 m.
- Cooling towers - height approximately 30 m.
- Auxiliary boiler - height approximately 12 m.
- Electrical Building to house switchgear enclosures - height approximately 12 m.
- Enclosure for Water Treatment Plant with chemical storage tanks - height approximately 12 m.
- Exhaust Stacks - height approximately 45 – 60 m for HRSGs, 45 m for by-pass stacks (if provided) and 45 m for auxiliary boiler.
- Water storage tanks for raw water, semi-treated and treated water - height approximately 20 m.
- Liquid fuel storage tanks (if provided) within a bunded area - height approximately 20 m.

Other components at lower elevations include the following:

- Workshops and Stores Building
- Control and Administration Building
- Generator, Unit and House Transformers
- Gas compound
- 400 kV Switchyard
- Fenced enclosure to house gas compressors (if provided)
- Black-start facility (if provided)

Some of these buildings may be combined or be subdivided depending on the final choice of plant. The structural form of buildings will be conventional structural steel supported on reinforced concrete foundations. Steel columns will be fire protected as necessary. Floors will be concrete. Profiled fibre cement cladding will be used for external walls.

Roofs will be constructed of profiled fibre cement decking on purlins spanning between rafters and will be flat or shallow pitched. Buildings will have access gantries and walkways for access to plant and equipment. These will be constructed of stainless/galvanised steel open grating type flooring supported on steel beams and columns.

External personnel and escape doors will generally comprise metal flush doors and mild steel frames. Stacks will be fabricated from painted insulated carbon steel. External finishes to all structures and components will be appropriate to the highly corrosive / abrasive environment encountered at the site.

### **3.4 Unit Operations**

Brief descriptions of the principal individual unit operations are as follows:

#### **Gas Compressor (if provided)**

Depending on the plant selected and gas supply pressure, it may be necessary to compress the gas for supply to the gas turbine.

#### **Gas Turbine (GT)**

The GT will essentially comprise a multi-stage axial-flow compressor section with movable inlet guide vanes, a combustion chamber with several burners and a multi-stage axial-flow turbine section. Natural gas will be burned using air from the air compressor. The hot gas will pass through the turbine blades. Mechanical energy will be converted into electrical energy in the electrical generator coupled to the gas turbine. The exhaust gases will pass to the HRSG.

The gas turbine will be equipped with an intake air filtration system, a starting system, a lubrication system, a cooling system and other ancillary features.

#### **HRSG**

Exhaust gases from the gas turbine will be used to produce steam, which will feed a steam turbine. The cooled exhaust gases will then be emitted to atmosphere. The HRSG will be a multi-pressure type and will be equipped with a supplementary firing system to burn condensate that must be removed from the natural gas.

#### **Steam Turbine and Condenser**

The steam turbine will be of a multiple cylinder type suitable for direct coupling to a two-pole generator for power generation at 50Hz. The thermal energy of the steam generated by the HRSG will be converted to mechanical energy in order to drive a generator to produce electric power. The exhaust steam will flow out of the steam turbine to a condenser system.

#### **Boiler Water Treatment**

The steam-water cycle will be a closed-loop system with make-up supplied from the incoming water supply via an on-site water treatment plant where water for use in the HRSG will be treated to achieve a high purity. The water treatment process will consist of organic scavengers, and cation, anion and

mixed bed ion-exchange. Regeneration of the ion-exchange resins will utilise sulphuric acid ( $H_2SO_4$ ) and caustic soda (NaOH).

Corrosion in the HRSG may be mainly caused by dissolved oxygen ( $O_2$ ) or carbon dioxide ( $CO_2$ ) in the feedwater. The feedwater must be pH controlled to prevent corrosion and it is desirable to use deaerated water. It is anticipated that feedwater will be dosed with ammonia ( $NH_3$ ), caustic soda (NaOH) or phosphate ( $Na_3PO_4$ ). In addition, an oxygen scavenging chemical, dilute hydrazine ( $N_2H_4$ ), may be required to achieve the required water quality by absorbing any traces of oxygen that get into the boiler.

### **Electrical Transformer(s)**

The electricity generated will be fed to a generator transformer where the voltage will be stepped up. It will be an indoor, three phase unit and of the oil immersed design. It will be banded and blast protected with a deluge system for fire protection. Power will flow from this transformer to the electrical gas-insulated switchgear building, and thence to the power grid.

## **3.5 Cooling Water**

### **3.5.1 Systems Under Consideration**

Three potential cooling water system technologies have been considered for application at the CCGT site:

#### **Direct seawater cooling**

Direct seawater cooling entails cooling the steam turbine condensers by means of a once-through heat exchanger. The volumes required are large (ca. 50 000  $m^3$ /hour) and the discharged water would be about 10°C hotter than the intake sea water. Direct seawater cooling is the most efficient method to condense exhaust steam.

#### **Evaporative cooling**

Evaporative cooling using induced draught cooling towers incorporates a semi-closed water circulation system (see Figure 3.8). The cooling system includes a large storage capacity (approximately 50,000  $m^3$ ) into which make-up water is introduced at a rate of 2 000  $m^3$ /hour. Sea water is used as make-up, described in Figure 3.9. Approximately 700  $m^3$ /hour is lost through evaporation and a further 1 300  $m^3$ /hour is purged from the system to maintain the dissolved solids of the reservoir at acceptable levels. The temperature of the discharged purge water will depend upon the prevailing atmospheric conditions but an increase of 10°C above ambient is unlikely to be exceeded. The salinity of the purge water is expected to be about 50-55%, i.e., a brine, as opposed to a salinity of 35% in normal seawater.

Because the water is predominantly recirculated within the cooling water system it requires treatment to prevent deterioration of the plant components. Treatment will be by injection of a biocide, possibly sodium hypochlorite (NaOCl), at very low concentrations.

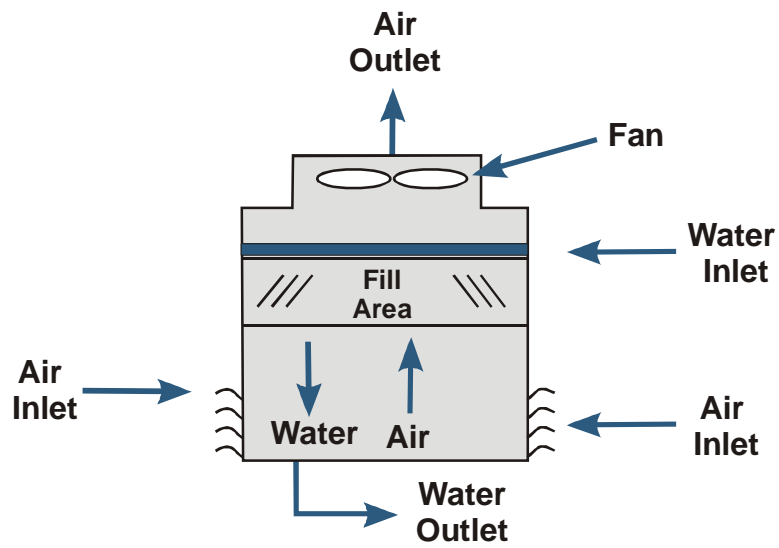


Figure 3.8: Semi-closed Evaporative Cooling System

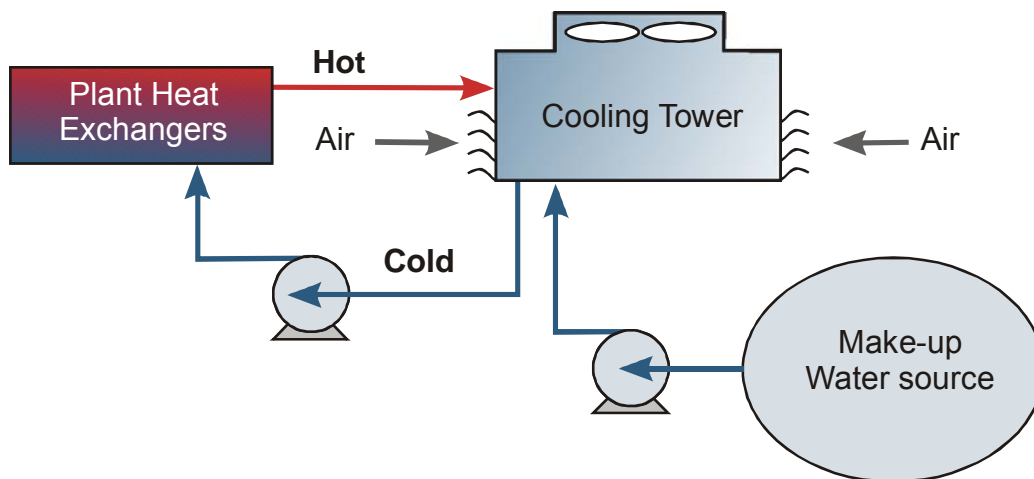


Figure 3.9: Make-up Water Cooling Tower System

### **Dry Cooling**

In a direct dry cooling system the exhaust steam is channelled directly to a radiator-type fin-tubed heat exchanger. The steam's latent heat is transferred to the metal surface of the finned tube. Air to cool the fins is forced across the heat exchanger by electrically driven fans.

While both systems are under consideration, because of the lower overall efficiency of air cooled systems, the preference for Kudu CCGT Power Plant is for an evaporative system, subject to the availability of a suitable supply of make-up water and the long-term reliability of that supply.

### **3.5.2 Sources of Cooling Water**

Potential sources of make-up water for evaporative cooling are as follows:

#### ***Direct Extraction from the Sea***

Sourcing of water from the sea would require a pipeline extending seaward of the surf zone, in order to extract relatively sediment-free water. The water intake must be located beyond the depth in which significant sand movement occurs is required. Based on existing bathymetric and wave climate data, this indicates that the intake be located at 15 m or more below sea level. Allowing for a potential 300 m progradation of the shoreline as a result of mining operations, the intake pipeline will extend about 1 400 m from the present shoreline. This distance is believed to be adequate for the greatest beach accretion predicted under various potential future mining scenarios. It is envisaged that the intake ports be situated about 2 m above the seabed to avoid intake of sediments suspended near the bottom.

#### ***Extraction from Mining Ponds***

Mining ponds associated with Namdeb's diamond mining operations, are a potential source of make-up water. These ponds are free of suspended sediment. Potential future mining scenarios and their impacts on overall stability and reliability of the ponds, together with the long-term availability of the necessary quantity of make-up water, are under detailed investigation.

#### ***Extraction from Beach Wells***

A beach well is a conduit by which groundwater can be extracted from aquifers in coastal environments. The well itself is generally a hole that intercepts the aquifer at some depth below the site surface, and is usually lined during, or immediately after, excavation, so as to prevent collapse. Well efficiency is influenced by clogging, and deformation of the aquifer due to excessive extraction, poor well field management or inappropriate design. Indeed, while water extracted from beach wells generally appears free of sediment, the significant maintenance of pumping equipment used in previously operating well-fields suggests that finer grained particles still enters from the aquifer. Often set back from the shoreline to prevent inundation during storm events, beach wells positioned adjacent to existing seawalls often derive most of their water via the mining ponds and not the sea. As such, management practices within the ponds have a direct influence on their yield and efficiency.

### **3.6 Plant Operation**

#### **3.6.1 Running Regime**

It is expected that the plant will operate at base load, i.e. continuous operation, 24 hours per day, 365 days per year and will be staffed on a shift basis for plant operation. An average annual load factor of about 92% is initially expected for the plant with the non-operational balance of hours being downtime for maintenance.

Best practice internationally would involve an operational workforce of 30 – 40 staff. Non-core activities such as security, grounds maintenance, etc. may increase this number to about 50.

Plant overhauls, during which workforce numbers will increase temporarily, may initially occur at intervals of about six years.

Normal operation of the plant will be as a combined cycle power station fuelled with natural gas. It is envisaged that the plant will operate in open cycle mode in exceptional circumstances (if a by-pass stack is provided).

Start-ups fall into two categories, namely cold start and warm start. A warm start occurs after a short outage. A cold start occurs less frequently, usually after a lengthy outage, such as for plant overhaul.

### 3.6.2 Use of Resources

The principal materials used will be as follows:

#### **Natural Gas**

The primary fuel for the Kudu CCGT Power Project will be natural gas. The maximum demand for gas for an 800 MW capacity plant is the equivalent of about 3.5 million m<sup>3</sup>/day. Natural gas will be delivered to the station from an on-shore conditioning plant that will be supplied via a new high pressure gas pipeline from the off-shore gas field.

#### **Water**

Water for use in the HRSG will be stored in bulk storage tanks filled by the supply from the water treatment plant. The maximum quantity for use for the HRSGs will be approximately 70 m<sup>3</sup>/hr and average use will be approximately 20 m<sup>3</sup>/hour. This storage will also serve as the supply for fire-fighting purposes and for water injection for NO<sub>x</sub> control when firing on liquid fuel (if capability is provided). Water injection during firing on liquid fuel would result in additional consumption of up to 180 m<sup>3</sup>/hr of water.

#### **Bulk Chemicals**

Regeneration of ion exchange resins used in water treatment will be by caustic soda (NaOH) and either sulphuric acid (H<sub>2</sub>SO<sub>4</sub>) or hydrochloric acid (HCl). These will be stored on site in bunded storage tanks. Smaller stocks will be held of ammonia (NH<sub>3</sub>) for control of pH and hydrazine (N<sub>2</sub>H<sub>4</sub>) or equivalent for control of dissolved oxygen (O<sub>2</sub>) levels of the water in the HRSGs.

#### **Electricity**

Kudu CCGT will produce its own electricity for auxiliary plant and during normal operation its electricity demand from the grid will be zero. At times when the power plant is not operational the grid will supply the plant with a small amount of power for start-up, lighting and other minor services.

#### **Liquid Fuel**

If liquid fuel is provided for use as stand-by fuel, it will be delivered by road and stored in bulk storage tanks. The nominal liquid fuel storage capacity will be sufficient for about 8 days of operation at base load (approximately 17 kg/s for each GT).

## 3.7 Air Emissions

### 3.7.1 Main Air Emissions

The main fuel for Kudu CCGT will be natural gas, which contains a mixture of gases, with methane (CH<sub>4</sub>) predominating. The main products of combustion released to atmosphere will be carbon dioxide (CO<sub>2</sub>), water vapour (H<sub>2</sub>O) and small quantities of oxides of nitrogen (NO<sub>x</sub>). The latter is due predominantly to the high temperature oxidation of atmospheric nitrogen with a contribution of fuel bound nitrogen. NO<sub>x</sub> composition is estimated to comprise ~ 95% nitric oxide (NO) and ~ 5% nitrogen dioxide (NO<sub>2</sub>).



In addition, use of liquid fuel for standby, if provided for when natural gas is unavailable, will give rise to sulphur dioxide (SO<sub>2</sub>) emissions due to its sulphur content. With on-site storage limited to approximately 8-days supply, a maximum load factor of 2-3% on liquid fuel is expected.

Emissions of particulates are considered to be negligible for natural gas and liquid fuel because of the efficient burnout and low ash content in the GT. The maximum emission rate for PM<sub>10</sub> will be in the order of 1-2 g/s (4-8 kg/hr) when operating on natural gas and 5 g/s (19 kg/h) when the plant is firing on liquid fuel. These emission rates are very low and include the condensable particulate fraction in the exhaust gas. In addition, emissions of carbon monoxide (CO) and hydrocarbons are also normally very low with significant levels emitted only during periods of incomplete combustion / low-temperature operation at start-up. Nearly all the fuel carbon (>99.5%) is converted to CO<sub>2</sub> during the combustion process when firing on gas or liquid fuel and so the amount of CO formed is very low.

The plant will be equipped with dry low-NO<sub>x</sub> burners for operation on natural gas. If provision is made for firing on liquid fuel, water injection will be used for NO<sub>x</sub> suppression. This involves the addition of demineralised water from the water treatment plant to the combustion chamber. This reduces the temperature of combustion and so reduces the formation of thermal oxides of nitrogen. One GT manufacturer is now offering no water injection and compliance at up to 60% load with recognised industry standards for ELVs on liquid fuel without water injection. This could be an attractive option for Kudu CCGT Power Plant where water is scarce.

With the type of plant expected to be offered by the manufacturers, typical emissions concentrations for NO<sub>x</sub> in combined cycle mode that are regarded as appropriate for the new plant are as follows:

- Natural gas: 50 mg/Nm<sup>3</sup> with provision for higher concentrations for efficiencies of > 55%
- Liquid fuel: 120 mg/Nm<sup>3</sup>

The above fully meet emission limit values (ELVs) of the World Bank guidelines for NO<sub>2</sub> (125 mg/Nm<sup>3</sup> for gas firing and 165 mg/Nm<sup>3</sup> for liquid fuel firing).

The approximate annual tonnages of NO<sub>x</sub> (expressed as NO<sub>2</sub>), SO<sub>2</sub> (assuming 0.3% S in liquid fuel) and CO<sub>2</sub> that will arise, based on 95% overall load factor for the initial 800 MW development are as follows:

Operation	Oxides of Nitrogen (NO <sub>x</sub> )	Sulphur Dioxide (SO <sub>2</sub> )	Carbon Dioxide (CO <sub>2</sub> )
100% Gas:	1 450 t	Negligible	2 365 Gg
97% Gas / 3% Liquid Fuel:	1 500 t	185 t	2 365 Gg

Emission rates for SO<sub>2</sub> from gas turbines are commonly not regulated as concentrations are determined by the fuel characteristics rather than plant performance. World Bank requirements specify that the concentration of SO<sub>2</sub> in flue gases should not exceed 2 000 mg/Nm<sup>3</sup> with a maximum emissions level of 500 t/day. However, annual emissions of SO<sub>2</sub> from an 800 MW capacity power plant may not exceed the World Bank guideline of almost 50 000 t/annum.

If a bypass stack is provided, in addition to combined cycle mode, it will be possible to operate the plant in open cycle mode. The maximum mass emission rate from the plant will be the same regardless of the mode of operation. However, the thermal buoyancy and therefore the dispersion of the flue gas emission is enhanced for open cycle operation due to the higher discharge temperature of the exhaust gases. Hence, only the ground level concentrations of air emissions resulting from combined cycle operation are considered.

The proposed ELVs for NO<sub>2</sub> apply to operation at greater than 60% load and exclude start-up and shut-down periods. Emission concentration will normally be higher below this load level because the

dry low-NO<sub>x</sub> burner system does not operate at low load. Owing to the very high efficiency of this type of plant it will normally operate at full load with very infrequent occurrence of start-up and shut-down. Operation at reduced load will be confined to starting and stopping transitions. Since these periods will be infrequent and of short duration, they are not relevant to the consideration of air quality impacts.

### 3.7.2 Auxiliary Boiler

An auxiliary steam boiler, with a rating of about 7 t of steam/hr, may be provided for start-up of the HRSGs and this unit will have a single stack.

Outside of routine testing, operation of the auxiliary boiler will be restricted to about 1-2 hours for plant starting and this is unlikely to occur more than once per month during normal plant operation. This boiler will operate on natural gas with a firing rate of about 500 kg/hr. It may also operate on liquid fuel, if provision is made, with a firing rate of 550 kg/hr.

Emissions of NO<sub>x</sub> and SO<sub>2</sub> are estimated to be very low and under 0.5 g/s. These rates are about 2% of the emissions from the HRSG exhaust stack. Furthermore, due to the limited period of operation of the auxiliary boiler during the year, the emissions will be insignificant in terms of those arising during operation of the CCGT. Because the auxiliary boiler does not operate while the CCGT is on load, cumulative emissions do not arise.

### 3.7.3 Minor/Fugitive Air Emissions

Minor air emissions from the power plant will include the following:

#### **Cooling Towers**

Water vapour arising from the evaporation of water within the cooling system will lead to a visible plume.

#### **HRSG**

Steam will be discharged to atmosphere at various stages through safety valves under certain process fault conditions and through HRSG vents and drains during HRSG start-up. HRSG blowdown also leads to some steam release. These emissions will be of short duration and will have no significant impact.

#### **Natural Gas**

Purging of gas pipelines and the gas compressor (if provided) will lead to venting of natural gas to the atmosphere. The emissions will be of short duration and will have no significant impact.

#### **Diesel Generator**

A diesel generator may be provided for black-start capability. With infrequent use, other than for testing, emissions will not be significant.

#### **Storage Tanks**

Storage tanks used for bulk storage of chemicals, liquid fuel (if provided) and condensate extracted from the gas will be vented to the atmosphere. During any transfers of liquid fuel and/or gas condensate to and from road tankers, some venting may take place. The volumes of resulting gaseous emissions will be very low and will have no significant impact.

#### **Lube Oil Vents**

An oil mist will be released by the lubricating oil vents on the gas turbines and steam turbines. A demister will be installed to minimise these emissions.

#### **Ventilation**

Various parts of the plant will be provided with positive ventilation. The volumes of resulting emissions will be very low and will have no significant impact.

### **Odours**

None of the air emissions from the proposed plant will give rise to odours external to the site.

### **Gas conditioning plant**

It is provisionally expected that on average a maximum of 120 cubic metres of liquids, mainly water, will have to be removed from the maximum 140 MMscfd gas required by the power plant. The liquids are separated into two distinct phases: a water/MEG mixture and condensate. A small amount of gas which will be used as probably in the MEG regenerator is liberated in this process. Following the separation step the condensate is cooled and stabilized at atmospheric pressure before being stored in banded atmospheric tanks. The stabilization process produces also a small amount of gas, which will be used as fuel for e.g. the flare pilot light. The water will be boiled off and turned into steam. The MEG will be cooled and sent to atmospheric banded storage tanks. The bunding should be able to contain the content of the storage tanks plus water from typically a one in ten year rainfall event. The MEG/water mixture sent to the boiler contains a small amount of aromatic components namely benzene, toluene and xylene (BTX). These aromatics also will be boiled off in the process and fed to an enclosed combustion unit where complete combustion to CO<sub>2</sub> and water takes place. The contribution to the overall atmospheric emissions from the power plant will, therefore, be negligible.

Blow down of plant gas will only be required for inspections of the high pressure vessels and would involve only very small quantities of gas to be flared during a very short period. More extensive blow downs of the plant and/or pipeline are not foreseen as these should only be necessary in emergency situations. Because of the very dry (very little condensate) and sweet (no sulphur compounds) nature of the gas there would be no smoke or odour and no health hazard.

The environmental emissions from the facilities are presented in Table 3.1, and (potential) water discharges are discussed in Section 3.8.2, that deals with low volume aqueous discharges from both the power plant and gas conditioning plant.

**Table 3.1: Phase 1 Emissions Summary from the Uubvlei  
gas conditioning plant**

Source	Units	Slug Catcher Inlet Gas	Condensate Stabiliser Vent	Condensate Storage Vent	MEG overhead vent
		Vapour	Vapour	Vapour	Vapour
Phase					
Release		Emergency Flaring Only	Normal Operating Release	Normally No Flow (NNF)	Normally No Flow (NNF)
Vapour Fraction		1.000	1.000	1.000	1.000
Temperature	°C	14.4	20.0	19.9	40.0
Pressure	kPa	5000.0	100.0	50.0	50.0
Molar Flow	kgmole/hr	2992	0	0	0
Mass Flow	kg/hr	50351	7	1	0
Liquid Volume Flow	m <sup>3</sup> /h	163.3	0.0	0.0	0.0
Heat Flow	kJ/h	-229230812	-22038	-2306	-109
Molar Enthalpy	kJ/kgmole	-76613	-86943	-95672	-105628
Component Mol %					
CO <sub>2</sub>		0.010	0.074	0.084	3.777
Nitrogen		0.561	0.076	0.017	6.689
Methane		96.297	63.904	39.320	74.147
Ethane		2.209	16.016	23.448	0.842
Propane		0.378	7.082	12.885	0.017
i-Butane		0.099	2.386	4.583	0.000
n-Butane		0.118	2.997	5.810	0.000
i-Pentane		0.048	1.187	2.330	0.000
n-Pentane		0.038	0.932	1.831	0.000
n-Hexane		0.078	1.659	3.266	0.000
Mycyclopentan		0.008	0.192	0.379	0.000
Benzene		0.025	0.611	1.205	0.001
Cyclohexane		0.025	0.557	1.097	0.000
n-Heptane		0.021	0.375	0.737	0.000
Mycyclohexane		0.014	0.270	0.531	0.000
Toluene		0.013	0.260	0.511	0.000
n-Octane		0.014	0.203	0.398	0.000
m-Xylene		0.003	0.057	0.112	0.000
n-Nonane		0.007	0.088	0.172	0.000
n-Decane		0.002	0.022	0.043	0.000
n-C11		0.000	0.004	0.007	0.000
H <sub>2</sub> O		0.033	1.043	1.224	14.525
EGlycol		0.000	0.006	0.010	0.001
Total		100.000	100.000	100.000	100.000

### 3.8 Aqueous Discharges

#### 3.8.1 Cooling Water Purge

The use of an evaporative cooling system will lead to discharge of cooling water purge. With the sea water make-up for a 800 MW nominal capacity plant amounting to 2,000 m<sup>3</sup>/hour and evaporation accounting for 700 m<sup>3</sup>/hour, a discharge of 1 300 m<sup>3</sup>/hour will arise.

The evaporation of water within the system leads to concentration of dissolved solids and in the case of seawater make-up leads to increased salinity of the residual water. The constant discharge and make-up allows for control of water quality.

The addition of a biocide in low concentration to control biofouling is the only alteration in the quality of the make-up water as the accumulation of impurities in the system is simply the concentrations of constituents such as dissolved solids that were already present.

It is envisaged that the pipeline for the cooling water purge discharge will follow the same route as the pipeline for the incoming make-up water. The terminal point for the discharge is not yet determined and its selection will be based on a number of factors that include avoidance of interference with and from future mining operations and recirculation of cooling water.

### 3.8.2 Low Volume Aqueous Discharges

In addition to the cooling water purge discharge, there will be a number of low volume aqueous discharges associated with operation of the power plant and the gas conditioning plant. On the basis of assessing a worst-case scenario, it is assumed that these will discharge to the marine environment. There will be some drainage from the gas conditioning plant, particularly rainwater run-off, and such water will be treated jointly with the power station. At a practical level, it is envisaged that these will either be recovered for use in landscape maintenance at the plant or discharged to the cooling tower basin to minimise the required cooling water make-up.

Discharges that will arise frequently comprise treated water treatment plant effluents and treated sewage effluent. Less frequent discharges will include HRSG blowdowns (ultra pure water). The volume and frequency of surface water drainage will be rainfall dependent. Other infrequent discharges may arise from time to time associated with, for instance, compressor cleaning.

#### **Water Treatment Plant Effluent**

The incoming water supply will be treated to achieve a high level of purity and then stored prior to its use in the HRSG. Regeneration of the ion-exchange resins will be by sulphuric acid ( $H_2SO_4$ ) and caustic soda (NaOH), leading to alternate acidic and alkaline waste streams. Effluent will be neutralised prior to discharge which is expected to last up to one hour daily with a flow rate of up to 7 kg/s.

#### **Sewage Effluent**

Sewage effluent will be treated in a sewage treatment plant to achieve a quality standard of 30 mg/l for suspended solids and 20 mg/l for biological oxygen demand (BOD). The volume of treated effluent is estimated at a maximum of approximately 4 m<sup>3</sup>/day. This is based on the system serving up to approximately 50 permanent employees, although the shift nature of operations means that not all of these employees will be present on each day.

#### **HRSG Blowdown**

The water in the HRSG will be blown down intermittently to remove accumulation of impurities. This blowdown water will be discharged to a tank to reduce pressure prior to entering station drains before discharge. The average volume of the discharge will be approximately 150 m<sup>3</sup>/day. This heated water may contain traces of hydrazine ( $N_2H_4$ ), sodium phosphate ( $Na_3PO_4$ ), caustic soda (NaOH) and ammonia ( $NH_3$ ). However, the concentrations will be low and the discharge is essentially of ultra-pure water.

#### **Surface Water Drainage**

Drainage arising from paved surfaces within the power plant site, such as the turbine floor and maintenance areas, and from controlled discharges from bunds to bulk storage tanks, will be discharged to the cooling water system following passage through an appropriate oil interceptor.

#### **Plant Cleaning**

Water washing of the gas side of the HRSG tubes may be carried out to remove deposits, which mostly comprise carbonaceous material, that build up and reduce plant efficiency. Minimal deposits would be expected with natural gas being used as the principal fuel and washing may arise only on a

few occasions over the life of the plant. Wash-water will be discharged following treatment to isolate and remove suspended particles.

### ***GT Compressor Washing***

A few times each year each of the gas turbine compressors will be washed off-load. The high-frequency washing medium will be a solution of environmentally benign surfactants in pure water. The wash water will be treated and discharged to the cooling tower basin.

### ***HRSG Storage Solutions***

Two methods may be used to protect an HRSG when it is out of use for an extended period and these are referred to as dry storage and wet storage. Dry storage, which is the preferred method, will comprise circulation of dry air or the use of the inert gas nitrogen ( $N_2$ ). There are no resulting discharges. Wet storage may use a solution of hydrazine ( $N_2H_4$ ) and ammonia ( $NH_3$ ). The resulting discharges, should they arise, will be either sent for disposal by an appropriate waste contractor or else suitably treated prior to release.

### ***HRSG Acid Cleaning***

Acid washes during the life of the plant are carried out at intervals of roughly 8 - 10 years, depending on many factors such as large-scale replacement of HRSG tubes, severe on-load corrosion, or excessive magnetite or deposit build-up. The resulting effluents will be taken off-site for safe treatment/disposal at environmentally licensed facilities.

### ***Water from gas conditioning plant***

The ongoing design studies of the gas conditioning plant strongly suggest that all water separated from the gas will be turned into vapour and that there will be no effluent discharges from the gas conditioning plant, except occasional small quantities of storm water discharges. Nevertheless the discharge of a nominal 5 m<sup>3</sup> metres of water, at a temperature of 40°C and containing trace amounts of dissolved hydrocarbons ( $\leq 10$  ppm max) have been considered. This water can be co-discharged with the cooling purge water (31 200 cubic metres per day), with negligible effect on the receiving environment. Due to the nature of the process adopted, the oil content of the condensed water will be well within permitted international standards for disposal of such water, i.e., any oil content will be less than 10 mg/litre which is well within the international Marpol 93/96 standards. If co-disposed with the power plant purge water the concentration of free and dissolved hydrocarbons will be less than 0.0016 ppm.

## ***3.9 Noise and Vibration***

The main potential sources of noise from the plant, mitigation of which will be an integral feature of the plant design, will be as follows:

### ***Gas Turbines***

High noise levels originate in the air inlet and flue gas exhaust. Strong pure tonal components are associated with the inlet, while the exhaust results in high levels of low-frequency noise. Specially designed silencers are provided to control such noise emissions to acceptable levels. The gas turbine itself will be housed in an acoustic enclosure.

### ***HRSG***

Venting of steam will occur during HRSG start-up and blowdowns. This is routinely controlled by suitable silencers. Boiler safety valves may be tested on an annual basis for insurance certification. Outside of such testing, operation of safety valves will occur for very short periods under process fault conditions. They will be fitted with silencers but will be audible outside the plant. Owing to their safety function, it is not possible to totally abate noise from such high temperature/high volume sources.

### ***Cooling Towers***

Noise from evaporative cooling towers arises from mechanical equipment and predominantly from falling water. Areas of noise breakout include the air inlet to the fill medium, fan outlets and the casing.

Cooling towers comprise a series of point sources and cooling tower noise is very directional. Silencing will be effected by optimum orientation of towers, splash attenuation mats, low speed gearboxes and noise baffles as necessary.

#### **Steam Turbine**

The steam turbine, together with a range of auxiliary plant, much of which contains rotating or reciprocating machines, is a source of noise. This is attenuated by acoustic lagging and enclosure and by the acoustic design of the turbine house.

#### **Gas Release**

When it is required to purge the gas pipelines and gas compressor (if provided), gas will be vented to the atmosphere. This will last for a short period and may result in slightly increased noise levels. It may occur up to ten times annually.

#### **Transformers**

Fans on generator and other large transformers are provided for cooling purposes. The transformers themselves may emit noise at multiples of the power line frequency (50 Hz) but are treated to minimise noise emission and will be inaudible at the site boundary.

#### **Traffic**

Road traffic associated with plant operations will normally consist of the movement of a relatively small number of station personnel to and from the site together with maintenance and servicing activities. Routine delivery of consumables will not lead to significant additional traffic. Operation on liquid fuel (if provided) could involve significant transportation over short periods.

The plant will not give rise to significant vibrations.

### **3.10 Waste Management**

Waste generated in the operational phase will include the following:

#### **Air Filters**

Filters on air intakes will require changing periodically.

#### **HRSG Washing**

Insoluble and precipitated materials from treatment of HRSG wash water.

#### **Gas Turbine Washing**

Intermittent liquid effluent arising from off-line washing with surfactant solution of the air compressor.

#### **General Cleaning**

Rags, etc. arising in maintenance and cleaning operations.

#### **Lamps/Batteries**

Lighting units replaced as required.

#### **Metal Waste**

Waste comprising scrap metal.

#### **Oil Interceptors**

Oily sludge from cleaning of oil interceptors.

#### **Waste Oils**

Waste oils arising from maintenance activities.

#### **Water Treatment**

Spent ion exchange resins.

#### **Auxiliary Cooling Water**

Drainage solution containing an anti-freeze and possible corrosion inhibitors.

#### **Packaging Waste**

Timber, cardboard, plastic etc.

In order to avoid risk of contamination, all waste will be segregated into hazardous and non-hazardous waste and removed off site for appropriate treatment/disposal at recognised facilities.

### **3.11 Project Construction**

#### **3.11.1 Construction Site**

##### **Principle construction activities**

The principal activities associated with the construction of the CCGT power plant include:

- Erection of accommodation for the workforce, temporary site office, workshops and fuel storage tanks, if the present hostel accommodation is not utilised.
- Provision of site services (roads, electricity, water, sanitation, etc.).
- Clearance of construction site.
- Excavation and piling.
- Erection of the power house and installation of machinery.
- Construction of the cooling system.
- Electrical installation.
- Laying of the gas pipeline and construction of the gas treatment plant (this will be the responsibility of Energy Africa and its contractors).

##### **Duration and Phasing**

It is envisaged that construction work will commence in late-2006 and that commissioning of the plant will be completed in mid-2009. Development of a second 800 MW unit would extend the construction period.

The construction period of less than three years compares favourably with a conventional thermal plant which may take up to seven years to complete and with a nuclear plant which may take even longer.

##### **Employment**

The average number of persons employed during construction is expected to be in the order of 600 with numbers peaking at approximately 1 300.

##### **Works Safety**

Works will be carried out by an experienced contractor using appropriate and established safe methods of construction. All requirements arising from statutory obligations regarding health and safety will be met in full.

The contractor will be required to ensure that all workers receive appropriate safety training and are equipped with appropriate personal protective equipment.

Appropriate medical first-aid facilities will be provided at the site and at the workforce accommodation.



***Works Method Statement***

The contractor will be required to prepare and implement a detailed Works Method Statement and Management Plan to address managing the environmental impacts associated with the construction of the plant in line with nationally and internationally recognised best practices.

All construction will be carried out under the supervision of Consulting Engineers with appropriate experience.

### **Site Facilities and Accommodation**

A suitably surfaced contractor's laydown area will be developed at the site. Standard pre-fabricated structures will be provided for office accommodation.

If the present hostel facilities at Uubvlei are not utilized, a 10 ha area will be designated for provision of temporary accommodation for the workforce. It is envisaged that standard pre-fabricated structures would be used for all components of the accommodation, i.e. sleeping quarters, washing facilities, canteen, laundry, etc. The accommodation will include appropriate recreation facilities.

All necessary infrastructure facilities, such as water supply, electricity, waste disposal and sewage treatment, will be provided for the workforce accommodation and the construction site.

All temporary facilities will be fully removed upon project completion and the respective areas will be rehabilitated.

### **3.11.2 Environmental Factors**

Environmental impacts during project construction will be as follows:

#### **Traffic**

Construction of the project will require delivery of materials, plant and equipment, and construction personnel to the site. However, the volume of additional traffic will be within the capacity of the existing road network and will not cause a disturbance.

#### **Noise**

Noise during construction will predominantly arise from on-site construction plant, with earthmoving and concreting usually being the noisiest construction activities. A further significant potential source of noise is piling of foundations. If piling works become necessary, they will be restricted to daytime hours.

#### **Air**

Some site preparation and construction activities are a potential source of local dust emissions. To prevent dust becoming a nuisance during the construction phase, dust suppression will be used within the site.

#### **Waste**

Construction waste will be generated. All relevant regulations and best practice relating to waste management will be fully met.

Any damage caused to local infrastructure or facilities as a result of the construction works will be repaired.

### **3.12 Commissioning**

Plant commissioning will follow completion of the plant construction phase. Emissions particular to the commissioning phase will include the following:

#### **Noise**

On a small number of occasions during commissioning there will be additional noise for short periods. Commissioning will involve a steam blow through the HRSGs and pipework to purge them, with the steam being exhausted to atmosphere. These once-off occurrences can lead to high noise levels. These blow out activities will be scheduled to occur during daytime hours only.

### **Waste**

Water-side cleaning of the HRSG tubes is carried out during commissioning to remove deposits of metals and other impurities on the tubes' surfaces. This work will be undertaken by specialist contractors and will involve the use of acids, alkalis and proprietary chemicals. The process effluents will be taken off-site by the contractor for safe treatment/disposal at environmentally licensed facilities.

Commissioning will generally involve setting up and testing the equipment to ensure that it is fully functional and that all technical, environmental and safety requirements have been met.

### **3.13 Hazards and Safety**

The basic technology to be employed in the project is well understood and has been used successfully in many equivalent projects elsewhere. The main potential hazards that are associated with the proposal arise from the storage of quantities of combustible material, storage of small volumes of chemicals, presence of high voltage equipment and use of high-pressure steam.

The measures taken to mitigate against their occurrence comprise passive and active systems. The main passive safety measures to be incorporated in plant design are as follows:

- The incorporation of adequate emergency response access and means of escape.
- The provision of continuous gas monitoring systems, construction of bunding to storage tanks for fuels and chemicals, and installation of smoke detectors
- The venting of air/gas accumulations and protection of ignition sources from damage.

The active hazard protection measures relate to the provision of emergency fire fighting facilities, including automatic/manually operated deluge systems for the areas of the plant most at risk, a hydrant system and in-house procedures specifically developed in recognition of potential hazards.

The project will be designed with adequate fire protection/detection systems, which will be consistent with the requirements of internationally recognised best practice and compliant with all relevant statutory requirements.

The most serious potential emergency situations at the proposed plants are well known. Documented emergency procedures, taking account of the plant's management structure and physical layout will be established. The contents will address the following:

- Oil spill risk control procedures.
- Chemical spill control procedures.

Prior to start-up, a comprehensive set of operating procedures will be drawn up for operation of the plant and all operatives will be fully trained. Any potential emergency situations associated with the proposed development will be managed under the emergency response procedures that will be put in place at the plant.

Personnel welfare and safety on site will be of primary importance to the Owner, who is committed to ensuring that facilities are as safe and healthy as possible to work in. Staff will be trained to operate and maintain plant to a high degree of proficiency and will be capable of dealing with any emergency on the site, including fire.

### **3.14 Decommissioning**

When the supply of gas from the Kudu gas field is exhausted the CCGT power plant at Uubvlei will be decommissioned, the plant demolished and the site rehabilitated.

### ***3.15 Environmental Management Plan***

#### **3.15.1 Environmental management structure and responsibilities**

A formal Environmental Management System (EMS) will be developed. The system will be fully documented and meet the requirements of the international standard for Environmental Management Systems ISO 14001 - Specification with guidance for use.

A member of the plant's management team will be assigned the task of Health, Safety and Environmental (HSE) Manager. Duties in the environmental area, being additional to other duties, will include:

- Establishing the plant's environmental policy.
- Initiating environmental programmes encompassing all plant activities that help to achieve the targets and goals of the policy.
- Drawing up documented procedures and instructions for each plant group.
- Operating a yearly review of policy, objectives and programmes in conjunction with the plant manager.
- Developing and drawing up budgets for specific environmental targets and goals on a yearly basis.
- Preparing a yearly report on environmental performance.
- Maintaining a base of documentation for the environmental management system.
- Maintaining a register of records and measurements carried out.
- Identifying training needs of plant staff. The most important function would be monitoring, control and optimisation of the wastewater streams and other emissions.

#### **3.15.2 Environmental management of construction phase**

The environmental management plan will include a major section designed to ensure that the environmental, health and safety aspects of all construction activities meet the required standards. The contractor and subcontractors will be required to implement plans for the management of:

- Site
- Dust
- Water Use
- Materials Handling and Storage
- Fire Control and Emergency Procedures
- Leak and Spill
- Solid Waste
- Wastewater
- Transportation
- Noise

## CONTENTS

---

4. PROJECT ALTERNATIVES .....	4-1
4.1 Introduction .....	4-1
4.2 No-project alternative .....	4-1
4.3 Activity alternatives .....	4-1
4.3.1 Process alternatives .....	4-2
4.3.2 Location alternatives.....	4-3
4.3.3 Process alternatives for cooling of a CCGT plant .....	4-8
4.3.4 Summary of alternatives considered .....	4-8
4.3.5 The CCGT technology alternative.....	4-10

## FIGURES

---

Figure 4.1:	Location alternatives for the Kudu CCGT power plant .....	4-4
Figure 4.2:	Site alternatives considered in 1997 for the CCGT power plant at Oranjemund .....	4-6
Figure 4.3:	Location of the Uubvlei site, with Site D and the town of Oranjemund.....	4-7
Figure 4.4:	Potential generation and transmission options for Namibia over the medium to longer term. ....	4-8
Figure 4.5:	Potential generation and transmission developments for Namibia .....	4-9

## TABLES

---

Table 4.1:	Summary Table of Alternatives Considered.....	4-9
Table 4.3:	Fossil fuel and natural gas properties .....	4-11

## 4. Project Alternatives

### 4.1 Introduction

It is recognized Best Practice that environmental impact assessments (EIAs) consider alternatives<sup>1</sup> that also meet the stated need and purpose for the project (DEAT, 2004). As part of the planning for this project, NamPower has considered activity alternatives, location alternatives and process alternatives. Activity alternatives include policies, plans and programmes that address the project need, but which require variations in the fundamental nature of the project. Location alternatives are geographically separate or located in close proximity to one another, and include different sites or layouts. Process alternatives are variations in the technology or aspects of technology to be used.

### 4.2 No-project alternative

The Second National Development Plan of Namibia, 2001/2 – 2005/6, guided by Vision 2030, states that

*“The nation shall develop its natural capital for the benefit of its social, economic and ecological well-being by adopting strategies that: promote the sustainable, equitable and efficient use of natural resources; maximize Namibia’s comparative advantages; and reduce all inappropriate use of resources. However, natural resources alone cannot sustain Namibia’s long-term development, and the nation must diversify its economy and livelihood strategies.”*

A customer such as power generation is needed to commercialise development of the Kudu gas field as a Namibian resource. Such exploitation of the Kudu gas field would be utilizing the natural capital of Namibia for the well-being of its people, as well as diversifying its economy and maximizing a comparative advantage. The Kudu gas field would become a “stranded asset” if the proposed power plant is not built and operated, and the opportunity to convert natural capital into wealth for the people of Namibia would be lost.

### 4.3 Activity alternatives

NamPower wants to reduce its dependence on South Africa for electricity supply while meeting electricity demand in Namibia and exporting electricity to the regional market; currently about half of Namibia’s electricity is sourced through imports from South Africa. Although this electricity is purchased at very low prices from Eskom, tariffs are low due to structural characteristics of the energy supply industry in South Africa.

South Africa has diminishing capacity to supply Namibia with electricity (NamPower, 2002). It is expected that by 2007 there will no longer be a surplus of generating capacity in Southern Africa, and additional generating capacity will have to be brought on line in South Africa or elsewhere in the region. Restructuring of the South African electricity supply industry increases the uncertainty of the import supply. It is also likely that any surplus capacity generated by other Southern African countries such as the Democratic Republic of Congo, through the Inga hydropower scheme, will be absorbed by South Africa, given that about 85 % of the regional electricity demand is exerted by South Africa (NamPower, 2002).

Arising from these conditions, it is likely that the terms for renewal of Namibia’s importation contract with Eskom in 2006 will be considerably different and may not be in Namibia’s favour (NamPower,

---

<sup>1</sup> Both the IFC (Operational Policy OP 4.01) and EBRD require that the EIA assess alternatives to the project, including the “without project” option.

2002). In view of this uncertainty, it follows that Namibia should seek to increase domestic electricity generation through use of local resources.

NamPower, in its generation investment plan (Nampower, 2002), considered a range of alternatives for increasing electricity supply in Namibia. Namibia's energy resource inventory includes hydropower, natural gas and renewable energy in the form of biomass, wind and solar energy. Of these, hydropower and natural gas are deemed to be the most feasible large-scale resources in a country in which over 90 % of the rural population do not have access to grid electricity. The process alternatives discussed below are those which utilize the natural capital of Namibia, and exclude alternatives based on imported coal and fossil fuels. Namibia already has the Van Eck coal fired thermal power station in Windhoek and a diesel powered station at Walvis Bay. However, the cost of fuel delivered at Windhoek is becoming excessive, and Namibia is looking to building its economy by basing it on its own natural resources.

### **4.3.1 Process alternatives**

#### **4.3.1.1 Hydropower**

Considerable hydropower resource potential exists at the Epupa and Baynes sites on the Kunene River, Divundu/Popa Falls on the Okavango River and various sites suitable for medium and small projects on the Orange River (NamPower, undated). Detailed feasibility studies, including EIAs, have been conducted at Epupa, Baynes and Divundu/Popa. At Epupa, a large-scale hydropower project is considered technically feasible, while at Baynes it is considered to be technically feasible only if Gove Dam in Angola is operative (Namang, 1998). The Divundu/Popa Falls project is a relatively small project expected to produce about 20MW. However, since none of these projects has yet been initiated, there will be a considerable delay before any of these becomes operational.

Future sources of hydropower could be from new projects in Mozambique (Mepanda Uncua), Democratic Republic of Congo (Inga Complex) or Zambia (Kafue Gorge Lower). However, serious drawbacks for these sources are financial constraints and weak connections into the Southern African transmission grid (NamPower, 2002).

#### **4.3.1.2 Biomass Power**

A study undertaken for MME was to determine the potential biomass resources in Namibia usable for power generation purposes (Nampower, 2002). Such resources include:

- Municipal waste;
- Industrial waste; and
- Bio fuel in the form of invasive bush plant species.

Power station sizes were chosen as 30 MW for Windhoek, to suit the existing Van Eck turbines, and 10 MW in Grootfontein, to suit the generating capacity required for that area.

The key findings were that the proposed power stations might be viable under certain circumstances, i.e., the cost of capital, the selling price of electricity generated and the cost of waste and bio-fuel as fuel for power generation.

It was concluded that a more detailed study of optimisation of the power stations should be done as a next phase of the project.

#### **4.3.1.3 Wind power**

The feasibility of electricity generation using wind energy has been investigated in considerable detail by the Namibian government and by Gesellschaft für Technische Zusammenarbeit GmbH (GTZ). The Ministry of Mines and Energy started a programme in 1993 to promote renewable energy and to evaluate the potential for wind energy to contribute to Namibia's energy mix (GTZ, undated). By 1996, two wind monitoring stations had been established at Walvis Bay and Lüderitz, and preliminary results

published in 1997. In the following year, GTZ launched a more detailed feasibility study at three sites in Lüderitz, and investigated economic and financial viability, as well as technical and environmental challenges of implementing wind energy generation. Annual average wind speeds at the two sites were found to be suitable for electricity generation, while environmental impacts were acceptable or could be avoided through differential siting alternatives (GTZ, undated).

Due to the configuration of Namibia's electricity grid, the maximum size of the putative wind energy generation facility was taken to be 20 MW. For all the sites and scenarios investigated, the costs of wind energy are predicted to be higher than the current or future projected costs of imported or local coal- or gas-fired energy. However, Namibia may derive financial benefits of up to N\$ 100 per ton of avoided carbon dioxide emissions, which may warrant government subsidy or other grant funding to support wind energy development (GTZ, undated). Although a commitment has been made by all stakeholders to further investigate wind energy with assistance from the international donor community, this does not present an immediate option for additional large-scale generation capacity in Namibia.

#### **4.3.1.4 Solar Power**

Namibia is extremely well endowed with solar energy with around 3,300 hours of sunshine per year, which is one of the highest national figures in the world.

A significant amount of practical experience in the operation of solar thermal power stations has been gained globally. Despite this, solar thermal applications remain economically unattractive in the Namibian context. Prospects that solar thermal generation technology might become economically attractive for Namibia within the next 10-15 years are poor (Nampower, 2002). Solar energy could, however, be utilized in direct water heating collectors by house owners.

#### **4.3.1.5 Nuclear Power**

Nuclear energy is not being considered as a practical alternative for bulk electricity generation in Namibia, because it is an expensive alternative compared with hydro- and thermal (gas) stations. Waste fuel disposal also constitutes a major problem. Nuclear power generation will not be developed in Namibia until the available hydropower and thermal resources have been fully exploited.

#### **4.3.1.6 Natural gas for a CCGT plant**

The Kudu Gas Field provides Namibia with the opportunity to generate electricity for its own use and for export. Such gas can, with very little treatment, be used as fuel for gas turbine-powered electricity generation, in the form of a combined cycle gas turbine plant where the waste heat is used to raise steam for use in a steam turbine-powered electricity generator and the maximum efficiency of fuel use is achieved. This is the preferred alternative for this project.

### **4.3.2 Location alternatives**

In addition to the Uubvlei site that is the subject of this EIA, seven location alternatives were originally considered in a 1997 feasibility study for a CCGT plant in Namibia, all of which were deemed to be technically and environmentally viable, shown in Figure 4.1. Three sites were at Lüderitz, three at Oranjemund, and one at Keetmanshoop (NamPower, undated).



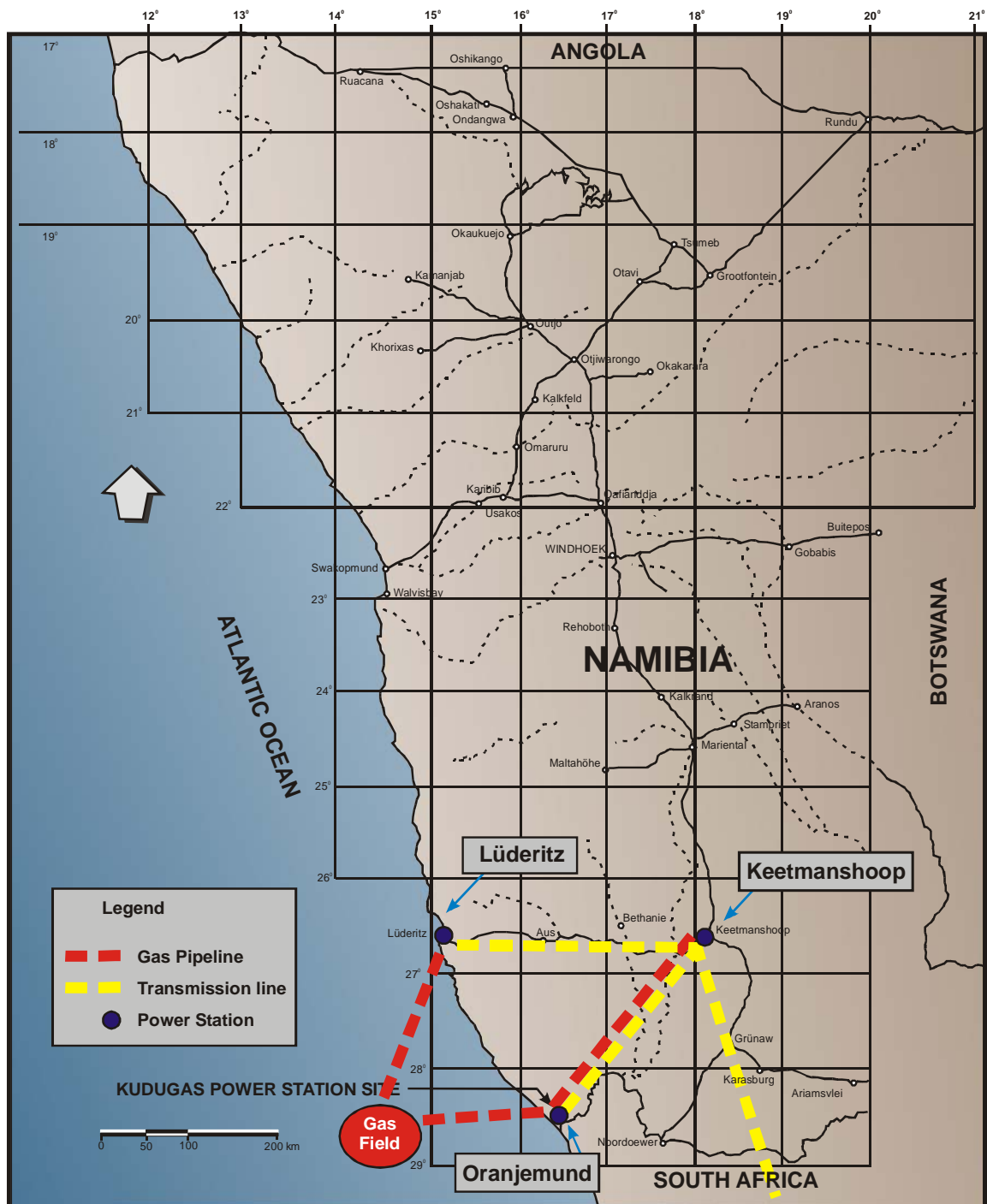


Figure 4.1: Location alternatives for the Kudu CCGT power plant

The criteria for evaluating the locations were:

- Environmental impact,
- Cost of gas supply pipeline link and transmission integration,
- Strategic position in relation to potential future gas pipeline link to Cape Town,
- Availability of cooling water for the turbines,
- Founding conditions for the plant (bedrock) and
- Operating efficiency.

#### **4.3.2.1 Keetmanshoop site**

The potential site is located about 23 km north east of Keetmanshoop, adjacent to Kokerboom substation. The elevation of the site and the lack of adequate cooling water supply are the major disadvantages of the site. The altitude of the site at about 1 170 m above sea level, and the use of an air-cooled condensing system would reduce the efficiency and performance of the CCGT plant. This site ranked as the least favourable of the location alternatives.

#### **4.3.2.2 Lüderitz sites**

The distance of these three sites from the Kudu gas field entails higher construction costs, as the gas supply pipeline would have to be considerably longer than that required for the Oranjemund sites, and this would be only partially offset by the shorter transmission line required to transport electricity away from the site. These sites were rejected for reasons of cost.

#### **4.3.2.3 Oranjemund sites**

Four sites in the Oranjemund area were evaluated during the extensive lead up period to this EIA; these have been examined by NamPower (NamPower, undated). The position of the sites is shown in Figure 4.2, and a short discussion follows.

##### **Site A and Site A\***

The original Site A lay on the coast inside the high security area; due to poor founding conditions and security issues around the original site, a new site in the area was proposed. Site A\* was then chosen, 5 km north of the Orange River mouth inside the mine security fence (NamPower, undated). Site A\* was one of the three sites evaluated in the Preliminary Environmental Assessment (Walmsley Environmental Consultants, 1998).

##### **Site B**

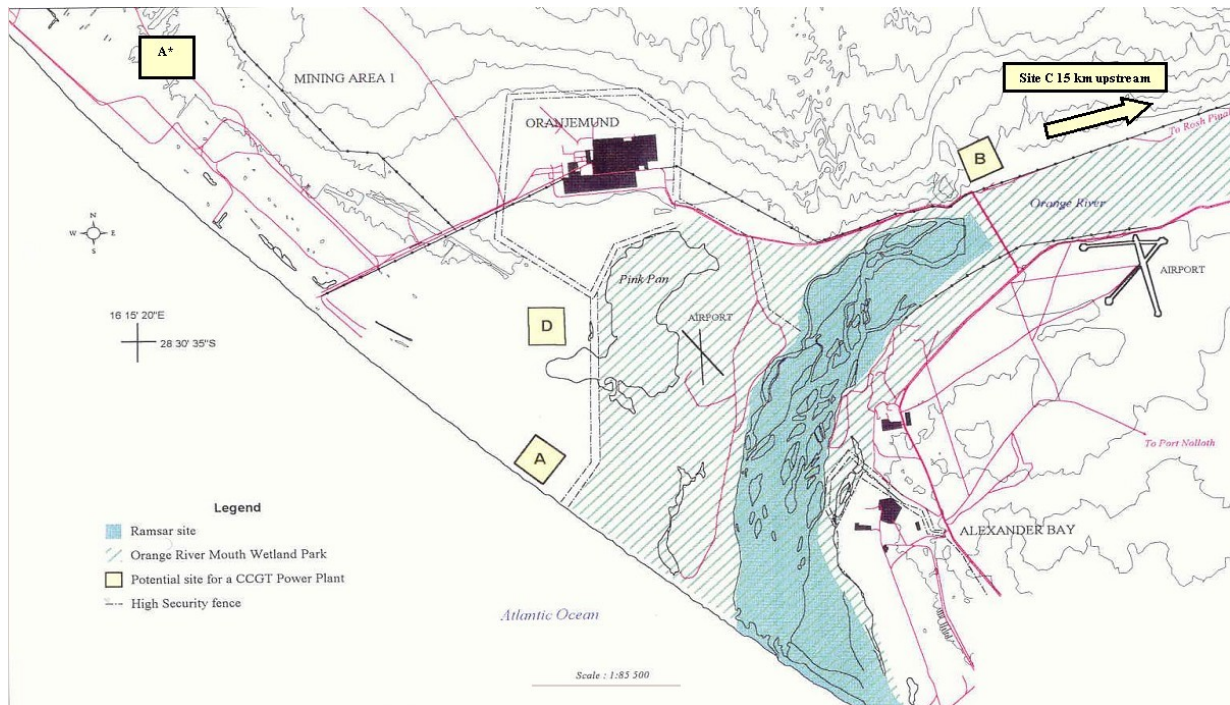
The general area of Site B lay between Swartkop and Oranjemund town, and from the north bank of the Orange River to about 2 km inland (NamPower undated). This site was found to have the most suitable founding conditions of all the Oranjemund sites. Potential concerns at this site include visual and noise impacts on the Ramsar site, access to the site, inadequate water supply from the Orange River for cooling purposes and difficulties of abstraction, and the impacts of effluent discharge on the river (NamPower, undated). Site B was one of the three sites evaluated in the Preliminary Environmental Assessment (Walmsley Environmental Consultants, 1998)

##### **Site C**

Site C lies about 15 km upstream of Oppenheimer Bridge, but has been eliminated due to its distance from the gas source (entailing higher construction costs than either Site A\* or Site B) and its proximity to a dune field, which would result in a high load of suspended sand in the area (NamPower undated).

##### **Site D**

During later discussions between NamPower, Shell, Eskom and National Power Kudu Project Development Team (KDT), technical and environmental consultants, a new site was added to the range of options (NamPower, undated). Site D lies about 2.5 km south south west of Oranjemund, roughly halfway between the town and the sea, and just inside the high security area.



Source: NamPower

**Figure 4.2: Site alternatives considered in 1997 for the CCGT power plant at Oranjemund**

Site D was one of the three sites included in the Preliminary Environmental Assessment (Walmsley Environmental Consultants, 1998). Based on the evaluation, NamPower made a decision that Site D is the preferred alternative and should be the principal alternative considered in the EIA, stating that Site D performed best against the evaluation criteria suggested by the KDT (NamPower, undated). It should be noted that strategic consideration of Oranjemund in relation to a pipeline to the Western Cape no longer holds.

#### 4.3.2.4 Uubvlei

After the EIA for Site D at Oranjemund had been approved by MET, it was found that the routing of a gas pipeline from the gas platform to the proposed Site D was subject to severe constraints because of likely opportunity costs due to possible diamond lock-up offshore, and inconvenience it would impose on mining activities.

A preliminary investigation by NamPower and Namdeb identified Uubvlei (Figure 4.3) as the most suitable alternative site to Site D at Oranjemund, based on the following criteria:

- Cost implications;
- Already disturbed/mined-out area at the site (i.e., minimal impact on biodiversity and landscapes);
- Minimal interference with Namdeb mining operations;
- Availability of cooling water for the power plant;
- Good founding conditions for the power plant and landing site for the gas pipeline and seawater intake pipeline;
- Proximity to infrastructure and services;
- Minimal impact on mining reserves offshore;
- Suitability for transmission lines (interconnectivity).



### 4.3.3 Process alternatives for cooling of a CCGT plant

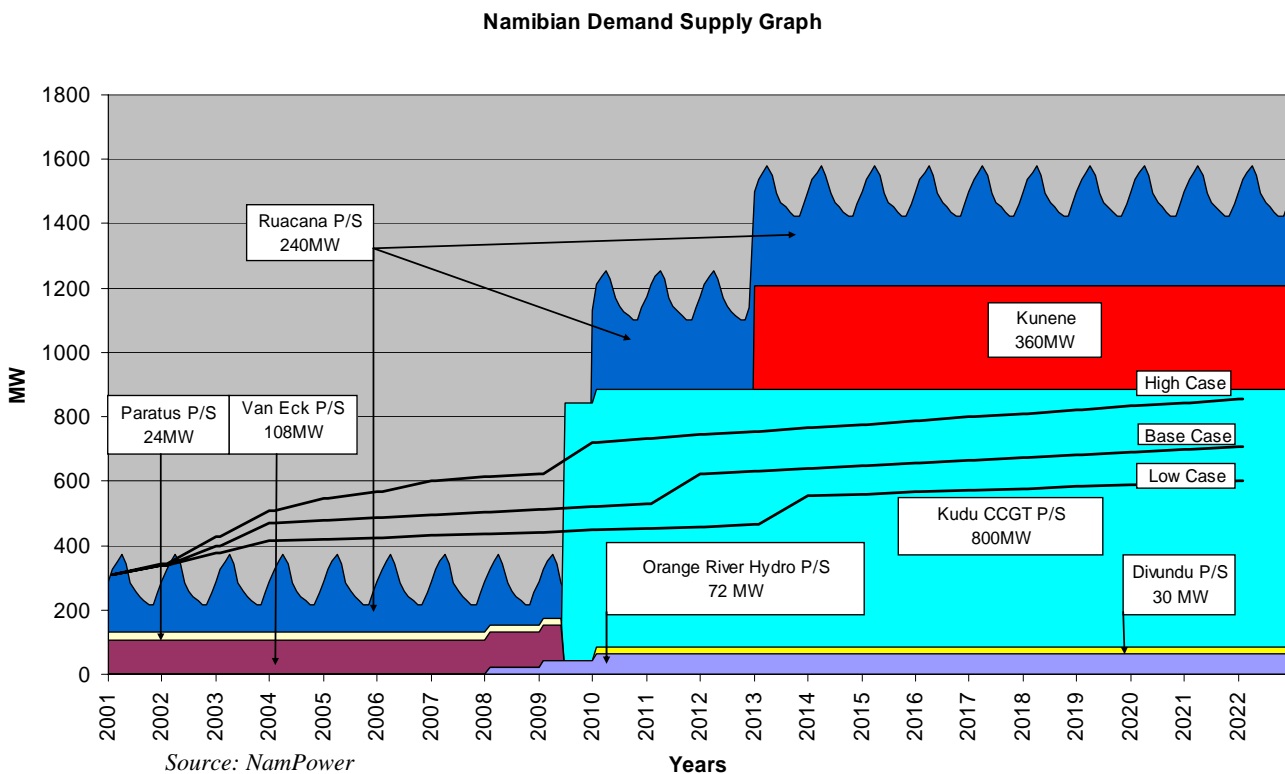
Two alternatives for cooling of the CCGT plant at Uubvlei are the use of direct seawater cooling and the preferred alternative of forced draught cooling towers with seawater make up from beach wells or mining ponds. Although direct seawater cooling might well be the cheapest option at this site, further consideration will need to consider its interaction with Namdeb's mining operations (NamPower, undated; Walmsley Environmental Consultants, 1998).

### 4.3.4 Summary of alternatives considered

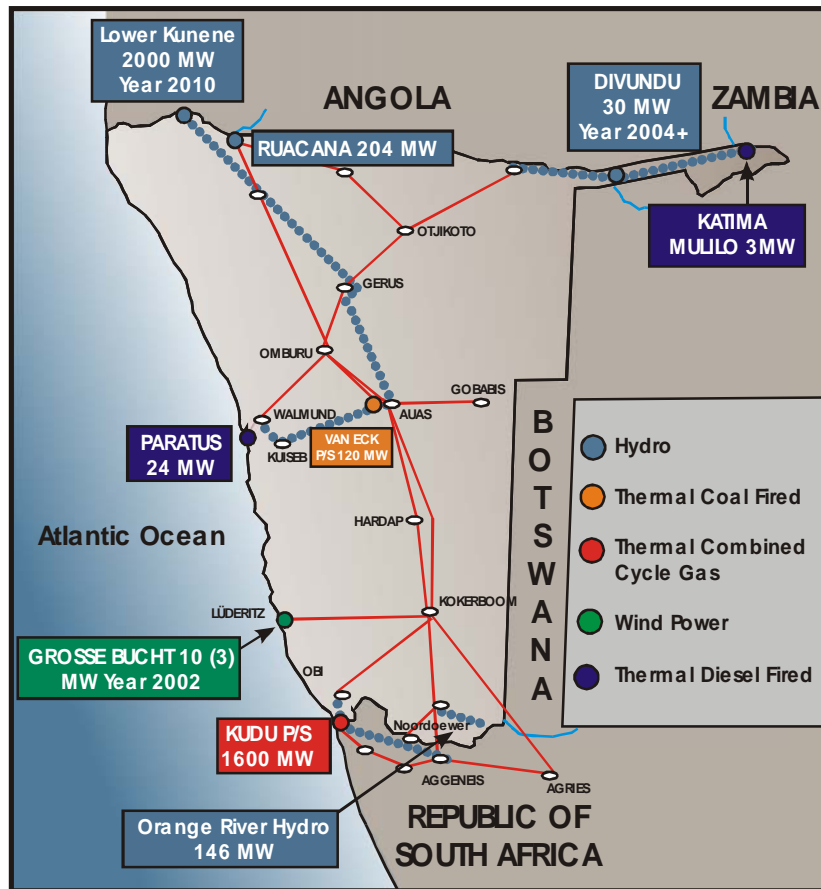
Ultimately, a combination of large- and small-scale hydropower, natural gas and possibly wind energy will be used to diversify Namibia's energy mix, with a future demand and supply scenario for Namibia illustrated in Figure 4.4 below.

Generation and transmission initiatives identified with potential to contribute in the next five to ten years are illustrated in Figure 4.5 These include the following:

- The CCGT plant based on Kudu gas (earliest commissioning date 2009);
- A Lower Kunene hydropower plant, potentially at Baynes (earliest commissioning date 2014);
- Small-scale hydropower schemes on the Orange River (up to 12 plants each with a 6 MW capacity - earliest commissioning date for the first plant around 2004); and,
- The Divundu hydropower plant on the Okavango River (earliest commissioning date 2008).



**Figure 4.4: Potential generation and transmission options for Namibia over the medium to longer term.**



Source: NamPower

Figure 4.5: Potential generation and transmission developments for Namibia

Major reasons for elimination of the various activity, process and location alternatives are given in Table 4.1

Table 4.1: Summary Table of Alternatives Considered

Alternative	Major reason for consideration as an alternative
<i>Activity alternatives</i>	
Increase importation of energy from South Africa	Importation agreement with Eskom due to expire in 2006; terms of subsequent agreements likely to be different and more costly
Natural gas in Namibia	Activity alternative being considered in the EIA
<i>Process alternatives</i>	
Additional hydropower from the Kunene River	Lag time to bring electricity production on line (commissioning date 2014)
Wind energy from various sites	Costs prohibitive without international donor funding and/or carbon offset benefits

<i>Process alternatives for cooling of a CCGT plant</i>	
Direct seawater cooling	Inlet structure could interfere with Namdeb's long-term plans; siltation levels at intakes
Forced draught cooling towers with seawater make up from beach wells	Process alternative being considered in the EIA
<i>Location alternatives</i>	
Keetmanshoop (Site A)	Decreased plant performance due to altitude and lack of an adequate cooling water source
Lüderitz (Sites A, B and C)	Increased construction costs associated with distance from gas source
Oranjemund Site A*	
Oranjemund Site B	
Oranjemund Site C	Distance from the source in the gas field
Oranjemund Site D	Approved by MET. Routing of a gas pipeline from the gas platform to the site was subject to severe constraints.
Uubvlei	Location alternative being considered in this EIA

#### 4.3.5 The CCGT technology alternative

The principal activity alternative being considered for this EIA is the generation of electricity using CCGT technology at Uubvlei, 25 km north of Oranjemund.

CCGT stations have a considerably higher operational thermal efficiency compared with conventional coal-fired power stations (up to 40%). The net thermal efficiency of the Kudu power project, depending on the gas turbine selected, is currently projected to be around 57% at site conditions and to average around 56% over a 20 year operating life. Natural gas, the fuel used in CCGTs, possesses a much lower carbon-content than coal and petroleum and in comparison produces lesser emissions of CO<sub>2</sub> and NO<sub>x</sub> (Blakemore et al., 2001).

The combination of using natural gas as a fuel and employing CCGT technology in a power station ultimately reduces CO<sub>2</sub> by 50% per unit of generated power (Blakemore et al., 1998). There will be no emissions of dust or particulates during the normal operation of the plant (Energy Management News, 2002). The main atmospheric emissions of concern from the proposed power station will be the oxides of nitrogen. However, according to Blakemore et al. (2001) a Combined Cycle Gas Turbine Stations will produce an 81% reduction of NO<sub>x</sub> per unit of power of that generated by an equivalent coal-fired plant.

The environmental performance of combined cycle gas turbines and other natural gas-fired combustion system are also significantly better than coal-fired boilers. These include low emissions of particulate matter, sulphur oxides and volatile organic compounds.

As pointed out earlier, natural gas is a cleaner burning fuel than either oil or coal, with greater energy density relative to fuel carbon than other fossil fuels such as coal and oil. Therefore, per unit of heat input there are fewer emissions of carbon dioxide. Table 4.3 presents fossil fuel and natural gas properties in this regard.

**Table 4.3: Fossil fuel and natural gas properties**

Fuel		Average carbon content (%)	Average heat value (kJ/kg carbon) Values rounded to the nearest 10
Coal	<i>Anthracite</i>	84	37 890
	<i>Bituminous</i>	80	41 600
	<i>Subbituminous</i>	55	39 750
	<i>Lignite</i>	42	39 750
Oil	<i>No. 2</i>	86	52 760
	<i>No. 4</i>	86	50 900
	<i>No. 6</i>	86	50 900
<b>Natural gas</b>		75	74 380

*Adapted from: Air Pollution Engineering Manual (Buonicore, A.J.; Davis, W.T. (Eds.), 1992)*

The IPCC, in their Workgroup III Third Assessment Report, issued in Accra in 2001, stated that at least up to 2020, energy supply and conversion will remain dominated by relatively cheap and abundant fossil fuels. Natural gas, where transmission is economically feasible, will play an important role in emission reduction together with conversion efficiency improvement and greater use of CCGT and cogeneration plants.

Emission reductions have a market value, even though there is no current regulatory program mandating them, but the value of these reductions should be taken into consideration when evaluating the environmental advantages and financial feasibility of CCGT technology. In terms of the Kyoto Protocol and the Clean Development Mechanism, markets for greenhouse gas emission credits will develop, and there will be opportunities for Namibia to benefit not only from the application of this technology in utilising its natural resources at the Kudu gas field, but also from such markets in emissions credits.



# CONTENTS

---

5. THE AFFECTED ENVIRONMENT .....	5-1
5.1 Oranjemund: Location and ownership	5-1
5.2 Geology, topography and soils	5-2
5.3 Hydrology	5-2
5.4 Marine environment	5-4
5.5 Climate	5-5
5.6 Temperature	5-6
5.7 Precipitation	5-7
5.7.1 Rainfall	5-7
5.7.2 Fog	5-7
5.8 Wind	5-7
5.9 Humidity	5-8
5.10 Sunshine and cloudiness	5-13
5.11 Terrestrial Ecology	5-13
5.11.1 Vegetation	5-14
5.11.2 Terrestrial Fauna	5-15
5.11.3 Terrestrial and Coastal Avifauna	5-17
5.12 Air quality	5-18
5.13 Noise	5-18
5.14 Archaeology	5-18
5.15 Orange River Transboundary Conservation Area	5-18
5.16 Population Centres	5-19
5.16.1 Oranjemund	5-19
5.16.2 Alexander Bay	5-20
5.16.3 Lüderitz	5-20
5.16.4 Rosh Pinah / Skorpion	5-20
5.17 Communications	5-21
5.17.1 Roads	5-21
5.17.2 Rail	5-21
5.17.3 Air	5-21
5.17.4 Telecomms	5-21
5.18 Tourism	5-21

## FIGURES

Figure 5.1:	Location of Oranjemund and Diamond Area No. 1.....	5-1
Figure 5.2:	The Orange River: its mouth and its catchment .....	5-3
Figure 5.3:	The Namdeb mine and Oranjemund use Orange River water abstracted from sand wells just upstream of the Openheimer Bridge. The water is used mainly for the town of Oranjemund and current use is in the order of 7 million m <sup>3</sup> per annum. The town boasts one of the few golf courses on the west coast which always shows up clearly as a patch of green vegetation in an otherwise desolate and vegetation free area. ...	5-4
Figure 5.4:	Wind rose for Alexander Bay for 2000 and 2001.....	5-8
Figure 5.5:	Wind rose for Alexander Bay for 08h00, for 2000 and 2001 .....	5-9
Figure 5.6:	Wind rose for Alexander Bay 14h00, for 2000 and 2001.....	5-10
Figure 5.7:	Wind rose for Alexander Bay 20h00, for 2000 and 2001.....	5-11
Figure 5.8:	Wind rose for Alexander Bay for 24h00, for 2000 and 2001 .....	5-12
Figure 5.9:	Map of Uubvlei area that shows the extent of land disturbed by diamond mining operations (hatching), and proposed situation of the power plant and associated activities. Boundaries of habitat zones are not indicated as these were not mapped at the site .....	5-13
Figure 5.10:	Vegetation types in the Greater Richtersveld area, that includes Uubvlei .....	5-16

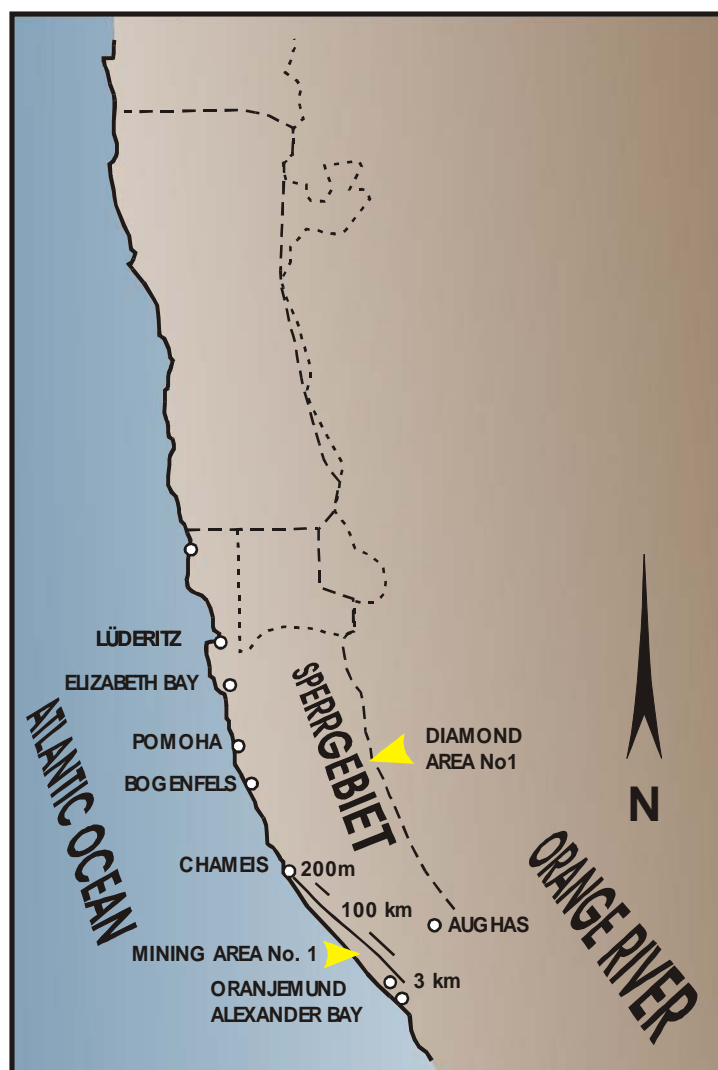
## TABLES

Table 5.1:	Mean monthly and monthly extreme temperatures at Alexander Bay including average monthly rainfall and fog days .....	5-6
Table 5.2:	Protected and endemic species found during field survey, March 2005.....	5-15
Table 5.3:	Red Data Book bird species occurring between Port Nolloth and Lüderitz. ....	5-17

## 5. The Affected Environment

### 5.1 Oranjemund: Location and ownership

After diamonds were discovered in Namibia in 1908, the German Colonial Government of the time declared a "Sperrgebiet" or "Forbidden Zone" (Brittan, 1979), a strip extending 100 km inland from the coast between latitude 26°S and the Orange River, to prevent foreign companies from becoming involved in the expected diamond boom. The Consolidated Diamond Mines of South West Africa (CDM) was formed in 1920 to control all diamond mining within the Sperrgebiet. The new Minerals Agreement between CDM and the Namibian Government in November 1994 reconstituted CDM as Namdeb Diamond Corporation (Pty) Ltd., a 50:50 partnership between the government and De Beers Centenary AG (Pallett (ed.) 1995). Namdeb continues to exercise complete control over all diamond mining in the Sperrgebiet.



Source: Namdeb Information

Figure 5.1: Location of Oranjemund and Diamond Area No. 1

Following the discovery of rich ore deposits on the north bank of the Orange River, south of Lüderitzbucht, the town of Oranjemund was founded in 1936. It lies within Diamond Area 1, where public access is strictly controlled (Figure 5.1). The land is owned by the State, but all the infrastructure and assets in Oranjemund are currently owned by Namdeb. In mid 2003, the Namibian Cabinet resolved to alienate unreserved state land in preparation for the future proclamation of Oranjemund as a municipality. Though the structure plan and site layout are currently being finalised, the plan excludes the proposed CCGT site at Uubvlei, and the power plant will therefore not be within the boundaries of the new municipal area. There is the intention to set up an independent town management company to run the town on a commercial, municipal basis until proclamation. The proposed site at Uubvlei lies within Diamond Area 1.

## **5.2 Geology, topography and soils**

Oranjemund and its surrounds are located on rocks of the Gariep Belt, which is a sequence of sediments and volcanics that accumulated in a basin on rocks of the Namaqua Mobile Belt, Orange River Group, Vioolsdrift Suite and the Richtersveld Intrusive Complex. The Oranjemund Formation is a displaced low-grade metamorphic unit within the Gariep Belt, overlain by one to fifteen metres of diamondiferous palaeo-marine and palaeo-alluvial sediments that are covered by windblown sand.

The topography between Oranjemund and the coast is low-lying and flat, but the sand dunes rise up gently towards the interior to the north and east of town. The main topographic features are the rocky outcrop of Swartkop, 73 metres above mean sea level, the mobile dunes east of town and the shallow Orange River valley.

The soils of the desert are poorly developed, but some alluvial soils occur on the southern bank of the Orange River further upstream, where crops are cultivated. There is no agriculture or agricultural potential at the proposed Uubvlei site for the CCGT power plant.

Erosion processes over time have resulted in accumulations of diamonds along the banks of the Orange River in old palaeo-channels and in relic marine beaches. These deposits have been mined since 1908 and revenues from the mining operations have been the cornerstone of the Namibian economy ever since. The site at Uubvlei for the proposed CCGT power plant is located near the southern boundary of Mining Area 1 and has been mined previously by Namdeb (Figure 1.6)

## **5.3 Hydrology**

The Orange River is the longest in South Africa and enters the sea at 28°38'S; 16°28'E between the settlements of Oranjemund, Namibia and Alexander Bay, South Africa. It is one of southern Africa's largest river systems; the catchment exceeds one million square kilometers (Figure 5.2).

Its mouth is a delta, with a multiple channel system between sand banks, a tidal basin and a salt marsh on the south bank. The Orange River is the only perennial fresh water source along the coast for 370 km to the south and 1350 km to the north. This, together with the variety of habitats, makes it extremely important for wetland birds, especially migrants along a very inhospitable coast. Because of its international importance as a waterfowl habitat, it has been listed as a Ramsar Site by both Namibia and South Africa. In recent years the decreasing flows at the mouth have been a concern and special water allocations have been requested from the Permanent Water Commission for the Orange River (PWC), in order to maintain ecological functioning of the Ramsar wetlands.



**Figure 5.2: The Orange River: its mouth and its catchment**

The total natural or virgin flow of the Orange River at the mouth used to be 10 670 Mm<sup>3</sup>/a, but this had decreased by 50% to 5 340 Mm<sup>3</sup>/a by 1991 due to construction of several dams and interbasin transfer schemes upstream. A feature of the Orange River is its periodic, massive floods. Major floods occur every 8-10 years on average, but upstream regulation has resulted in fewer smaller floods. The most recent flood was in 1988, and the discharge was the largest since 1921 when systematic flow recording began (Swart *et al*, 1990). The March 1988 flood probably had an exceedance discharge value of between 100 and 200 years. The water quality in the river is generally good, but is characterised by a high silt load, especially after a major flood. Such floods introduce large amounts of terrigenous material into the nearshore region. Bremner *et al* (1990) showed that the mud belt off the Orange River expanded in width immediately following the flood. There are indications that the water quality is becoming increasingly saline due to high evaporation and irrigation return flows.

Oranjemund obtains its domestic water supply from ground water in an old palaeo-channel of the Orange River just upstream of the town (Figure 5.3). The coastal zone is underlain by both saline and fresh water shallow aquifers. The former is recharged constantly by the sea and the latter by the river, especially when the river is in high flow.



Source: Department of Water Affairs and Forestry, RSA

**Figure 5.3:** The Namdeb mine and Oranjemund use Orange River water abstracted from sand wells just upstream of the Openheimer Bridge. The water is used mainly for the town of Oranjemund and current use is in the order of 7 million m<sup>3</sup> per annum. The town boasts one of the few golf courses on the west coast which always shows up clearly as a patch of green vegetation in an otherwise desolate and vegetation free area.

#### 5.4 Marine environment

The coast of Namibia is one of the most hostile in the world. It is characterised by large swells and breakers, the strong, northward-flowing Benguela current, less strong counter currents and gale-force winds. It is also a corrosive and abrasive environment.

The coastline between Port Nolloth and Lüderitz is roughly linear with a north-west by north trend with few prominent features. With the exception of Elizabeth Bay, the bays are hardly more than shallow indentations in a generally straight coastline. Twelve islands, ranging from the 90-hectare Possession Island to small rock outcrops lie close inshore between Lüderitz and Baker's Bay (27°40'S;15°32'E).

South of the Orange River the 80 km of shore is predominantly rocky, with 51% being exposed rocky headlands and 17% wavecut rocky platforms. The balance (32%) is sandy beach (Jackson and Lipschitz, 1984). North of the Orange River the pattern changes with the first 110 km to Chameis Bay almost exclusively sandy shore. The remaining 180 km to Lüderitz alternates between rocky headlands, half-heart bays and shallow to deep embayments, backed by sandy beaches.

Natural processes that impact severely on the coastal ecosystem include high sediment loads from the Orange River (Bremner *et al.*, 1990) and major floods causing mortality of intertidal organisms as a result of severely reduced salinity (Branch *et al.*, 1990). The nearshore ecosystem also has been affected by the movement inshore of water having a low dissolved oxygen content (Bailey *et al.*, 1985; Bailey, 1991).

Surface currents are mainly wind driven and flow to the NW (Shillington, *et al.*, 1990). Current velocities in broad continental shelf areas such as that adjacent to the Orange River are generally 10 - 20 cm.s<sup>-1</sup> (Boyd and Oberholster, 1994) where the flows are predominantly wind-forced, barotropic and fluctuate between poleward and equatorward flow (Shillington *et al.*, 1990; Nelson and Hutchings, 1983). Fluctuation periods of these flows are 3 - 10 days and velocities are 0.15 - 0.20 m.s<sup>-1</sup>. Near bottom shelf flow is mainly poleward (Nelson, 1989) with low velocities of typically 0.05 m.s<sup>-1</sup>. In the absence of major changes in bathymetry the tidal flows along this section of the coastline are of the order of a few cm.s<sup>-1</sup>.

Typically wave-driven flows dominate in the surfzone (characteristically 150m to 250 m wide), with influence of waves on currents extending out to the base of the wave effect (~40 m, Rogers, 1979). The influence of wave-driven flows extend beyond the surfzone in the form of rip currents.

The salinity of upwelled waters in this region is typically 34.8 to 34.85 psu while the waters reaching the surface during upwelling typically contain about 5 ml.l<sup>-1</sup> of dissolved oxygen (Chapman and Shannon, 1985).

The beaches immediately north of the Orange River mouth are characterised by medium, well sorted sands in the size range 373 - 505 µm (McLachlan and de Ruyck, 1993) and are classified as being of the reflective type, dynamic environments with low faunal biomass and few species.

The tightly controlled diamond mining areas have kept the numbers of people to a minimum. However, the coast between Lüderitz and Port Nolloth has been heavily impacted by human activity both below and above the high water mark. Diamond mining has totally altered many parts of the coastal zone. The Consolidated Diamond Mines of South West Africa (CDM) began recovering diamonds from the intertidal zone in 1964 by using the bold concept of building sea walls behind which the sea could be pumped out, gravel removed and the bedrock exposed. In potholes, cracks and niches the diamonds were found and removed manually. The advantage of the sea wall method is that work can continue regardless of the sea state. This contrasts with the many small diamond diving operations which are heavily dependent on calm conditions to work in the immediate subtidal zone. The intertidal and subtidal zones are mined by shore-and boat-based divers, who operate pumps in the intertidal and subtidal zones whenever sea conditions permit. Some prospecting trenches are large enough to be marked as major features on 1:50 000 scale topographic maps. In many areas the bedrock lies exposed and little attempt has been made to replace the overburden or to rehabilitate mined areas.

In the early 1960s the Marine Diamond Corporation was established to mine diamonds from the sea using specially-equipped suction dredgers. De Beers Marine is applying this concept to fossil shorelines in deep water where robot-controlled suction equipment is deployed. A number of other mining companies, contracted to Namdeb, operate closer to the coast using similar techniques.

The effect of the diamond mining activity is that hardly any of the coast between Lüderitz and the Olifants River has been left undisturbed. Active mines include Elizabeth Bay (Namdeb), Oranjemund (Namdeb), Alexander Bay (Alexkor) and Kleinzee (CDM, Namaqualand).

## 5.5 Climate

Winds and weather in the region are controlled by the interaction of the south Atlantic anticyclone, the northward-flowing and cold Benguela Current (with associated upwelling), eastward moving mid-

latitude cyclones and the atmosphere pressure field over the subcontinent (Kamstra, 1985). This generally leads to strong zonal pressure gradients at the coast and the resultant fresh to strong equatorward winds. These strong equatorwards winds are interrupted by the passing of coastal lows with which are associated periods of calm or NW wind conditions.

Semi-permanent temperature inversion is caused by warm, dry air mass overlapping the cool air mass above the ocean, and is ideal for the formation of fog and low stratus cloud. Although located in a desert, cool, foggy conditions occur most mornings and strong southerly winds are a distinct feature of the afternoons. Temperatures along the coastal strip are modified by the cold ocean, but rise sharply inland.

The area is arid with rainfall mostly restricted to the winter months. Very hot, dry and dusty conditions occur occasionally in winter when there are offshore (north-easterly) berg winds. Detailed information pertaining to the climate of the study area is presented below based on observations at the South African Weather Service station at Alexander Bay. The station is located about 35 km south-east of the proposed site of the power station. The Namibian Meteorological Service's nearest station is located at Luderitz, however there are plans to expand the monitoring network to include Oranjemund in the future. Namdeb have a network of meteorological monitoring stations located in the diamond mining areas along the Namibian coast, however due to time constraints and the ready availability of the Alexander Bay data it was decided to exclude these stations.

## 5.6 Temperature

At the Orange River mouth average sea surface temperatures in winter are 12 - 13°C, spring 13 - 14°C, summer 14 - 15°C and autumn 13 - 14°C (Boyd and Agenbag, 1985). Similar ranges are evident in the long term monthly mean coastal sea surface temperatures for Lüderitz in the north with those for Port Nolloth in the south being some 1°C lower than those reported above (Greenwood and Taunton-Clark, 1992, 1994). During episodic large Orange River floods, e.g. March 1988, nearshore sea surface temperatures may attain 23,5 - 24,5°C (Shillington *et al*, 1990). Nearshore sea surface temperatures during 'normal' summer floods probably attain similar levels but these will not extend very far from the river mouth itself.

Because of oceanic influences, temperatures are moderate compared with much of Namibia. Average temperatures in Alexander Bay are mild throughout the year with slightly cooler temperatures in winter. The average daily maximum temperature in summer is 23.5°C with extremes exceeding 40°C. In winter the average maximum temperature is 20.8°C with extremes in the region of 35°C. Annual average 08h00 and 14h00 relative humidity levels are 84% and 53% respectively. Monthly averages and extreme temperatures from the South African Weather Service (SAWS) 27-year climate record (SAWB, 1990) are presented in Table 5.1.

**Table 5.1: Mean monthly and monthly extreme temperatures at Alexander Bay including average monthly rainfall and fog days**

Month	Temperature (°C)			Rainfall (mm)	Fog Days
	Average	Maximum	Minimum		
Jan	19.8	24.4	15.1	1	4.0
Feb	19.6	24.1	15.1	3	6.5
Mar	19.2	24.3	14.2	2	10.5
Apr	18.2	23.8	12.6	4	12.6
May	17.0	23.2	10.7	4	11.3
Jun	15.7	21.6	9.8	9	8.0
Jul	14.9	21.0	8.8	5	9.4
Aug	14.7	20.5	8.9	7	8.2
Sep	15.5	20.9	10.1	3	5.7



Month	Temperature (°C)			Rainfall (mm)	Fog Days
	Average	Maximum	Minimum		
Oct	16.6	21.7	11.5	5	3.7
Nov	17.9	22.8	13.0	1	4.6
Dec	18.9	23.5	14.4	2	4.3
Annual	17.3	22.6	12.0	46	89

## 5.7 Precipitation

### 5.7.1 Rainfall

The region is characterized by extreme aridity. The rainfall varies from about 15 mm at the coast to about 200 mm at the escarpment; the influence of topography is evident in the steep gradients of the isohyets at the escarpment itself. At the coast no seasonal pattern is evident but moving inland towards the Great Escarpment the summer (October - March) rainfall pattern is increasingly evident. Southern Namibia, in general is much more arid than the north (Van der Merwe (ed), 1983). Rainfall is highly variable; variability ranges from 70 - 80% at Lüderitz to 40 - 50% at Oranjemund.

Rains come in winter and summer, with rainfall averaging 51 mm per annum, and coastal fog an important factor for the moisture regime of many organisms. Alexander Bay receives an annual average rainfall of 46mm. Most rain falls in the winter months; however the area receives very limited annual rainfall with no month exceeding 10mm on average. Mean monthly rainfall totals from the SAWS 27-year climate record (SAWB, 1990) are presented in Table 5.1 above.

### 5.7.2 Fog

Fog is the most distinctive feature of the coastal climate of the Namib. It is usually considered to be a hazard since it reduces visibility and may contribute to weathering and mineral breakdown. On the other hand, it is a significant source of moisture for desert animals and plants. The semi-permanent temperature inversion caused by the warm, dry air mass overlying the cool mass above the ocean is ideal for the formation of fog and low stratus cloud. The fog lies close to the coast extending about 20 nautical miles (~35 km) seawards (Olivier, 1992, 1995). Within a 15 - 20 nautical mile zone offshore, fog frequency may be as high or even higher than at coastal stations. This fog is usually quite dense, visibility less than 300 m, and appears as a thick bank hugging the shore.

The coast from Elizabeth Bay northwards (including Lüderitz) and from Chameis Bay south to Port Nolloth experiences an average of 50 fog days per annum. Between Elizabeth and Chameis bays a lower fog frequency occurs, namely 25 fog days per year. Fog precipitation often exceeds rainfall and is considerably more reliable. At Swakopmund 130 mm of fog precipitation was measured in 1958 - seven times the mean annual rainfall. In the Central Namib, fog precipitation averages 34 mm/year at the coast. Unfortunately there are no fog precipitation data for the study area.

Alexander Bay has on average 89 days of fog per year. Most fog is in the late summer and early autumn; they complement the very limited rainfall that occur in the area and help to sustain the arid vegetation. Mean monthly fog days from the SAWS 26-year climate record (SAWB, 1990) are presented in Table 5.1 above.

## 5.8 Wind

In the coastal environment, the wind regime hampers the operation of equipment which must be protected from sandblasting. The strong winds coupled with the low precipitation creates an extremely harsh environment for plants and animals which adopt various strategies to avoid these extreme conditions.

The prevailing winds in Alexander Bay are predominantly southerly, associated with strong anti-cyclonic circulation in the southern Atlantic Ocean (Figure 5.4). The annual frequency of occurrence of southerly winds is approximately 30%. The average annual wind speed is 4.6 m/s and the station experienced calm conditions for only 5.8% of the observation period. The other dominant wind patterns are on-shore (west / south-westerly) and off-shore (easterly). On-shore winds tend to be stronger than the off-shore winds and this can be attributed to the cold Benguela current that flows up the west coast of southern Africa. From the wind roses in Figures 5.5 to 5.8, it is evident that on-shore winds from the south to south-west are stronger in the afternoon, at about 7.4 m/s.

### 5.9 Humidity

Relative humidity (RH) is strongly influenced by distance from the sea. The mean annual humidity falls sharply towards the interior from around 85% at the coast. Periods of very low RH (<10%) are rare and occur when winter easterly berg winds blow. Very high evaporation rates are recorded during such episodes.

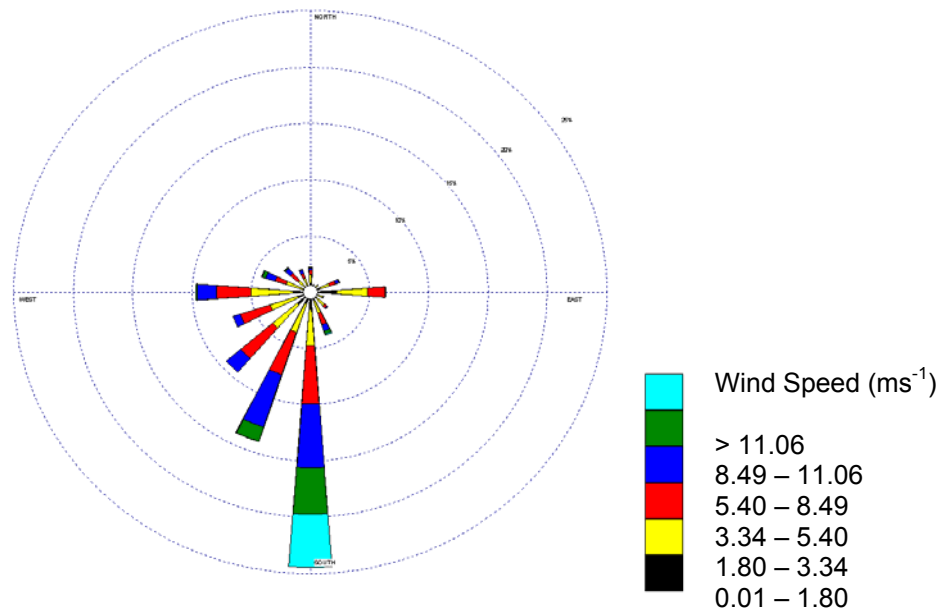
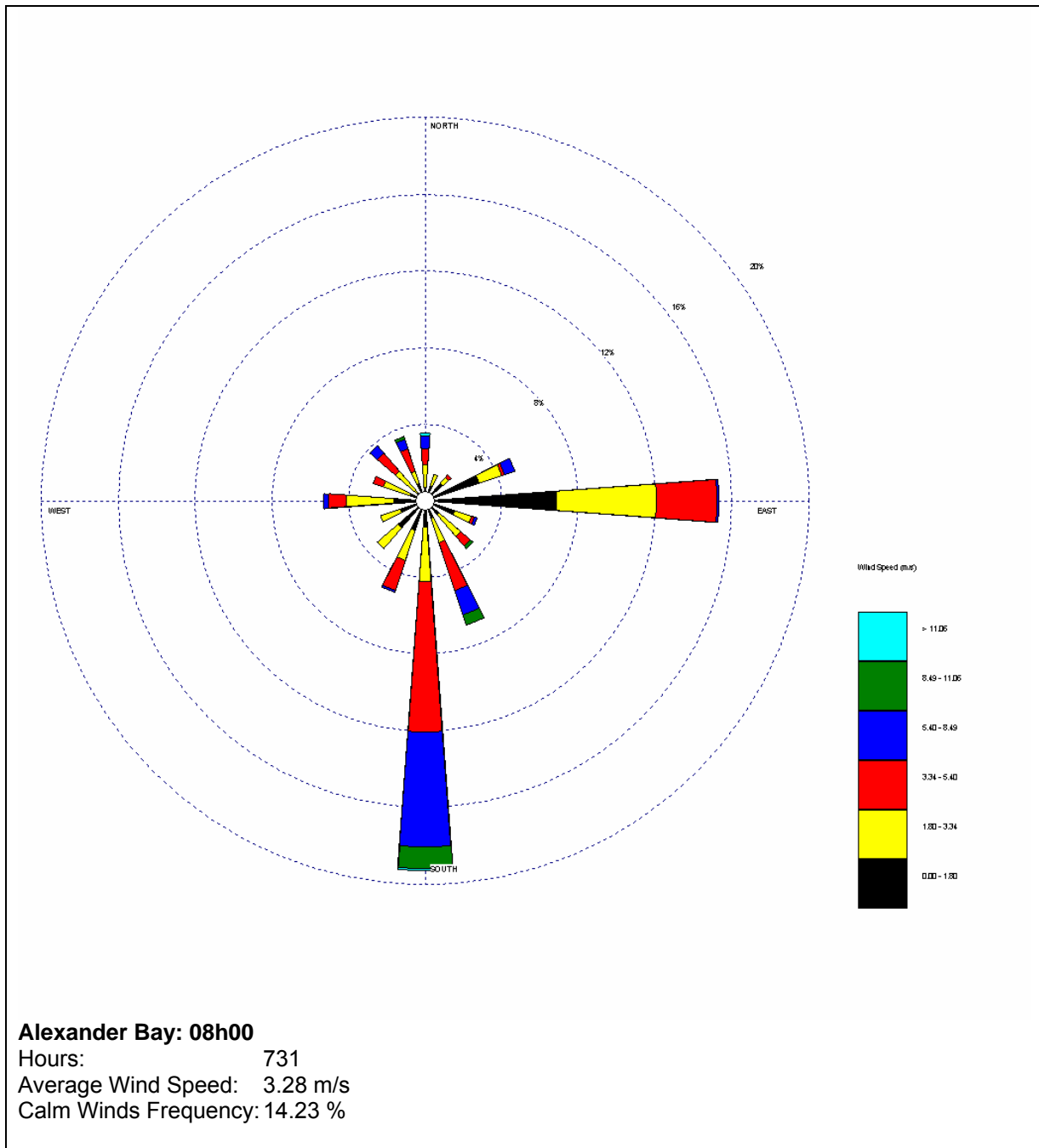


Figure 5.4: Wind rose for Alexander Bay for 2000 and 2001



**Figure 5.5: Wind rose for Alexander Bay for 08h00, for 2000 and 2001**

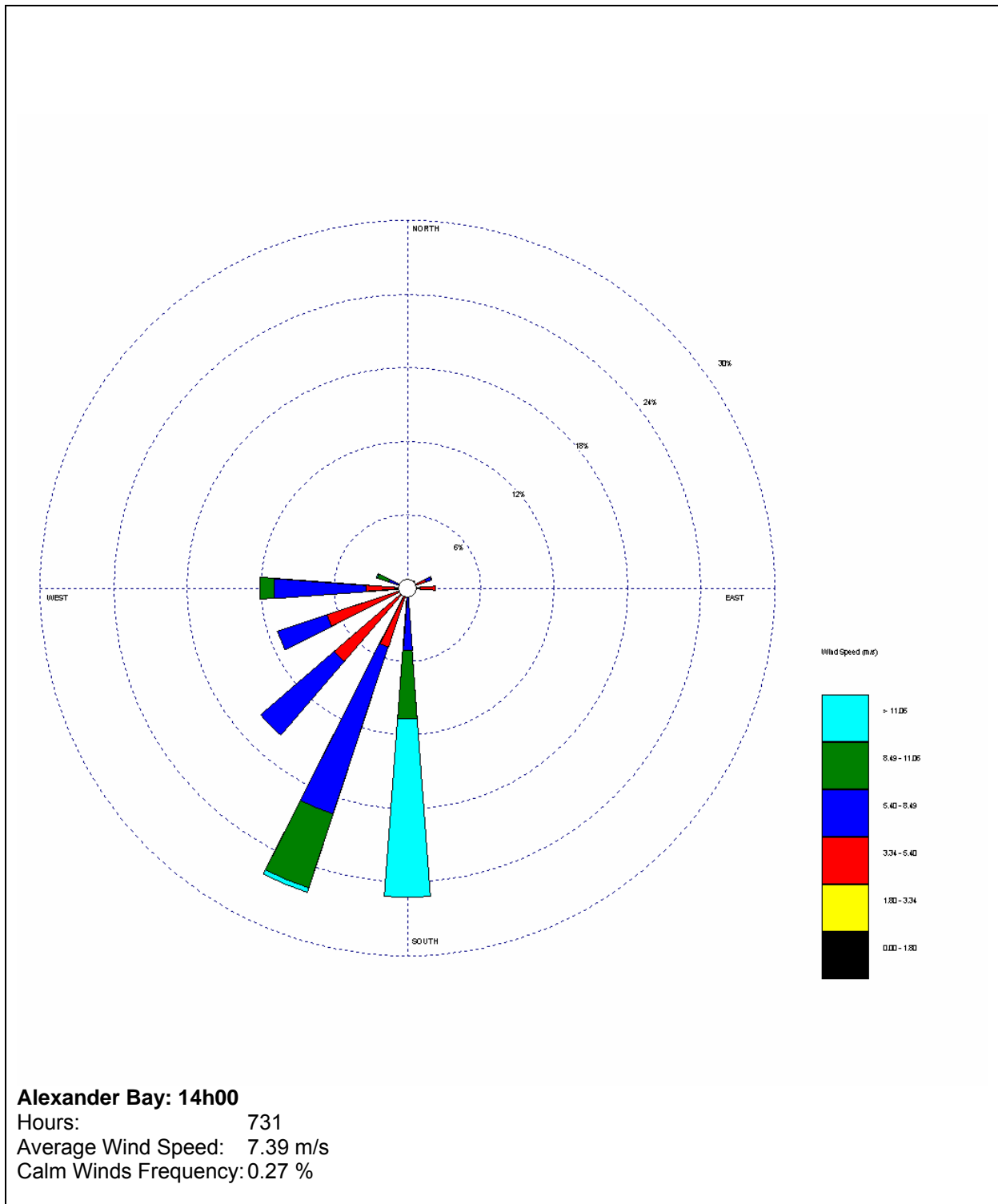


Figure 5.6: Wind rose for Alexander Bay 14h00, for 2000 and 2001

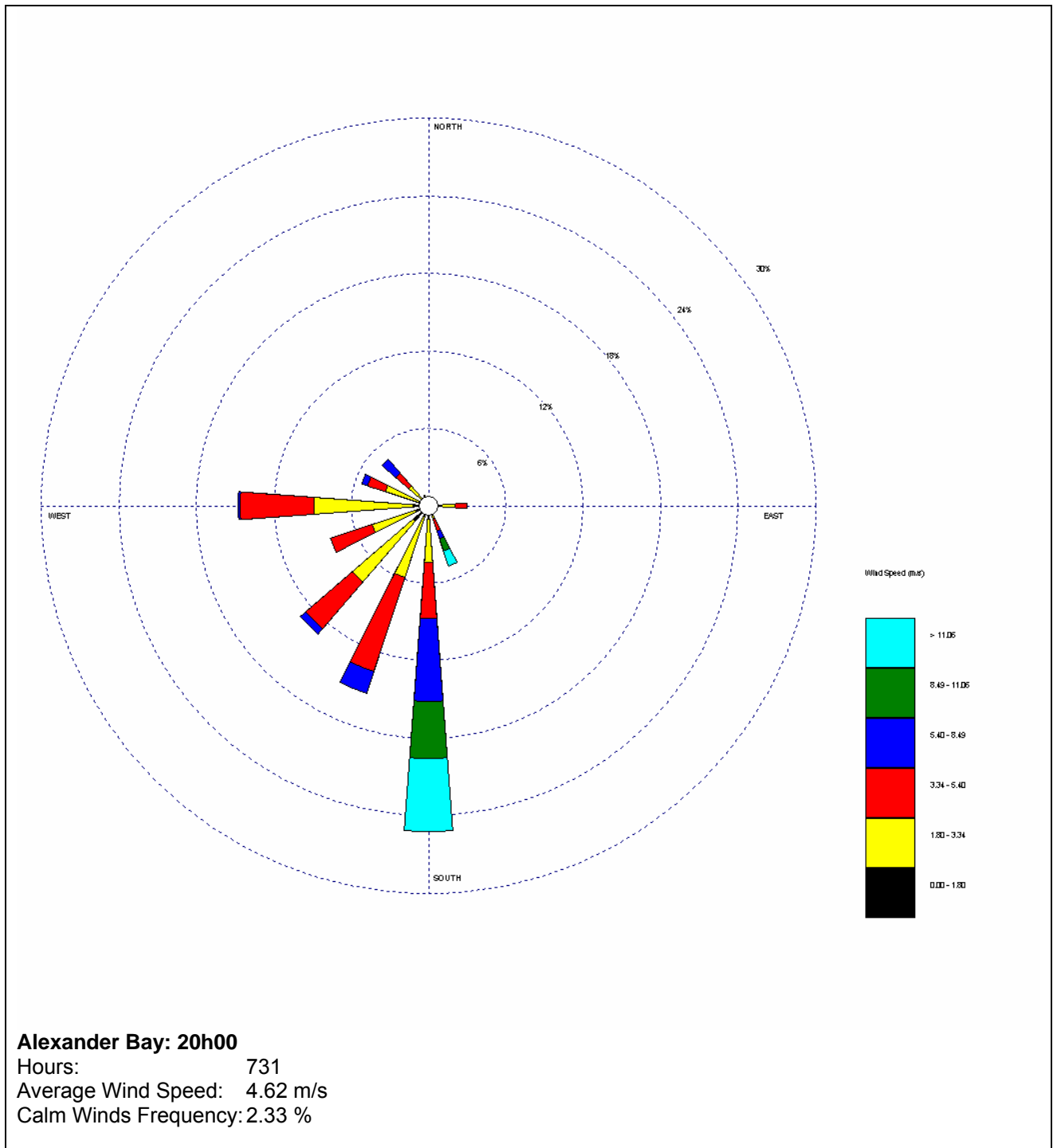


Figure 5.7: Wind rose for Alexander Bay 20h00, for 2000 and 2001

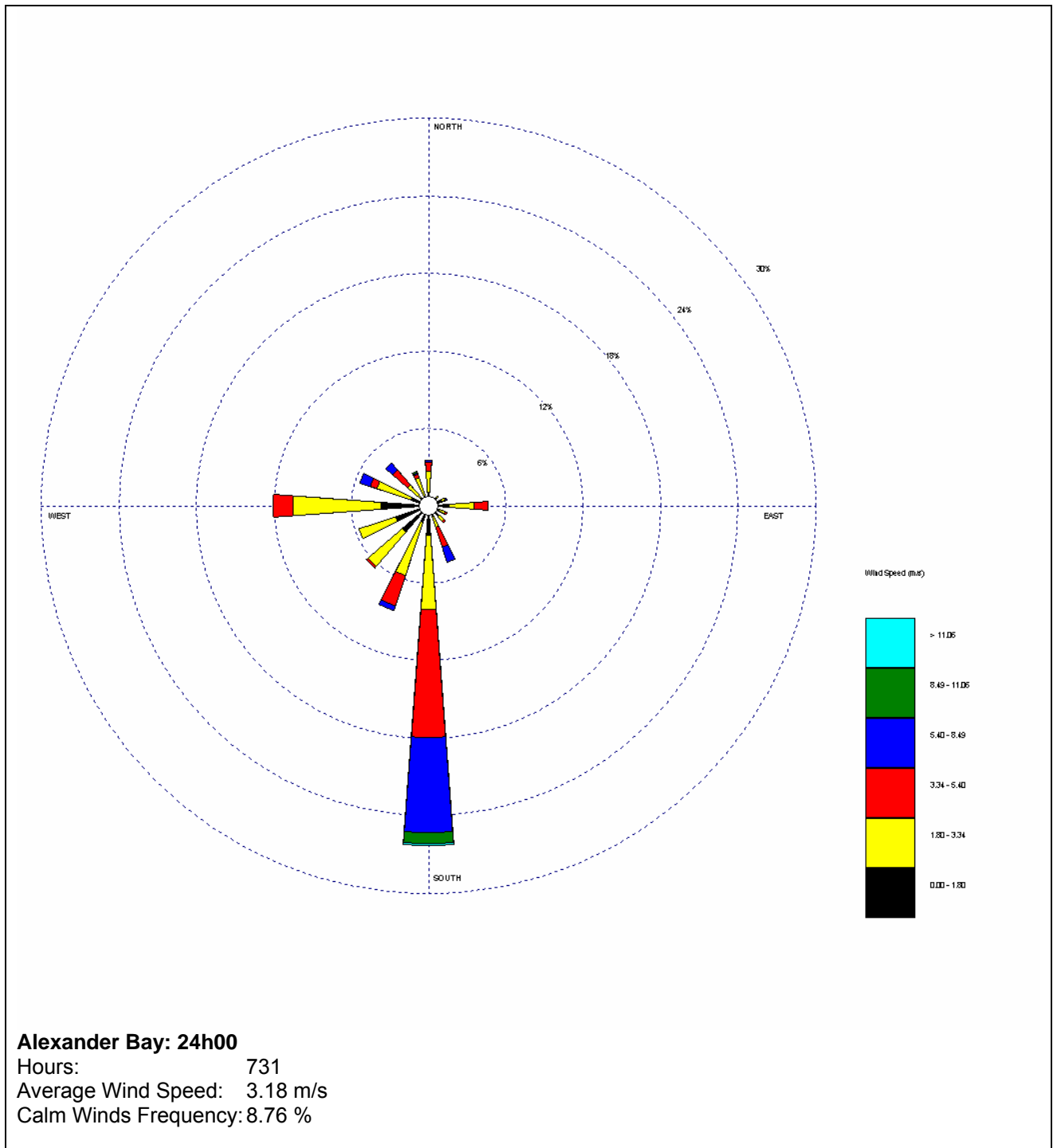


Figure 5.8: Wind rose for Alexander Bay for 24h00, for 2000 and 2001

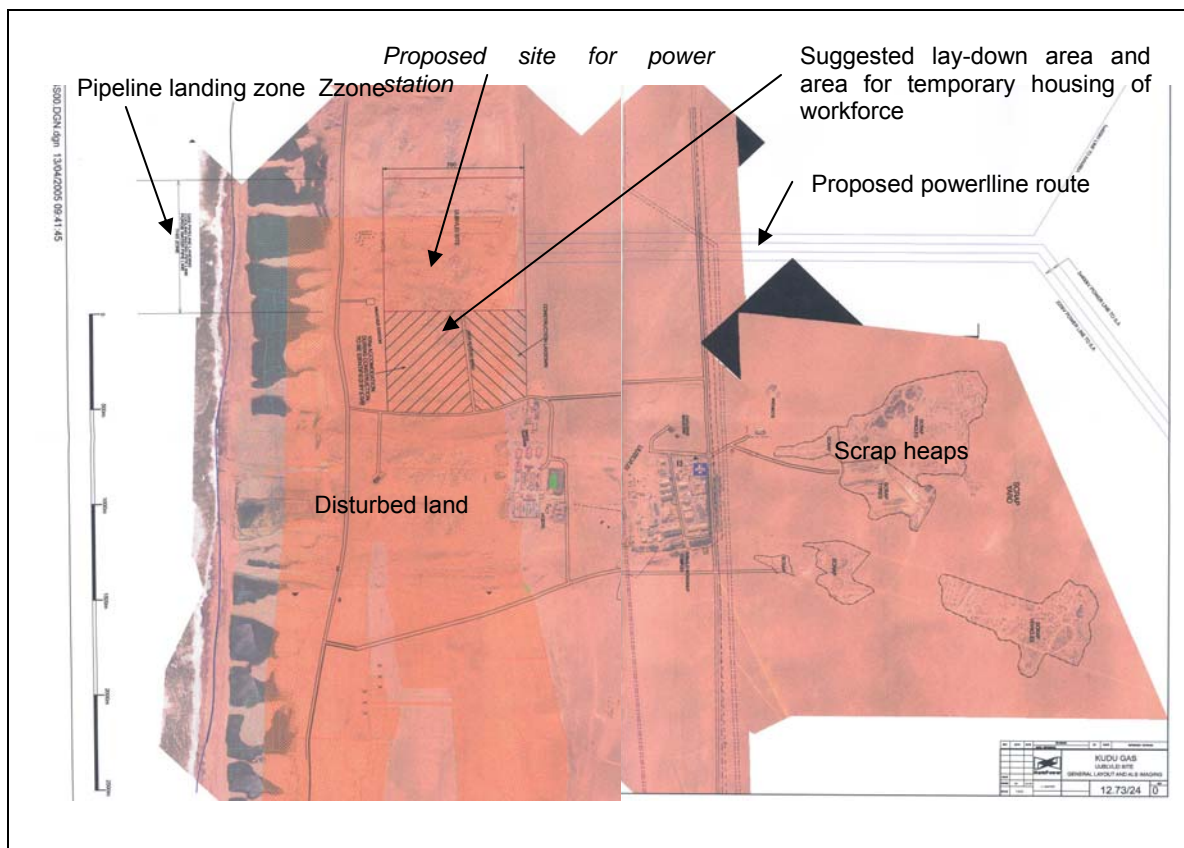
### 5.10 Sunshine and cloudiness

Low stratus and stratocumulus clouds are often formed during the early morning hours (02h00 – 04h00) when onshore breezes blow over the upwelling zone. These clouds may be advected inland, intersecting the rising land to produce fog. The amount of cloud cover is thus highest at night but decreases consistently from 08h00 through midday to 20h00.

The incoming radiation experienced on the Namaqualand coast, as measured at Alexander Bay, is one of the highest values recorded for a coastal region in the world. Drummond and Vowinkel (1957) report a maximum radiation density of  $300 \times 10^5 \text{ J/m}^2/\text{day}$ .

### 5.11 Terrestrial Ecology

The ecology of most of the desert is undisturbed, because Diamond Area 1 has been closed to the public since 1908 and mining activities were confined to the coastal strip and the Orange River valley. Parts of the area at Uubvlei are already greatly disturbed by diamond-mining activities and by scrap-heaps of metal, old equipment and used tyres, but there are also areas that are relatively unspoilt within Mining Area 1 (MA1). Figure 5.9 shows the areal distribution of existing natural habitats and disturbed areas around the CCGT site.



**Figure 5.9:** Map of Uubvlei area that shows the extent of land disturbed by diamond mining operations (hatching), and proposed situation of the power plant and associated activities. Boundaries of habitat zones are not indicated as these were not mapped at the site

### 5.11.1 Vegetation

The study area falls into the northern section of the Succulent Karoo Biome (Figure 5.10), which is regarded as a global biodiversity hotspot, and is thus important in global as well as regional and national terms. This makes only absolutely unavoidable damage acceptable. Williamson (1997) designated this part more specifically as the Lower Orange River Zone, which falls within the Desert and Succulent Steppe as defined by Giess (1971). The vegetation in this area is dominated by low-growing succulents.

The proposed CCGT site is in a very disturbed mining area where nobody resides permanently. Apart from the mine hostels south-east of it, the closest areas to the site where people reside are Oranjemund, approximately 25 km to the south-east, and Alexander Bay, some 7 km further south-east. Due to the mining activities, the vegetation in the most part of the mining area designated for construction of the plant itself, as well as the new access road, possible accommodation site and the construction laydown area (Fig. XXX) is very sparse and in a disturbed state. The existing vegetation, dominated by *Brownanthus arenosus*, *Eberlanzia sedoides*, *Zygophyllum clavatum*, *Lycium tetrandrum* and *Salsola* sp., has re-established itself since the area was mined-out approximately two decades ago. Similar reestablishment of these species may be anticipated over the long term. Although *B. arenosus* is near-endemic, and *E. sedoides* is an endemic and protected species, they are relatively common along a considerable stretch of the coastal plains, and have already shown their propensity for re-establishing themselves once disturbance ceases.

The zone to be affected by the pipelines to and from the sea is similarly disturbed, except on the shoreline, where - examination of aerial photographs - it appears to cross an area of *Salsola* dunes. The mined-out foreshore and ponds habitat has already been extensively compromised, to such an extent that none of the proposed construction would compromise it any further. The coastal *Salsola* hummocks, if present, occur reasonably frequently further north and south along the Namibian coast where similar conditions prevail. *S. nollothensis* is not of conservation concern at present.

The exit zone of the powerlines to Namibia and South Africa east of the plant site comprises a largely undisturbed coastal plain. The vegetation in this area is dominated by low-growing succulents, including *B. arenosus*, *B. marlothii*, *Stoeberia beetzii*, *Othonna furcata* and *Sarcocaulon patersonii*. In addition, *Cephalophyllum ebracteatum* is quite common, as is *Asparagus capensis*, and both *Crassula atropurpurea* var. *cultriformis* and *Juttadinteria deserticola* occur occasionally. *Tridentea pachyrrhiza* a near-endemic, protected species with a very restricted distribution was found (collectors number CM 2682, live plant collection NBRI). With the exception of the last-mentioned species, this assemblage of species is typical of the coastal plains, but less diverse areas of sandy hummocks dominated by the grass *Cladoraphis cyperoides* intervene occasionally towards the western sections. Most of the plant species observed here are found in similar habitats along the coast of the southern Namib, but as several of the species are endemics, and/or protected (Table 5.2), and *J. deserticola* and *T. pachyrrhiza* are thought to occur at a very low density throughout their ranges, it is absolutely essential that unnecessary collateral damage, particularly that due to uncontrolled vehicle activity should be held to a minimum by usage of strictly designated access roads and turning points. This is additionally important because several more species of conservation concern have been recorded in this area previously, although they were not seen during the survey. These include the endemic red data species *Tromotriche aperta* and *Euphorbia cibdela*, as well as *Stapelia garipeensis*, a protected species. The undisturbed nature of this zone, as well as occurrence of species of high conservation importance makes it unacceptable as a construction laydown and accommodation site, particularly as previously disturbed areas are available and suitable for that purpose to the south of the plant site.



**Table 5.2: Protected and endemic species found during field survey, March 2005**

Family	Species	Endemic (E), Near-endemic (nE)	Protected (P) by legislation
Aizoaceae	<i>Brownanthus arenosus</i>	nE	
	<i>Cephalophyllum ebracteatum</i>		P
	<i>Eberlanzia sedoides</i>	E	P
	<i>Juttadinteria deserticola</i>	E	P
Crassulaceae	<i>Crassula atropurpurea</i> var. <i>cultriformis</i>		P
Apocynaceae	<i>Tridentea pachyrrhiza</i>	nE	P

Several more species of conservation concern have been recorded in this area previously, although they were not seen during a survey conducted during March 2005. These include the endemic red data species *Tromotriche aperta* and *Euphorbia cibdela*, as well as *Stapelia garipeensis*, a protected species.

### 5.11.2 Terrestrial Fauna

The terrestrial fauna of the study area from the Orange River mouth to the proposed CCGT site is adapted to a harsh environment with low rainfall and, inland of the fog belt, high summer temperatures. In adopting strategies to survive in these conditions, many of the species are cryptic or nocturnal or have extended dormant periods and only emerge under optimum conditions.

**Low hummocks and coastal plains.** Areas disturbed by earlier mining have vegetation areas that are sparser than normal, and presumably similarly for fauna. During mining, the soil in these areas has been excavated, sieved and dumped back, and some re-establishment of plants has subsequently taken place. Recolonisation by invertebrates and small vertebrate animals has probably also taken place, but the extent of this has not been ascertained. Where this habitat has not been disturbed by mining, it supports an interesting array of plant species and is home to some specialised fauna. Lichens are an important feature in this habitat, growing on hummocks of *Salsola* and *Brownanthus*. Lichens in general in Namibia are poorly known, and this area even less because of the restrictions of Diamond Area 1 (Wessels 1994), so it is not known if any species are endemic to a limited area here, or are of any conservation significance for other reasons.

As in much of the Namib, most of the ecological action by fauna in this area is carried out by small animals that can shelter from the harsh conditions of strong winds and meagre rainfall, and that can take advantage of the moisture provided by fog. Evidence of animal activity is seen in spider webs in most of the plants, tracks of snails, beetles, lizards, snakes, larks and hares on the ground, tracks of beetle larvae and legless lizards just beneath the surface, burrows of scorpions and small rodents, and various other signs of cryptic life.

The habitat supports a well-developed, mainly sand-living invertebrate fauna with a large but unspecified number of endemic species (Marais 1998).

Of the amphibians, a noteworthy species is the desert rain frog (*Breviceps macrops*), which might even be a separate species from adjacent Namaqualand populations. If this is the case, Namibian responsibility for this species, (presently classified as Insufficiently Known & Endemic, Griffin 1999) would increase considerably (Griffin 1998). This unusual frog depends on fog moisture, confining it to a thin belt close to the coast, and lives in sandy hummock habitat in the Sperrgebiet only, much of which has been or will be destroyed in diamond mining operations.

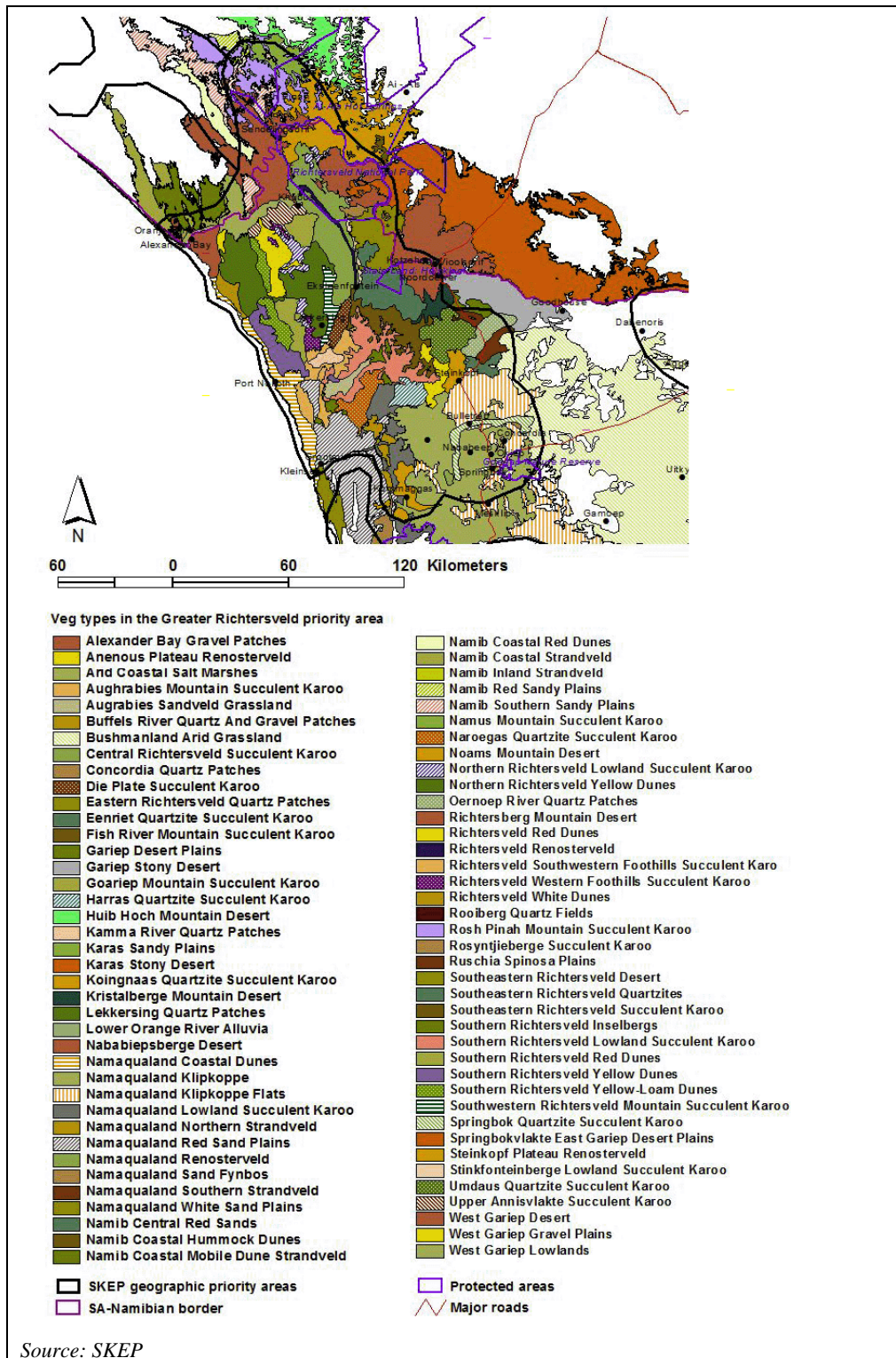


Figure 5.10: Vegetation types in the Greater Richtersveld area, that includes Uubvlei

Reptile species of concern are the Namaqua dwarf adder (*Bitis schneideri*, also called twin-spotted adder) classified as Insufficiently Known [Griffin 1999] and possibly some underground-living lizards (legless skinks of the genus *Typhlosaurus*) which have still to be confirmed. These species are also confined to the vegetated hummock habitat, and are thus threatened by mining activities (Griffin 1998). The snake *Bitis schneideri* exists largely in the area that is or has been mined out in the course of diamond mining by Namdeb. It is known to exist in two colour morphs, dark and pale, and these may be separate species. Thus the conservation status for this possible species complex is raised.

No mammals of conservation significance occur in this area.

**Coastal hummock habitat.** The foreshore area near the CCGT site has been completely mined out, leaving little of the original vegetation and fauna. It is assumed to support depauperate remnants of the original vegetation and animals, namely hummocks around *Salsola* bushes, and fauna similar to the low hummock habitat immediately inland.

### 5.11.3 Terrestrial and Coastal Avifauna

The terrestrial avifauna of the study area is adapted to a harsh environment with low rainfall. The Chestnutbanded Plover frequents salt pans and nests on and around them. The Damara Tern nests in dune slacks and on exposed gravel plains. The marine and coastal species listed in Table 5.3 plus the Black-necked Grebe, use the mining ponds for feeding and roosting. Barlow's Lark is found virtually throughout the Sperrgebiet plains, wherever there is sufficient vegetation. It has the smallest range (about 18 000 km<sup>2</sup>), and its habitat use and morphology is highly variable (Pallett, 1995). They appear to be susceptible to changed land use practices that reduce the amount of vegetation cover. Since the CCGT site has already been reduced of vegetation cover, there would be no additional impact as a result of building the proposed power plant.

At times the area supports more than 1 % of the world population of three species endemic to south-western Africa: the Cape Cormorant *Phalacrocorax capensis*, Damara Tern *Sterna balaenarum* and Hartlaub's Gull *Larus hartlaubii*. On a southern Africa scale the Orange River wetland supports more than 1 % of the subcontinental population of Blacknecked Grebe *Podiceps nigricollis*, Lesser Flamingo *Phoenicopterus minor*, Chestnutbanded Plover *Charadrius pallidus*, Curlew Sandpiper *Calidris ferruginea*, Swift Tern *Sterna bergii*, and Caspian Tern *Hydroprogne caspia*. The sixteen species found in the study area that are listed in *The Eskom Red Data Book of Birds of South Africa, Lesotho and Swaziland* (Barnes (ed) 2000) are given in Table 5.3

**Table 5.3 Red Data Book bird species occurring between Port Nolloth and Lüderitz.**

Species	Status
<b>Marine and Coastal species:</b>	
African Penguin <i>Spheniscus demersus</i>	Vulnerable
White Pelican <i>Pelecanus onocrotalus</i>	Near-threatened
Cape Gannet <i>Morus capensis</i>	Vulnerable
Cape Cormorant <i>Phalacrocorax capensis</i>	Near-threatened
Bank Cormorant <i>Phalacrocorax neglectus</i>	Vulnerable
Crowned Cormorant <i>Phalacrocorax coronatus</i>	Near-threatened
Greater Flamingo <i>Phoenicopterus ruber</i>	Near-threatened
Lesser Flamingo <i>Phoenicopterus minor</i>	Near-threatened
Chestnutbanded Plover <i>Charadrius pallidus</i>	Near-threatened
Caspian Tern <i>Sterna caspia</i>	Near-threatened
Damara Tern <i>Sterna balaenarum</i>	Endangered
<b>Terrestrial species:</b>	
Kori Bustard <i>Ardeotis kori</i>	Vulnerable

Ludwig's Bustard	<i>Neotis ludwigii</i>	Vulnerable
African Black Oystercatche	<i>Haematopus moquini</i>	Near-threatened
Martial Eagle	<i>Polemaetus bellicosus</i>	Vulnerable
Barlow's Lark	<i>Certhilauda barlowi</i>	Near-threatened

### 5.12 Air quality

The ambient air quality at Uubvlei is generally good, although dust storms do occur, particularly in the winter when easterly off-shore winds are more common. Visibility along the coast is often reduced as a result of the frequent fog and salt spray. As such, the only pollutant of concern would be particulate matter, which has more of a nuisance value than human health impact except when fine particulate matter can enter the respiratory system. Other sources of air pollution in the study area would be limited to activities associated with diamond mining along the coastline, but their impact is minimal on the area where the CCGT site is. There is currently no ambient air quality monitoring in the study area.

### 5.13 Noise

Ambient noise would be generated by wind, thundering waves and occasionally, mining activities, air traffic and vehicle movements. The power plant will operate continuously over a 24-hour period, and the major potential impact of noise would be during evening and night-time when man-made noise at any location is at a minimum, and when people expect to rest in quiet surroundings.

### 5.14 Archaeology

The archaeological evidence shows that early man frequented the shores of the Orange River from about 1.5 million years ago. It was used as both a linear oasis and a route from inland to the coast during the Early Stone Age, the Middle Stone Age and the Later Stone Age. A full archaeological survey was undertaken over the southern part of Mining Area 1 (which includes the CCGT site) prior to mining. Since the CCGT site has since been mined out, there are no archaeological concerns on the site *per se*. Depending on their various locations, however, the access routes, the gas pipeline, the power line and construction camps could easily put the archaeological record at risk if they are not evaluated as an integral part of the final EIA and EMP.

### 5.15 Orange River Transboundary Conservation Area

It is envisaged that an overall Transfrontier Conservation Area will consist of a national park, provincial parks, a community-based conservancy, several South African Heritage Resource Association (SAHRA) sites, municipal reserves and Sensitive Coastal Areas (SCAs). A proposed network of protected areas includes the Orange River Mouth Transboundary Ramsar Site, the Richtersveld - Ai-Ais Transfrontier Park, the Richtersveld Community-based Conservancy and the Sperrgebiet.

In Namibia, the Sperrgebiet will become a protected area. The Ai-Ais-Richtersveld Transfrontier Conservation Park spans some of the most spectacular scenery of the arid and desert environments in southern Africa. It is bisected by the Orange River, and it comprises the Ai-Ais Hot Springs Game Park in Namibia and the Richtersveld National Park in South Africa. Some of the distinctive features in the area include the Fish River Canyon (often likened to the Grand Canyon in the USA) and the Ai-Ais Hot springs. This arid zone is further characterised by a unique and impressive variety of succulent plant species, which makes the proposed park an internationally recognized biodiversity "hot spot".

## 5.16 Population Centres

### 5.16.1 Oranjemund

Oranjemund lies within Diamond Area 1, but outside Mining Area 1 (MA1), a roughly 3km band from the Orange River mouth to Chameis Bay, with strict controls on access. Though the land is owned by the State, infrastructure and assets are owned by Namdeb. The government of Namibia intends for Oranjemund to become a municipality, and a structure plan and site layout are being finalized in preparation for this. The 6 000 to 8 000 people who inhabit the “Sand Hotel” informal settlement around Rosh Pinah are an indication of what could happen to the town if it were to be proclaimed and opened to the public.

For planning purposes, the population services by the town of Oranjemund is estimated at between 6 000 and 9 000, of whom 60% will be males. Currently some 750 of the 3000 employees are resident in hostel accommodation near the Uubvlei mining operation outside the town. However, as land-based mining winds down, these employees are being relocated into town. Within 5 years, all employees will live in Oranjemund. It is expected that, by 2009, the number of persons employed by Namdeb will be reduced to approximately 1500 and that these will all be resident in Oranjemund (Rukamba, 2004).

The majority of the workforce are Namibians. Those who are employed from outside the country bring skills not available in Namibia in the technical, professional and management fields. All employees who are classified as unskilled labourers enjoy a wage rate which is three to four times higher than that of most other workers in Namibia in similar occupations. The impact of these workers on the local town economy is therefore significant.

Excellent schooling facilities are available in town for primary and pre-primary education. High schooling is only available at Alexander Bay or at boarding schools in Namibia and South Africa.

As is the case with the rest of Namibia, prevalence of HIV/AIDS among the workforce is high and constitutes the single highest risk in Oranjemund. Namdeb currently estimates that 7.5% of their staff is HIV positive. All medical services for the mine and Oranjemund are provided by the Chief Medical Officer based at the town's hospital. The clinical medical services provided include physiotherapy, dental, x-ray, laboratory, paramedical services, social therapy, occupational health and preventative health. Namdeb also provides a district surgeon.

Namdeb delivers social services to the community in the form of individual casework, family counselling and community development projects. Community health, family planning, baby and immunisation clinics are available once per week. Alcohol abuse is one of the main problems experienced by Namdeb employees and thus a branch of Alcoholics Anonymous has been established in the town.

The town of Oranjemund offers social services and facilities at a level usually only found in much bigger towns. These include health facilities, schools, a technical college, a crèche, a public library, parks, recreation facilities and sports fields. Although Oranjemund remains a “closed” town, it nevertheless has developed a viable commercial service and industrial sector. There are more than 30 social and recreation clubs in Oranjemund, including horse riding, yachting, golf, soccer, tennis, youth clubs and gymnasiums. Namdeb equips and maintains all clubs and children's playgrounds. Staff work with parents to co-ordinate youth activities.

Oranjemund has always rated itself as a highly safe and secure town for its residents with an exceptionally low crime rate. This is partly due to the isolated nature of the town and its small size, but mostly because of the security measures which are implemented around the diamond industry. However, local residents and business operators report a recent increase in the crime rate which they

attribute to the out sourcing of certain Namdeb functions and the operation of private business in town. This slight "opening" of the town has facilitated the influx of unemployed people.

### 5.16.2 Alexander Bay

Alexander Bay, exists to support the Alexkor diamond mine. In future the town may be opened to the public. It may serve as a staging point en route to the new Richtersveld National Park some 100 km inland. Alexkor is a wholly state owned corporation charged with development in north-west Namaqualand. It is envisaged that Alexander Bay will become an "open" town in the not too distant future, but there are land claims that still have to be resolved in terms of South African law.

### 5.16.3 Lüderitz

Lüderitz is an important port which serves southern Namibia, connected via Keetmanshoop to the southern African rail network. At present the railway line between Lüderitz and Aus is disused; the high cost of maintaining this section of line in the face of constant inundation by mobile sand dunes has led to its closure. Lüderitz serves as a base for the local fishing industry: catches are processed, and boats repaired and serviced. Various light industries serve local requirements and much of the hinterland. Equipment for the resuscitated diamond mine at Elizabeth Bay has been imported through Lüderitz. Tourism is becoming more important. Visitors are drawn by the German colonial architecture, the ghost-town of Kolmanskop and the mystique of the *Sperrgebiet* or "Forbidden Zone".

### 5.16.4 Rosh Pinah / Skorpion

Rosh Pinah is about 75 kilometers to the north-east of Oranjemund. It is a mining town that is managed jointly by Roshkor, the company founded by Rosh Pinah Zinc Corporation and the Skorpion Zinc Project to jointly develop this desert town. Because it is not able to exercise the same immigration control available to Oranjemund and Alexander Bay, an informal settlement known as the "Sand Hotel", of some 6000 to 8000 speculative employment seekers, has developed adjacent to the town. This is causing major town management problems.

Like Oranjemund, Rosh Pinah will be proclaimed as a town and the management of the town will eventually be in the hands of a local authority. Its commonage of more than 10 000 hectares is situated in the Ai-Ais Hot Springs Game Park, and this area will be deproclaimed before proclamation of the town takes place.

After construction of the Skorpion Zinc Mine, the town changed in size. Buildings and houses appeared in areas on the fringes of the town that have been uninhabited desert for the past thirty years, tar roads replaced some gravel roads and plots for development were made available.

Since the opening of the Skorpion Zinc Mine, heavy-duty traffic has increased considerably on the 146km stretch of gravel road that used to be the mining town's only link to the interior of Namibia. Rosh Pinah is also linked to the south by a gravel road that crosses the Orange River and connects to the road to Alexander Bay. This is currently the only link for the general public to Oranjemund. Kumba Resources, the owner of the mining operation at Rosh Pinah uses the road to Aus to transport zinc ore in bulk to the railway terminal just outside Aus. From here the ore is transported by rail to their zinc smelter in Van der Bijl Park in South Africa's industrial heartland, the Gauteng Province. Ore from Rosh Pinah is also transported further to Richards Bay on South Africa's east coast from where it is exported to Kumba Resources' smelter in China.

Transporting the ore from Rosh Pinah to Aus has always been done by TransNamib on tender. Skorpion exports zinc ingots which are also transported by truck on the same road to Aus, from where they are taken to Lüderitz for export by sea. The Aus-Rosh Pinah road is meant to provide Oranjemund and Rosh Pinah with an all-weather access to the national road grid. Aus is situated

some 140km from Lüderitz on the main artery between the southern harbour town and Keetmanshoop.

## **5.17 Communications**

### **5.17.1 Roads**

By road, Oranjemund is accessible from three different directions:

- A gravel road along the north bank of the Orange River from Rosh Pinah in the east;
- A security gravel road from the Lüderitz-Aus road in the south; and,
- From South Africa via the Ernst Oppenheimer bridge seven kilometers south-east of Oranjemund.

The southern security road runs through the Sperrgebiet and is planned to be the route used to transport the main combined cycle power plant components from Lüderitz. The road from Aus via Rosh Pinah will be upgraded and tarred.

Lüderitz is connected to Keetmanshoop, the "capital" of southern Namibia, by an all weather tarred road. A private dirt road connects Lüderitz with Oranjemund.

Oranjemund is connected to Alexander Bay and thence to Port Nolloth via a recently tarred road. The single-lane Oppenheimer Bridge spans the Orange River some 9 km from its mouth. Port Nolloth is connected to the extensive South African highway network through Steinkopf and Springbok.

### **5.17.2 Rail**

Until recently, Lüderitz was served by rail. It was connected via Aus and Keetmanshoop to the extensive southern African rail network.

### **5.17.3 Air**

There is an airport at both Oranjemund and Alexander Bay. Lüderitz and Oranjemund are served by a regular Air Namibia service which connects them to Windhoek and Cape Town. Alexander Bay is served charter services. There is no regular air service to Port Nolloth.

### **5.17.4 Telecomms**

Oranjemund has an automatic telephone exchange and full cellphone reception. All four centres, Lüderitz, Oranjemund, Alexander Bay and Port Nolloth are connected to their respective national (mainly microwave) telephone networks that are fully connected to the global system.

## **5.18 Tourism**

The Namibian government has decided, in principle, that the once restricted diamond mining area, the Sperrgebiet, be proclaimed a national park. The Government and De Beer Centenary reached an agreement in 1994 that mining rights and control of 63% of the Sperrgebiet should be given back to the State and to be controlled by the Namibian Police. De Beers Centenary, which is a partner in Namdeb, continued to control the entire area of the Sperrgebiet to guard against theft and because they had the logistical capacity. Permits to enter the area are issued by the Namibian Police. In 1999, the Ministries of Environment and Tourism (MET), Mines and Energy (MME) and Lands, Resettlement and Rehabilitation commissioned a land use plan for the Sperrgebiet.

The main objective of the land use plan is to seek ways of developing and managing the area in an integrated way for the long-term benefit of the country, and it is funded by Denmark. The Sperrgebiet

is one of the world's 25 top globally recognised bio-diversity hotspots for fauna and flora, and offers unique scenery ideal for high quality, low impact tourism. The area has been identified as a priority area for conservation in the Succulent Karoo Ecosystem Plan (SKEP), a 20-year strategy that now guides conservation action in this hotspot. The strategy was developed and is being implemented with support from the Critical Ecosystem Partnership Fund (CEPF) and Conservation International's Global Conservation Fund.

Tourism throughout Namibia has developed into an extremely important growth industry. Tourists to Namibia wish to experience wide open, unspoilt places. However, since the West Coast Recreation Area to the north of Swakopmund was opened to the general public, off-roaders have degraded it with multitudes of tracks, and the Kaokoveld is heading in the same direction. A good model for Sperrgebiet tourism is probably provided by the Kolmanskop Tour Company, which has been operating a small-scale form of zero-impact eco-tourism in the area since 1993. With the exception of Kolmanskop, no self-driving was allowed, and access was limited to only 5 % of the area. Even that access was restricted to the use of fixed routes along existing roads in the coastal margin which had already been disturbed by mining.

If implemented properly and sustainably, the development of tourism in the Sperrgebiet can stimulate the economy of southern Namibia by bolstering the economies of towns such as Rosh Pinah and Lüderitz, and serve as a gateway to the Lüderitz waterfront.



# CONTENTS

6. IMPACT DESCRIPTION AND ASSESSMENT .....	6-1
6.1 Socio-economic assessment .....	6-2
6.1.1 Impact on the population, employment and social services .....	6-2
6.1.2 Impact on the infrastructure and urban services.....	6-10
6.1.3 Impact on the economic structure and urban management .....	6-16
6.1.4 World Bank requirements for assessment of socio-economic impacts.....	6-24
6.2 Impact of noise on the receiving environment .....	6-24
6.2.1 World Bank requirements for assessment of noise impacts .....	6-25
6.3 Impact on vegetation.....	6-25
6.3.1 The vegetation on the site and its environs .....	6-25
6.3.2 Impact description: Impact on vegetation.....	6-26
6.3.3 Impact assessment: Impact on vegetation .....	6-26
6.3.4 Impact assessment: Mitigation and monitoring .....	6-26
6.3.5 World Bank requirements for assessment of impacts on vegetation .....	6-26
6.4 Impact on terrestrial ecology and fauna, excluding birds.....	6-28
6.4.1 The terrestrial ecology of the CCGT site and its environs.....	6-28
6.4.2 Construction phase.....	6-29
6.4.3 Operational phase.....	6-31
6.4.4 Emergencies.....	6-31
6.4.5 World Bank requirements for assessment of impacts on the terrestrial ecology.....	6-31
6.5 Impact of air emissions .....	6-32
6.5.1 Air emissions in the study area.....	6-32
6.5.2 Approach to the air quality study.....	6-34
6.5.3 Impact of NO <sub>x</sub> on vegetation .....	6-37
6.5.4 Impact description: Impact of air pollution on vegetation.....	6-37
6.5.5 Impact assessment: Impact of air pollution on vegetation .....	6-38
6.5.6 Impact description: Impact of air pollution on human health.....	6-39
6.5.7 Impact assessment: Impact of air emissions .....	6-42
6.5.8 Mitigation and monitoring measures .....	6-44
6.5.9 World Bank requirements for assessment of impacts from atmospheric emissions .....	6-45
6.5.10 Permit requirements.....	6-47
6.6 Visual impact of the power plant.....	6-47
6.7 Impact of the purge water discharge.....	6-48
6.7.1 World Bank requirements for assessment of effluent discharges .....	6-48
6.7.2 Description of the purge water discharge.....	6-49

6.7.3	<i>Discharge Scenarios Assessed</i> .....	6-57
6.7.4	<i>Anticipated changes in the marine environment due to a discharge of heated brine</i> .....	6-57
6.7.5	<i>Potential Environmental Impacts</i> .....	6-67
6.7.6	<i>Offshore Discharge Impact Assessment</i> .....	6-74
6.7.7	<i>Shoreline Discharge Impact Assessment</i> .....	6-78
6.7.8	<i>Mitigation and monitoring measures</i> .....	6-84
6.7.9	<i>Permit requirements</i> .....	6-86

## FIGURES

Figure 6.1:	Vegetation zoning around Uubvlei for Kudu CCGT power plant .....	6-27
Figure 6.2:	The extent of land disturbed by diamond mining operations (orange hatching) and proposed situation of the power station and associated activities. Boundaries of habitat zones are not indicated as these were not mapped at the site. ....	6-29
Figure 6.3:	Schematised behaviour of a typical negatively buoyant effluent plume such as the heated brine being considered in this study. ....	6-59
Figure 6.4:	Schematised discharge pipeline and dimensions.....	6-60
Figure 6.5:	Characterisation of the mixing processes in the near shore zone (after RSA DWAF, 2004b).....	6-65
Figure 6.6:	Southern Namibian rock lobster fishing area in relation to the proposed location of the CCGT pipeline at Uubvlei (after MDP, 2004) .....	6-69

## TABLES

Table 6.1:	Stress on Health Systems .....	6-3
Table 6.2:	Stress on occupational health .....	6-5
Table 6.3:	Stress on education, social and recreation facilities .....	6-6
Table 6.4:	Stress due to increased crime and alcohol related violence .....	6-8
Table 6.5:	Employment opportunity for retrenched Namdeb workers.....	6-9
Table 6.6:	Increased urban road traffic .....	6-11
Table 6.7:	Impact on the town's housing stock .....	6-13
Table 6.8:	Impact on the town's reticulated services .....	6-15
Table 6.9:	Impact on Namdeb diamond mining operations.....	6-17
Table 6.10:	Macro-economic spin-offs from the operation of the plant.....	6-18
Table 6.11:	Local economic spin-offs.....	6-20
Table 6.12:	Impact on local governance .....	6-21
Table 6.13:	Impact of informal employment speculators (squatters) .....	6-22
Table 6.14:	Impact of decommissioning.....	6-23
Table 6.15:	World Bank guidelines on maximum noise levels .....	6-25
Table 6.16:	Assessment of clearing the area for power plant buildings, and temporary accommodation for construction workers.....	6-30

Table 6.17:	Compounds of potential concern and health endpoints .....	6-33
Table 6.18:	Summary of stack parameters and emission rates per shaft for the Kudu CCGT power plant.....	6-34
Table 6.19:	Emission scenarios modelled.....	6-35
Table 6.20:	Summary of the pollutants assessed .....	6-35
Table 6.21:	Emission and exposure scenarios for SO <sub>2</sub> , PM and NO <sub>x</sub> .....	6-36
Table 6.22:	Environmental loading of nitrogen.....	6-38
Table 6.23:	Nitrogen enrichment causing water-stress, increased predation, etc. ....	6-38
Table 6.24:	Nitrogen enrichment causing soil nutrient imbalances.....	6-39
Table 6.25:	Nitrogen enrichment causing changes in community structure .....	6-39
Table 6.26:	Reference guidelines and standards concentrations for NO <sub>x</sub> , SO <sub>2</sub> and TSP.....	6-40
Table 6.27:	Maximum modelled ambient concentrations of NO <sub>x</sub> for the six emission scenarios .....	6-40
Table 6.28:	Maximum modelled ambient concentrations of SO <sub>2</sub> for two emission scenarios.....	6-41
Table 6.29:	Maximum modelled concentrations of TSP for oil-fired power plant.....	6-42
Table 6.30:	No <sub>x</sub> – oil .....	6-43
Table 6.31:	No <sub>x</sub> – gas .....	6-43
Table 6.32:	SO <sub>2</sub> – oil.....	6-43
Table 6.33:	TSP – oil.....	6-44
Table 6.34:	CO <sub>2</sub> .....	6-44
Table 6.35:	Fugitive dust .....	6-44
Table 6.36:	Summary of emission requirements and Kudu CCGT emissions.....	6-46
Table 6.37:	Characteristics of discharged cooling/purge waters from an evaporative cooling system.....	6-50
Table 6.38:	Potential aqueous discharges .....	6-52
Table 6.39:	Summary of discharge options.....	6-57
Table 6.40:	Estimated plume dimensions for a 800 MW nominal capacity power plant.....	6-66
Table 6.41:	Estimated plume dimensions for a 1600 MW nominal capacity power plant.....	6-66
Table 6.42:	Water quality guidelines for the discharge of a heated brine into the marine environment.....	6-71
Table 6.43:	International guidelines for benzene, toluene, chlorinated benzenes and xylene ...	6-72
Table 6.44:	International guidelines for ammonia and inorganic nutrients.....	6-73
Table 6.45:	Impact of thermal plume .....	6-75
Table 6.46:	Impact of salinity plume .....	6-75
Table 6.47:	Impact of biocide plume .....	6-75
Table 6.48:	Impact of aromatic hydrocarbons .....	6-76
Table 6.49:	Impact of HRSG blowdown effluent .....	6-76
Table 6.50:	Impact of a decline in dissolved oxygen levels .....	6-77
Table 6.51:	Impact of flow field distortion due to momentum transfer .....	6-77
Table 6.52:	Impact of discharge and intake structures .....	6-78
Table 6.53:	Impact of thermal plume on marine biota.....	6-79

Table 6.54:	Impact of salinity on beach and surf-zone communities .....	6-80
Table 6.55:	Impact of elevated salinity interfering with physiological function of larval fish and invertebrates.....	6-80
Table 6.56:	Impact of biocide on beach and surf-zone communities .....	6-81
Table 6.57:	Impact of aromatic hydrocarbons .....	6-81
Table 6.58:	Impact of HRSG blowdown effluent .....	6-82
Table 6.59	Impact of a decline in dissolved oxygen levels .....	6-82
Table 6.60	Impact of salinity acting as a barrier to larval migration .....	6-82
Table 6.61	Impact of elevated salinity & temperature of brine interfering with larval fish cueing .....	6-83
Table 6.62	Impact of flow field distortion due to momentum transfer .....	6-83
Table 6.63:	Impact of discharge and intake structures on sediment transport .....	6-83

## 6. Impact Description and Assessment

Potential impacts of the proposed activity on the environment are described and assessed in this Chapter, by applying the criteria in Box 6.1.

### Box 6.1: Assessment of potential impacts

The significance of potential impacts should be described as follows:

- **Low:** Where the impact will not have an influence on the decision, nor is it critical for it be accommodated in the project design
- **Medium:** Where it could have an influence on the decision unless it is mitigated, and would require modification of the project design;
- **High:** Where it would influence the decision regardless of any possible mitigation, with possible 'no-go' implication for the project.

The assessment of impacts should be based on the following criteria:

- **Nature of impact** - this appraises the type of effect a proposed activity would have on the environment and should include "what will be affected and how?"
- **Extent** - this should indicate whether the impact will be local and limited to the immediate area of the activity (the site or the servitude corridor); limited to within 5km of the development; or whether it will have an impact regionally, nationally or even internationally.
- **Duration** - this indicates what the lifetime of the impact will be, whether short term (0 - 5 years), medium (5 - 15 years), long term (>15 years, but where the impacts will cease after the operation life of the activity), or permanent.
- **Intensity** – this establishes whether the impact is destructive or benign, and described as low (where no environmental functions and processes are affected), medium (where the affected environment is altered and continues to function, but in a modified manner) or high (where environmental functions and processes are altered to the extent that they temporarily or permanently cease).
- **Probability** - this describes the likelihood of the impact actually occurring, indicated as improbable (possibility very low), probable (distinct possibility), highly probable (most likely) or definite (impact will occur regardless of prevention measures).

*Note: the descriptions provided for extent, duration, intensity and probability should be reviewed by each specialist, and adapted if necessary.*

The status of the impacts and degree of confidence with respect to the assessment of the significance, must be stated as follows:

- **Status of the impact:** A description of whether the impact will be positive (a benefit), negative (a cost), or neutral.
- **Degree of confidence in predictions:** This is based on the availability of information and specialist knowledge.

Other aspects to be taken into consideration in the specialist studies:

- Impacts should be described both before and after the proposed mitigation and management measures have been implemented.
- All impacts should be evaluated for the full life cycle of the proposed development, including design, construction, operation and decommissioning.
- The impact evaluation should take into consideration the cumulative effects associated with this and other facilities that are either developed, or are in the process of being developed in the region.
- The specialist studies must attempt to quantify the magnitude of potential impacts (direct and cumulative effects) and outline the rationale used. Where appropriate, national standards are to be used as a measure of the level of impact.

- All relevant legislation and permit requirements must be identified and the permit application process discussed.

#### **Mitigation and monitoring**

- Where negative impacts are identified, specialists should set mitigation objectives (i.e. ways of reducing negative impacts), and recommend attainable mitigation actions. Where no mitigation is feasible, this should be stated and the reasons given. Where positive impacts are identified actions to enhance the benefit must also be recommended.
- The specialists should set quantifiable standards for measuring the effectiveness of mitigation and enhancement. In addition, specialists should recommend monitoring, and review programmes to assess the effectiveness of mitigation.

## **6.1 Socio-economic assessment**

### **6.1.1 Impact on the population, employment and social services**

The main concerns by the public raised during the 1998 PEA, the 2004 EIA and the present EIA were the following:

- Construction: Increase in crime; integration of old and new residents; stress on community facilities and services; stress on recreation facilities; urban management; increased squatting at Rosh Pinah.
- Operations: Impact of retrenched workers; health risks from hazardous by-products.
- Decommissioning: Impact of retrenched workers and urban management.

#### **During Construction**

It is proposed that both the CCGT power plant and the gas conditioning plant will be constructed at the Uubvlei site located about 25 kilometres from Oranjemund. Access for construction workers, plant and equipment will be through the urban area, so that the town will most certainly “feel” the construction activity.

The construction will take place over a 3-year period starting in 2006 according to the current schedule. The construction work force will vary from 600 to 1 300 during various construction phases. This may constitute 20% or more of people moving around Oranjemund at times.

The construction workforce will be housed in dedicated facilities close to the plant; they will be mainly single male unskilled labourers and semi-skilled artisans. The administrative functions and certain support facilities (eg mess hall, clinic, basic needs shops etc) for construction activity will be located at the accommodation facilities.

Should the second phase of the plant be commissioned, the construction period could be extended to five or six years. Once construction is completed, the construction workers will be repatriated to their place of origin and the construction camp – if the present Uubvlei hostel accommodation was not used, will be demolished.

Practically all of the social impacts identified are significant only during the three year construction period. Of the five social impacts identified, none fall into the category of high significance and / or high intensity. Only one is considered to have medium intensity. This means that it could have sufficient influence on the environment to affect project design or require alternative mitigation. This is:

- Stress on existing health systems (negative impact)

The remaining four social impacts are rated as having either medium-low intensity or a low significance. This means that the impact will not have an influence on the project design. Helpful mitigations may be implemented but are not essential. These are:

- Impact on occupational health (negative impact)
- Stress due to increased crime and alcohol related violence (negative impact)
- Stress on education, social and recreation facilities (negative impact)
- Employment opportunities for retrenched Namdeb workers (positive impact)

### During Operation

Once the CCGT plant is operational, a permanent force of 60 – 70 mainly technical and management staff will be employed, plus up to 30 for the gas conditioning plant. This number will be augmented by maintenance personnel during periods of routine maintenance. Operators will work in shifts and will have to be multi-skilled and be able to undertake basic maintenance. Most workers will be operators and technicians, with a few managers. These employees will live in Oranjemund itself.

The estimated life of the plant is more than 20 years. However, this could be extended by several years if the second phase is commissioned. All five of the social impacts identified are rated as having either a low intensity or low significance.

### Decommissioning

Once the gas reserves have been exhausted - assuming new sources are not discovered, or the CCGT power plant has reached the end of design life, the power station will be decommissioned, the plant demolished and the site rehabilitated. The social impacts identified will have either a low intensity or low significance.

#### 6.1.1.1 Impact description: Stress on health systems

The influx of between 600 and 1 300 temporary workers during construction will place stress on the existing health care systems of the town which are currently designed to cater for Namdeb employees and their families only.

#### 6.1.1.2 Impact assessment: Stress on health systems

The assessment of how the proposed activity will impose stress on the health systems of Oranjemund is given in Table 6.1.

**Table 6.1: Stress on Health Systems**

<b>Nature of Impact: Stress on Health Systems</b>		
Extent		The new workers will live within 25 kilometres of Oranjemund. Because comprehensive health facilities are unlikely to be available at Uubvlei, there will be stress on the health system of the town itself. Other regional facilities and nearby towns will not be affected.
Duration	Construction	<b>Short term.</b> 3 years. The greatest impact will take place over the three years of the construction period, where the number of workers will be greatest.
	Operation	<b>Long term.</b> 20 - 30 years. The impact of the 60 to 70 permanent employees, plus up to 30 for the gas conditioning plant, during the operations period will continue for 20 to 30 years, depending on the life of the gas field and whether a second plant is commissioned.
	Decommissioning	-

<b>Nature of Impact: Stress on Health Systems</b>		
Intensity	Construction	<b>Medium.</b> The most intense impact will take place during the 3 years of the construction period. If it is assumed that a new temporary clinic could be developed at the construction camp for minor and routine health matters, the town's hospital will have to deal with all serious medical problems experienced by the construction workforce.  Since this temporary workforce could constitute as much as 20% of the permanent population of the town, the impact could be significant. The incidence of HIV/AIDS in Oranjemund is already one of its most serious health problems and this will most certainly exacerbated by the arrival of 600 – 1300 mostly male labourers.
	Operation	<b>Low.</b> The 60 – 70 operational staff , plus up to 30 for the gas conditioning plant, will be less than 2% of the town's population.
	Decommissioning	<b>Low.</b>
Probability	Construction	<b>Probable.</b> The major impact on the town's existing health services will take place during the construction period.
	Operation	<b>Improbable.</b>
	Decommissioning	<b>Improbable.</b>
Status of Impact	Construction	<b>Negative</b>
	Operation	<b>Negative</b>
	Decommissioning	<b>Neutral.</b>
Degree of Confidence	Construction	<b>Medium.</b>
	Operation	<b>Medium.</b>
	Decommissioning	<b>Medium.</b>
<b>Significance before mitigation</b>	Construction	<b>Medium/low.</b>
	Operation	<b>Low.</b>
	Decommissioning	<b>Low.</b>
<b>Significance after mitigation</b>	Construction	<b>Low.</b>
	Operation	<b>Low.</b>
	Decommissioning	<b>Low.</b>

### Cumulative Effects

It has been stated by Namdeb that it plans to decrease its workforce significantly over the next 5 years as it moves its mining emphasis from on- to off-shore. Should this take place, then the extra capacity in the health system so created will reduce the intensity, probability and significance of the impact.

#### 6.1.1.3 Impact mitigation and monitoring: Stress on health systems

- (i) A temporary clinic should be available at the accommodation facilities for the construction workers, so that the impact on the local hospital for minor and routine health matters will be reduced;
- (ii) If Namdeb significantly reduces its workforce over the next 5 years, it may also plan to reduce resources allocated to the health system. NamPower and Namdeb must come to an agreement that will ensure that the current capacity of the health system is maintained at least until the end of the construction period. This should include a financial agreement on the use of Namdeb health facilities by power plant workers. Awareness programmes and all services and facilities related to counselling and treatment of HIV/AIDS patients must also be maintained during the construction period.



#### 6.1.1.4 Impact Description: Stress on occupational health

There had been a concern by the Oranjemund community that the process of constructing the plant and of converting gas into power may produce by-products (dust and pollutants) harmful to the health of the town's inhabitants in general, and to the 60 - 70 plant employees, plus up to 30 for the gas conditioning plant, in particular.

#### 6.1.1.5 Impact assessment: Stress on occupational health

The assessment of how by-products (dust and pollutants) from proposed activity will impose stress on the occupational health of workers and the people of Oranjemund and Alexander Bay is given in Table 6.2.

**Table 6.2: Stress on occupational health**

<b>Nature of Impact: Stress on Occupational Health</b>		
Extent		The extent of this impact would cover a radius of less than 5 kilometres.
Duration	Construction	<b>Short term.</b> 3 years. The most visible impact will emanate from dust generated from building activity mainly during the final year of the construction period.
	Operation	<b>Long term.</b> 20 - 30 years.
	Decommissioning	<b>Short term.</b> One year.
Intensity	Construction	<b>Low.</b> Uubvlei is 25 km away from Oranjemund, and the prevailing wind direction is away from the town,
	Operation	<b>Low.</b>
	Decommissioning	<b>Low.</b>
Probability	Construction	<b>Improbable.</b> The proposed location of the plant is 25 km down-wind of Oranjemund. There is almost no possibility that dust will be blown towards the town or Alexander Bay during construction and that this could constitute a health risk.
	Operation	<b>Improbable.</b> It is improbable that emissions from the plant during its operation will constitute a health hazard. The technology for this type of plant has been tested and improved over many years of operation and the risks are well documented and generally regarded as low.
	Decommissioning	<b>Improbable.</b>
Status of Impact	Construction	<b>Negative</b>
	Operation	<b>Negative</b>
	Decommissioning	<b>Neutral.</b>
Degree of Confidence	Construction	<b>High.</b>
	Operation	<b>High.</b>
	Decommissioning	<b>High.</b>
<b>Significance before mitigation</b>	Construction	<b>Low.</b>
	Operation	<b>Low.</b>
	Decommissioning	<b>Low.</b>
<b>Significance after mitigation</b>	Construction	<b>Low.</b>
	Operation	<b>Low.</b>
	Decommissioning	<b>Low.</b>

#### Cumulative Effects

The procedures for on-shore diamond mining by Namdeb also generate significant dust which could be carried towards the town during certain wind conditions. However, Namdeb is in the process of scaling down its land based operations and has, to a large extent, already mined out the areas

reasonably close to the town. Also, it has adopted wet mining (dredging) technology that further reduces the amount of dust. For this reason, cumulative effects are not foreseen.

#### 6.1.1.6 Impact mitigation and monitoring: Stress on occupational health

No mitigation measures required.

#### 6.1.1.7 Impact description: Stress on education, social and recreation facilities

The influx of between 600 and 1 300 temporary workers during construction may place some stress on the existing education, social and recreation facilities of the town that are currently designed to cater for Namdeb employees and their families only.

#### 6.1.1.8 Impact assessment: Stress on education, social and recreation facilities

The assessment of how the proposed activity will impose stress on the educational, social and recreational facilities of Oranjemund is given in Table 6.3.

**Table 6.3: Stress on education, social and recreation facilities**

<b><i>Nature of Impact: Stress on Education, Social and Recreation Facilities</i></b>		
Extent		The extent of this impact will be limited to the town and its immediate environs. Other regional facilities and nearby towns will not be affected.
Duration	Construction	<b>Short term.</b> 3 years. The most significant impact will take place over the three years of the construction period.
	Operation	<b>Long term.</b> 20 - 30 years. The impact of permanent employees during the operations period will continue for 20 to 30 years depending on the life of the plant.
	Decommissioning	<b>Short term.</b> One year.
Intensity	Construction	<b>Low.</b> The most intensive impact will take place during the construction period although this is expected to be relatively low, especially if basic social and recreational facilities are provided at the construction camp. Since most of the temporary work force will be single men, school education for additional children will be a minor factor. They will make use of shops, banks, commercial facilities and certain recreation facilities not provided at the construction camp, but the impact can be regulated through transport arrangements for the bulk of the work force. Overall, the impact will be manageable provided that a policy is agreed and managed between Namdeb and NamPower on the use of existing facilities. In this case the intensity will be low, even during the construction period.
	Operation	<b>Low.</b>
	Decommissioning	<b>Low.</b>
Probability	Construction	<b>Improbable.</b> There is a low likelihood that medium or high impact on the town's education, social and recreation facilities will occur at any period during the project.
	Operation	<b>Improbable.</b>
	Decommissioning	<b>Improbable.</b>
Status of Impact	Construction	<b>Negative</b>
	Operation	<b>Negative</b>
	Decommissioning	<b>Neutral.</b>
Degree of	Construction	<b>Medium.</b>

<b>Nature of Impact: Stress on Education, Social and Recreation Facilities</b>		
Confidence	Operation	<b>Medium.</b>
	Decommissioning	<b>Medium.</b>
<b>Significance before mitigation</b>	Construction	<b>Low.</b>
	Operation	<b>Low.</b>
	Decommissioning	<b>Low.</b>
<b>Significance after mitigation</b>	Construction	<b>Low.</b>
	Operation	<b>Nil.</b>
	Decommissioning	<b>Low.</b>

### **Cumulative Effects**

It has been stated by Namdeb that it plans to reduce its workforce significantly over the next 5 years as it moves its mining operation off-shore. Should this occur, then extra capacity in the education, social and recreation facilities will further reduce the intensity, probability and significance of the impact.

#### **6.1.1.9 Impact mitigation and monitoring: Stress on education, social and recreation facilities**

- (i) Temporary commercial, service, social and recreational facilities should be provided at the construction camp to meet the most common needs of the workforce. These would include general shops, mess facilities, food outlets, bars and simple recreation facilities such as pool tables, volleyball courts, soccer field, etc.
- (ii) A financial and access arrangement for the use of Namdeb's specialist community and recreation facilities (eg library, parks, adult education, tennis courts, golf course, etc) should be concluded between NamPower and Namdeb and/or the managing clubs. This should be concluded before the arrival of workers and should be clearly publicised to all stakeholders.
- (iii) Access into Oranjemund by the workforce must be facilitated in order for them to use the commercial facilities and designated social and recreation facilities. It is not suggested that formal access controls be instituted, unless issues of safety and security become serious. Provided that the most common needs are provided within the construction camp, this situation should be manageable.
- (iv) The plant and construction camp are most likely to be established in a cordoned-off camp within the Mining Area. A corridor should be established between the camp and the town to facilitate free movement by vehicles. Alternatively, a system of supervised public transport should be created to give regular access to construction workers needing to make use of Oranjemund services.

#### **6.1.1.10 Impact Description: Stress due to increased crime and alcohol related violence**

There is currently a very low level of theft and violent crime in Oranjemund. The influx of between 600 and 1 300 temporary workers, many of them in the basic income category, during the construction period with free access to the town may result in increased levels of crime. Alcohol abuse is already a recognised problem amongst Namdeb employees and the influx of large numbers of single male employees could increase this problem.

#### **6.1.1.11 Impact assessment: Stress due to increased crime and alcohol related violence**

The assessment of how the proposed activity will impose stress due to increased crime and alcohol related violence in Oranjemund is given in Table 6.4.

**Table 6.4: Stress due to increased crime and alcohol related violence**

<b>Nature of Impact: Stress due to Increased Crime and Alcohol Related Violence</b>		
Extent		The extent of this impact will be limited to the town and its immediate environs. Alexander Bay will be protected to a large extent by border controls.
Duration	Construction	<b>Short term.</b> 3 years. This impact will only be an issue during the three year construction period.
	Operation	<b>Long term.</b>
	Decommissioning	
Intensity	Construction	<b>Low.</b> Due to the distance from Oranjemund of the proposed construction camp, the intensity of this impact is likely to be low. Provided that informal settlements are prevented from establishing at the town's periphery, then crime events resulting from severe poverty due to unemployment should not be significant. Alcohol abuse will most certainly take place and this can be expected to be problematic. Overall, the intensity of the safety and security impact should be regarded as low.
	Operation	<b>Low.</b>
	Decommissioning	<b>Low.</b>
Probability	Construction	<b>Probable.</b> It is a distinct possibility that there will be an increase in alcohol abuse and associated violence. The impact of poverty related crime is less certain and its probability could therefore be seen as low.
	Operation	<b>Improbable.</b>
	Decommissioning	<b>Improbable.</b>
Status of Impact	Construction	<b>Negative</b>
	Operation	<b>Negative</b>
	Decommissioning	<b>Neutral.</b>
Degree of Confidence	Construction	<b>Medium.</b>
	Operation	<b>Medium.</b>
	Decommissioning	<b>Medium.</b>
<b>Significance before mitigation</b>	Construction	<b>Medium/Low.</b>
	Operation	<b>Low.</b>
	Decommissioning	<b>Low.</b>
<b>Significance after mitigation</b>	Construction	<b>Low.</b>
	Operation	<b>Low.</b>
	Decommissioning	<b>Low.</b>

#### **Cumulative Effects**

The advent of alcohol abuse will not be a new phenomenon for the town. In this sense, the new workforce could exacerbate an existing situation.

#### **6.1.1.12 Impact mitigation and monitoring: Stress due to increased crime and alcohol related violence**

- (i) It has already been recommended that temporary health, commercial, service, social and recreational facilities should be erected at the construction camp to meet the most common needs of the workforce. Apart from alleviating potential stress on the corresponding facilities in Oranjemund, this would also serve to minimise the number of visits to Oranjemund undertaken from the camp residents and therefore the opportunities for the perpetration of acts of crime.

- (ii) It is not suggested that a system of curfew or entrance control to Oranjemund is instituted unless a security problem becomes significant. The NAMPOL Station Commander in Oranjemund (W O de Jay) suggested that, provided contractors are properly screened to exclude known criminals, the increase in crime should not be significant. Existing law enforcement and residents need to be aware of the need for vigilance during the three year construction period.
- (iii) Existing facilities and services related to alcoholism and alcohol abuse should be augmented during the three year construction period. This should be discussed between Namdeb and NamPower and a financial contribution made if necessary.

#### 6.1.1.13 Impact Description: Employment opportunity for retrenched Namdeb workers

Namdeb has indicated that it may scale down the current workforce by 50% over the next 5 years as mining changes from land- to sea-based operation. With construction of the CCGT plant due to commence in 2006, this may present an opportunity for retrenched Namdeb employees who fit the required profiles to obtain new employment in Oranjemund. This would be a social rather than an economic benefit to the individual and the community.

#### 6.1.1.14 Impact assessment: Employment opportunity for retrenched Namdeb workers

The assessment of employment opportunity for retrenched Namdeb workers by the proposed activity is given in Table 6.5.

**Table 6.5: Employment opportunity for retrenched Namdeb workers**

<b>Nature of Impact: Employment opportunity for retrenched Namdeb workers</b>		
Extent		It is not possible that all retrenched employees could benefit from this opportunity. Much depends on the timing between retrenchments on the one hand and construction requirements on the other. Matching skills are also important and this is more likely to happen at the worker rather than artisan or manager level.
Duration	Construction	<b>Short term.</b> 3 years. The opportunity will only present itself over the three year period of construction. However, such staff would need prior training.
	Operation	<b>Long term.</b> 20 - 25 years. The opportunity will present itself at the beginning of the operation period.
	Decommissioning	<b>Short term.</b> One year.
Intensity	Construction	<b>Medium/low.</b> The intensity will be low to medium during the construction period and low during the operation period. The proportion of retrenched Namdeb workers who can be re-employed by NamPower's contractors will not be high given the problems of timing and skills matching.
	Operation	<b>Low.</b>
	Decommissioning	<b>Low.</b>
Probability	Construction	<b>Probable.</b> The probability is low to medium and the impact is not likely to significantly influence the project design.
	Operation	<b>Improbable.</b>
	Decommissioning	<b>Improbable.</b>
Status of Impact	Construction	<b>Positive</b>
	Operation	<b>Positive</b>
	Decommissioning	<b>Neutral.</b>
Degree of Confidence	Construction	<b>Medium.</b>
	Operation	<b>Medium.</b>
	Decommissioning	<b>Medium.</b>

<b>Nature of Impact: Employment opportunity for retrenched Namdeb workers</b>		
<b>Significance before mitigation</b>	Construction	<b>Low.</b>
	Operation	<b>Low.</b>
	Decommissioning	<b>Low.</b>
<b>Significance after mitigation</b>	Construction	<b>Low.</b>
	Operation	<b>Low.</b>
	Decommissioning	<b>Low.</b>

### **Cumulative Effects**

The more former Namdeb employees that are employed in the construction of the plant, the fewer outside employees will be introduced into the system. This will serve to reduce some of the negative social impacts already identified, especially concerning safety and security.

#### **6.1.1.15 Impact mitigation and monitoring: Employment opportunity for retrenched Namdeb workers**

In order to maximise the positive potential of this impact, Namdeb and NamPower should hold discussions that will examine their respective proposed retrenchment and employment schedules, with a view to co-ordinating them, where possible. Profiles of employees to be retrenched would then be made available for evaluation by NamPower and its contractors.

### **6.1.2 Impact on the infrastructure and urban services**

Only two concerns were raised by the public during both the 1998 PEA and the 2004 EIA, that relate to infrastructure and urban services. These were:

- The creation of a housing shortage due to the influx of new urban residents; and,
- The impact of increased traffic on road safety.

During the March 2005 public meeting, concerns were raised about the possible use of the Uubvlei hostel and single quarters as accommodation for the plant construction workers. The standard of these facilities have fallen into decline in recent years and are no longer considered fit for extended worker habitation. Nampower would have to ensure that these facilities are improved and upgraded to make them suitable for occupation for a further 3 to 6 years.

Three urban infrastructure impacts are identified. These are all linked to the construction phase of the project only and concern the impact of the 600 – 1 300 temporary workers on the town's housing and its sewage disposal system, and also concern the impact of additional traffic moving through the town.

#### **During Construction**

The construction workforce will be housed in a dedicated construction camp close to the plant. It will comprise mainly single-quarters for the workforce, support facilities as well as offices and workshops. The population in the camp will range between 600 and 1 300, depending on works being implemented.

The construction of the plant is planned to take 3 years, but this could be extended to 5 to 6 years if the second phase is commissioned. At the conclusion of construction works, the construction camp will be demolished and the area rehabilitated.

As already noted, Namdeb is in the process of relocating its existing 750 field workers from the Uubvlei hostel. The current capacity is approximately 1466, of which a significant portion is already vacant.

Two impacts are identified during the construction phase which fall into the category of medium or medium/low significance with medium intensity. This means that they could have sufficient influence on the environment to affect the project design or require alternative mitigation. These are:

- Increased Urban Road Traffic (negative impact)
- Impact on Namdeb's Housing stock (negative impact)

There are no impacts of high significance and / or high intensity.

#### During Operation

Once the plant is operational, a permanent force of 60 - 70 technical and management staff, plus up to 30 for the gas conditioning plant, will be employed. It has already been agreed that they will be accommodated in Oranjemund in family houses to be constructed at a site already earmarked in the western sector of town.

There are no impacts of high/medium significance and/or high/medium intensity.

Two urban infrastructure impacts are rated as having low intensity and low significance. This means that the impact will not have an influence on the project design. Helpful mitigations may be implemented but are not essential. These are: -

- Impact on the Town's Housing Stock (negative impact)
- Impact on the Town's Reticulated Services (negative impact)

#### Decommissioning

Upon decommissioning, the power plant and associated on-site infrastructure will be demolished and the site rehabilitated.

##### 6.1.2.1 Impact description: Increased urban road traffic

During the three year construction period there will be a significant increase in heavy and light vehicular traffic passing through Oranjemund on the way to and from the construction site. This could lead to traffic safety problems for the residents of Oranjemund.

##### 6.1.2.2 Impact assessment: Increased urban road traffic

The assessment of increased urban road traffic in Oranjemund due to the proposed activity is given in Table 6.6.

**Table 6.6: Increased urban road traffic**

<b>Nature of Impact: Increased urban road traffic</b>		
Extent		The main impact will be on the town of Oranjemund and the roads leading in and out, including the border control facilities related to the Ernest Oppenheimer Bridge. A 10 kilometre impact radius is envisaged.
Duration	Construction	<b>Short term.</b> 3 years. Most traffic disturbance will be from construction related traffic in the first 3 years. If a facility for liquid fuel operation is provided, replenishment of fuel stocks would involve very significant transportation.
	Operation	<b>N/a.</b>
	Decommissioning	<b>N/a.</b>

Intensity	Construction	<b>Medium.</b> The most disruptive impact is likely to come from large delivery and construction vehicles moving along the periphery of the town. There is also likely to be an increase in bus and taxi transport, especially over weekends and at the beginning and end of construction phases. Intensity is assessed to be medium – the streets will continue to function but they will just be more busy.
	Operation	<b>Medium.</b> If fuel stocks need to be replenished regularly for a liquid fuel operation, large vehicles would be moving along the periphery of the town. Intensity is assessed to be medium – the streets will continue to function but they will just be more busy.
	Decommissioning	<b>N/a.</b>
Probability	Construction	<b>Probable.</b> There is a distinct possibility that the traffic flow, particularly in the main streets, will be affected.
	Operation	<b>Probable.</b> Traffic flow will be affected with fuel replenishment vehicles.
	Decommissioning	<b>N/a.</b>
Status of Impact	Construction	<b>Negative.</b>
	Operation	<b>Negative.</b>
	Decommissioning	<b>N/a.</b>
Degree of Confidence	Construction	<b>Medium.</b>
	Operation	<b>N/a.</b>
	Decommissioning	<b>N/a.</b>
<b>Significance before mitigation</b>	Construction	<b>Medium.</b>
	Operation	<b>N/a.</b>
	Decommissioning	<b>N/a.</b>
<b>Significance after mitigation</b>	Construction	<b>Low.</b>
	Operation	<b>N/a.</b>
	Decommissioning	<b>N/a.</b>

### Cumulative Effects

None are foreseen.

#### 6.1.2.3 Impact mitigation and monitoring: Increased urban road traffic

- (i) Town authorities should direct all traffic through town associated with the power plant, especially heavy delivery and construction vehicles, to the most southerly through route which runs along the northern extent of the town's industrial zone between the eastern and western gates to the town.
- (ii) Traffic calming measures, including speed bumps and speed limits should be imposed by town authorities along strategic routes. Consideration should be given to increasing the number of traffic control personnel.
- (iii) Negotiations should take place between Namdeb and NamPower's contractors on how the town authorities should implement traffic calming measures and improve long- and short-haul taxi and bus facilities.

#### 6.1.2.4 Impact Description: Impact on the town's housing stock

Since it is intended to operate a separate contractor camp to house the 600 – 1 300 employees during the construction period, this will have no impact on the existing housing stock in Oranjemund. Should it be agreed with Namdeb utilise the whole or a portion of the Uubvlei hostel for the construction camp, then this will have a significant impact on Namdeb's relocation programme. Either they will have to accelerate the relocation programme to move all workers to Oranjemund within a year, or arrangements will have to be made to separate the existing hostel facilities so they can be shared



between Namdeb and Nampower construction workers. The potential exists for conflict between mine and construction workers which may create security and management problems. During the operational period, however, the project intends to provide housing for 60 - 70 permanent employees, plus up to 30 for the gas conditioning plant, within the town. This could result in a 5% increase in the housing stock. Upon decommissioning of the plant, the houses may become redundant.

#### 6.1.2.5 Impact assessment: Impact on the town's housing stock

The assessment of impact on Oranjemund's housing stock due to the proposed activity is given in Table 6.7.

**Table 6.7: Impact on the town's housing stock**

<b>Nature of Impact: Impact on the town's housing stock</b>		
Extent		The impact will affect the town of Oranjemund. It will also impact on the existing hostel at Uubvlei, depending on final agreements between Namdeb and Nampower regarding the use and development of these facilities.
Duration	Construction	<b>Short term.</b> 3 years. Impact on Uubvlei only during construction phase.
	Operation	<b>Long term.</b> 20 - 30 years. The impact will take effect for the duration of the operational period – 20 to 30 years depending on the life of the gas field. In practical terms, however, the impact will no longer be felt a few years after the housing is constructed. An impact will again be felt upon closure and decommissioning when the houses become superfluous to needs.
	Decommissioning	<b>Short term.</b> One year.
Intensity	Construction	<b>Medium/low.</b> Depends on how Uubvlei hostel facilities are deployed.
	Operation	<b>Low.</b> The impact will be relatively innocuous with low intensity. It is unlikely that the construction of the houses will affect the functional environment of the town.
	Decommissioning	<b>Medium.</b>
Probability	Construction	<b>Probable.</b> If the Uubvlei hostel is used for construction workers, it will impact on Namdeb's worker housing programme.
	Operation	<b>Improbable.</b> It is improbable (low likelihood) that the additional houses will impact the efficient operation of the town.
	Decommissioning	<b>Probable.</b>
Status of Impact	Construction	<b>Negative.</b>
	Operation	<b>Negative</b>
	Decommissioning	<b>Negative</b>
Degree of Confidence	Construction	<b>Medium.</b>
	Operation	<b>Medium.</b>
	Decommissioning	<b>Low.</b>
<b>Significance before mitigation</b>	Construction	<b>Medium.</b>
	Operation	<b>Low.</b>
	Decommissioning	<b>Low.</b>
<b>Significance after mitigation</b>	Construction	<b>Low.</b>
	Operation	<b>Low.</b>
	Decommissioning	<b>Low.</b>

### **Cumulative Effects**

It has been stated by Namdeb that may reduce its current workforce by 50% over the next 5 years. This being the case, it is possible that, by the year 2009 when electricity generation commences, that sufficient Namdeb houses will become vacant as a result of retrenchments and that it will not be necessary to construct any new houses. It is also unlikely that Namdeb will need the housing at Uubvlei for more than another year or so.

#### **6.1.2.6 Impact mitigation and monitoring: Impact on the town's housing stock**

- (i) The occupational status of Namdeb's housing stock should be carefully monitored prior to commitment by NamPower to the construction of new housing for its operational employees. Should major vacancies be present, then a lease or sale agreement should be negotiated before resources are allocated to construct new houses in Oranjemund.
- (ii) If new housing is indeed built for operational employees, the design and construction of the houses should be sensitive to the 20 – 40 year lifespan of the project. With Namdeb also scaling down its operations, it is unlikely that the houses would be needed for other purpose after decommissioning of the plant.
- (iii) Utilising the Uubvlei hostel as the core for the construction workers camp and sharing it with Namdeb could become difficult. If so, it is recommended that either:
  - Namdeb abandon the hostel and accelerate its programme to construct housing in Oranjemund for its remaining workers ahead of schedule; or
  - A new construction camp is developed on a suitable site separate from the hostel but adjacent to the plant.
- (iv) The first of these options is preferred since it totally eliminates the potential problems of conflict between Namdeb and Nampower workers.

#### **6.1.2.7 Impact description: Impact on the town's reticulated services**

The sewage generated by the existing hostel complex at Uubvlei is piped to the sea and discharged into the ocean without any treatment. If agreement is reached with Namdeb on the use of the hostel complex as accommodation for the construction workforce, the existing sewage installation would need to be upgraded. This will have to include a treatment plant so that the sewage ultimately discharged into the sea meets the applicable Namibian standards. A license to operate the sewage system will have to be obtained from MET. The existing outfall pipe can be re-used, but may have to be extended to comply with the licensing requirements.

If a new temporary construction camp is built, there are two options for sewage disposal:

- Sewage and waste water from both the temporary accommodation camp and the power plant could be disposed of in the Oranjemund municipal treatment works. These are situated south of the town, have sufficient spare capacity for the full 1 300 temporary work force, and a 27 km long rising main and connection to the existing sewer outfall line from the town would have to be constructed. Depending on the topography of the route along the road between Uubvlei and the town, a number of pump stations would have to be incorporated in the rising main to handle the sewage flow over this distance. This option has the advantage of making use of the existing facilities of Oranjemund and would not create a new effluent source for the project. However, costs would very likely be prohibitive in comparison with a sea discharge option.
- Sewage could be discharged to sea after treatment, with an outfall pipe following the route of the existing hostel line. One pumpstation will be required at the site, as well as one at the construction camp, to pump the waste water to the treatment works. The pumpstation and rising main from the CCGT site should be permanent, and the construction camp pumpstation could make use of the same rising main, with connection and pumpstation to be removed after completion of the construction phase. The pipeline should be installed underground, with the route following that of the existing hostel pipe line. Proper maintenance and operation of the

whole sewage installation will be required, to ensure compliance with general health standards and to minimize the impact on the environment.

#### 6.1.2.8 Impact assessment: Impact on the town's reticulated services

The assessment of how the option of using Oranjemund's sewage disposal system will impact is given in Table 6.8.

**Table 6.8: Impact on the town's reticulated services**

<b>Nature of Impact: Impact on the town's reticulated services</b>		
Extent		The impact will be local and limited to the 25 km route from Uubvlei to Oranjemund.
Duration	Construction	<b>Short term.</b> 3 years. The impact duration will be short and limited to the 3-year life of the construction camp. However, new pump stations along the route from Uubvlei will become a permanent upgrade.
	Operation	<b>Long term.</b> 20 - 30 years.
	Decommissioning	<b>Short term.</b> 1 year.
Intensity	Construction	<b>Low.</b> The Oranjemund system has sufficient capacity to handle the increased load.
	Operation	<b>Low.</b>
	Decommissioning	<b>Low.</b>
Probability	Construction	<b>Improbable.</b> The Oranjemund system has sufficient capacity to handle the increased load.
	Operation	<b>Improbable.</b>
	Decommissioning	<b>Improbable.</b>
Status of Impact	Construction	<b>Negative.</b>
	Operation	<b>Negative.</b>
	Decommissioning	<b>Negative.</b>
Degree of Confidence	Construction	<b>High.</b>
	Operation	<b>High.</b>
	Decommissioning	<b>High.</b>
<b>Significance before mitigation</b>	Construction	<b>Low</b>
	Operation	<b>Low.</b>
	Decommissioning	<b>Low.</b>
<b>Significance after mitigation</b>	Construction	<b>Low</b>
	Operation	<b>Low.</b>
	Decommissioning	<b>Low.</b>

#### Cumulative Effects

None are foreseen.

#### 6.1.2.9 Impact mitigation and monitoring: Impact on the town's reticulated services

- (i) If the option of using Oranjemund's reticulated services is chosen, the environmental management plan for construction of the CCGT power plant should set guidelines that will minimize the environmental effects of the sewage and wastewater pipeline from the CCGT site to Oranjemund and its pumpstations.

### 6.1.3 Impact on the economic structure and urban management

During the 1998 meetings held for the PEA, three main concerns were raised concerning economic impact on the town. These were:

- Potential impact of the plant on existing diamond mining operations;
- Economic benefits to the town; and
- Impacts on the future of tourism.

Additional concerns and issues raised during the 2004 meetings were:

- Negative impact on the town's viability and management after decommissioning;
- Economic benefits and problems to Rosh Pinah;
- Economic spin-offs, e.g., in tourism and agriculture;
- Need for financial contributions (e.g., a trust fund) to mitigate decommissioning impacts.

Five main economic and urban management impacts are identified. Four are linked to both the construction and operation phase of Kudu, and one is relevant to the operation phase only. The five impacts identified are:

- Impact on Namdeb mining operations;
- Macro-economic spin-offs from the operation of the plant;
- Local economic spin-offs;
- Impact on local governance; and,
- Impact of informal employment speculators (squatters).

#### During Construction

The combined salaries of 600 – 1300 employees during the construction of the plant will be paid monthly in Oranjemund. Most plant and machinery will be imported from outside the region, but many opportunities will be created for local construction and service enterprise.

Three impacts fall into the category of medium / high significance and / or impact and are therefore considered to have sufficient influence on the environment to affect the project design or require alternative mitigation. These are:

- Local economic spin-offs (positive impact);
- Impact of Informal Employment Speculators (negative impact), and
- Impact on local governance (neutral impact).

The impact of the Kudu project on Namdeb's overall terrestrial and coastal mining operations was evaluated to be of low significance and low impact.

#### During Operation

Once the plant has been commissioned and is operational, it will need urban services and management for its 50 – 60 permanent employees and for the plant itself by way of land, utilities, communications, etc.

The socio-economic impact on Namdeb mining operations was again deemed to be of low significance and low impact during the operational phase. Similarly, the impact of the power plant operations on local governance is considered to be of low significance and low impact.

Three impacts scored medium or high impact and / or significance within the operation period and one after decommissioning. These were:

- Macro-economic spin-offs (positive impact);
- Local economic spin-offs (positive impact); and,
- Impact of Informal Employment Speculators (negative impact), and
- Impact on decommissioning (negative impact).

#### Decommissioning

The economic contributions to the town will be significant during construction and operation, but these will cease upon decommissioning of the power plant. For a year or less, the operational phase employees will be replaced by contractors involved in demolishing the plant and rehabilitating the site. Thereafter, all human and economic activity related to the power plant will cease.

### 6.1.3.1 Impact description: Impact on Namdeb diamond mining operations

Strategic decisions concerning the future of mining operations have already been made by Namdeb on the basis of economic and production criteria. Indirectly, the development could add value to the town and thereby defer the threat to the long term viability of Oranjemund brought about by the downscaling of Namdeb's mining operations. There is also the opportunity for the power plant project to take up retrenched Namdeb workers.

### 6.1.3.2 Impact assessment: Impact on Namdeb diamond mining operations

The assessment of how the proposed activity will impact on Namdeb's diamond mining operations is given in Table 6.9.

**Table 6.9: Impact on Namdeb diamond mining operations**

<b>Nature of Impact: Impact on Namdeb diamond mining operations</b>		
Extent		This impact would have impact only within the mining activities operating out of Oranjemund.
Duration	Construction	<b>Short term.</b> 3 years. Any impacts would take place over a long term period that includes the construction and operational phase of the project.
	Operation	<b>Long term.</b> 20 - 30 years. Any impacts would take place over a long term period that includes the construction and operational phase of the project.
	Decommissioning	<b>N/a.</b>
Intensity	Construction	<b>Low.</b>
	Operation	<b>Low.</b>
	Decommissioning	<b>N/a.</b>
Probability	Construction	<b>Improbable.</b> The probability is low that the power plant will impact on the future economic operation of diamond mining (MA1).
	Operation	<b>Improbable.</b>
	Decommissioning	<b>N/a.</b>
Status of Impact	Construction	<b>Neutral.</b>
	Operation	<b>Neutral.</b>
	Decommissioning	<b>N/a.</b>
Degree of Confidence	Construction	<b>Medium.</b>
	Operation	<b>Medium.</b>
	Decommissioning	<b>N/a.</b>
<b>Significance before mitigation</b>	Construction	<b>Low.</b>
	Operation	<b>Low.</b>
	Decommissioning	<b>N/a.</b>
<b>Significance after mitigation</b>	Construction	<b>No mitigation measures required.</b>
	Operation	
	Decommissioning	

### Cumulative Effects

None are foreseen.

### 6.1.3.3 Impact mitigation and monitoring: Impact on Namdeb diamond mining operations

None required.

### 6.1.3.4 Impact Description: Macro-economic spin-offs from the operation of the plant

During the dry winter months, Namibia imports up to 50% of its power from South Africa. Growth in demand is some 4% per annum, resulting in an increase in projected demand from 380 MW in 2003 to 540 MW by 2012. The construction of a nominal 800 MW power plant by 2009 (with the possibility of a further nominal 800 MW in phase 2) would not only fully cater for Namibia's needs, but would establish Namibia as a power exporting country. South Africa's power demand is expected to exceed supply by 2009.

### 6.1.3.5 Impact assessment: Macro-economic spin-offs from the operation of the plant

The assessment of macro-economic spin-offs from the operation of the proposed activity is given in Table 6.10.

**Table 6.10: Macro-economic spin-offs from the operation of the plant**

<b><i>Nature of Impact: Macro-economic spin-offs from the operation of the plant</i></b>		
Extent		In the sense that Namibia is likely to export excess power, the extent of this impact is both national and international.
Duration	Construction	<b>N/a</b>
	Operation	<b>Long term.</b> 20-30 years. The duration of this impact is long term. It will cease after the decommissioning of the plant.
	Decommissioning	<b>N/a.</b>
Intensity	Construction	<b>N/a</b>
	Operation	<b>High.</b> The positive impact of revenue from the sale of the power to South Africa will vary in intensity depending on the excess available for sale and the extent of South Africa's demand. The impact of the commissioning of a second plant would be high.
	Decommissioning	<b>N/a.</b>
Probability	Construction	<b>N/a</b>
	Operation	<b>Probable.</b> It is most likely that Namibia will be in a position to export power to South Africa at some time during the operation of the plant.
	Decommissioning	<b>N/a.</b>
Status of Impact	Construction	<b>N/a</b>
	Operation	<b>Positive.</b>
	Decommissioning	<b>N/a.</b>
Degree of Confidence	Construction	<b>N/a</b>
	Operation	<b>Medium.</b>
	Decommissioning	<b>N/a.</b>
<b>Significance before enhancement</b>	Construction	<b>N/a</b>
	Operation	<b>High.</b>
	Decommissioning	<b>N/a.</b>
<b>Significance after enhancement</b>	Construction	<b>N/a.</b>
	Operation	<b>High.</b>
	Decommissioning	<b>N/a.</b>

### Cumulative Effects

None are foreseen.

#### **6.1.3.6 Impact enhancement: Macro-economic spin-offs from the operation of the plant**

No enhancement measures required.

#### **6.1.3.7 Impact description: Local economic spin-offs**

The increased levels of employment and income during the construction phase will most certainly improve the economy of Oranjemund, not only through the generation of additional small private sector business, but also because of secondary employment in response to the increased need for services. Fledgling economic enterprises in the agricultural and service sector may be boosted into viability by the increased critical mass and, once established, could survive into the operational period as well.

Viability for conservation and eco-tourism ventures has already improved following the approval of the Sperrgebiet Land Use Plan and the imminent proclamation of the new Sperrgebiet National Park. The construction and operation of the power plant could play a further positive role in tourism promotion as a result of improved road and air transport.

Both Alexander Bay and Rosh Pinah are likely to experience an increase in economic activity resulting from the passage through of people and vehicles destined for the power plant construction site. This will be particularly felt in Rosh Pinah when the Aus-Oranjemund road has been fully upgraded and goods and services no longer have to travel via South Africa and Alexander Bay.

#### **6.1.3.8 Impact assessment: Local economic spin-offs**

The assessment of local economic spin-offs from the proposed activity is given in Table 6.11.

**Table 6.11: Local economic spin-offs**

<b>Nature of Impact: Local economic spin-offs</b>		
Extent		Although the greatest impact will be felt in and around Oranjemund, the economic benefit will extend to the entire western part of the Karas Region and the north-western portion of the NW Cape.
Duration	Construction	<b>Short term.</b> 3 years. The effects of this impact will be long term during the operation of the power plant, but the greatest economic impact will occur during the 3-year construction period.
	Operation	<b>Long term.</b> 20-30 years. The effects of this impact will be felt throughout the operation of the power plant.
	Decommissioning	<b>N/a</b>
Intensity	Construction	<b>Medium.</b> Potentially, the increased economic activity generated by the power plant could have a medium to high positive impact on Oranjemund, especially in view of the parallel downscaling of mining activities. The intensity of impact on Rosh Pinah and Alexander Bay will be low.
	Operation	<b>Medium.</b>
	Decommissioning	<b>N/a</b>
Probability	Construction	<b>Probable.</b> There is a distinct possibility that the extent and intensity of impact described above will materialise.
	Operation	<b>Probable.</b>
	Decommissioning	<b>N/a</b>
Status of Impact	Construction	<b>Positive.</b>
	Operation	<b>Positive.</b>
	Decommissioning	<b>N/a</b>
Degree of Confidence	Construction	<b>Medium.</b>
	Operation	<b>Medium.</b>
	Decommissioning	<b>N/a</b>
<b>Significance before enhancement</b>	Construction	<b>Medium.</b>
	Operation	<b>Medium.</b>
	Decommissioning	<b>N/a.</b>
<b>Significance after enhancement</b>	Construction	<b>High.</b>
	Operation	<b>Medium.</b>
	Decommissioning	<b>N/a.</b>

### Cumulative Effects

The cumulative effects of the positive and negative local economic impacts generated from the construction and operation of the plant on the one hand and the negative impact of downscaling mining operations on the other have already been discussed above.

#### 6.1.3.9 Impact enhancement: Local economic spin-offs

Every effort should be made to maximise opportunities for local businesses to benefit from the services which will be needed at the construction camp. Those services which can be outsourced (eg catering, shopping, recreation facilities etc) should be identified prior to construction and offered on tender to the local business community.



### 6.1.3.10 Impact Description: Impact on local governance

Potentially, the increased population and need for urban services during the construction period could increase the need for, and viability of, proclaiming Oranjemund as a municipality and constituting a democratically elected local authority. However, the conditions for a viable town will remain uncertain due to the potential decline in the mine population due to downscaling. It must also be said that the economic activity associated with construction is short term and the conditions for a viable settlement need to be proved during the long-term operational phase.

It is likely that Namdeb will have to subsidise the operation of the town's services for a long time even should it proceed with proclamation. The Kudu project will contribute financially to the town's management - whether by way of an operational contribution or, following proclamation, as rates and taxes. In this way, the power plant is a positive development towards the financial viability of Oranjemund.

### 6.1.3.11 Impact assessment: Impact on local governance

The assessment of how the proposed activity will impact on local governance is given in Table 6.12.

**Table 6.12: Impact on local governance**

<b>Nature of Impact: Impact on local governance</b>		
Extent		The impact of local governance will be local, limited to the boundaries of the settlement of Oranjemund.
Duration	Construction	<b>Short term.</b> 3 years. This impact will only be an issue during the three year construction period.
	Operation	<b>Long term.</b> 20-30 years. The effects of this impact will be long term for the full operational life of the power plant.
	Decommissioning	<b>N/a.</b>
Intensity	Construction	<b>Medium.</b> The most positive conditions for the proclamation of the town would be evident during the three year construction of the power plant. This would be misleading however, since the true intensity of this impact is during the long term operational period when intensity will actually be low.
	Operation	<b>Low.</b>
	Decommissioning	<b>N/a.</b>
Probability	Construction	<b>Probable.</b> It is probable (distinct possibility) that the extent and intensity of the impact on local governance estimated above will materialise.
	Operation	<b>Probable.</b>
	Decommissioning	<b>N/a.</b>
Status of Impact	Construction	<b>Negative.</b>
	Operation	<b>Positive.</b>
	Decommissioning	<b>N/a.</b>
Degree of Confidence	Construction	<b>Medium.</b>
	Operation	<b>Medium.</b>
	Decommissioning	<b>N/a.</b>
<b>Significance before mitigation</b>	Construction	<b>Medium.</b>
	Operation	<b>Low.</b>
	Decommissioning	<b>N/a.</b>
<b>Significance after mitigation</b>	Construction	<b>Low.</b>
	Operation	<b>Low.</b>
	Decommissioning	<b>N/a.</b>

### Cumulative Effects

In view of the parallel downscaling of mining activities, the intensity of the economic activity generated by the power plant on local governance is likely to be downgraded to low.

#### 6.1.3.12 Impact mitigation and monitoring: Impact on local governance

No mitigation measures required.

#### 6.1.3.13 Impact Description: Impact of informal employment speculators (squatters)

It is a natural phenomenon in Namibia that unemployed or underemployed persons move to urban areas in search of employment. They generally set themselves up in informal “squatter” settlements on the periphery of towns where they have access to some urban services and are strategically placed to react to employment offers. An informal settlement of some 6000 to 8000 people has developed at Rosh Pinah on the basis of perceived job opportunities at the two local mines (Rosh Pinah and Skorpion). It is a reality that, once established, these become permanent features of the town’s landuse profile.

No informal settlements have developed at Oranjemund or Alexander Bay. This is because the towns are closed and because strict security enforcement has ensured that these could not develop. However, if proclaiming Oranjemund as a municipality coincides with the commencement of construction of the power plant, the spontaneous development of a large informal settlement is likely within a very short period of time.

If Oranjemund remains closed, however, it is equally as likely that employment speculators will move to Rosh Pinah as the closest town to the perceived new opportunities.

#### 6.1.3.14 Impact assessment: Impact of informal employment speculators (squatters)

The assessment of the impact of squatters, due to the proposed activity, is given in Table 6.13.

**Table 6.13: Impact of informal employment speculators (squatters)**

<b><i>Nature of Impact: Impact of informal employment speculators (squatters)</i></b>		
Extent		The potential growth of new or enlarged informal settlements will be limited to Rosh Pinah and, possibly, Oranjemund if proclaimed as a municipality.
Duration	Construction	<b>Short term.</b> 3 years. The impact will be long-term; as long as the perception of employment opportunities exists.
	Operation	<b>Long term.</b> 20 - 30 years. The impact will be long-term; as long as the perception of employment opportunities exists.
	Decommissioning	<b>N/a.</b>
Intensity	Construction	<b>Medium/high.</b> The intensity is likely to be medium to high, especially during the construction period when a significant number of jobs are likely to be available.
	Operation	<b>Medium/low.</b> Intensity should drop to low during the operation period.
	Decommissioning	<b>N/a.</b>
Probability	Construction	<b>Highly probable.</b> It is highly probable that, without mitigation, job speculators will converge on Oranjemund if they are permitted to do so, and that at least a proportion of these will move to Rosh Pinah if they are not.
	Operation	<b>Probable.</b>
	Decommissioning	<b>N/a.</b>
Status of Impact	Construction	<b>Negative.</b>
	Operation	<b>Negative.</b>

<b>Nature of Impact: Impact of informal employment speculators (squatters)</b>		
	Decommissioning	<b>N/a.</b>
Degree of Confidence	Construction	<b>Medium.</b>
	Operation	<b>Medium.</b>
	Decommissioning	<b>N/a.</b>
<b>Significance before mitigation</b>	Construction	<b>Medium/high.</b>
	Operation	<b>Medium.</b>
	Decommissioning	<b>N/a.</b>
<b>Significance before mitigation</b>	Construction	<b>Low.</b>
	Operation	<b>Low.</b>
	Decommissioning	<b>N/a.</b>

### Cumulative Effects

None are foreseen.

#### 6.1.3.15 Impact mitigation and monitoring: Impact of informal employment speculators (squatters)

The Contractor appointed by NamPower should conduct its recruitment of artisans and labourers away from Oranjemund, for example, in Keetmanshoop, and make it clear that no recruitment will be made from any other centre. This may help to reduce the number of employment speculators moving to Rosh Pinah. This policy could be reviewed once construction of the Plant is completed.

#### 6.1.3.16 Impact Description: Impact of decommissioning

Once the power plant has been decommissioned and the site rehabilitated, the town will lose the population, level of economic activity, rates and taxes and consumption of urban services associated with the power plant's operation. Assuming that the town by this stage has been proclaimed and is managed by a conventional local authority, its potentially fragile economic balance may be upset.

#### 6.1.3.17 Impact assessment: Impact of decommissioning

The assessment of how the decommissioning of the proposed power plant will affect Oranjemund is given in Table 6.14.

**Table 6.14: Impact of decommissioning**

<b>Nature of Impact: Impact of decommissioning</b>		
Extent		This will affect the viability of Oranjemund to operate as a local authority.
Duration	Construction	<b>N/a.</b>
	Operation	<b>N/a.</b>
	Decommissioning	<b>Permanent.</b> Following the final closure of the power plant, such an impact would be permanent.
Intensity	Construction	<b>N/a.</b>
	Operation	<b>N/a.</b>
	Decommissioning	<b>Uncertain.</b> This is difficult to predict since this event will only take place 20 to 30 years from now. Hopefully by then, the economy of the town will have evolved sufficiently so that the impact would not be fatal. If the viability of the town remains marginal, however, the intensity should be considered as potentially high.
Probability	Construction	<b>N/a.</b>
	Operation	<b>N/a.</b>

<b>Nature of Impact: Impact of decommissioning</b>		
	Decommissioning	<b>Uncertain.</b> Since this is an impact which will only take place in the distant future, outcomes are uncertain.
Status of Impact	Construction	<b>N/a.</b>
	Operation	<b>N/a.</b>
	Decommissioning	<b>Neutral to Negative.</b>
Degree of Confidence	Construction	<b>N/a.</b>
	Operation	<b>N/a.</b>
	Decommissioning	<b>Low.</b>
<b>Significance before mitigation</b>	Construction	<b>N/a.</b>
	Operation	<b>N/a.</b>
	Decommissioning	<b>Low.</b>
<b>Significance before mitigation</b>	Construction	<b>N/a.</b>
	Operation	<b>N/a.</b>
	Decommissioning	<b>Low.</b>

### **Cumulative Effects**

The viability of Oranjemund in, for example, 2040, will depend on the cumulative influence of a number of economic forces, including the power plant, the diamond mining operations as well as other local and regional economic endeavours.

#### **6.1.3.18 Impact enhancement: Impact of decommissioning**

No impact enhancement measures required.

#### **6.1.4 World Bank requirements for assessment of socio-economic impacts**

Operational Directive 4.01 of the World Bank requires that impacts of development and other socio-cultural aspects on the receiving socio-economic environment be assessed. In particular, the effects of secondary growth of settlements and infrastructure on the environment needs to be properly controlled. If the recommendations proposed for enhancement and mitigation of impacts on the socio-economic environment are implemented, then the project will comply with World Bank requirements as stipulated in Operational Directive 4.01.

### **6.2 Impact of noise on the receiving environment**

During construction, noise is caused by the operation of diesel powered earth moving and construction equipment, such as bulldozers, front end loaders, scrapers, excavators, concrete mixers as well as haulage and other kinds of trucks. These noise emissions have a characteristic low frequency content that is not readily attenuated by atmospheric absorption and can often be heard over long distances. However, because there have been mining activities for a very long time, these noise sources are not new in this environment. General construction activities, such as metalworking often have a broadband or high frequency character and are quickly attenuated by atmospheric absorption and soft ground conditions while travelling from the source to the receiver.

During the operational phase, noise is generated by the gas turbine units. The process involves the compression of air by high speed rotating machines, the combustion of gas and propulsion of generators and emission of high speed and high temperature exhaust gasses. They are, therefore, inherently noisy processes and can produce particularly disturbing single frequency noise components related to the blade passing frequency of the turbines. The noisiest sources on these units are the air intakes and exhausts. Noise is also caused by ancillary equipment, such as oil pumps and the two banks of cooling fans.

## 6.2.1 World Bank requirements for assessment of noise impacts

In terms of World Bank guidelines, noise abatement measures must achieve either the levels given below in Table 15, or a maximum increase in background levels of 3 decibels (measured on the A scale) [dB(A)]. Measurements must be taken at noise receptors located outside the project property boundary.

**Table 6.15: World Bank guidelines on maximum noise levels**

Location Category	Maximum allowable log equivalent (hourly measurements), in dB(A)	
	Day Time (07h00 – 22h00)	Night Time (22h00 – 07h00)
Residential Institutional, Educational	55	45
Commercial/Industrial	70	70

The impact of noise on construction workers at the CCGT site will be controlled by statutory occupational health regulations. Because Oranjemund is 25 km away, and mostly up-wind of Uubvlei, both construction and operational noise will not be heard in Oranjemund and therefore have no impact.

## 6.3 Impact on vegetation

### 6.3.1 The vegetation on the site and its environs

The Sperrgebiet is soon to be gazetted as a national park. The Orange River Wetland Park, including the pans, falls into Zone 4, a habitat/species management area according to the Sperrgebiet Land Use Plan (Ministry of Environment and Tourism, 2001). Such areas are to be managed mainly for conservation, through management intervention.

The hummock vegetation east and south-west of the CCGT site, excluding the Ramsar site, are included in Zone 5, that of a protected landscape/seascape, in which a broader spectrum of recreational activities occur and private vehicle access is allowed. This is strictly monitored to prevent close approach to Mining Area 1. The CCGT site *per se* falls into Zone 6, a Managed Resource Protected Area. These areas are to be managed mainly for the sustainable use of natural ecosystems in the long term, thus they should be available in future for some land use that meets the objectives of the protected area.

Mining has already severely disturbed the CCGT site, to the extent that there are few plant species on the site itself, as well as north and south of it throughout the mined-out area (Figure 6.1, orange-hatching). This makes it an ideal site from a conservation point of view.

Stabilised hummock vegetation is found to the south-east of the site. It is probably the original vegetation type at the site, because pockets of it may still be seen in the surrounding yet-to-be-mined areas within Mining Area 1. Diversity here is higher than that on the low hummocks, with two protected species, *Othonna furcata* and *Eberlanzia sedoides* (which is also endemic) occurring. Neither these species, nor the assemblage of species found, is rare or threatened in Namibia. Nevertheless, the presence of two protected species makes it essential that any unnecessary damage to the area be avoided.

There is an area of coastal hummock vegetation west of the CCGT site, south of the ponds in Mining Area 1. This type of habitat has already been compromised by mining to a certain extent, but occurs reasonably frequently further north along the Namibian coast where similar conditions prevail.

### 6.3.2 Impact description: Impact on vegetation

Impacts on low hummock vegetation may be expected during construction and operational phases, because it will almost certainly be traversed by a new access road, and a large contractors' camp will be constructed in the vicinity of the CCGT site. Although quite distant from the site, a stabilised hummock area will be close to infrastructure involved in extraction and return of sea water used for cooling, where roads and pipelines will be constructed on already mined-out areas.

### 6.3.3 Impact assessment: Impact on vegetation

The impact on the vegetation of the site will be low. No species of major conservation concern will be affected. If sufficient control is exercised, later recolonisation of damaged areas by these plants, (as can already be seen within the mining area) may be expected. This will reduce long-term defacement and will permit the re-establishment of reasonably natural habitats and ecosystems. Coastal hummock vegetation will not be impacted, and should be guarded from unnecessary collateral damage.

### 6.3.4 Impact assessment: Mitigation and monitoring

It should be emphasized that impacts such as clearing for roads and other structures on any remaining pristine or less disturbed hummock vegetation in the direct surrounds of the CCGT site should be minimized in the hope of later recolonisation of the habitat.

In regard to the low hummock vegetation, where there will probably be a new access road, routes (preferably a single route) should be identified and demarcated before construction activities commence, in order to minimize disturbance. The environmental management plan should provide for the prohibition of new tracks being made, where the surface of the original track has become corrugated.

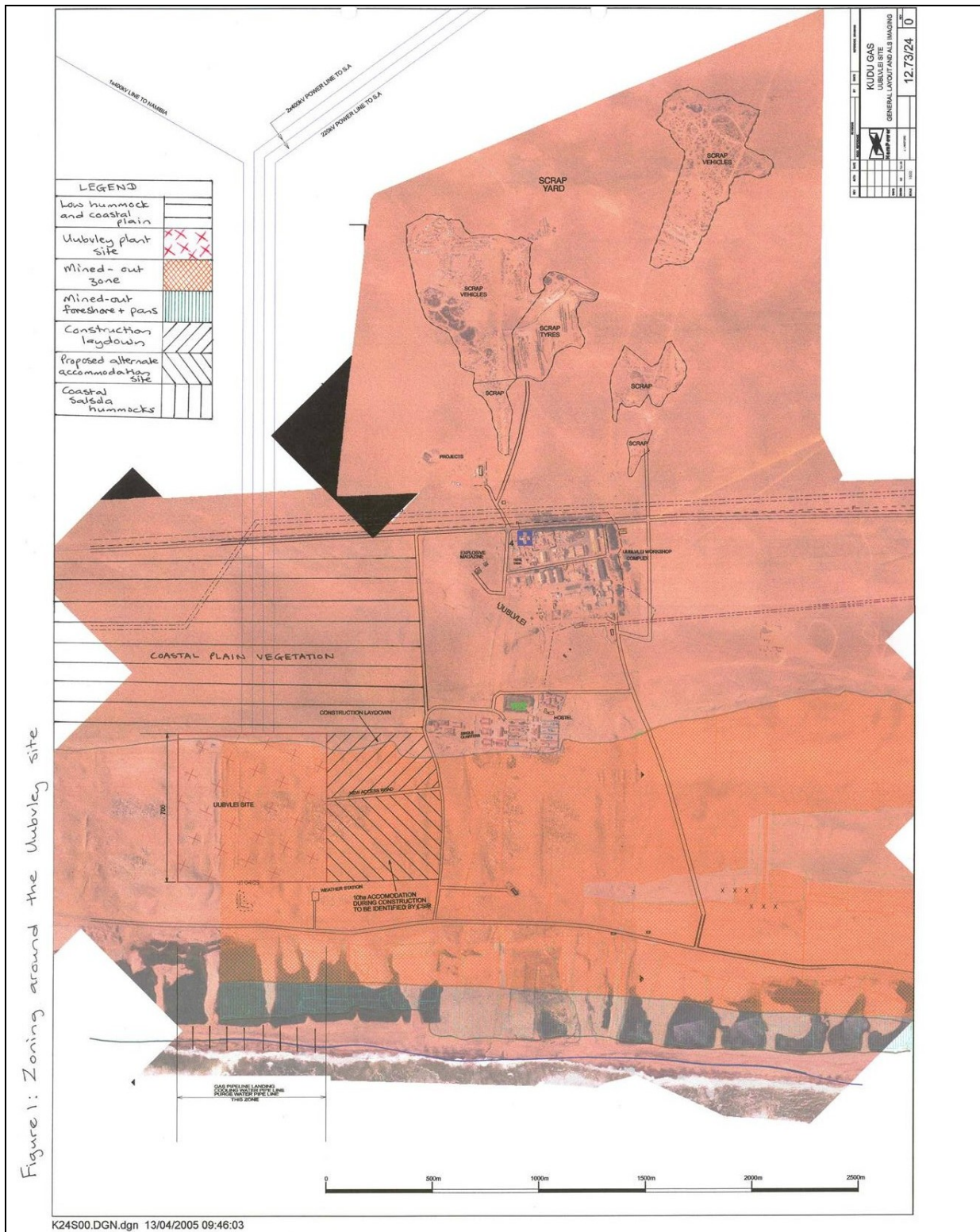
In regard to the construction camp, provision should be made for waste disposal. The contractors should be responsible for compliance by their workforce to all rules concerning the management of waste. It is recommended that, in order to conserve the remaining pocket of stabilized hummock vegetation, collateral damage such as unnecessary tracks and turning-points during the construction phase be prevented through careful planning of road routes and control of staff. If sufficient control is exercised, later recolonisation of damaged areas by these plants (as can already be seen within the mining area) may be expected, reducing long-term defacement and will permit the re-establishment of reasonably natural habitats and ecosystems. For the coastal hummock vegetation, beyond prevention of unnecessary collateral damage, no mitigation measures are suggested.

### 6.3.5 World Bank requirements for assessment of impacts on vegetation

Section 95(l) of the Constitution of Namibia, and Article 14 of the Convention on Biological Diversity require that important ecosystems and biodiversity be maintained, and that impacts be avoided/minimized. The World Bank Operational Policy 4.04; *Natural Habitats* also recommends that rehabilitation be considered, particularly in the case of natural habitats. Its section 3 states that:

*“the Bank promotes and supports natural habitat conservation and improved land use by financing projects designed to integrate into nation and regional development the conservation of natural habitats and the maintenance of ecological functions. Furthermore, the Bank promotes the rehabilitation of degraded natural habitats”.*

These requirements will be met if the recommended mitigation measures for impacts on the remaining hummock vegetation are implemented.



**Figure 6.1: Vegetation zoning around Uubvlei for Kudu CCGT power plant**

## 6.4 Impact on terrestrial ecology and fauna, excluding birds

### 6.4.1 The terrestrial ecology of the CCGT site and its environs

Parts of the area at Uubvlei in Mining Area 1 (MA1) are already greatly disturbed by diamond-mining activities and by scrap-heaps of metal, old equipment and used tyres, but there are also areas that are relatively unspoilt within MA1. Figure 6.2 shows the distribution of existing natural habitats and disturbed areas.

On the fauna side, most of the ecological action in this area, like in much of the Namib, is carried out by small animals than can shelter from the harsh conditions of strong winds and meagre rainfall, and that can take advantage of the moisture provided by fog. Evidence of animal activity is seen in spider webs in most of the plants, tracks of snails, beetles, lizards, snakes, larks and hares on the ground, tracks of beetle larvae and legless lizards just beneath the surface, burrows of scorpions and small rodents, and various other signs of cryptic life. It is impossible to provide species lists, and in any case these would be meaningless, so mention will be made of only a few species that are known to be of conservation significance.

The habitat supports a well-developed, mainly sand-living invetebrate fauna with a large but unspecified number of endemic species (Marais, 1998).

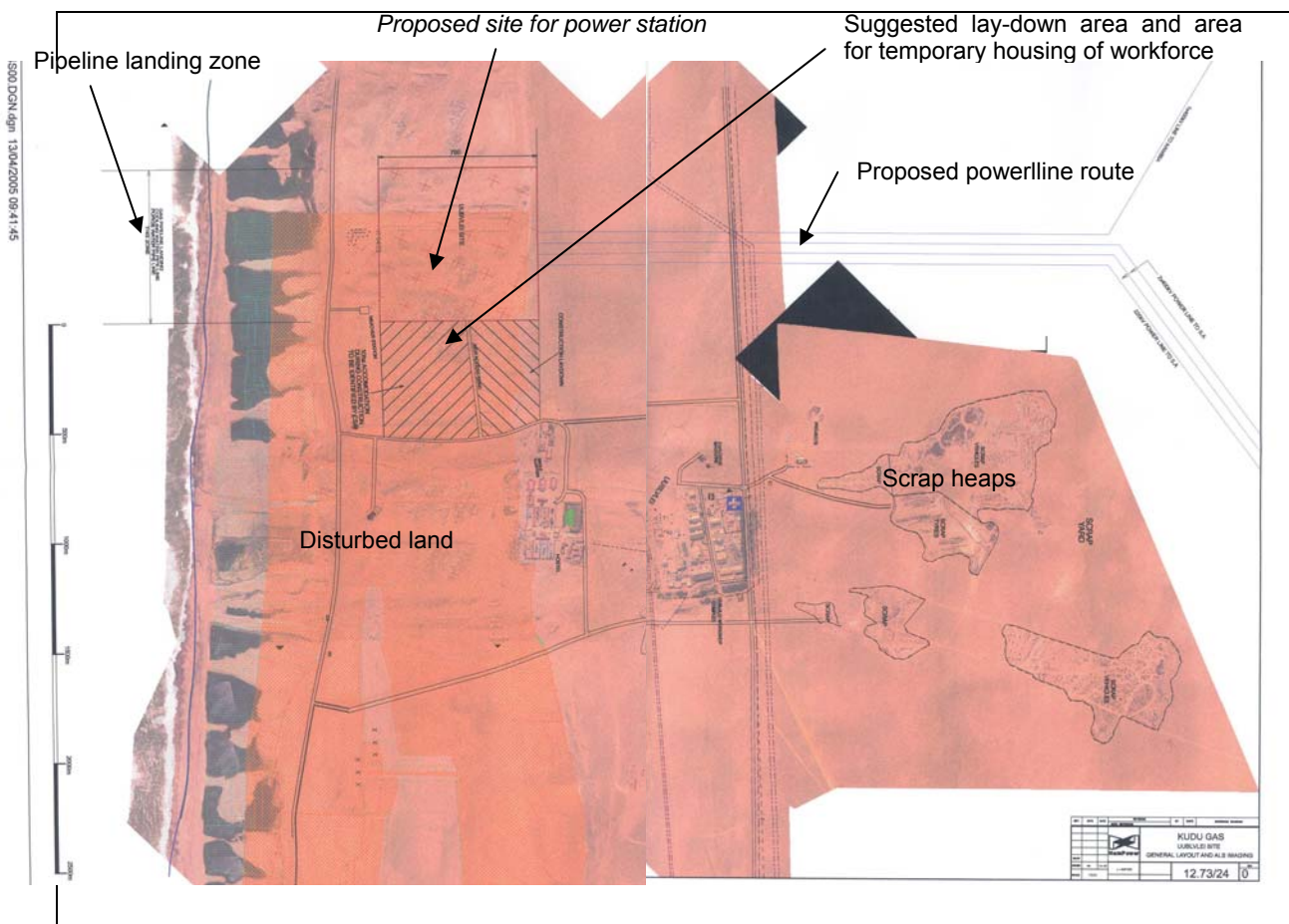
Of the amphibians, a noteworthy species is the desert rain frog (*Breviceps macrops*), which might even be a separate species from adjacent Namaqualand populations. If this is the case, Namibian responsibility for this species, (presently classified as Insufficiently Known & Endemic, Griffin 1999) would increase considerably (Griffin 1998). This unusual frog depends on fog moisture, confining it to a thin belt close to the coast, and lives in sandy hummock habitat in the Sperrgebiet only, much of which has been or will be destroyed in diamond mining operations.

Amongst reptiles, species of conservation concern are the Namaqua dwarf adder (also called twin-spotted adder, *Bitis schneideri*), and classified as Insufficiently Known [Griffin 1999]) and possibly some underground-living lizards (legless skinks of the genus *Typhlosaurus*) which have still to be confirmed. These species are also confined to the vegetated hummock habitat, and are thus threatened by mining activities (Griffin 1998). The snake *Bitis schneideri* is of as it exists largely in the area that is or has been mined out in the course of diamond mining by Namdeb. It is known to exist in two colour morphs, dark and pale, and these may be separate species. Thus the conservation status for this possible species complex is raised.

No mammals of conservation significance occur in this area.

Large areas of 'low hummock' vegetation type on the southern Namibian coast have been, or are destined to be, destroyed or considerably degraded by diamond mining operations. The areas of this habitat that have not been disturbed are growing smaller, so every effort should be made to leave them undisturbed. The emphasis in all future human activities in the Sperrgebiet should be on confining them to areas that are already disturbed, rather than on spreading the disturbance further.





**Figure 6.2:** The extent of land disturbed by diamond mining operations (orange hatching) and proposed situation of the power station and associated activities. Boundaries of habitat zones are not indicated as these were not mapped at the site.

## 6.4.2 Construction phase

Construction activities, most particularly clearing of the surface where the power station and associated structures will be built, and making access roads, could raise clouds of dust. This effect will be short-lived, and will probably not increase dust levels significantly more than the area already experiences from mining activities. Plants, lichens and animals that inhabit this area are probably frequently exposed to strong sand-laden winds, so there will be no difference for them. Namdeb already does dust suppression in its mining areas.

For any atmospheric pollutants, strong winds at the coast, experienced on an almost daily basis, will disperse them so that there is no hazardous buildup.

Waste disposal facilities should be used for disposal of building wastes as well as domestic wastes produced in the living areas of construction staff. This will prevent litter blowing around and contaminating surrounding areas. The Windhoek hazardous waste disposal facility at Kupferberg is available for any hazardous waste generated during construction and operation.

#### 6.4.2.1 Impact description of clearing of area for power plant buildings, roads, lay-down area and temporary accommodation for construction workers

The proposed site of the power plant is in the previously mined area, where land is already disturbed. Construction here will have little further impact on the vegetation and flora.

Any of the other structures that will be associated with the power plant, access roads, a materials lay-down area, and possible temporary accommodation for the construction workforce, should also be situated on disturbed land. Due to the possible presence of amphibians and reptiles of conservation concern, and the trend of gradual reduction of their habitat, all activities should be confined (as far as possible) to areas that are already disturbed. They should not be situated on undisturbed land.

If the Namdeb hostel less than one kilometre distant from the Uubvlei site is not used for accommodating workers, then it is recommended that a site for temporary accommodation of workers be situated immediately south of and adjacent to the CCGT site, on land that has already been disturbed for mining.

Similarly, the proposed lay-down area is recommended to be immediately south of and adjacent to the CCGT site, on land that has already been disturbed for mining.

#### 6.4.2.2 Impact assessment of clearing of area for power plant buildings, roads, lay-down area and temporary accommodation for construction workers

The assessment of how clearing of the area will affect the terrestrial ecology and fauna, excluding birds, is provided in Table 6.16.

**Table 6.16: Assessment of clearing the area for power plant buildings, and temporary accommodation for construction workers**

<b><i>Nature of Impact: Clearance of area for power plant buildings, and temporary accommodation for construction workers</i></b>	
Extent	<b>Local.</b> Immediate area of the CCGT site.
Duration	<b>Long-term</b>
Intensity	<b>High.</b> Loss of low hummock habitat and its associated biota.
Probability	<b>Definite</b>
Status of Impact	<b>Negative</b>
<b>Significance before mitigation</b>	<b>High</b> in Sperrgebiet. <b>Moderate</b> at national level due to two or more endemic species. <b>Low</b> at international level.
<b>Significance after mitigation</b>	<b>Low</b>

#### 6.4.2.3 Mitigation and monitoring measures for impact of clearing of area for power plant, fuel tank depot, roads, lay-down area and temporary accommodation for construction workers

Construction activities should not be allowed to spill over into undisturbed low hummock habitat, as this can quickly spread and destroy a much wider area of this kind of hummock vegetation and its associated fauna. Roads for vehicles should be clearly demarcated and drivers instructed to keep strictly to these tracks only.

If it is unavoidable to extend activities onto undisturbed land, then rehabilitation procedures that are currently being applied in the mining areas should be followed. This involves preparation before

construction begins, by moving plants and as much of their surrounding substrate as possible, from areas that will be excavated to others where they are safe.

B. schneideri snakes in the area that are directly impacted by the project should be collected and possibly relocated to an area of similar habitat that is not disturbed, nearby. This would involve some fieldwork to locate and catch the reptiles by specialists who could start a captive breeding programme to help clarify the taxonomic status of the different morphs, as well as to build up numbers of this/these species.

### 6.4.3 Operational phase

#### 6.4.3.1 Impact description of operations on terrestrial ecology and fauna, excluding birds

Emissions from burning of gas in the power station will be very low, so air-borne pollution will not be significant. If liquid fuel firing capability is provided for times when the gas supply is not sufficiently consistent, that is, 2% - 3% of the operating time, there will be atmospheric emissions from burning diesel.

Extraction of seawater from beach wells, and discharge of effluent in the sea, are not expected to have any impacts on the terrestrial fauna. Pipelines for these purposes will traverse disturbed land lying between the shore and the power station, so they will also have negligible impacts.

#### 6.4.3.2 Impact assessment of operations on terrestrial ecology and fauna, excluding birds

The assessment of how atmospheric-borne pollutants from operation of the power plant will affect the vegetation and the habitats of terrestrial ecology and fauna, excluding birds, is provided in Tables 6.23 to 6.31, where the impact of atmospheric-borne pollutants is assessed.

#### 6.4.3.3 Mitigation and monitoring measures for impact of operations on terrestrial ecology and fauna, excluding birds

It is suggested that plants and lichens in the affected area and in a 'control' area be individually marked and monitored on a monthly basis to assess impacts.

### 6.4.4 Emergencies

All biota in the immediately affected area of the low hummock habitat would be threatened as a result of an oil spill, but, assuming it was confined to a small area, the overall impact would be small. Namibia has an oil-spill contingency plan that is coordinated by the Emergency Response Unit in the Ministry of Works, Transport and Communication. Nampower and its contractors should familiarize itself with steps to avoid an oil-spill accident and what to do in the event of such an accident.

### 6.4.5 World Bank requirements for assessment of impacts on the terrestrial ecology

The proposed site for the CCGT site has been degraded by mining operations. However, there are likely to be impacts to the ecology from both the construction and operational phases of the project. As previously mentioned, Section 95(I) of the Constitution of Namibia, Article 14 of the Convention on Biological Diversity, and the World Bank Operational Policy 4.04 (OP 4.04), *Natural Habitats*, require that important ecosystems and biodiversity be maintained, with impacts avoided/minimized. Section 1 of OP 4.04 states that

*“The conservation of natural habitats, like other measures that protect and enhance the environment, is essential for long-term sustainable development. The Bank therefore supports the protection, maintenance, and rehabilitation of natural habitats and their functions... The Bank supports, and expects borrowers to*

*apply, a precautionary approach to natural resource management to ensure opportunities for environmentally sustainable development”*

These requirements will be met if the recommended mitigation and monitoring measures implemented.

## **6.5 Impact of air emissions**

### **6.5.1 Air emissions in the study area**

Although the proposed plant is to be located close to the Namibia/South African border, the estimated dispersion from the plant is localised and predominantly towards the north, i.e. away from the nearest national border. The proposed plant is likely to have negligible transboundary effects on air quality. The modelled risk to human health in Alexander Bay (South Africa), for example, is not significant.

The ambient air quality of Uubvlei is generally good, although dust storms do occur on a regular basis, particularly in the winter when easterly off-shore winds are more common. Visibility along the coast is often reduced as a result of the frequent fog and salt spray. As such, the only pollutant of concern would be particulate matter, which has more of a nuisance value than human health impact except in the case of fine particulate matter that can enter the respiratory system.

Industrial sources of air pollution in the study area are limited to the activities associated with the diamond mining along the coastline. Here the air pollution generating activities include dust generation during excavation and screening, and diesel emissions from generators at the recovery unit. Other sources of air pollution in the broader area are the episodic use of an incinerator at the Oranjemund Hospital, emissions from the infrequent activity at the airports in Oranjemund and Alexander Bay, and emissions from a very small motor vehicle fleet in the two centres. There is currently no ambient air quality monitoring in the study area of Uubvlei.

Namibia has a small industrial sector and a relatively small economy which is not energy-intensive. At present, energy is imported as petroleum products, electricity and coal. The transport sector is responsible for emitting about 50% of total national CO<sub>2</sub> emissions due to the distributions of goods and services over vast distances. Enteric fermentation in cattle and sheep contributes 98% of the CH<sub>4</sub> emissions. Emissions of NO<sub>2</sub> are small and mostly derived from the savannas burning. Thus, Namibia has minimal impact on global greenhouse gas (GHG) emissions. In 1994, the greenhouse gas emissions from Namibia were 5 614 Gg CO<sub>2</sub> equivalent, which accounted for less than 0.05% to global CO<sub>2</sub> equivalent emissions. Namibia was also estimated to be a net sink for carbon dioxide in 1994 due to the large uptake of carbon dioxide by trees. This is mainly due to increasing magnitude of bush encroachment in Namibia's vast rangeland. A nominal 1600 MW CCGT plant will produce approximately 150 kg/s of CO<sub>2</sub> when firing on natural gas and it is assumed that a nominal 800 MW CCGT plant will produce approximately 75 kg/s, resulting in an emission of 2 500 Gg or 45% of the entire CO<sub>2</sub> equivalent of Namibia, based on 1994 figures. A double capacity CCGT plant will result in a 90% increase in the GHG emissions from Namibia, based on 1994 figures. While this figure indicates a large increase the overall emissions of CO<sub>2</sub> remain insignificant in global terms.

Pollutants of concern selected for this study were those major pollutants typically emitted from combined cycle gas turbine power production operations. These are listed in Table 6.17. Quantitative health risk assessments were required only for SO<sub>2</sub>, NO<sub>x</sub> and PM. Other pollutants were considered in a qualitative manner.

**Table 6.17: Compounds of potential concern and health endpoints.**

Medium	Compounds of potential concern	Health endpoint
Air	Sulphur Dioxide (SO <sub>2</sub> )	Broncho-constriction
	Oxides of Nitrogen (NO <sub>x</sub> )	Increased risk of respiratory infection
	Particulate Matter (PM)	Respiratory, cardiovascular effects

The concentrations modelled were for NO<sub>x</sub> but since NO<sub>x</sub> in the atmosphere is rapidly oxidised to NO<sub>2</sub>, the human health risk characterisation was performed using NO<sub>2</sub> concentrations as proxy for NO<sub>x</sub>. The main source of NO<sub>x</sub> from the proposed Kudu combined cycle gas turbine power station development is stack emissions from both the gas and fuel oil cycles.

Particulate matter (PM) is a broad term used for particles found in the atmosphere, including soil dust, dirt, soot, smoke, pollen, ashes, aerosols and liquid droplets. Sources of particulate matter from the proposed Kudu combined cycle gas turbine power station development include dust generated during the construction phase. Particulate emissions will result from the combustion of fuel oil used during short periods when gas is unavailable.

Sulphur dioxide (SO<sub>2</sub>) is a colourless gas with a stinging odour. It reacts on the surface of various airborne solid particles, is soluble in water and can be oxidised within airborne water droplets to form acid aerosols. Sources of SO<sub>2</sub> from the proposed Kudu combined cycle gas turbine power station development include the combustion of fuel oil used during short periods when gas is unavailable.

CCGT stations have a considerably higher operational thermal efficiency compared with conventional coal-fired power stations. The net thermal efficiency of the Kudu power project, depending on the gas turbine selected, is currently projected to be around 57% at site conditions and to average around 56% over a 20-year operating life. Natural gas possesses a much lower carbon-content than coal and petroleum and in comparison produces lesser emissions of CO<sub>2</sub> and NO<sub>x</sub> and negligible quantities of sulphur dioxide and black smoke per unit of energy consumed (Blakemore et al., 2001).

The combination of using natural gas as a fuel and employing CCGT technology in a power station ultimately reduces CO<sub>2</sub> by 50% per unit of generated power (Blakemore et al., 1998). There will be no emissions of dust or particulates during the normal operation of the plant (Energy Management News, 2002). Fugitive dust emissions will result from the following activities on the site:

- Site preparation
- Movement of vehicles
- Construction

The main atmospheric emissions of concern from the proposed power station will be the oxides of nitrogen. However, according to Blakemore et al. (2001) combined cycle gas turbine stations will produce an 81% reduction of NO<sub>x</sub> per unit of power of that generated by an equivalent coal-fired plant. The Air Pollution Control Office, Department of Environmental Affairs and Tourism, Pretoria, states that power stations in South Africa should emit no more than 300mg/m<sup>3</sup> of NO<sub>2</sub> (Energy Management News, 2002).

Emissions from the gas conditioning plant are negligible. Details on this are provided in the environmental impact assessment of the upstream Kudu gas development<sup>1</sup>.

<sup>1</sup> CSIR (2004) Environmental impact assessment for the proposed Kudu gas field development project on the continental shelf of Namibia. CSIR Report ENV-S-C 2004-066. Stellenbosch. Prepared for Energy Africa Kudu Ltd.

The emission data for the gas fired scenarios was provided by Siemens, while the emission data for the oil fired scenarios were calculated based on emission factors provided in the US-EPA Compilation of Emission Factors - AP42 (US-EPA, 2004). It was assumed that there would be no atmospheric emissions from the gas conditioning plant. The stack parameter and the emissions data for the power station are provided in Table 6.18. The emissions data presented are for one single shaft unit (400 MW). The proposed power station would have a generating capacity of 800 MW, or two shaft units. A double capacity (1600 MW) scenario was also modelled, assuming four shafts.

The assessment looked at a stack height of 60 m and NO<sub>x</sub> emissions with and without mitigation.

Stone and Webster (1998) assessed the option of using fuel oil as a standby fuel in the case of failure of the gas supply. The natural gas supply to the plant would have 96% guaranteed availability, representing an annual downtime of 14.6 days, but the maximum continuous gas supply interruption is specified as 5 – 7 days. The standby liquid fuel consumption by the power station was estimated to be a maximum of 3 100 m<sup>3</sup>/day (Stone and Webster, 1998). Based on this fuel consumption a summary of the emissions from the oil fired stacks are provided in Table 6.18 below. Mitigation measures employed would be dry low NO<sub>x</sub> burners for gas-fired operation and water injection for liquid fuel operation.

**Table 6.18: Summary of stack parameters and emission rates per shaft for the Kudu CCGT power plant**

Parameter	Fuel Gas Stack	Fuel Oil Stack NO <sub>x</sub> mitigation
Emission Temperature	361.2 K	373.2 K
Emission Exit Velocity	21.5 m/s	21.5 m/s
Stack Height	60 m	60 m
Stack Diameter:	6.4 m	6.4 m
Emission Rate – NO <sub>x</sub>	30.28 g/s	21.53 g/s
Emission Rate – SO <sub>2</sub>	0.0 g/s	168.99 g/s
Emission Rate – PM	0.0 g/s	4.31 g/s

## 6.5.2 Approach to the air quality study

The air quality study was undertaken to address the generation and subsequent dispersion of air pollution from the proposed power plant at Uubvlei. Air dispersion modelling was undertaken using the US-EPA approved CALPUFF suite of models, to predict ambient air pollution concentrations and deposition rates. It is a Lagrangian model that treats emissions as a series of puffs. CALPUFF has the ability to simulate dispersion over complex terrain and also for calm winds (< 2 m/s).

The meteorological description of the study area was based on observations from the South African Weather Service (SAWS) station based at Alexander Bay and seven modelled sites. The modelled sites were generated using The Air Pollution Model (TAPM). TAPM is a prognostic meteorological and dispersion model developed by the CSIRO in Australia (Hurley, 1999). This model assists in overcoming a lack of site-specific meteorological information, by generating surface and upper air data that can be used in dispersion modelling exercises. There is no ambient air quality monitoring currently being undertaken in the study area. All available monitored hourly average meteorological data from the Alexander Bay station for 2000 and 2001 were considered as inputs to the dispersion modelling. The observed data from the Alexander Bay station was augmented with model derived surface and upper air meteorological data at seven selected points within the modelling domain

The study considered air pollution only from the proposed power station. The limitation of this approach is that urban air pollution sources such as motor vehicle emissions are not considered,

neither are emissions from the local diamond mining industry. The impact of air pollution *per se* is therefore not considered quantitatively but an assumption is made that indoor and outdoor air pollution concentrations are similar. It is important to note that maximum 1-hour and 24-hour concentrations are used in the risk assessment. The results therefore do not present ranges, but rather the worst-case scenario. Natural sources of air pollution are also not considered in this modelling exercise i.e. sand storms and sea spray. However the potential impacts of these natural sources are considered in terms of mitigation measures. The results of dispersion modelling were assessed in a human health risk assessment and a vegetation impact assessment.

Emission scenarios modeled are described in Table 6.19.

**Table 6.19: Emission scenarios modelled**

Scenario	Sources	Pollutants To Be Modelled
Construction	Roads and construction site	Particulates
<b>800 MW generating capacity: Normal operations</b>		
Gas cycle only	CCGT power station	NO <sub>x</sub>
Fuel oil cycle only	CCGT power station	SO <sub>2</sub> , NO <sub>x</sub> , Particulates
<b>1600 MW generating capacity: Normal operations</b>		
Gas cycle only	CCGT power station	NO <sub>x</sub>
Fuel Oil cycle only	CCGT power station	SO <sub>2</sub> , NO <sub>x</sub> , Particulates

A summary of the pollutants assessed in the air quality study is presented in Table 6.20.

**Table 6.20: Summary of the pollutants assessed**

Pollutant	Modelled	Health Risk Assessment	Qualitative Assessment
PM	Yes	Yes	No
SO <sub>2</sub>	Yes	Yes	No
NO <sub>x</sub>	Yes	Yes	No
CO <sub>2</sub>	No	No	Yes
CO	No	No	Yes
Dust	No	No	Yes

A network of uniformly spaced receptor points, 1 km apart, was used, covering a 25 km by 25 km study area of approximately 625 km<sup>2</sup>, centred on the proposed CCGT site. The selection criteria for receptor points were:

- Geographical spread around the proposed development.
- Location of human settlements where exposure is most likely to occur in order to protect the most sensitive individuals.
- Location of areas with natural vegetation and cultivated lands.
- Location of recreational and tourist areas.

The exposure assessment considered the following:

- The emissions and pathways of the pollutants in the environment.
- The estimated concentrations or doses of the pollutants that the target population is exposed to.
- The target population exposed to the pollutants, and the target organs in the body which are affected by exposure to the pollutants.

- The magnitude, frequency and duration of exposure of the target population, as well as behaviour patterns, geographic distribution and population size of the target population. Since behaviour patterns of the specific communities are not known, default values according to the EPA exposure factors handbook have been used (EPA, 1996).
- The estimated dose received (van Leeuwen and Hermens, 1995; Paustenbach, 1989).

The exposure assessment scenarios are shown in Table 6.21. Risks are determined for a normal adult and a child of 10 years old, representing a sensitive individual.

**Table 6.21: Emission and exposure scenarios for SO<sub>2</sub>, PM and NO<sub>x</sub>.**

PM			
	Receptor	Receptor point	Time
Construction activities	Adult Child (10 years)	All receptor points	1 hour 24 hours Annual
SO <sub>2</sub> , TSP and NO <sub>x</sub>			
CCGT – normal / upset / shut down	Adult Child (10years)	CCGT site, Uubvlei hostel site	1 hour 24 hour Annual
CCGT – double capacity			

For this study the following acute and chronic dose-response levels were used:

- Sulphur dioxide 1-hour California EPA Standard of 660 µg/m<sup>3</sup> (252 ppb), the uncertainty factor is 1 suggesting a low degree of uncertainty in the standard. This standard is based on studies conducted on humans with the health end point being “respiratory system irritation”.
- Sulphur dioxide 24-hour average World Health Organisation (WHO) air quality guideline of 125 µg/m<sup>3</sup> (48 ppb), the uncertainty factor is 2 therefore a low degree of uncertainty is associated with this guideline. The guideline level is based on the health endpoint of “exacerbations of respiratory symptoms in sensitive individuals”.
- Sulphur dioxide annual average WHO air quality guideline of 50 µg/m<sup>3</sup> (19 ppb), the uncertainty factor is 2 therefore a low degree of uncertainty is associated with this guideline. The guideline level is based on the health endpoint of “exacerbations of respiratory symptoms in sensitive individuals”.
- Nitrogen dioxide 1-hour average WHO air quality guideline of 200 µg/m<sup>3</sup>, the uncertainty factor is 0.5, therefore a low degree of uncertainty. The guideline is based on “slight changes in lung functions of asthmatics”.
- Nitrogen dioxide annual average WHO air quality guideline of 40 µg/m<sup>3</sup>, the uncertainty factor is 0.5, therefore a low degree of uncertainty. The guideline is based on “slight changes in lung functions of asthmatics”.
- Proposed South African 24-hour standard of 300 µg/m<sup>3</sup> for TSP.
- Proposed South African annual standard of 100 µg/m<sup>3</sup> for TSP



### 6.5.3 Impact of NO<sub>x</sub> on vegetation

Common air pollutants impacting on vegetation have been identified as NO<sub>x</sub> (nitrogen oxides), ammonia, sulphur dioxide and ozone. The contribution of these pollutants to injury of any vegetation type is dependent on ambient concentration, and very importantly, on the “mix” of pollutants present in a particular area. This is due to synergistic effects that result in greater damage than may be caused by single pollutants acting alone (Mansfield and McCune; McCormick, 1997). This is due in part to complex chemical interactions that occur in the environment e.g. NO<sub>x</sub> promotes the production of ozone which actually contributes to the most of the damage noted. In addition, exposure to multiple stressors may impact severely on the capacity of plants to allocate resources to protect against stressors.

NO<sub>x</sub> was identified as important in terms of potential damage to vegetation in the study area. Its potential impact on vegetation in the study area is based on published data on effects of atmospheric pollutants on vegetation, the results of air dispersion modelling for NO<sub>x</sub> emissions from the proposed Kudu CCGT Power Station and the specialist studies on vegetation (Burke, 1998; Mannheimer, 2004) for the PEA of 1998 in the area. It must be noted that existing data on impacts of air pollution are essentially based on observations and experimental evidence for industrialised northern hemisphere countries. Information of potential impacts on local flora is very poorly documented, both in terms of field and laboratory investigations (Olbrich and van Tienhoven, 1998). Thus caution must be exercised in extrapolating published information to the current situation that is being assessed.

### 6.5.4 Impact description: Impact of air pollution on vegetation

Based on limited data de Vries and Gregor (1991) estimated the following guideline for ambient levels of NO<sub>x</sub> to protect sensitive plant communities:

Annual Average	4 hour average
30 ug/m <sup>3</sup>	95ug/m <sup>3</sup>

In the absence of more appropriate data, nitrogen deposition rates for Lowland Dry Heathlands are given below, as this community type exhibits some xerophytic characteristics and may occur on relatively nutrient poor soils.

Vegetation Community	Critical Load
Lowland Dry Heathlands	1500-2000 mg/m <sup>2</sup> /annum

With the exception of acute effects that may result from upset conditions where high concentrations of pollutants such as NO<sub>x</sub> and SO<sub>2</sub> may be experienced, vegetation impacts are usually indicated by chronic exposure to effective levels of a particular pollutant. Thus the annual averages for worst case operational conditions (1600 MW oil and 1600 MW gas fired) for ambient NO<sub>x</sub> levels and dry deposition rates were modelled for assessment of potential impacts on vegetation in the study area. The low rainfall in the area makes wet deposition relatively insignificant in comparison to dry deposition although it is recognized that frequent fogs may scavenge pollutants from the lower atmosphere, thus increasing the expected levels of “wet” deposition.

Values obtained from air quality modelling for average annual ambient concentration levels could be compared directly with the guideline value obtained from the literature. However for deposition rates, guideline values were only obtained for average annual deposition rates while the modelling conducted was for average daily deposition rates. The annual deposition rate was calculated based on the assumption that the plant would run 97% of the year on gas and 3% of the year on oil. The environmental loading for nitrogen based on maximum values for the study is presented in Table 6.22.

**Table 6.22: Environmental loading of nitrogen**

	Annual average ambient concentration ug/m <sup>3</sup>		Annual Deposition Rate mg/m <sup>2</sup> /annum
	1 600 MW Oil	1 600 MW Gas	1 600 MW
<b>Maximum in study area</b>	3.40	2.25	156.95 102.20 103.84
<b>Guidelines</b>	30		1500

### 6.5.5 Impact assessment: Impact of air pollution on vegetation

The overall assessment on the impact of the proposed development on vegetation indicates that the significance of impacts are low based on pollutant loads and the distribution of the vegetation types on a regional (Namibian coast) scale. Assessment of the data did not indicate any fatal flaws.

The area of maximum potential impact is essentially the same as described for ambient NO<sub>x</sub> concentrations above in Table 6.22, and would thus have a vegetation cover characteristic of low hummocks i.e. succulent herbs and shrubs. The maximum annual dry deposition rate of 156.95 mg/m<sup>2</sup>/annum for the Oil Fired option is well below the guideline of 1500 mg/m<sup>2</sup>/annum.

The modelling of NO<sub>x</sub> emissions for the proposed development indicates that levels would be well below those that would indicate potential for impact. However, confidence levels for this assessment was low due to lack of data on effects that may occur in the very specialised vegetation that is characteristic of the study area.

A potential threat to succulent vegetation is the possibility that nitrogen enrichment may result in the grasses out-competing the succulents, which are adapted to poor nutrient conditions, and in the long term this could lead to community changes. Nitrogen loading assessment for this type of vegetation requires investigation. The impact of NO<sub>x</sub> on floodplain vegetation was considered to be insignificant.

The potential impacts of exposure to NO<sub>x</sub> and the assessment (extent, duration, probability, significance etc.) of each of these is summarized in Tables 6.23 to 6.25.

**Table 6.23: Nitrogen enrichment causing water-stress, increased predation, etc.**

<b><i>Nature of Impact: Nitrogen enrichment causing water-stress, increased predation, etc</i></b>	
Extent	<b>Local.</b>
Duration	<b>Medium/Long-term.</b>
Intensity	<b>Low.</b>
Probability	<b>Low.</b>
Status of Impact	<b>Negative</b>
Degree of confidence	<b>Low.</b>
<b>Significance before mitigation</b>	<b>Low.</b>
<b>Significance after mitigation</b>	<b>No mitigation measures required.</b>

**Table 6.24 Nitrogen enrichment causing soil nutrient imbalances**

<b><i>Nature of Impact: Nitrogen enrichment causing soil nutrient imbalances</i></b>	
Extent	<b>Local.</b>
Duration	<b>Medium/Long-term.</b>
Intensity	<b>Low.</b>
Probability	<b>Low.</b>
Status of Impact	<b>Negative</b>
Degree of confidence	<b>Low.</b>
<b>Significance before mitigation</b>	<b>Low.</b>
<b>Significance after mitigation</b>	<b>No mitigation measures required.</b>

**Table 6.25: Nitrogen enrichment causing changes in community structure**

<b><i>Nature of Impact: Nitrogen enrichment causing changes in community structure</i></b>	
Extent	<b>Local.</b>
Duration	<b>Long-term.</b>
Intensity	<b>Low.</b>
Probability	<b>Low.</b>
Status of Impact	<b>Negative</b>
Degree of confidence	<b>Low.</b>
<b>Significance before mitigation</b>	<b>Low.</b>
<b>Significance after mitigation</b>	<b>No mitigation measures required.</b>

### 6.5.6 Impact description: Impact of air pollution on human health

The health risk assessment was based on the worst case scenario as specified above at the receptor points. This conservative approach means that if the risk to human health is found to be low, then the chance of an adverse impact on health is minimal and even sensitive individuals will not be affected by the emissions from the proposed plant.

The World Health Organisation (WHO) guidelines for NO<sub>x</sub>, World Bank standard and the proposed new ambient air quality standards for South Africa were used for the assessment. For the air quality assessment, isopleth maps were drawn to reflect annual average, 24-hour maximum and 1-hour maximum concentrations, where model outputs for annual periods represented the actual predicted average for 2 years of meteorological data. The 24-hour and 1-hour maxima represented the worst-case scenario, as the highest concentration modelled at each receptor point. For the isopleth maps the maximum value modelled at each grid point at any time in the year was used to calculate the isopleths. In reality no such day or hour is likely to occur but provides an indication as to the potential worst-case scenario.

Risks were evaluated for a child of 10 years and an adult of between 18 - 65+ years of age at the Uubvlei CCGT site.

The reference guidelines used are shown in Table 6.26.

**Table 6.26: Reference guidelines and standards concentrations for NO<sub>x</sub>, SO<sub>2</sub> and TSP**

	WHO Guideline	World Bank Standard	Proposed SA limit values (SANS, 2004)	SA Air quality guidelines
<b>Reference guideline and standards concentration for NO<sub>x</sub> (µg/m<sup>3</sup>)</b>				
1 hour maximum	200	-	200	380
24 hour maximum	-	150	187	-
Annual average	40	100 (200*)	94	40
<b>Reference guideline and standards concentration for SO<sub>2</sub> (µg/m<sup>3</sup>)</b>				
1 hour maximum		-	350	
24 hour maximum	125	150	125	
Annual average	50	50 (100*)	50	
<b>Reference guideline and standards concentration for TSP (µg/m<sup>3</sup>)</b>				
1 hour maximum	-	-		-
24 hour maximum	75 (for PM <sub>10</sub> )	150 (230*)		300
Annual average	40 (for PM <sub>10</sub> )	80 (160*)		100

\* This standard applied to airsheds with existing poor quality. The airshed refers to the local area around the plant whose ambient air quality is directly affected by emissions from the plant. The size of the relevant local airshed depends on factors such as stack height, local meteorological conditions and topography. A poor quality airshed according to the World Bank either has annual mean value of 100 mg/m<sup>3</sup> for PM<sub>10</sub>, 160 mg/m<sup>3</sup> for TSP, more than 100 mg/m<sup>3</sup> for SO<sub>2</sub> and 200 mg/m<sup>3</sup> for NO<sub>2</sub>, or the 95<sup>th</sup> percentile of 24-hour mean values of PM<sub>10</sub>, SO<sub>2</sub> or NO<sub>2</sub> for the airshed over a period of a year exceeds 150 mg/m<sup>3</sup> (230 mg/m<sup>3</sup> for TSP).

Maximum average annual and 1-hour ambient concentrations for NO<sub>x</sub> from No.2 fuel oil and, as well as those for gas fired scenarios are presented in Table 6.27 below. Hazard quotients based on these results were all below the safety margin of 1 for the acute and chronic NO<sub>2</sub> exposure scenarios. Under these exposure scenarios, even the most sensitive receptors are not likely to develop chronic NO<sub>2</sub> associated adverse health effects. Exceedences of the maximum 1-hour guidelines and limit values do occur over the adjacent ocean with no exceedences occurring on land.

**Table 6.27: Maximum modelled ambient concentrations of NO<sub>x</sub> for the six emission scenarios**

Scenario	WHO Guideline	World Bank Standard	Proposed SA limit values (SANS, 2004)	Modelled Parameter	Location
<b>Ambient concentrations for NO<sub>x</sub> annual average (µg/m<sup>3</sup>)</b>					
Oil fired (800 MW)	40	100 (200*)	94	2.45	~ 4 km north of the CCGT site, near Uubvlei
Oil fired (1600 MW)	40	100 (200*)	94	4.94	~ 4 km north of the CCGT site, near Uubvlei
Gas fired (800 MW)	40	100 (200*)	94	1.12	~ 4 km north of the CCGT site, near Uubvlei
Gas fired (1600 MW)	40	100 (200*)	94	2.25	~ 4 km north of the CCGT site, near Uubvlei

<b>Ambient concentrations for NO<sub>x</sub>, 1-hour maximum (µg/m<sup>3</sup>)</b>					
<b>Oil fired (800 MW)</b>	200	-	200	427.7	Approximately 8 km to the southwest of the proposed CCGT site, over the Atlantic Ocean
<b>Oil fired (1600 MW)</b>	200	-	200	855.5	Approximately 8 km to the southwest of the proposed CCGT site, over the Atlantic Ocean
<b>Gas fired (800 MW)</b>	200	-	200	175.1	Approximately 8 km to the southwest of the proposed CCGT site, over the Atlantic Ocean
<b>Gas fired (1600 MW)</b>	200	-	200	350.3	Approximately 8 km to the southwest of the proposed CCGT site, over the Atlantic Ocean

Since humans, especially asthmatics, react within minutes when exposed to SO<sub>2</sub>, risk characterisation was performed for 1-hour and 24-hour exposure scenarios, shown in Table 6.28. The reference concentration used for determining of hazard quotients was the proposed South African standard of 350 µg/m<sup>3</sup>. This concentration is stricter than the 660 µg/m<sup>3</sup> of the Californian EPA. The health risk assessment for 800 MW 1-hour, and both 800 MW and 1 600 MW 24-hour, SO<sub>2</sub> exposure scenarios showed that it would be unlikely for any individual to develop adverse health effects due to SO<sub>2</sub> exposure at these modelled concentrations. The Hazard Quotients calculated (1.28 and 1.29), based on the modelled 1-hour SO<sub>2</sub> concentrations from the oil stack at 1600 MW capacity, using the proposed South African standard of 350 µg/m<sup>3</sup> as a reference concentration, indicate that individuals at the site are at risk. When using the Californian-EPA standard of 660 µg/m<sup>3</sup>, hazard quotients are below 1, indicating no risk to any individual. It must be noted that this risk was calculated for individuals on site, an occupational environment, and it is highly unlikely that sensitive individuals, such as children, asthmatics and the elderly will work at an industrial site. The recommended South African occupational exposure limit-recommended limit (OEL-RL) for SO<sub>2</sub> is 5000 µg/m<sup>3</sup> measured as an 8-hour time-weighted average.

**Table 6.28: Maximum modelled ambient concentrations of SO<sub>2</sub> for two emission scenarios**

<b>Scenario</b>	<b>WHO Guideline</b>	<b>World Bank Standard</b>	<b>Proposed SA limit values (SANS, 2004)</b>	<b>Modelled Parameter</b>	<b>Location</b>
<b>Ambient concentrations for SO<sub>2</sub> 1-hour maximum (µg/m<sup>3</sup>)</b>					
<b>Oil fired(800 MW)</b>			350	971.1	Approximately 8 km to the southwest of the proposed CCGT site, over the Atlantic Ocean
<b>Oil fired(1600 MW)</b>			350	1942.2	Approximately 8 km to the southwest of the proposed CCGT site, over the Atlantic Ocean

<b>Ambient concentrations for SO<sub>2</sub> 24-hour maximum (µg/m<sup>3</sup>)</b>					
<b>Oil fired(800 MW)</b>	125	150	125	81.15	Approximately 9 km to the southeast of the proposed CCGT site, between the coast and shifting sand dunes
<b>Oil fired(1600 MW)</b>	125	150	125	162.3	Approximately 9 km to the southeast of the proposed CCGT site, between the coast and shifting sand dunes

Particulate matter will be emitted when the Kudu CCGT plant operates on No. 2 fuel oil. This fuel type generates a small particulate emission. The results of the dispersion modelling for the maximum 24-hour and annual average concentrations are presented in Table 6.29. The risk characterization for Particulate Matter was done qualitatively, since there are no reference concentrations for Total Suspended Particulate Matter (TSP). As can be seen in the table, the concentrations modelled for TSP from the oil stack after NO<sub>2</sub> mitigation were all well below international and proposed South African guidelines.

**Table 6.29: Maximum modelled concentrations of TSP for oil-fired power plant**

<b>Scenario</b>	<b>WHO Guideline</b>	<b>World Bank Standard</b>	<b>SA air quality guidelines</b>	<b>Modelled Parameter</b>
<b>Maximum concentrations for TSP annual average (µg/m<sup>3</sup>)</b>				
<b>Oil fired(800 MW)</b>	40 (PM <sub>10</sub> )	80	100	0.14
<b>Oil fired(1600 MW)</b>	40 (PM <sub>10</sub> )	80	100	0.29
<b>Maximum concentrations for TSP 24-hour maximum (µg/m<sup>3</sup>)</b>				
<b>Oil fired(800 MW)</b>	75 (PM <sub>10</sub> )	150	300	2.12
<b>Oil fired(1600 MW)</b>	75 (PM <sub>10</sub> )	150	300	4.32

### 6.5.7 Impact assessment: Impact of air emissions

For the main pollutants of concern no acute or chronic health effects are expected in any healthy or sensitive individuals from the emissions of the proposed CCGT power station. Dust generated during the construction phase, particularly after the early excavation period may have a nuisance impact beyond the immediate region under windy conditions. Management measures to minimize or mitigate the impact must be implemented.

Based on comprehensive air quality modelling, using the best available input data, and risk assessments, it is apparent that impacts from emissions from the proposed Kudu CCGT power station are limited to the immediate area surrounding the plant, they will however persist for the lifetime of the plant, but the intensity of the impact are low, with and without mitigation. Tables 6.30 to 6.35 provide a summary of the potential impact of the proposed CCGT power plant on human health.

**Table 6.30: No<sub>x</sub> – oil**

<b>Nature of Impact: No<sub>x</sub> – oil</b>	
Extent	<b>Local.</b>
Duration	<b>Long-term.</b>
Intensity	<b>Low.</b>
Probability	<b>Improbable</b>
Status of Impact	<b>Negative</b>
Degree of confidence	<b>High</b>
<b>Significance before mitigation</b>	<b>Low.</b>
<b>Significance after mitigation</b>	<b>Low.</b>

**Table 6.31: No<sub>x</sub> – gas**

<b>Nature of Impact: No<sub>x</sub> – gas</b>	
Extent	<b>Local.</b>
Duration	<b>Long-term.</b>
Intensity	<b>Low.</b>
Probability	<b>Improbable</b>
Status of Impact	<b>Negative</b>
Degree of confidence	<b>High</b>
<b>Significance before mitigation</b>	<b>Low.</b>
<b>Significance after mitigation</b>	<b>Low.</b>

**Table 6.32: SO<sub>2</sub> – oil**

<b>Nature of Impact: SO<sub>2</sub> – oil</b>	
Extent	<b>Local.</b>
Duration	<b>Long-term.</b>
Intensity	<b>Low.</b>
Probability	<b>Improbable</b>
Status of Impact	<b>Negative</b>
Degree of confidence	<b>Medium</b>
<b>Significance before mitigation</b>	<b>Low.</b>
<b>Significance after mitigation</b>	<b>Low.</b>

**Table 6.33: TSP – oil**

<b>Nature of Impact: TSP – oil</b>	
Extent	<b>Local.</b>
Duration	<b>Long-term.</b>
Intensity	<b>Low.</b>
Probability	<b>Improbable</b>
Status of Impact	<b>Negative</b>
Degree of confidence	<b>High</b>
<b>Significance before mitigation</b>	<b>Low.</b>
<b>Significance after mitigation</b>	<b>Low.</b>

**Table 6.34: CO<sub>2</sub>**

<b>Nature of Impact: CO<sub>2</sub></b>	
Extent	<b>Global</b>
Duration	<b>Long-term to permanent.</b>
Intensity	<b>Medium</b>
Probability	<b>Probable</b>
Status of Impact	<b>Negative</b>
Degree of confidence	<b>Medium</b>
<b>Significance before mitigation</b>	<b>Low.</b>
<b>Significance after mitigation</b>	<b>Low.</b>

**Table 6.35: Fugitive dust**

<b>Nature of Impact: Fugitive dust</b>	
Extent	<b>Local. Immediate area</b>
Duration	<b>Long-term.</b>
Intensity	<b>Low with mitigation.</b>
Probability	<b>Probable</b>
Status of Impact	<b>Negative</b>
Degree of confidence	<b>Medium</b>
<b>Significance before mitigation</b>	<b>Low.</b>
<b>Significance after mitigation</b>	<b>Low.</b>

## 6.5.8 Mitigation and monitoring measures

### **Construction**

- Remove only limited vegetation to accommodate construction activities.
- Spray unpaved site roads with water routinely throughout construction to contain dust. Water can be used as a wetting or binding agent on the unpaved roads and terraces.
- Implement traffic control mechanisms to limit vehicle-entrained dust from unpaved roads e.g. by limiting vehicle speeds and by restricting traffic volumes.
- Re-vegetation of the construction terraces once all the construction is completed, and when the laydown area is vacated.



### **Commissioning and Operations**

- All equipment must be subject to regular inspection and maintenance to ensure efficient operation.
- It is recommended that, where possible, oil-fired operation should not occur under calm or light on-shore wind conditions.

### **Monitoring and Further Studies**

- An ambient air quality monitoring programme must be established following the commissioning of the plant. This could initially be achieved through a passive monitoring network and the results from this survey could inform future monitoring at the site.
- Quantify air emissions through a continuous emission monitoring.
- Regular (annual) monitoring of vegetation is recommended. The first survey should be undertaken prior to commissioning of the power plant to establish a baseline condition. The following recommendations are made with regard to monitoring surveys:
  - Sampling sites should be selected on the basis of vegetation types present in the area (Burke, 2004) and air dispersion modelling (this report).
  - The community composition and species distributions within each vegetation type must be recorded.
  - Field visual observations of plant condition should be undertaken with special attention to endemics and species considered to be of conservation significance. Observations should include indications of chlorosis, necrosis, deformities, changes in growth patterns (stunting or increase above ground productivity) and phenological changes.
  - Microscopic observations of foliage to determine cuticular erosion or other impacts should be conducted.
  - Any increase in predation of plants or presence of pathogens should be assessed.
  - In the event of an upset condition where high pollution concentrations are released, additional surveys should be undertaken to assess the recovery of vegetation affected by the event. Such surveys should continue until vegetation returns to a condition indicated prior to the event. Similar observations to those described above should be undertaken during such monitoring.

## **6.5.9 World Bank requirements for assessment of impacts from atmospheric emissions**

In terms of Principle 21 of the Stockholm Declaration on the Human Environment, Stockholm 1972 that was adopted by Namibia in 1996, it has responsibility to ensure that activities within its jurisdiction or control does not cause damage to the environment of other States or of areas beyond the limits of national jurisdiction. In addition, Principle 22 enjoins on Namibia the duty to cooperate with international customary law regarding liability and compensation for the victims of pollution and other environmental damage caused by activities within its jurisdiction or control to areas beyond its jurisdiction. In particular, the provisions of the 1941 Trail Smelter Arbitration (Trail Smelter Arbitration US v Canada (1938 and 1941)) must be complied with, which states:

'...under the principles of international law, as well as of the law of the United States, no State has the right to use or permit the use of its territory in such a manner as to cause injury by fumes in or to the territory of another or the properties or persons therein, when the case is of serious consequence and the injury is established by clear and convincing evidence'.

Namibia acceded to the Kyoto Protocol of 1997 in 2003, the objective of which is to stabilize and reduce greenhouse gas emissions, mitigate climate change, and promote sustainable development in line with the objectives of the United Nations Framework Convention for Climate Change.

Namibia has not set ambient air quality standards. In the absence of local ambient standards (quality of the air in the receiving environment), consensus values that take account of WHO, US EPA and EU

standards and guidelines were constructed for the 1998 World Bank guidelines for new thermal power plants. These are:

Pollutant	24 hour average	Annual average
SO <sub>2</sub> (µg/m <sup>3</sup> )	125	80
NO <sub>2</sub> (µg/m <sup>3</sup> )	150	100
Total Particulates (PM <sub>10</sub> ) (µg/m <sup>3</sup> )	150	50

The World Bank guidelines for concentrations exiting the stack (emissions guidelines) allow a maximum of 0.2 tonnes of SO<sub>2</sub> per day per MW for the first 500 MW, plus an additional 0.1 tons/day per MW, up to a maximum of 500 tons/day per MW. This translates into an emission allowance of 130 tons/day for a nominal 800 MW power plant, and 260 tons/day for a nominal 1600 MW plant. The guidelines for SO<sub>2</sub>, NO<sub>x</sub> and PM<sub>10</sub> are:

Type of emission	Guideline standards
PM <sub>10</sub>	<50 mg/Nm <sup>3</sup>
SO <sub>2</sub>	130 tons per day for nominal 800 MW CCGT power plant 260 tons per day for nominal 1600 CCGT plant
NO <sup>x</sup>	125 mg/Nm <sup>3</sup> for gas 165 mg/Nm <sup>3</sup> for diesel No. 2 oil 300 mg/Nm <sup>3</sup> for fuel oil (all dry at 15% oxygen)

Emissions from the proposed Kudu CCGT conform to the emission requirements of the World Bank when operating under natural gas and No. 2 fuel oil. Table 6.36 summarises the World Bank requirements for emissions and the anticipated emissions from the proposed development.

**Table 6.36: Summary of emission requirements and Kudu CCGT emissions**

Pollutant	Gas Fired Scenario		No 2 Fuel Oil Fired Scenario	
	World Bank Guidelines	Kudu CCGT	World Bank Guidelines	Kudu CCGT
NO <sub>x</sub>	125 mg/Nm <sup>3</sup>	50 mg/Nm <sup>3</sup>	165 mg/Nm <sup>3</sup>	120 mg/Nm <sup>3</sup>
SO <sub>2</sub>	2000 mg/Nm <sup>3</sup>	0.0 mg/Nm <sup>3</sup>	2000 mg/Nm <sup>3</sup>	264 mg/Nm <sup>3</sup>
Particulate Matter	50 mg/Nm <sup>3</sup>	0.0 mg/Nm <sup>3</sup>	50 mg/Nm <sup>3</sup>	6.7 mg/Nm <sup>3</sup>

The maximum emissions levels are expressed as concentrations to facilitate monitoring and dilution of emissions to achieve these guidelines is unacceptable. All of the maximum emissions levels should be achieved for at least 95% of the time that the plant or unit is operating. The remaining 5% of annual operating hours is assumed to be for start-up, shutdown, emergency fuel use and unexpected incidents. For peaking units where the start-up mode is longer than 5% of annual operating hours, exceedance should be justified.

EIAs required in conjunction with new thermal power plant units greater than 300 MWt (~140 MWe) are also required to contain air-modelling studies that take into account existing air quality data to assess the quantitative impact of the new plant on the airshed of the area, i.e., the local areas around the plant whose ambient air quality is directly influenced by the plant emissions.

The only way in which the performance of any dispersion model can be evaluated is based on the availability of monitored data in the area where the model is being applied. There are currently no

monitored data of ambient concentrations of NO<sub>x</sub>, or any other air pollutant in the Uubvlei area. The dispersion model can therefore not be tested or evaluated.

It is recommended that an ambient air quality monitoring programme must be established following the commissioning of the plant. This could initially be achieved through a passive monitoring network and the results from this survey could inform future monitoring at the site. Once a reasonable data record is established it can be used to evaluate past and future modelling exercises.

The information supplied by an OEM and the predictions from the dispersion model does, however, indicate that the proposed power plant will comply with World Bank requirements as defined above.

### 6.5.10 Permit requirements

In terms of the proposed Pollution Control and Waste Management Bill, an air pollution licence will be required for the discharge of pollutants to the air, subject to air pollution objectives that are set, standards, treatment processes, the contents of an environmental assessment, and an air pollution action plan that stipulates the best possible means for reducing and preventing the discharge of pollutants to the air. The Atmospheric Pollution Prevention Ordinance 11 of 1976 is administered by the Namibian Ministry of Health, and in terms of section 5 any person carrying on a "scheduled process" within a "controlled area" has to obtain a registration certificate from the Department of Health. The Act lists 72 processes in Schedule 2, which includes:

*"29. Power stations: That is to say, processes in which -*

*"33. Producer gas works: That is to say, processes in which producer gas is made from coal and in which raw producer gas is transmitted or used".*

*"34. Gas and coke works: That is to say, processes (not being producer gas works) in which ...."*

According to Sections 5 and 6 of the Ordinance, the premises in which the scheduled process will be conducted must be registered and a registration certificate (air pollution permit) obtained.

## 6.6 Visual impact of the power plant

The sources of visual impact are the following:

- The power plant, and particularly the 4 stacks, which reach up to 60 m in height, would be visible on the skyline from most viewpoints in an open desert landscape.
- The plume from the power plant would extend some distance above and beyond it, and would therefore also be noticeable from a distance.
- Flaring from the gas conditioning plant. Gas flaring at the gas processing plant will occur in emergency cases only, to blow down the gas pressure in the plant and/or pipeline, and would last for a short time only. Should such an emergency happen at night, there would be a temporary visual impact. The pilot of the flare has no visible effect.
- The lighting from the power plant, including red navigation lights on the tall stacks, which would be visible at night.

Visibility is largely determined by topography (viewsheds), by the elevation and distance of the observer, and by foreground buildings or trees which may obscure sightlines. The degree of visibility in a flat landscape is determined largely by distance, although silhouette effects against the skyline also play a role. Degrees of visibility can be described as:

- Highly visible - Dominant within the observer's viewframe ( $\pm$  0 to 1km);

- Clearly visible - Clearly noticeable within the observer's viewframe (1 to 2km)
- Moderately visible - Recognisable feature within observer's viewframe (2 to 4km)
- Marginally visible - Not particularly noticeable within observer's viewframe (4 to 6km)
- Hardly visible - Practically not visible unless pointed out to observer (6km+)

The proposed CCGT power plant will not be visible from Oranjemund, and there is thus no visual impact on the town. However, the future development of the Sperrgebiet will be accompanied by an increase in tourist numbers, though it is not known how visible the power plant will be to any likely travel routes. To minimize any potential negative visual impacts on a desired Sperrgebiet experience, the following guidelines are recommended:

- Limit the visual effect of buildings scattered in the landscape;
- Use muted colours for building finishes to reduce light reflection and resulting visual prominence of structures. Light blue-grey colours will tend to be less visible when seen against the sky.
- Outdoor lighting, where required, must be as unobtrusive as possible.

## 6.7 Impact of the purge water discharge

In this report the assessment of potential environmental impacts associated with the purge water discharge is undertaken in accordance with:

- The operational policies of the International Finance Corporation (IFC, 1998) that, *inter alia*, require that the assessment is undertaken within the country's overall policy framework and national legislation,
- The **World Bank Water Quality Guidelines** for new thermal power plants (World Bank (1998) as well as other Water Quality Guidelines considered to be of relevance (e.g. RSA DWAF, 1995 and ANZECC, 2000), and
- International best practice that includes principles such as the precautionary approach (whereby, if there is uncertainty in the nature and severity of a potential impact, conservative assumptions are made with respect to the significance and potential severity of the said impact).

The Water Resources Management Act (Act 24 of 2004) was promulgated in December 2004. In terms of Section 64 of the Act, the Minister may prescribe minimum standards of effluent quality with which effluent discharges must comply. Where there are no standards, current South African standards can be made applicable (R. Roets, MAWRD, personal communication).

### 6.7.1 World Bank requirements for assessment of effluent discharges

To assist in the assessment of potential environmental impacts, the following water quality guidelines have been utilised, namely:

- The World Bank Water Quality Guidelines for new thermal power plants (World Bank, 1998) that state that emissions levels for the design and operation of each thermal power project must be established through the Environmental Assessment process on the basis of country legislation and the Pollution Prevention and Abatement Handbook, as applied to local conditions. The emissions levels selected must be justified in the EA and acceptable to the World Bank Group. The maximum emissions levels normally acceptable to the World Bank Group in making decisions regarding the provision of World Bank Group assistance are contained in the table below. These levels need to be achieved daily without dilution.

Parameter	World Bank Guidelines <sup>a</sup>
-----------	------------------------------------

<b>Zone of impact / mixing zone</b>	100 m radius from point of discharge for temperature
<b>Temperature</b>	< 3° C above ambient at the edge of the zone where initial mixing and dilution take place. Where the zone is not defined, use 100 meters from the point of discharge when there are no sensitive aquatic ecosystems within this distance.
<b>Salinity</b>	-
<b>Residual Chlorine</b>	0.2mg/l at point of discharge prior to dilution <sup>b</sup> .

- a. The World Bank guidelines are based on maximum permissible concentrations at the point of discharge and do not explicitly take into account the receiving environment, *i.e.* no cognisance is taken of the fact of the differences in transport and fate of pollutants between, for example, a surfzone, estuary or coastal embayment with poor flushing characteristics and an open and exposed coastline. It is for this reason that we include in this study other generally accepted Water Quality guidelines that take the nature of the receiving environment into account.
  - b. "Chlorine shocking" may be preferable in certain circumstances. This involves using high chlorine levels for a few seconds rather than a continuous low-level release. The maximum value is 2 mg/l for up to 2 hours, not to be repeated more frequently than once in 24 hours, with a 24-hour average of 0.2 mg. l<sup>-1</sup>. (The same limits would apply to bromine and fluorine.)
- Other generally accepted Water Quality Guidelines and policies used in similar environments (*e.g.* RSA DWAF, 1995, 2004a,b; ANZECC, 2000). (Presently underway is a Benguela Current Large Marine Ecosystem (BCLME) project (a Global Environmental Fund funded transboundary project) to harmonise the policy and legislation related to marine water quality in the participating countries, *i.e.* Angola, Namibia and South Africa. Consequently, there is likely to be a closer alignment of the policy and legislation in the three countries at the culmination of this project. The adoption of best practice as far as it is practicable in the three countries is also likely to be recommended as a basic tenet of policy and legislation pertaining to marine water quality in the three countries. It is for this reason that we have also considered the South African Water Quality guidelines (RSA DWAF, 1995) and policies as presently they are the most comprehensive of the three countries involved in the BCLME project.)

Both a surfzone and offshore discharge of purge water are assessed. (International best practice is not to discharge into "sensitive" environments and the recently drafted South African Operational Policy for the disposal of land-derived water containing waste to the marine environment (RSA DWAF, 2004b), based on a review of international best practice and international trends in marine waste disposal policy, suggests that the surf-zone in general should be considered a sensitive environment. The surfzone option, nevertheless, has been fully assessed as a potential marine disposal option.)

## 6.7.2 Description of the purge water discharge

For the 800 MW nominal capacity gas-fired combined cycle power station under consideration, the characteristics of the proposed cooling technology are an evaporative cooling system having the following characteristics:

- Abstraction rate of 2 000 m<sup>3</sup>/hr (~ 0.56 m<sup>3</sup>/s)
- Discharge rate of 1 300 m<sup>3</sup>/hr (~ 0.36 m<sup>3</sup>/s)
- Water return will contain a trace of chlorine of 0.1 mg/l NaOCl.
- Temperature rise in discharge waters of approximately 10°C relative to intake seawater temperature (*i.e.* ΔT=10°C) or approximately 5°C relative to wet bulb temperature (*pers comm.*, John Jenkins, ESKOM).
- Salinity rise of approximately 1.5 x the salinity at the intake, *i.e.* a discharge salinity of approximately 55 psu.

This implies discharge temperatures ranging from as little as 16°C to 22°C (wet bulb temperature + 5 °C) to 32°C to 35°C (ambient water temperature +10°C) for the evaporative cooling option. Should the capacity of the plant be increased to nominal 1600 MW, the characteristics of the effluent discharges will remain the same, however the volumes discharges will approximately double in magnitude. The effluent discharged will be a dense effluent having roughly the characteristics listed in Table 6.37.

**Table 6.37: Characteristics of discharged cooling/purge waters from an evaporative cooling system.**

Variable	Ambient conditions (approximate)	Increase above ambient	Approximate discharge characteristics
Seawater temperature	Seawater temperature: Winter: 12 - 13°C Spring: 13 - 14°C Summer: 14 - 15°C Autumn: 13 - 14°C  Mean daily wet bulb air temperature at Alexander Bay ranges between 11 and 17°C with variability in the means at 0800B, 14:00 B and 20:00 B ranging between 8 and 18°C.	$\Delta T = +10^\circ\text{C}$ above ambient seawater temperature  or  $\Delta T = +5^\circ\text{C}$ above wet bulb air temperature	T = 22 - 25°C under typical conditions, but T = 33,5 - 34,5°C under extreme conditions  or  T = +16°C to 22°C under typical conditions, but +12°C to 25°C under more extreme conditions
Salinity	34,8 to 34,85 psu	Approximately +20 psu (brine concentration factor = 1,5)* <sup>1</sup>	S = 55 psu
Biocide (free chlorine)	none	0,1mg.ℓ <sup>-1</sup> NaOCl* <sup>2</sup>	0,1 mg.ℓ <sup>-1</sup> NaOCl

\*<sup>1</sup> The brine concentration value is a function of the purge quantity, which in principle can be manipulated according to environmental requirements. Increasing the purge water will however result in increased thermal impacts and an increased discharge of biocides (as well as increased costs associated with these increased volumes to be pumped and associated chlorination requirements.)

\*<sup>2</sup> Typically a sodium hypochlorite (NaOCl) solution is pumped directly into the cooling system inlet by a controlled injection system, so as to maintain a residual level of 0,1 mg.ℓ<sup>-1</sup> NaOCl (or free chlorine) at the cooling water outlet from the condensing plant. De-chlorination of the effluent is possible for an evaporative cooling system but at an increased operational cost.

Other effluents that could possibly be discharged together with the heated brine waters are:

- boiler blowdown
- gas turbine blade cleaning effluent
- drainage from processes in the plant and surface water drainage
- steam generator chemical cleaning effluent
- other effluent and drainage discharges
- sewage treatment plant effluent
- BTEX (benzene, toluene, ethylbenzene and xylene).

These include various chemical compounds either associated with the exploitation and transport of the Kudu gas itself, or with power generation. As some of these, for example aromatic hydrocarbons, have potentially deleterious human health effects if discharged to the atmosphere, the intention is to discharge these low volume effluents to the natural environment along with the cooling waters. Although these will most likely initially be discharged to the cooling tower basin to minimise the required cooling water make-up, on the basis of assessing a worst-case scenario, it is assumed that they are ultimately discharged to the marine environment in the purge water.

Discharges that will arise frequently comprise treated water treatment plant effluents and treated sewage effluent. Less frequent discharges will include heat recovery steam generator (HRSG) blowdowns (ultra pure water) and discharges from similar maintenance activities (e.g. infrequent discharges due to compressor cleaning). Other effluents that could be discharged together with the heated brine waters are discussed below, and are summarised in Table 6.38.

**Table 6.38: Potential aqueous discharges**

Discharge	Nature of discharge	Duration and flow rate of discharge	Constituents in discharge	Constituent concentrations in discharge	Alternative methods to handle waste
Cooling System Purge water Discharge	Purge water with constituents as specified in Table 6.37	<p><b>800 MW</b> continuous 1300 m<sup>3</sup>.hour<sup>-1</sup> (0.36 m<sup>3</sup>.s<sup>-1</sup>)</p> <p><b>1600 MW</b> continuous 2600 m<sup>3</sup>.hour<sup>-1</sup> (0.72 m<sup>3</sup>.s<sup>-1</sup>)</p>	Elevated temperature, salinity and a biocide, most probably sodium hypochlorite (NaOCl)	Elevated temperature, salinity and a biocide as specified in Table 6.37	<p>Once through cooling</p> <p>Dry cooling</p>
Water treatment plant effluent	Regeneration of the ion-exchange resins used in the water treatment plant will be by sulphuric acid and caustic soda, leading to alternate acidic and alkaline waste streams. Effluent will be neutralised prior to discharge	Discharge up to one hour daily with a flow rate of up to 7 kg.s <sup>-1</sup> (or 25 m <sup>3</sup> .h <sup>-1</sup> ) for a 800 MW plant and approximately 14 kg/s (or 50 m <sup>3</sup> .h <sup>-1</sup> ) for a 1600 MW plant. .	Neutralised effluent of salts	The concentration of salts unknown but at most discharge would comprise only approximately 25 m <sup>3</sup> .h <sup>-1</sup> for up to one hour a day compared to the continuous brine discharge of 1 300 m <sup>3</sup> .h <sup>-1</sup> (i.e. water treatment plant effluent of neutralized salts would be diluted by a factor of approximately 50 before discharge). Due to a doubling of both the water treatment plant and purge water effluent stream for a 1600 MW plant the dilution factor remains 50.	Not specified



Discharge	Nature of discharge	Duration and flow rate of discharge	Constituents in discharge	Constituent concentrations in discharge	Alternative methods to handle waste
HRSG blowdown	The water in the HRSG will be blown down intermittently to remove accumulation of impurities. This blowdown water will be discharged to a tank to reduce pressure prior to entering station drains before discharge via the purge water discharge.	Average discharge volume will be approximately $150 \text{ m}^3 \cdot \text{day}^{-1}$ with a maximum discharge of $150 \text{ m}^3 \cdot \text{hour}^{-1}$ for a 800 MW plant and roughly double that for a 1600 MW plant.	Quantities of: <ul style="list-style-type: none"> <li>• hydrazine (<math>\text{N}_2\text{H}_4</math>),</li> <li>• trisodium phosphate (<math>\text{Na}_3\text{PO}_4</math>),</li> <li>• caustic soda (<math>\text{NaOH}</math>) and</li> <li>• ammonia (<math>\text{NH}_3</math>).</li> </ul> Water is de-oxygenated Dissolved oxygen concentration conservatively assumed $\sim 0 \text{ mg} \cdot \text{l}^{-1}$	Actual concentrations as indicated in Table 6.37. As the maximum discharge is $150 \text{ m}^3/\text{h}$ compared to the purge water discharge of $1\ 300 \text{ m}^3/\text{h}$ , the effluent will be diluted by a factor of approximately 10 but up to 200 times if the release was to take place over a 24 hour period..	Not specified
Plant and Surface water drainage	All potentially contaminated run-off / drainage from within the plant and bunded areas, together with controlled discharges, will be discharged to the cooling water system following passage through an appropriate oil interceptor/separator. All other stormwater, if uncontaminated, will be discharged directly to the stormwater system via a holding pond	The volume and rate of discharge is unknown (depends of rainfall and the design of facilities), but is expected to be controlled	Expect some dissolved hydrocarbons but constituents of the discharge unspecified.	Expect some oils but unspecified. Oil separator system will need to ensure that dissolved hydrocarbons do not exceed acceptable standards (e.g. not exceeding $2.5 \text{ mg} \cdot \text{l}^{-1}$ to $15 \text{ mg} \cdot \text{l}^{-1}$ , depending on guidelines considered to be acceptable for the region)	Unknown, but could include specific waste management.

Discharge	Nature of discharge	Duration and flow rate of discharge	Constituents in discharge	Constituent concentrations in discharge	Alternative methods to handle waste
Plant cleaning (water washing of gas side of HRSG tubes)	Water washing to remove deposits of carbonaceous material	Only a few occasions over life-cycle of plant  Volumes and rates of discharge are unknown but are likely to be limited.	Initial effluent will contain carbonaceous materials and oxides and sulphates of iron, sodium, vanadium and silicon, however the effluent will be treated with caustic soda to precipitate materials present in soluble form and the sediments removed for disposal. Final discharge expected to comprise neutralised effluent containing salts and only traces of metals, dissolved salts	Concentration of contaminants unknown but expected to be extremely limited	Unknown
GT Compressor Washing	Gas turbine compressor blading may be cleaned by a combination of on-line and off-line washing. Effluent from on-line washing is burnt in the combustion chamber of the gas turbine. Effluent resultant from off-line cleaning comprising a solvent and dissolved oil will be removed off-site for treatment or disposal.	No discharge - the resulting effluents will be taken off-site for treatment/disposal at environmentally licensed facilities	No discharge	No discharge	unspecified

Discharge	Nature of discharge	Duration and flow rate of discharge	Constituents in discharge	Constituent concentrations in discharge	Alternative methods to handle waste
HRSG acid cleaning	Acid washes at commissioning and during the life of the plant are carried out at intervals of roughly 5 - 15 years. The resulting effluents will be taken off-site for treatment/disposal at environmentally licensed facilities.	No discharge - the resulting effluents will be taken off-site for treatment/disposal at environmentally licensed facilities	No discharge	No discharge	unspecified
HRSG Storage Solutions	Storage may be used to protect an HRSG when it is out of use for an extended period, whereby a solution of hydrazine (N <sub>2</sub> H <sub>4</sub> ) and ammonia (NH <sub>3</sub> ) is used.	The resulting discharges, should they arise, will be either sent for disposal by an appropriate waste contractor or else suitably treated prior to release.	hydrazine (N <sub>2</sub> H <sub>4</sub> ) residual and ammonia (NH <sub>3</sub> ) concentration is unknown	200-300 mg/l hydrazine residual in the storage water, NH <sub>3</sub> concentration is unknown Concentration information unnecessary as waste is likely to be sent for disposal by an appropriate waste contractor or else suitably treated prior to release.	unspecified

Discharge	Nature of discharge	Duration and flow rate of discharge	Constituents in discharge	Constituent concentrations in discharge	Alternative methods to handle waste
Water from gas conditioning plant	The water from the gas conditioning plant ( $5 \text{ m}^3 \cdot \text{day}^{-1}$ ) will be at a temperature of $40^\circ\text{C}$ and will contain trace amounts of dissolved hydrocarbons ( $< 10 \text{ ppm max.}$ ). This water can be co-discharged with the cooling purge water, in dilution of the effluent of 6000. The anticipated effect on the environment is negligible.	$5 \text{ m}^3$ per day	Dissolved hydrocarbons ( $< 10 \text{ ppm max}$ ) containing mainly trace quantities of aromatics, cyclic compounds, unrecovered MEG and traces of methanol *MEG, methanol, benzene, m/p-xylenes, toluene, cyclo-pentane, cyclo-hexane.	Exact concentrations unknown but may not be relevant as a dilution of $> 6000$ can be achieved prior to discharge	unknown

### 6.7.3 Discharge Scenarios Assessed

The discharge location needs to be such that it does not stir up sediments that could be drawn into the intake. Similarly the discharge needs to be located such that there is no significant re-circulation of heated brine from the discharge into the intake. Possible discharge locations include:

- a discharge inshore of the intake but beyond the surfzone;
- a discharge offshore of the intake but beyond the surfzone, and
- a shoreline discharge

For the discharges beyond the surfzone, to avoid the intake of excessive sediment, the seawater intake is assumed to be located at a water depth of approximately 15 m. Over the life-time of the project it is expected that the shoreline will prograde by up to 300 m.

In terms of existing and potential future marine discharge policy and legislation (e.g. RSA DWAF, 2004a) and the likely migration of the shoreline at the discharge location due to mining operations in the region, a discharge location at the shoreline or in the surfzone is an option that needs to be carefully considered both in terms of environmental and engineering constraints.

The possible discharge options under consideration, and their associated constraints are summarised in Table 6.39.

**Table 6.39: Summary of discharge options**

Discharge Option	Constraints
Shoreline discharge into the surf-zone	Both environmental and engineering constraints.
Discharge through a submerged pipeline approximately 400 m inshore of the intake but beyond the surf-zone (900 to 1 000 m offshore of the present surf-zone) in a water depth of 15 m – 18 m	Elevated risk of re-circulation of the (dense) heated brine
Discharge through a submerged pipeline located approximately 300 m seawards of the intake location at a water depth of approximately 18 m - 21 m.	The discharge location would be approximately 1 700 m offshore of the present shoreline

For both of the offshore discharge options a single port diffuser, directed upwards at 60 degrees to the horizontal and is located approximately 1 m above the sea bed, is assumed. The discharge velocities from the single port range between  $0.9 \text{ m.s}^{-1}$  and  $5 \text{ m.s}^{-1}$ . (The higher discharge velocity is typical of higher volume once-through hot water discharges)

For the shoreline discharge, the discharge is assumed to occur at the shoreline. The exact location of the discharge relative to the moving (accreting) shoreline is unknown as is the engineering design of such a discharge. For the purposes of this assessment a discharge at the shoreline has been assumed at all times, *i.e.* the discharge point moves with the accretion of the coastline.

### 6.7.4 Anticipated changes in the marine environment due to a discharge of heated brine

The discharge will add heat, brine (elevated salinity) and residual biocide (free chlorine) to the natural environment. The heat and elevated salinities in the heated brine will directly modify the physical characteristics of the seawater in the vicinity of the discharge whilst the heat, brine, biocide and

potential co-discharges can all negatively affect the biota. To determine the scale of their effect here first order estimates of the impact area both offshore and in the surf-zone are provided.

The rationale adopted to determine the scale of impact is to assume that heat acts as a conservative variable, *i.e.* heat is only dissipated to the receiving water body with no losses to the atmosphere. Given that the heated brine being discharged is denser than the ambient water into which the discharge occurs and is likely to have limited exposure to the atmosphere, this is a reasonable assumption. Furthermore, this provides conservative estimates of the area impacted by elevated seawater temperatures.

Under the assumption that temperature is a conservative parameter, these estimates of the thermal effluent distribution in the receiving environment will also generate information on the likely distribution of the elevated salinities, biocide and pollutants contained in potential co-discharges in the marine waters (*i.e.* the temperature, salinity, biocide and toxicants are all treated as conservative tracers).

#### 6.7.4.1 Discharges offshore of the surf-zone

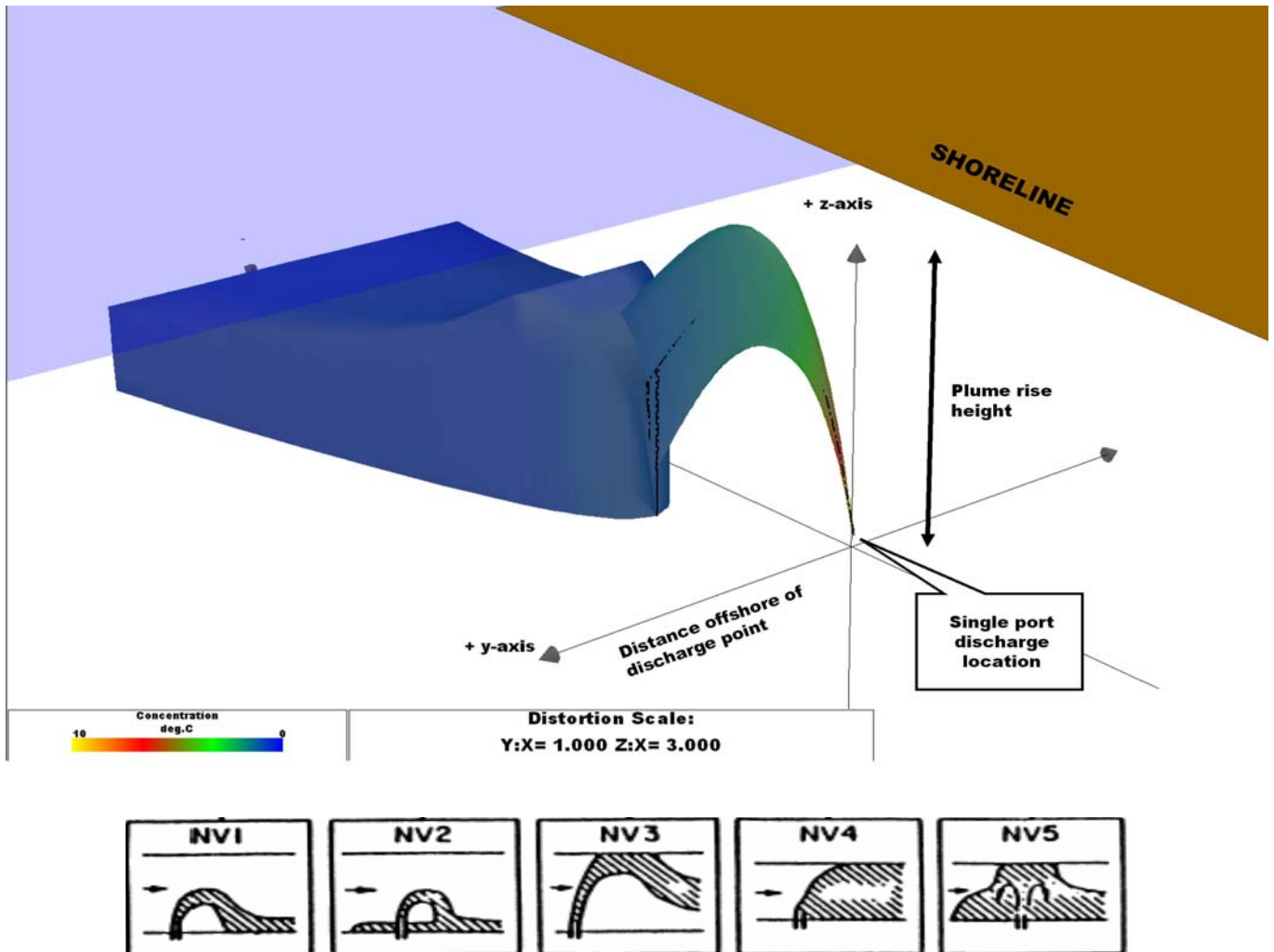
For the pipeline discharges offshore of the surfzone, the potential changes in the marine environment have been assessed by using a predictive modelling approach, using the CORMIX mixing zone expert system which comprises a software system for the prediction and design of aqueous toxic or conventional pollutant discharges into diverse water bodies developed for the United States Environmental Protection Agency (U.S. EPA) by the Cornell University during the period 1985-1995 (Jirka *et al.*, 1996). The CORMIX system is applicable to all types of ambient water bodies, including small streams, large rivers, lakes, reservoirs, estuaries and coastal waters. The method has been extensively verified by the developers through comparison of simulation results with available field and laboratory data on mixing processes and has undergone extensive peer-review (for example, Summer *et al.*, 1994). Although the system's major emphasis is on predicting the geometry and dilution characteristics of the initial mixing zone so that compliance with water quality regulatory constraints may be judged, the system also predicts the behaviour of the discharge plume at greater distances. The model is a steady-state model providing distributions of conservative pollutants and non-conservative pollutants with a specific allowance being made for heated effluents. This model has been successfully applied in other studies of thermal discharges (CSIR, 1995, 1997b and Carter and van Ballegooyen, 1998). However, a limitation of the model is that it assumes an infinite receiving body of water and consequently does not take into account the potential build-up of pollutants. Where the potential for such build-up in, for example, temperature exists due to poor flushing, the results provided by the model will not be conservative. This is a potential concern for discharges into a surfzone, coastal embayments and similar enclosed semi-enclosed or enclosed bodies of water embayments and similar enclosed semi-enclosed or enclosed bodies of water, however this is unlikely to be of concern along an open and energetic coastline as being considered here. Nevertheless, presentation of the modelling results has erred on the side of caution.

The heated brine being discharged comprises a dense effluent. It is anticipated to have a temperature of 24°C (+10°C above the ambient seawater temperature of 14°C), a salinity of 55 psu (for a brine concentration factor of approximately 1.5) and a density of 1038.9 kg/m<sup>3</sup>. The ambient seawater density is approximately 1026 kg/m<sup>3</sup>. To ensure adequate dilution in the near field the port is configured to discharge at an angle of 60° above horizontal. The typical behaviour of the effluent upon discharge is schematized in Figure 6.4. A negatively buoyant discharge, when jetted into the water column almost vertically will rise up to a maximum height in the water column. Depending on the discharge velocity, the effluent plume may reach the surface. In shallow water the effluent may be mixed throughout the water column. These behaviours are represented schematically in Figure 6.3.

As shown in the figure, the effluent plume rises to a maximum rise height in the water column and then settles back to the seabed and continues to spread due to buoyancy spreading and advection. For the purposes of this study, the extent of the "footprint" of the effluent is given as contours of maximum temperature or salinity rise or concentration of biocide at any location within the water column. In

general the effluent is trapped on or near the bottom thus the impacts are expected to be greatest at or near the seabed.

The approach used is conservative, as it is assumed that there is no heat loss to the atmosphere and that there is no modification of the free chlorine concentration by organic material in the receiving waters.



**Figure 6.3:** Schematised behaviour of a typical negatively buoyant effluent plume such as the heated brine being considered in this study.

For each discharge scenario, the effluent behaviour can be characterized in terms of effluent characterizations, and plume dimensions described in Figure 6.4

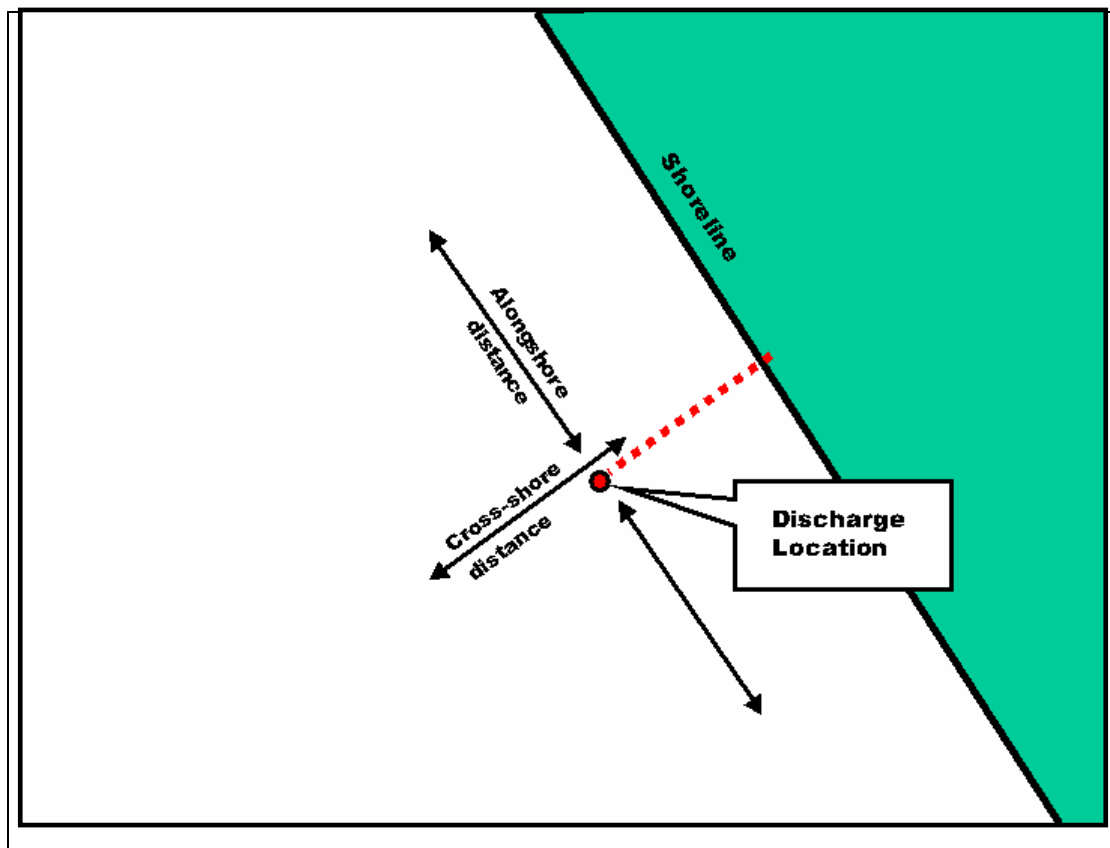


Figure 6.4: Schematised discharge pipeline and dimensions

#### 6.7.4.1.1 Offshore discharge located offshore of the intake

Here the discharge being assessed is an offshore pipeline discharge where the discharge location lies offshore of the intake. The discharges are assessed for both a 800 MW and a 1600 MW power plant

The results for the modeling of these discharges indicate that whether target values for water quality are met is very much dependent on the design of the discharge, i.e. discharge velocities, number and configuration of ports, etc. Through careful engineering design the potential “footprint” of the heated brine effluent can be limited to the minimum footprints indicated.

For a **pipeline discharge beyond the surfzone and offshore of the intake, from a 800 MW nominal capacity power plant:**

- For the worst case scenario modelled, heated effluent exceeding the most stringent target value of + 1°C above ambient seawater temperature extends no further than 200 m in a longshore direction from the discharge and < 80 m in an offshore direction. This maximum extent of the thermal “footprint” of concern however is for a low discharge velocity through the single port at the end of the pipeline. For higher velocity discharges  $\geq 1,8 \text{ m.s}^{-1}$  the zone in which the most stringent water quality guidelines are exceeded extends no further than a 20 m radius of the discharge location.
- For the worst case scenario modelled, the heated brine exceeding the most stringent target value of  $S < 36$  psu will extend 450 m alongshore and approximately 120 m offshore of the discharge location. Again these observations are for a low velocity discharge. For higher velocity discharges  $\geq 1,8 \text{ m.s}^{-1}$  the zone in which the most stringent water quality guidelines



are exceeded extends no further than a 70 m alongshore distance and 55 m offshore distance from the discharge location.

- For the worst case scenario modelled, the heated brine exceeding the most stringent target value of free chlorine  $< 3 \mu\text{g}\cdot\text{l}^{-1}$  will extend 660 m alongshore and approximately 150 m offshore of the discharge location. If the less stringent but nevertheless conservative free chlorine value of  $5 \mu\text{g}\cdot\text{l}^{-1}$  is used as the target value then this target value will be exceeded for a distance of 450 m alongshore and 120 m cross-shore. Again these observations are for a low velocity discharge. For higher velocity discharges  $\geq 1,8 \text{ m}\cdot\text{s}^{-1}$  the zone in which the most stringent water quality guidelines are exceeded extends no further than a 360 m in an alongshore direction and 120 m in the offshore direction, while there will be compliance with the guideline of  $5 \mu\text{g}\cdot\text{l}^{-1}$  at all times beyond a radius of 70 m. For a discharge velocity of  $\geq 5 \text{ m}^3\cdot\text{s}^{-1}$  there will be compliance with the most stringent values within a 25 m alongshore distance and 20 m offshore distance of the discharge location.
- The only co-discharge effluent that after appropriate design and mitigation measures that may exceed water quality guidelines is the HRSG blowdown effluent that may contain phosphates and ammonia exceeding the relevant water quality guidelines. The relevant plume dimensions (*i.e.* extent the 10 dilution contour) where the guidelines (under the worst case scenario) may be exceeded are 200 m alongshore and 80 m cross-shore. For a well-designed discharge there will always be compliance within a 20 m radius of the discharge. However as indicated, the HRSG effluent can be “bled” into the purge water discharge to ensure compliance at the point of discharge for any outfall design.
- Any oily water waste streams should be managed to the relevant water quality guidelines before discharge.
- With appropriate design of the discharge and mitigation measures, the discharges from the gas conditioning plant are expected to meet water quality guidelines at the point of discharge.<sup>2</sup>

Thus for a well-designed outfall (port exit velocity  $\geq 1,8 \text{ m}\cdot\text{s}^{-1}$ ) in a water depth of 15 m, compliance with the chosen water quality guidelines for an increase in seawater temperature is likely to occur within a 20 m radius of the discharge location, compliance with the guidelines for an increase in seawater salinity is likely to occur within a 70 m radius while there will be compliance with all but the most stringent water quality guidelines for free chlorine within a 70 m radius of the discharge location (For the most stringent water quality guideline for free chlorine, the guideline will be met within 360 m downstream of the discharge location and offshore distance of approximately 120 m). With appropriate design and implementation of mitigation measures, it is expected that all co-discharges will comply the relevant water quality guidelines. However, it is not possible to assess potential synergistic effects of the co-discharges.

**For a *pipeline discharge beyond the surfzone and offshore of the intake, from a 1600 MW nominal capacity power plant.***

- For the worst case scenario modelled, heated effluent exceeding the most stringent target value of  $+ 1^\circ\text{C}$  above ambient seawater temperature extends no further than 430 m in a longshore direction from the discharge and 140 m in an offshore direction. This maximum extent of the thermal “footprint” of concern however is for a low discharge velocity through the single port at the end of the pipeline. For higher velocity discharges ( $\geq 1,8 \text{ m}\cdot\text{s}^{-1}$ ) the zone in which the most stringent water quality guidelines are exceeded extends no further than a 20 m radius of the discharge location.

- For the worst case scenario modelled, the heated brine exceeding the most stringent target value of  $S < 36$  psu will extend 800 m alongshore and approximately 120 m offshore of the discharge location. Again these observations are for a low velocity discharge. For higher velocity discharges  $\geq 1,8 \text{ m.s}^{-1}$  the zone in which the most stringent water quality guidelines are exceeded extends no further than a 325 m alongshore and 140 m offshore from the discharge location. For a  $5 \text{ m.s}^{-1}$  there will be compliance with the most stringent target value within 50 m of the discharge point.
- For the worst case scenario modelled, the heated brine exceeding the most stringent target value of free chlorine  $< 3 \text{ } \mu\text{g.l}^{-1}$  will extend 1 100 m alongshore and approximately 240 m offshore of the discharge location. If the less stringent but nevertheless conservative free chlorine value of  $5 \text{ } \mu\text{g.l}^{-1}$  is used as the target value then at worst this target value will be exceeded for a distance of 800 m alongshore and 200 m cross-shore. Again these observations are for a low velocity discharge. For higher velocity discharges  $\geq 1,8 \text{ m.s}^{-1}$  the zone in which the most stringent water quality guidelines are exceeded extends no further than a 725 m in an alongshore direction and 230 m in the offshore direction, while there will be compliance with the guideline of  $5 \text{ } \mu\text{g.l}^{-1}$  at all times within a distance of 325 m alongshore and 140 m cross-shore.
- The only co-discharge effluent that after appropriate design and mitigation measures that may exceed water quality guidelines is the HRSG blowdown effluent that may contain phosphates and ammonia exceeding the relevant water quality guidelines. The relevant plume dimensions (*i.e.* extent the 10 dilution contour) where the guidelines (under the worst case scenario) may be exceeded are 450 m alongshore and 120 m cross-shore, For a well-designed discharge (port exit velocity  $\geq 1,8 \text{ m.s}^{-1}$ ) there will always be compliance within a 70 m radius of the discharge. However as indicated, the HRSG effluent can be “bled” into the purge water discharge to ensure compliance at the point of discharge for any outfall design.
- Any oily water waste streams should be managed to the relevant water quality guidelines before discharge.
- With appropriate design of the discharge and mitigation measures, the discharges from the gas conditioning plant are expected to meet water quality guidelines at the point of discharge.

Thus for a well-designed outfall (port exit velocity  $\geq 1,8 \text{ m.s}^{-1}$ ) in a water depth of 15 m, compliance with the water quality guidelines for an increase in seawater temperature is likely to occur within a 20 m radius of the discharge location, compliance with the water quality guidelines for an increase in seawater salinity is likely to occur within a alongshore distance of 315 m and a 120 m offshore from the discharge location (for a  $5 \text{ m.s}^{-1}$  there will be compliance with the most stringent target value within 25 m of the discharge point) and there will be compliance with all but the most stringent water quality guidelines for free chlorine within a 325 m alongshore and 140 m cross-shore distance of the discharge location (for a  $5 \text{ m.s}^{-1}$  discharge velocity there will be compliance with the most stringent target value for free chlorine within a distance of 30 m alongshore and 250 m cross-shore). With appropriate design and implementation of mitigation measures, it is expected that all co-discharges will comply the relevant water quality guidelines. However, it is not possible to assess potential synergistic effects of the co-discharges.

#### **6.7.4.1.2 Offshore discharge located inshore of the intake**

Here the discharge being assessed is an offshore pipeline discharge where the discharge location lies inshore of the intake. The discharges are assessed for both a 800 MW and a 1600 MW power plant

The results for the modeling of these discharges indicate that whether target values for water quality are met is very much dependent on the design of the discharge, *i.e.* discharge velocities, number and configuration of ports, etc. Through careful engineering design the potential “footprint” of the heated brine effluent can be limited to the minimum footprints indicated.

**For a pipeline discharge beyond the surfzone and inshore of the intake, from a 800 MW nominal capacity power plant:**

- For the worst case scenario modelled, heated effluent exceeding the most stringent target value of + 1°C above ambient seawater temperature extends no further than 200 m in a longshore direction from the discharge and < 80 m in an offshore direction. This maximum extent of the thermal “footprint” of concern however is for a low discharge velocity through the single port at the end of the pipeline. For higher velocity discharges  $\geq 1,8 \text{ m.s}^{-1}$  the zone in which the most stringent water quality guidelines are exceeded extends no further than a 20 m radius of the discharge location.
- For the worst case scenario modelled, the heated brine exceeding the most stringent target value of  $S < 36$  psu will extend 450 m alongshore and approximately 120 m offshore of the discharge location. Again these observations are for a low velocity discharge. For higher velocity discharges  $\geq 1,8 \text{ m.s}^{-1}$  the zone in which the most stringent water quality guidelines are exceeded extends no further than a 70 m alongshore distance and 55 m offshore distance from the discharge location.
- For the worst case scenario modelled, the heated brine exceeding the most stringent target value of free chlorine  $< 3 \mu\text{g.l}^{-1}$  will extend 660 m alongshore and approximately 150 m offshore of the discharge location. If the less stringent but nevertheless conservative free chlorine value of  $5 \mu\text{g.l}^{-1}$  is used as the target value then this target value will be exceeded for a distance of 450 m alongshore and 120 m cross-shore. Again these observations are for a low velocity discharge. For higher velocity discharges  $\geq 1,8 \text{ m.s}^{-1}$  the zone in which the most stringent water quality guidelines are exceeded extends no further than a 360 m in an alongshore direction and 120 m in the offshore direction, while there will be compliance with the guideline of  $5 \mu\text{g.l}^{-1}$  at all times beyond a radius of 70 m. For a discharge velocity of  $\geq 5 \text{ m}^3\text{s}^{-1}$  there will be compliance with the most stringent values within a 35 m alongshore distance and 25 m offshore distance of the discharge location.
- The only co-discharge effluent that after appropriate design and mitigation measures that may exceed water quality guidelines is the HRSG blowdown effluent that may contain phosphates and ammonia exceeding the relevant water quality guidelines. The relevant plume dimensions (i.e. extent the 10 dilution contour) where the guidelines (under the worst case scenario) may be exceeded are 200 m alongshore and 80 m cross-shore. For a well-designed discharge there will always be compliance within a 20 m radius of the discharge. However as indicated, the HRSG effluent can be “bled” into the purge water discharge to ensure compliance at the point of discharge for any outfall design.
- Any oily water waste streams should be managed to the relevant water quality guidelines before discharge.
- With appropriate design of the discharge and mitigation measures, the discharges from the gas conditioning plant are expected to meet water quality guidelines at the point of discharge.

Thus for a well-designed outfall (port exit velocity  $\geq 1,8 \text{ m.s}^{-1}$ ) in a water depth of 15 m, compliance with the water quality guidelines for an increase in seawater temperature is likely to occur within a 20 m radius of the discharge location, compliance with the guidelines for an increase in seawater salinity is likely to occur within a 70 m radius while there will be compliance with all but the most stringent water quality guidelines for free chlorine within a 70 m radius of the discharge location (For the most stringent water quality guideline for free chlorine, the guideline will be met within 360 m downstream of the discharge location and offshore distance of approximately 120 m.) With appropriate design and implementation of mitigation measures, it is expected that all co-discharges will comply the relevant water quality guidelines. However, it is not possible to assess potential synergistic effects of the co-discharges.

**For a *pipeline discharge beyond the surfzone and inshore of the intake, from a 1600 MW nominal capacity power plant:***

- For the worst case scenario modelled, heated effluent exceeding the most stringent target value of + 1°C above ambient seawater temperature extends no further than 430 m in a longshore direction from the discharge and 140 m in an offshore direction. This maximum extent of the thermal “footprint” of concern however is for a low discharge velocity through the single port at the end of the pipeline. For higher velocity discharges ( $\geq 1,8 \text{ m.s}^{-1}$ ) the zone in which the most stringent water quality guidelines are exceeded extends no further than a 20 m radius of the discharge location.
- For the worst case scenario modelled, the heated brine exceeding the most stringent target value of  $S < 36$  psu will extend 800 m alongshore and approximately 120 m offshore of the discharge location. Again these observations are for a low velocity discharge. For higher velocity discharges  $\geq 1,8 \text{ m.s}^{-1}$  the zone in which the most stringent water quality guidelines are exceeded extends no further than a 325 m alongshore and 140 m offshore from the discharge location. For a  $5 \text{ m.s}^{-1}$  there will be compliance with the most stringent target value within 50 m of the discharge point.
- For the worst case scenario modelled, the heated brine exceeding the most stringent target value of free chlorine  $< 3 \mu\text{g.l}^{-1}$  will extend 1100 m alongshore and approximately 240 m offshore of the discharge location. If the less stringent but nevertheless conservative free chlorine value of  $5 \mu\text{g.l}^{-1}$  is used as the target value then at worst this target value will be exceeded for a distance of 800 m alongshore and 200 m cross-shore. Again these observations are for a low velocity discharge. For higher velocity discharges  $\geq 1,8 \text{ m.s}^{-1}$  the zone in which the most stringent water quality guidelines are exceeded extends no further than a 725 m in an alongshore direction and 230 m in the offshore direction, while there will be compliance with the guideline of  $5 \mu\text{g.l}^{-1}$  at all times within a distance of 325 m alongshore and 140 m cross-shore.
- The only co-discharge effluent that after appropriate design and mitigation measures that may exceed water quality guidelines is the HRSG blowdown effluent that may contain phosphates and ammonia exceeding the relevant water quality guidelines. The relevant plume dimensions (*i.e.* extent the 10 dilution contour) where the guidelines (under the worst case scenario) may be exceeded are 450 m alongshore and 120 m cross-shore, For a well-designed discharge (port exit velocity  $\geq 1,8 \text{ m.s}^{-1}$ ) there will always be compliance within a 70 m radius of the discharge. However as indicated, the HRSG effluent can be “bled” into the purge water discharge to ensure compliance at the point of discharge for any outfall design.
- Any oily water waste streams should be managed to the relevant water quality guidelines before discharge.
- With appropriate design of the discharge and mitigation measures, the discharges from the gas conditioning plant are expected to meet water quality guidelines at the point of discharge.

Thus for a well-designed outfall (port exit velocity  $\geq 1,8 \text{ m.s}^{-1}$ ) in a water depth of 15 m, compliance with the water quality guidelines for an increase in seawater temperature is likely to occur within a 20 m radius of the discharge location, compliance with the water quality guidelines for an increase in seawater salinity is likely to occur within a alongshore distance of 315 m and a 120 m offshore from the discharge location (for a  $5 \text{ m.s}^{-1}$  there will be compliance with the most stringent target value within 25 m of the discharge point) and there will be compliance with all but the most stringent water quality guidelines for free chlorine within a 325 m alongshore and 140 m cross-shore distance of the discharge location (for a  $5 \text{ m.s}^{-1}$  discharge velocity there will be compliance with the most stringent target value for free chlorine within a distance of 30 m alongshore and 250 m cross-shore). With appropriate design and implementation of mitigation measures, it is expected that all co-discharges will comply the relevant water quality guidelines. However, it is not possible to assess potential synergistic effects of the co-discharges.

#### 6.7.4.1.3 Shoreline discharge into the surf-zone

Here a discharge into the surf-zone is assessed for both a 800 MW and a 1600 MW power plant. The proposed intake/discharge configuration to be assessed is as follows:

- The intake structure remains at 1 400 m offshore.
- The discharge is located on the shoreline. The exact location of the discharge relative to the moving (accreting) shoreline is unknown, as is the engineering design of such a discharge. For the purposes of this assessment a discharge is assumed at the shoreline at all times, *i.e.* the discharge point moves with the accretion of the coastline.

Wave-driven flows predominate in the surf zone where dispersion of pollutants is rapid *within* the surf zone due to the vigorous mixing processes and strong longshore and cross-shelf transports. Longshore transport is driven by the momentum flux of shoaling waves approaching the shoreline at an angle, while cross-shelf transport is driven by the shoaling waves. The magnitude of these transport processes is determined primarily by wave height, wave period, angle of incidence of the wave at the coast and bathymetry.

In terms of dispersion of pollutants, the surf zone is relatively isolated from the waters further offshore. Pollutants in the surf-zone are rapidly mixed across the surf-zone and then transported for long distances alongshore with relatively little dilution of the pollutant. Most of the exchange between the surf zone and the offshore waters occurs due to rip currents that transport surf zone waters further offshore (Figure 6.5). Some of the water mixed beyond the surf zone may be transported back into the surf zone with the next set of waves. This will reduce the effective dispersion of a pollutant. While high wave conditions often result in rapid dispersion within the surf zone and rapid alongshore dispersion of the pollutant, observations indicate a higher degree of re-entrainment of pollutant dispersed into the offshore zone thus effectively reducing the overall pollutant dispersion within the surf zone.

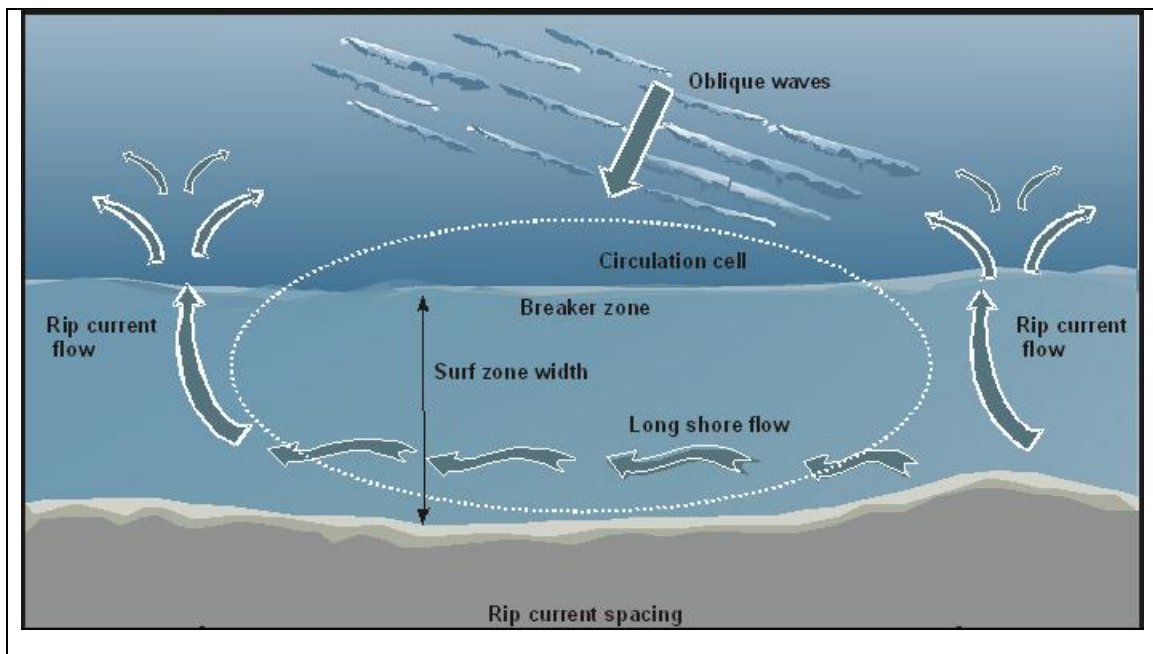


Figure 6.5: Characterisation of the mixing processes in the near shore zone (after RSA DWAF, 2004b)

The pollution “footprints” were assessed using two, essentially analytical, methods and by referring to existing observations along the South African coastline, i.e. observations. The assessment was undertaken for a range of wave conditions that encompass both typical and extreme conditions. For each wave height and direction a typical cross-shore integrated surf-zone current was estimated for the bathymetry of the region.

The analytical methods used are those of:

- Inman *et al.* (1971) that explicitly handles mixing in the surf-zone,
- CORMIX that has been utilized to assess mixing in a highly schematized surfzone.

Estimates of plume “footprints” using the above methods are utilized together with observational data to estimate the most likely plume dimension for a surfzone discharge. In general the plume is considered to extend over the full width of the surfzone and for alongshore distances as indicated in Tables 6.40 and 6.41.

**Table 6.40: Estimated plume dimensions for a 800 MW nominal capacity power plant**

Parameter	WQ Target	Estimated Plume Dimensions
All parameters		Cross-shore dimension of plume (m)
		<b>80 - 620</b>
Temperature		Alongshore dimension of plume (m)
	+5°C	<b>&lt; 20</b>
	+3°C	<b>20 - 150</b>
	+1°C	<b>200 - 250</b>
Salinity		Alongshore dimension of plume (m)
	40 psu	<b>200 - 250</b>
	36 psu	<b>200 - 500</b>
Biocide		Alongshore dimension of plume (m)
	10 µg.ℓ <sup>-1</sup>	<b>200 - 250</b>
	5 µg.ℓ <sup>-1</sup>	<b>250 - 500</b>
	3 µg.ℓ <sup>-1</sup>	<b>300 - 800</b>

**Table 6.41: Estimated plume dimensions for a 1600 MW nominal capacity power plant**

Parameter	WQ Target	Estimated Plume Dimensions
All parameters		Cross-shore dimension of plume (m)
		<b>80 - 620</b>
Temperature		Alongshore dimension of plume (m)
	+5°C	<b>&lt; 20</b>
	+3°C	<b>40 - 300</b>
	+1°C	<b>200 - 600</b>
Salinity		Alongshore dimension of plume (m)
	40 psu	<b>200 - 500</b>
	36 psu	<b>400 - 800</b>
Biocide		Alongshore dimension of plume (m)
	10 µg.ℓ <sup>-1</sup>	<b>200 - 600</b>
	5 µg.ℓ <sup>-1</sup>	<b>400 - 800</b>
	3 µg.ℓ <sup>-1</sup>	<b>600 - 1200</b>

The alongshore dimensions of the spatial area that exceeds the various Water Quality guidelines is substantially greater than those for an offshore pipeline discharge. This is primarily due to the surf zone trapping that occurs, resulting in the extensive spreading of the plume alongshore.

Based on the World Bank Water Quality guideline of not exceeding a 3°C temperature rise beyond a 100 m radius, there is marginal non-compliance for the surf zone discharge option for a 800MW nominal capacity power plant. For a 1600 MW nominal capacity power plant the non-compliance is more extensive however a 3°C temperature rise is not exceeded beyond a radius of 300 m. There is compliance, by default, with the World Bank guideline for biocides , i.e. the discharge concentrations are below the World Bank guidelines.

## 6.7.5 Potential Environmental Impacts

The major potential effects of a thermal effluent discharged into the marine environment are:

- Increased temperature in the receiving water and its impact on the biota and/or ecological processes
- Increased salinity in the receiving water and its impact on the biota and/or ecological processes.
- Biocidal action of the residual chlorine and low volume discharges of aromatic hydrocarbons.

Other potential impacts may be associated with the momentum transfer from the discharge and/or the discharge structure itself. The effect of a body of warm brine and its role as a potential barrier or as a cue to marine organisms is also discussed.

While these effects are expected regardless of the discharge configuration, the magnitude, duration and extent of the impacts will largely be determined by the extent of the discharge plume, which in turn is determined by the location of the discharge pipeline and environmental factors.

The potential impacts are discussed below in terms of the beneficial uses of the area.

### 6.7.5.1 Beneficial uses

#### ***Diamond mining and other industrial uses***

The alternative site at Uubvlei currently under consideration for the construction of a power plant for the Kudu Power Project falls within Namdeb Diamond Corporation's Mining Area 1. Diamonds have been extracted from coastal deposits for decades, with the consequence that the coastline and even the landscape between the Orange River mouth and Chameis Bay in the north, has been physically and irreversibly altered to an artificially accreted shoreline, backed by flooded excavations, overburden dumps and in places, exposed bedrock areas.

As public access to the mining area presently remains restricted, human utilisation of the beach and nearshore areas north of the Orange River mouth is limited. Furthermore, the rough seas, high degree of turbulence, strong winds, swift surf-zone currents and cold sea water temperatures are not conducive to recreational activities such as swimming, yachting, small-craft boating, sea kayaking, surfing, jetskiing or scuba-diving.

#### ***Pelagic and demersal fisheries***

The commercial fisheries targeting pelagic and demersal species are primarily concentrated offshore around the central Namibian continental shelf (O'Toole and Boyer, 1998). Other than rock lobsters, no other known biological resources are exploited as food organisms in the nearshore region.

#### ***The rock lobster fishery***

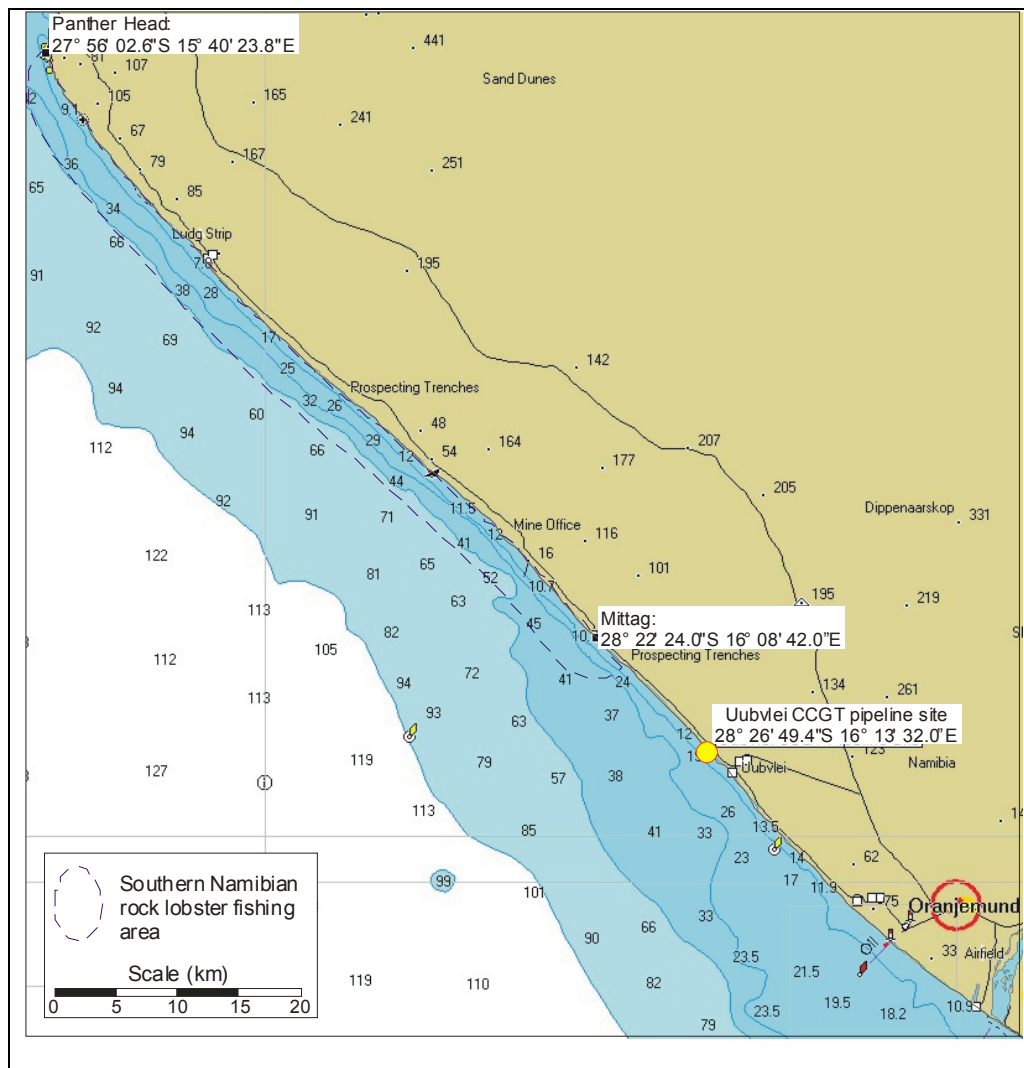
The commercial rock lobster fishery in Namibia is centred around Lüderitz and forms an important part of the coastal economy of southern Namibia, with annual catches valued at about US\$ 4 million

(Stuttaford, 1998). The general fishing area ranges from approximately Kerbe Huk 60 km north of the Orange River, to Sylvia Hill 130 km north of Lüderitz. It is primarily an inshore fishery, although rock lobsters have been caught by traps and bottom-trawl in deeper water.

In the southern region, Kerbe Huk is the most important fishing ground with an annual TAC of 70 tonnes (Figure 6.6). Most of the effort is directed at the area between Panther Head and Mittag (Marine Dredging Project, 2004; H. Ndjaula, MFMR Lüderitz, pers. comm.), with three specific fishing areas within the Kerbe Huk region being targeted by the vessels, which may fish in water as shallow as 7 m when conditions permit (J. Calaca, rock lobster fisherman, pers. comm.).

After the most recent environmentally induced decline of the rock lobster resource between 1989 and 1991, the total Namibian rock lobster landings have remained relatively stable at around 330 tonnes (K. Grobler, MFMR Lüderitz, pers. comm.). Catch per unit effort, however, has dropped by 50% over the 1998-2002. Although the commercial fishing season opens in early November, during the first two months of the season, fishing is restricted to the southern lobster grounds. Rock lobster fishing effort south of Lüderitz is thus primarily limited to a relatively short period of time. Only in years when fishers struggle to fill their quotas will they continue fishing on the southern grounds, particularly in the Kerbe Huk area, into January or February. During the 2003/2004 season most of the quota was fished in the Kerbe Huk area, with the season in the south being extended to May due to poor catches from the grounds north of Lüderitz. The low catches have primarily been attributed to extended periods of unusually high swell conditions (>2 m) during the fishing season (K. Grobler, MFMR Lüderitz, pers. comm.).





**Figure 6.6: Southern Namibian rock lobster fishing area in relation to the proposed location of the CCGT pipeline at Uubvlei (after MDP, 2004)**

The proposed position of the CCGT pipeline at Uubvlei is located about 11 km south of the southern rock lobster fishing grounds. Although the rock lobster industry is fairly conservative in their fishing practices, and therefore tends to fish in the same places year after year, there remains some possibility that they may extend their fishing further south from Mittag in future. Compared to past declines in catches in this southern area, the southern rock lobster ground has become significantly more important over the 2003 / 2004 fishing season as a result of good catch rates in the southern ground, and poor catch rates in the northern fishing areas. As a result, the number of vessels and the fishing effort is increasing in the southern area. This is likely to result in vessels moving beyond the traditional southern fishing sites in search of other reefs.

**Cumulative Impacts on Resources**

The alteration of more than 120 km of shoreline by mining activities has had considerable cumulative impacts on marine biota along the affected coast. This is particularly applicable to communities associated with reef habitats, which over the long-term would have experienced considerable sediment-related impacts. Changes in seabed structure, declining abundances or loss of biota, or significant long-term changes in community structure (e.g. loss of kelp bed habitat) in response to increased sediment loads, are likely to have ramifying cascade effects in the intertidal and nearshore ecosystem.

As the cumulative effects of mining-related impacts remain unknown, and in the light of declining rock lobster catches, rocky shores, offshore reefs and kelp beds (and their associated biota) have been identified as being threatened habitats on the coastline of the Sperrgebiet (Pallett, 1995; Burke and Raimondo, 2001).

#### ***Future-use scenarios***

The overall development objective for the Sperrgebiet, as identified in the Sperrgebiet Land-Use Plan (MET, 2001), is to ensure the long-term sustainable economic and ecological potential of the area. All future developments are therefore to be viewed within the context and recommendations of the Land Use Plan.

Over and above the current mining operations and commercial fisheries, a number of future-use opportunities involving the coastal and marine environment have been identified for the Sperrgebiet. These include:

- Eco-tourism in areas of scenic interest (especially north of Chameis), whale and dolphin watching, seal colonies, seabirds.
- Excellent surf angling potential based on pre-determined quotas.

### **6.7.5.2 Water quality guidelines**

#### ***6.7.5.2.1 Heated brine discharge***

The water quality guidelines of potential relevance for heated brine discharges and the associated required dilutions of the effluent to meet the most stringent of these target values are listed in Table 6.42 below.

#### ***6.7.5.2.2 Monocyclic aromatic hydrocarbons (BTEX)***

Although BTEX are not addressed in the South African Water Quality guidelines, some guidance can be obtained from Canadian freshwater water quality guidelines (CCME, 1987) and the U.S. Environmental Protection Agency quality criteria for both fresh and marine waters (US EPA, 1986). The latter guidelines for sea water are more comprehensive and are listed in Table 6.43 below. More recent guidelines were acquired from the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC, 2000).

In the context of BTEX, additivity of toxic effects (i.e. mixture toxicity) also needs to be considered (ANZECC, 2000). Danger for the environment will also exist if significant amount of trace metals are contained in these chemicals. Synergistic effects in the toxicology of the various pollutants may be significant. It needs to be confirmed (e.g. using direct toxicity assessment) that such a co-discharge does not result in unacceptable toxic effects.

#### ***6.7.5.2.3 Chlorinated Benzenes***

There is a direct relationship between the toxicity to fish, invertebrates and plant species and the degree of chlorination of benzene (CCME, 1987), consequently the guideline values decrease with increasing degree of chlorination. The half-life of chlorinated benzenes is typically 9 hours.

#### ***6.7.5.2.4 Dissolved nutrients***

Dissolved nutrients typically include nitrates, nitrites phosphates and ammonia. Ammonia (NH<sub>3</sub>-N) can act as a toxicant. Typically ammonia is reported as total ammonia (NH<sub>3</sub>-N + NH<sub>4</sub>-N). For this reason, the South African Water Quality Guidelines for the Natural Environment (DWA, 1995) specifies both ammonia and total ammonia guidelines (see Table 6.44). The suggested target value for PO<sub>4</sub>-P is roughly 50 to 60 µg/l.

**Table 6.42: Water quality guidelines for the discharge of a heated brine into the marine environment**

Parameter	SA Water Quality Guidelines (DWAf, 1995)	World Bank Guidelines <sup>a</sup>	International Water Quality Guidelines	Maximum required dilutions
<b>Zone of impact / mixing zone</b>	To be kept to a minimum, the acceptable dimensions of this zone informed by the EIA and requirements of licensing authorities, based on scientific evidence.	100 m radius from point of discharge for temperature	-	
<b>Temperature</b>	< 1 °C above ambient seawater temperature	< 3° C above ambient at the edge of the zone where initial mixing and dilution take place. Where the zone is not defined, use 100 meters from the point of discharge when there are no sensitive aquatic ecosystems within this distance.	Mean temperature of seawater in receiving environment not to exceed 80 percentile seawater temperature to be obtained from the seasonal distribution of temperature from a reference site (ANZECC, 2000)	10
<b>Salinity</b>	33 – 36 psu, however intertidal species may tolerate 40 psu or more	-	< 5% change in salinity from ambient/background (ANZECC, 2000) <sup>b</sup>	20
<b>Residual Chlorine</b>	no guideline, however deleterious effects recorded for concentrations as low as 2 – 20 µg.ℓ <sup>-1</sup>	0,2mg.ℓ <sup>-1</sup> at the point of discharge prior to dilution <sup>c</sup>	3 µg Cl.ℓ <sup>-1</sup> measured as total residual chlorine (low reliability trigger value at 95% protection level, to be used only as an indicative interim working level) (ANZECC, 2000)	5 to 50

<sup>a</sup> The World Bank guidelines are based on maximum permissible concentrations at the point of discharge and do not explicitly take into account the receiving environment, *i.e.* no cognisance is taken of the fact of the differences in transport and fate of pollutants between, for example, a surfzone, estuary or coastal embayment with poor flushing characteristics and an open and exposed coastline. It is for this reason that we include in this study other generally accepted Water Quality guidelines that take the nature of the receiving environment into account.

<sup>b</sup> The ANZECC (2000) Water Quality guideline for salinity is less stringent than, but roughly approximates the South African Water Quality guideline that requires that salinity should remain within the range of 33 psu to 36 psu.

<sup>c</sup> "Chlorine shocking" may be preferable in certain circumstances. This involves using high chlorine levels for a few seconds rather than a continuous low-level release. The maximum value is 2 mg. ℓ<sup>-1</sup> for up to 2 hours, not to be repeated more frequently than once in 24 hours, with a 24-hour average of 0,2 mg. ℓ<sup>-1</sup>. (The same limits would apply to bromine and fluorine.)

**Table 6.43: International guidelines for benzene, toluene, chlorinated benzenes and xylene**

Pollutant	Canadian Water Quality Guidelines	US EPA guidelines					ANZECC
		Acute toxicity	Chronic toxicity	Fish consumption	Tainting	*Carcinogenic risk levels	**Trigger Values
Benzene	110 µg. ℓ <sup>-1</sup> for marine waters	5,1 mg. ℓ <sup>-1</sup>	0,7 mg. ℓ <sup>-1</sup>	40 µg. ℓ <sup>-1</sup>	At low concentrations . No value given	4 - 400 µg.ℓ <sup>-1</sup>	500 µg.ℓ <sup>-1</sup>
Ethyl benzene	25 µg. ℓ <sup>-1</sup> for marine waters			29 mg.ℓ <sup>-1</sup>			5 to 80 µg.ℓ <sup>-1</sup>
Toluene	330 µg. ℓ <sup>-1</sup> for fresh water	6,3 mg. ℓ <sup>-1</sup>	5,0 mg. ℓ <sup>-1</sup>	200 mg.ℓ <sup>-1</sup>	At low concentrations . No value given	-	180 µg.ℓ <sup>-1</sup>
Chlorinated benzenes Monochlorobenzene Trichlorobenzene 1,2,4, Tetrachlorobenzenes Pentachlorobenzene Hexachlorobenzene	25 µg. ℓ <sup>-1</sup> 5.4 µg. ℓ <sup>-1</sup>	160 µg. ℓ <sup>-1</sup>	129 µg. ℓ <sup>-1</sup>	488 µg.ℓ <sup>-1</sup> - 48 µg.ℓ <sup>-1</sup> 85 µg.ℓ <sup>-1</sup>	20 µg. ℓ <sup>-1</sup> - - - - -	- - - - - 0,074 ng. ℓ <sup>-1</sup> to 7,4 ng. ℓ <sup>-1</sup> .	-
<i>o</i> -Xylene	None found	None found					350 µg.ℓ <sup>-1</sup>
<i>m</i> -Xylene							75 µg.ℓ <sup>-1</sup>
<i>p</i> -Xylene							200 µg.ℓ <sup>-1</sup>

\* for consumption of aquatic organism only. Levels given are those estimated to result in an incremental increase in cancer risk over a lifetime of 10<sup>-7</sup> to 10<sup>-5</sup>

\*\* Trigger values recommended for slightly-moderately disturbed systems at the 95% protection level (except benzene 99%) (ANZECC, 2000).

Note: In most cases Trigger Values have been derived from an incomplete data set using either assessment factors or from modelled data using the statistical method. As they have a low degree of confidence they should only be used as interim indicative working levels. Exceedances of the trigger values are an 'early warning' mechanism to alert the natural resource manager of a potential problem. **They are not intended to be an instrument to assess 'compliance' and should not be used in this capacity.**

**Table 6.44: International guidelines for ammonia and inorganic nutrients**

VARIABLE	SOUTH AFRICA (RSA DWAF, 1995)	AUSTRALIA/NEW ZEALAND (ANZECC, 2000)	US-EPA (US-EPA, 2004)	EUROPEAN COMMUNITY (CEC, 1979)
Dissolved inorganic nutrients for protection of the natural environment	<p>Waters should not contain concentrations of dissolved nutrients that are capable of causing excessive or nuisance growth of algae or other aquatic plants or reducing dissolved oxygen concentrations below the target range indicated for dissolved oxygen</p> <p>For the West Coast a guideline of 60 µg/l for PO<sub>4</sub>-P is suggested as being appropriate.</p>	<p>Where an appropriate local reference system(s) is available, and there are sufficient resources to collect the necessary information for the reference system, the trigger concentrations should be determined as the 80%ile of the reference system(s) distribution. Where possible, the trigger value should be obtained for that part of the seasonal or flow period when the probability of aquatic plant growth is most likely.</p> <p>Test data: Median (or mean) concentrations measured during growth periods</p>	<p>Phosphorus: 0,1 µg/l (elemental)</p> <p>Refer to US-EPA (2001) for further details on criteria</p>	<p>Nutrient concentrations do not exceed the levels established so as to ensure the functioning of the ecosystem and the achievement of the values specified above for the biological quality elements.</p>
Dissolved inorganic nutrient guidelines for mariculture	-	<p>NO<sub>3</sub>-N: 100 000 µg/l NO<sub>2</sub>-N: 100 µg/l Total Available N: 1000 µg/l PO<sub>4</sub>-P: 50 µg/l</p>	-	-
Total Ammonia-N as a toxicant	<p>600 µg/l (20 µg/l as NH<sub>3</sub>-N)</p>	<p>910 µg/l (M)</p>	<p>Target value are pH and Temperature dependent - refer to US-EPA (1989) for further details on criteria.</p> <p>Total ammonia-N at pH 8.2 and 15°C: 6700 (CMC); 1000 (CCC)</p>	<p>21 (un-ionised) (recommended Seager <i>et al</i>, 1988)</p>

**NOTE:**

H = High reliability; M = Moderate reliability; L = Low reliability; CCC = Criteria Maximum concentration; CMC = Criteria Continuous Concentration

### 6.7.6 Offshore Discharge Impact Assessment

Here the impacts associated with both an offshore pipeline discharge (discharge location offshore of the intake) and a pipeline discharge just beyond the surf-zone (discharge location inshore of the intake) are summarised. The impacts, although similar in magnitude, are marginally higher for a **discharge located inshore of the intake** than for a **marine discharge offshore of the intake**, however the risks of pollutants entering the surf-zone are higher for the discharge inshore of the intake.

Under most hydrodynamic scenarios the effluent from the **offshore marine discharge either inshore or offshore of the intake** will be trapped on or near the seabed, and any potential impacts are therefore expected to be greatest for the benthic communities of shallow subtidal soft-sediments offshore and downstream of the discharge outlet. The thermal plume is not expected to extend significant distances shorewards and is unlikely to ever extend as far as the surf-zone, even when in the future the shoreline has advanced by some 300 m due to beach accretion. No impact is thus expected on communities of intertidal sandy beaches and on surf-zone assemblages. The plume also will not extend greatly into the deeper waters. Based on the CORMIX model results for a 1 600 MW power plant, an assessment of the identified potential impacts are provided for:

- an offshore discharge (beyond the intake pipeline) on the receiving communities of nearshore unconsolidated sediments and emergent reefs
- a pipeline discharge beyond the surf-zone on the receiving communities of nearshore unconsolidated sediments and emergent reefs.

For the “worst case” scenario of a 1 600 MW power plant, the most stringent target value of + 1°C above ambient sea temperature will under the worst case scenario extend 430 m in a longshore and 140 m in an offshore direction. For higher velocity discharges ( $\geq 1,8 \text{ m.s}^{-1}$ ), the guideline exceedance zone is restricted to a 20 radius around the outlet.

The upper target value for salinity of 36 psu (RSA DWAF, 1995) will be complied with approximately 800 m downstream and 200 m offshore of the discharge point. If the port velocities of the purge water discharge are kept at velocities  $\geq 1,8 \text{ m.s}^{-1}$ , increases in salinity to 36 psu will be limited to 325 m in a longshore and 140 m in an offshore direction around the outlet.

The most stringent target value of  $<3 \mu\text{g/l}$  for free chlorine will be exceeded maximal for a distance of 1140 m alongshore and 250 m offshore of the discharge location. If the less stringent but still conservative target value of  $5 \mu\text{g/l}$  is used, the exceedance zone will be 800 m alongshore and 200 m cross-shore. A higher velocity discharge ( $\geq 1,8 \text{ m.s}^{-1}$ ) reduces the exceedance zone of  $3 \mu\text{g/l}$  to 740 m alongshore and 230 m offshore and the exceedance zone of  $5 \mu\text{g/l}$  to 325 m alongshore and 140 m offshore.

The water from the gas conditioning plant, discharged at a rate of  $5 \text{ m}^3 \cdot \text{day}^{-1}$ , will contain  $<10 \text{ mg/l}$  of dissolved hydrocarbons with lesser concentrations of monocyclic aromatic hydrocarbons (BTEX) and other oil-based toxic components. “Bleeding” of this effluent into the purge waters over a 24 hour period will achieve an effective 6 250 times dilution, reducing all toxic components of the effluent to  $1.6 \mu\text{g/l}$ . The ammonia and phosphates in the HRSG blowdown effluent can be reduced to 2.5 and  $1 \mu\text{g/l}$  respectively, when the effluent is “bled” into the purge water over a 24 hour period.

Potential environmental impacts for a pipeline discharge either offshore or inshore of the intake point, are assessed in Table 6.45 – 6.52.

**Table 6.45: Impact of thermal plume**

<b>Nature of impact: Effects of thermal plume</b>	
Extent	<b>Local:</b> Compliance with target value at discharge velocities of $\geq 1,8 \text{ m.s}^{-1}$ will occur within $< 20 \text{ m}$ radius of the discharge location.
Duration	<b>Long-term:</b> As long as the plant is in operation.
Intensity	<b>Low:</b> No lethal effects are anticipated.
Probability	<b>Definite:</b> The discharged purge water will have an elevated temperature.
Status of Impact	<b>Negative</b>
Degree of Confidence	<b>High</b>
Significance without mitigation	<b>Low</b>
Significance with mitigation	<b>No mitigation possible, but is not required</b>

**Table 6.46: Impact of salinity plume**

<b>Nature of impact: Effects of salinity plume</b>	
Extent	<b>Local:</b> Compliance with target value at discharge velocities of $\geq 1,8 \text{ m.s}^{-1}$ will occur with $325 \text{ m}$ downstream and $140 \text{ m}$ offshore of the discharge location.
Duration	<b>Long-term:</b> As long as the plant is in operation.
Intensity	<b>Low:</b> No lethal effects are anticipated, as adverse effects on biota are usually associated with decreases in salinity.
Probability	<b>Definite:</b> The discharged purge water will have an increased salinity.
Status of Impact	<b>Negative</b>
Degree of Confidence	<b>Medium:</b> Little information available on effects of high salinity on marine biota.
Significance without mitigation	<b>Low</b>
Significance with mitigation	<b>No mitigation possible, but not required</b>

**Table 6.47: Impact of biocide plume**

<b>Nature of impact: Effects of biocide plume</b>	
Extent	<b>Local:</b> Compliance with most stringent target value at discharge velocities of $\geq 1,8 \text{ m.s}^{-1}$ will occur with $730 \text{ m}$ downstream and $215 \text{ m}$ offshore of the discharge location. For less stringent but none-the-less conservative target values, compliance will be achieved $315 \text{ m}$ downstream and $120 \text{ m}$ offshore of outlet.

Duration	<b>Long-term:</b> As long as the plant is in operation.
Intensity	<b>Low:</b> No lethal effects expected for this impact; for very sensitive species, some deleterious effects at the sublethal level may occur.
Probability	<b>Definite:</b> The discharged purge water will contain residual chlorine. Could be mitigated at a cost.
Status of Impact	<b>Negative</b>
Degree of Confidence	<b>High</b>
Significance without mitigation	<b>Low</b>
Significance with mitigation	<b>Low</b>

**Table 6.48: Impact of aromatic hydrocarbons**

<b>Nature of impact: Effects of aromatic hydrocarbons</b>	
Extent	<b>Local:</b> Effluent from the gas conditioning plant will be 'bled' over a 24 hour period into purge water diluting the effluent by a factor of 6250, and thus reducing the discharge concentration to 1.6 µg/l. Similarly, the oil separator for the plant and surface water drainage needs to be set to meet the relevant standards.
Duration	<b>Long-term:</b> As long as the plant is in operation.
Intensity	<b>Low:</b> No lethal effects expected for this impact; some deleterious effects (e.g. tainting of fish and shellfish flesh) at the sublethal level may occur.
Probability	<b>Definite:</b> The discharged purge water will contain only traces of aromatic compounds. Could be mitigated at a cost.
Status of Impact	<b>Negative</b>
Degree of Confidence	<b>High</b>
Significance without mitigation	<b>Low</b>
Significance with mitigation	<b>Low</b>

**Table 6.49: Impact of HRSG blowdown effluent**

<b>Nature of impact: Effects of HRSG blowdown effluent</b>	
Extent	<b>Local:</b> When effluent is 'bled' over a 24 hour period into the purge water system, concentrations of ammonia and phosphates will comply with guidelines at point of discharge. Only trace quantities of hydrazine.
Duration	<b>Long-term:</b> As long as the plant is in operation.
Intensity	<b>Low:</b> No lethal or sublethal effects expected.
Probability	<b>Definite:</b> The HRSG blowdown effluent will contain traces of hydrazine, ammonia and phosphates.



Status of Impact	<b>Negative</b>
Degree of Confidence	<b>High</b>
Significance without mitigation	<b>Low</b>
Significance with mitigation	<b>Low</b>

**Table 6.50: Impact of a decline in dissolved oxygen levels**

<b>Nature of impact: Effects of a decline in dissolved oxygen levels</b>	
Extent	<b>Local:</b> Reduction of dissolved oxygen levels restricted to the extent of the thermal and high salinity plumes.
Duration	<b>Long-term:</b> As long as the plant is in operation.
Intensity	<b>Low:</b> A potential 25% reduction in dissolved oxygen levels in the heated effluent will only result in < 2% drop in dissolved oxygen for any significant area.
Probability	<b>Definite:</b> The heated and high saline effluent will cause a reduction in dissolved oxygen levels.
Status of Impact	<b>Negative</b>
Degree of Confidence	<b>High</b>
Significance without mitigation	<b>Low</b>
Significance with mitigation	<b>Low</b> (opportunity for mitigation is limited)

**Table 6.51: Impact of flow field distortion due to momentum transfer**

<b>Nature of impact: Effects of flow field distortion due to momentum transfer</b>	
Extent	<b>Local:</b> Restricted to the vicinity of the outlet.
Duration	<b>Long-term:</b> As long as the plant is in operation.
Intensity	<b>Low:</b> Due to the small volumes and the design of the outlet.
Probability	<b>Definite</b>
Status of Impact	<b>Negative</b>
Degree of Confidence	<b>High</b>
Significance without mitigation	<b>Low</b>
Significance with mitigation	<b>Low</b>

**Table 6.52: Impact of discharge and intake structures**

<b>Nature of impact: Effects of discharge and intake structures</b>	
Extent	<b>Local:</b> Restricted to the vicinity of the outlet and the construction site of the pipeline.
Duration	<b>Long-term:</b> As long as the plant is in operation.
Intensity	<b>Low</b>
Probability	<b>Definite</b>
Status of Impact	<b>Negative</b>
Degree of Confidence	<b>High</b>
Significance without mitigation	<b>Low</b>
Significance with mitigation	<b>Low</b>

For a pipeline discharge either offshore or inshore of the intake point, all potential environmental impacts as assessed in this study are considered to be of low significance, however the impacts increase on moving inshore, i.e. shortening the discharge pipeline length.

However, it should be noted that:

- The model results are strongly dependent on the assumed currents in the ambient waters and are also strongly dependent on the detailed design of the discharge (e.g. on port discharge velocity).

#### **6.7.6.1 Compliance with World Bank requirements for assessment of effluent discharges**

For all environmental conditions assessed for an offshore pipeline discharge, there is compliance with the World Bank Water Quality guidelines for temperature and biocides, and with international guidelines on aromatic hydrocarbons. No World Bank Water Quality guideline could be located for salinity, however the impacts are assessed to be low based on other Water Quality guidelines deemed to be of relevance (e.g. RSA DWAF, 1995).

#### **6.7.7 Shoreline Discharge Impact Assessment**

Nearshore circulation is highly complex and extremely variable. The surf-zone is relatively isolated from the waters further offshore. While pollutants in the surf-zone are rapidly mixed across the surf-zone, they may subsequently be transported for long distances alongshore with relatively little further dilution. This reduces the effective dispersion of a pollutant. Most of the exchange between the surf-zone and the offshore waters occurs due to rip currents that transport surf-zone waters further offshore. However, some of the water mixed beyond the surf-zone may be transported back into the surf-zone with the next set of waves. Observations have indicated that in high wave conditions, there is a higher degree of re-entrainment of pollutants dispersed into the offshore zone, and that the overall dispersion of pollutants within the surf-zone is thus effectively reduced.

The “footprint” of an effluent plume discharged into the surf-zone is thus somewhat more extensive than for either of the other two offshore pipeline discharge options. For an 800 MW nominal capacity power plant, the thermal “footprint” marginally exceeds World Bank Water Quality guidelines, but the

spatial extent remains relatively small (i.e. confined to approximately 150 m alongshore and 80 m to approximately 620 m offshore of the discharge point). The exceedance of the South African water quality guidelines is somewhat greater (i.e. confined to approximately 250 m alongshore and 80 m to approximately 620 m offshore of the discharge point). For a 1600 MW nominal capacity power plant the spatial extent of non-compliance with the World Bank Water Quality guidelines is somewhat larger (i.e. confined to approximately 300 m alongshore and 80 m to approximately 620 m offshore of the discharge point), while the exceedance of the South African water quality guidelines is greater (i.e. confined to approximately 600 m alongshore and 80 m to approximately 620 m offshore of the discharge point). However, the direct thermal impacts on benthic assemblages and potentially on egg and larval development is expected to be limited.

The South African Water Quality guidelines (RSA DWAF, 1995) sets an upper target value for salinity of 36 psu, which for a 800 MW power plant will be complied with approximately 200 m to 500 m downstream and between 80 m and 620 m offshore (i.e. the surf-zone width) of the discharge location and for a 1 600 MW nominal capacity power plant will be complied with approximately 400 m to 800 m downstream and between 80 m and 620 m offshore. The assessment of the impacts of elevated salinity on the biota of the Oranjemund coastline is of necessity speculative as little published information exists on this topic. Since the area in question is a high energy open sandy coastline with a small tidal range (ca. 1.8 m) the benthic organisms are unlikely to exhibit much tolerance to salinity variations, perhaps 1°-2°psu above and below the approximate 35 psu typical of seawater in this region.

There is a possibility that the larvae of a variety of species, including those of the commercially important rock lobster *Jasus lalandii*, could be transported by the longshore drift. In this case the heated brine could act as a barrier to their dispersal.

The scale of the impacts is somewhat uncertain but are expected to be proportional to the plume extent (estimated 200 to 500 m for a salinity of 40 psu).

The cumulative effect of elevated salinity and temperature, and of co-discharges, on the larval and juvenile stages of fish and invertebrates is not known, but could well be greater than the sum of the individual impacts. For example, on the southern Namibian coastline shallow, nearshore reef regions are thought to be important as recruitment habitats for rock lobsters. Furthermore, the population often becomes concentrated in very shallow waters in response to low oxygen concentrations near the seabed. The effect of an effluent plume discharged into the surf-zone could thus have far-reaching effects on the commercial fishery for this species. Because of the uncertainty of the impacts, the likely sensitivity of marine biota to elevated salinities, and the spatial extent and likely persistence of the plume in the surf-zone, the precautionary principle requires that the potential impacts be considered to be of medium significance or greater.

Based on the CORMIX model results for a 1600 MW power plant, an assessment of the identified potential impacts of a pipeline discharge into the surf-zone on the receiving communities of intertidal sandy beaches and rocky shores and surf-zone assemblages is provided below in Tables 6.53 – 6.63.

**Table 6.53: Impact of thermal plume on marine biota**

<b>Nature of impact: Effects of thermal plume on marine biota</b>	
Extent	<b>Local:</b> Compliance with target value at alongshore distances of < 600 m of the discharge location.
Duration	<b>Long-term:</b> As long as the plant is in operation.
Intensity	<b>Low:</b> No lethal effects are anticipated.
Probability	<b>Definite:</b> The discharged purge water will have an

	increased temperature.
Status of Impact	<b>Negative</b>
Degree of Confidence	<b>High</b>
Significance without mitigation	<b>Low</b>
Significance with mitigation	<b>No significant mitigation possible</b>

**Table 6.54: Impact of salinity on beach and surf-zone communities**

<b>Nature of impact: Effects of salinity on beach and surf-zone communities</b>	
Extent	<b>Local:</b> Estimated plume dimension of 200 to 500 m for a salinity of 40 psu.
Duration	<b>Long-term:</b> As long as the plant is in operation.
Intensity	<b>Locally high</b>
Probability	<b>Definite:</b> The discharged purge water will have an increased salinity.
Status of Impact	<b>Negative</b>
Degree of Confidence	<b>Medium:</b> Little information available on effects of high salinity on marine biota.
Significance without mitigation	<b>Low</b>
Significance with mitigation	<b>Low</b>

**Table 6.55: Impact of elevated salinity interfering with physiological function of larval fish and invertebrates**

<b>Nature of impact: Effects of elevated salinity interfering with physiological function of larval fish and invertebrates</b>	
Extent	<b>Local to regional:</b> The surf-zone is potentially a migration or dispersal medium
Duration	<b>Long-term:</b> As long as the plant is in operation.
Intensity	<b>High</b>
Probability	<b>Uncertain</b>
Status of Impact	<b>Negative</b>
Degree of Confidence	<b>Low:</b> Little information available on the ichthyofauna of the region
Significance without mitigation	<b>Medium</b>
Significance with mitigation	<b>Medium:</b> Mitigation possibilities uncertain

**Table 6.56: Impact of biocide on beach and surf-zone communities**

<b>Nature of impact: Effects of biocide on beach and surf-zone communities</b>	
Extent	<b>Local:</b> Compliance with most stringent target value will occur with 600 m to 1200 m. For less stringent but still conservative target value of $5 \mu\text{g}\cdot\text{t}^{-1}$ , compliance will be achieved within in 400 to 800 m.
Duration	<b>Long-term:</b> As long as the plant is in operation.
Intensity	<b>Locally high:</b> Potential lethal effects in a limited area ( <i>i.e.</i> 600 m on either side of the discharge point) and some deleterious effects within a 1200 m alongshore distance.
Probability	<b>Definite:</b> The discharged purge water will contain residual chlorine. Could be mitigated at a cost.
Status of Impact	<b>Negative</b>
Degree of Confidence	<b>Medium</b>
Significance without mitigation	<b>Medium</b>
Significance with mitigation	<b>Low</b>

**Table 6.57: Impact of aromatic hydrocarbons**

<b>Nature of impact: Effects of aromatic hydrocarbons</b>	
Extent	<b>Local:</b> Effluent from the gas conditioning plant will be 'bled' over a 24 hour period into purge water diluting the effluent by a factor of 6250, and thus reducing the discharge concentration to $1.6 \mu\text{g}/\text{l}$ . Similarly, the oil separator for the plant and surface water drainage needs to be set to meet the relevant standards (e.g. South African General Discharge Standard)
Duration	<b>Long-term:</b> As long as the plant is in operation.
Intensity	<b>Low:</b> No lethal effects expected for this impact; some deleterious effects ( <i>e.g.</i> tainting of fish and shellfish flesh) at the sublethal level may occur.
Probability	<b>Definite:</b> The discharged purge water will contain only traces of aromatic compounds. Could be mitigated at a cost.
Status of Impact	<b>Negative</b>
Degree of Confidence	<b>High</b>
Significance without mitigation	<b>Low</b>
Significance with mitigation	<b>Low</b>

**Table 6.58: Impact of HRSG blowdown effluent**

<b>Nature of impact: Effects of HRSG blowdown effluent</b>	
Extent	<b>Local:</b> When effluent is 'bled' over a 24 hour period into the purge water system, concentrations of ammonia and phosphates will comply with guidelines at point of discharge. Only trace quantities of Hydrazine.
Duration	<b>Long-term:</b> As long as the plant is in operation.
Intensity	<b>Low:</b> No lethal or sublethal effects expected.
Probability	<b>Definite:</b> The HRSG blowdown effluent will contain traces of hydrazine, ammonia and phosphates.
Status of Impact	<b>Negative</b>
Degree of Confidence	<b>High</b>
Significance without mitigation	<b>Low</b>
Significance with mitigation	<b>Low</b>

**Table 6.59 Impact of a decline in dissolved oxygen levels**

<b>Nature of impact: Effects of a decline in dissolved oxygen levels</b>	
Extent	<b>Local:</b> Reduction of dissolved oxygen levels restricted to the extent of the thermal and high salinity plumes.
Duration	<b>Long-term:</b> As long as the plant is in operation.
Intensity	<b>Low:</b>
Probability	<b>Definite:</b> The heated and high saline effluent will cause a reduction in dissolved oxygen levels.
Status of Impact	<b>Negative</b>
Degree of Confidence	<b>High</b>
Significance without mitigation	<b>Low</b>
Significance with mitigation	<b>Low</b> (opportunity for mitigation is limited)

**Table 6.60 Impact of salinity acting as a barrier to larval migration**

<b>Nature of impact: Effects of salinity acting as a barrier to larval migration</b>	
Extent	<b>Local to regional:</b> Depends on actual effect on overall populations of fishes and invertebrates.
Duration	<b>Long-term:</b> As long as the plant is in operation.
Intensity	<b>Medium to high</b>
Probability	<b>Uncertain</b>
Status of Impact	<b>Negative</b>
Degree of Confidence	<b>Low</b>

Significance without mitigation	<b>Medium</b>
Significance with mitigation	<b>Low to medium</b>

**Table 6.61 Impact of elevated salinity & temperature of brine interfering with larval fish cueing**

<b>Nature of impact: Effects of elevated salinity &amp; temperature of brine interfering with larval fish cueing</b>	
Extent	<b>Local to regional:</b> Depends on actual effect on overall populations of fishes and invertebrates.
Duration	<b>Long-term:</b> As long as the plant is in operation.
Intensity	<b>Medium to high</b>
Probability	<b>Uncertain</b>
Status of Impact	<b>Negative</b>
Degree of Confidence	<b>Low</b>
Significance without mitigation	<b>Medium</b>
Significance with mitigation	<b>Low to medium</b>

**Table 6.62 Impact of flow field distortion due to momentum transfer**

<b>Nature of impact: Effects of flow field distortion due to momentum transfer</b>	
Extent	<b>Local:</b> Restricted to the vicinity of the outlet.
Duration	<b>Long-term:</b> As long as the plant is in operation.
Intensity	<b>Low:</b> Due to the small volumes and the design of the outlet.
Probability	<b>Definite</b>
Status of Impact	<b>Negative</b>
Degree of Confidence	<b>High</b>
Significance without mitigation	<b>Low</b>
Significance with mitigation	<b>Low</b>

**Table 6.63: Impact of discharge and intake structures on sediment transport**

<b>Nature of impact: Effects of discharge and intake structures on sediment transport</b>	
Extent	<b>Local:</b> Restricted to the vicinity of the outlet and the construction site of the pipeline.
Duration	<b>Long-term:</b> As long as the plant is in operation.
Intensity	<b>Low</b>
Probability	<b>Definite</b>
Status of Impact	<b>Negative</b>

Degree of Confidence	High
Significance without mitigation	Low
Significance with mitigation	Low

For a discharge into the surfzone, all potential environmental impacts assessed are considered to be of low significance, except for:

- the potential impacts of elevated salinity on physiological function of larval fish and invertebrates
- impacts due to biocides associated with a larger and more persistent plume in the surfzone
- elevated temperatures and salinity acting as a barrier for the movement of the larvae of fishes and invertebrates that are transported by the littoral drift
- potential impacts on the cueing effects that guides larval/juvenile fish to nursery areas such as the Orange River estuary.

There is considerable uncertainty as to the significance of these impacts. Because of the uncertainty of the impacts, the sensitivity of marine biota and the likely extent and persistence of the biocide plume, the precautionary principle requires that the above potential impacts be considered to be of medium significance or greater until proven otherwise.

However, it should be noted that:

- The model results are strongly dependent on the assumed currents and mixing processes in the ambient waters.
- There is considerable uncertainty around the exact plume dimensions due to the lack of simple quantitative methods to assess surfzone dilutions. (This inherent uncertainty in assessing surfzone discharges is one of the reasons in the South African Water Quality guidelines for declaring the surfzone a sensitive area into which there should not be discharge of waste water / effluents unless there is a very strong motivation for doing so.) Consequently there is inherent uncertainty in the assessment of ecological impacts of a shoreline discharge.
- The “footprint” of the heated brine discharged through a shorter pipeline into shallower water will be significantly greater than for an offshore discharge, *i.e.* the area of non-compliance with water quality guidelines is significantly larger.

#### 6.7.7.1 Compliance with World Bank requirements for assessment of effluent discharges

Based on the World Bank Water Quality guideline of not exceeding a 3°C temperature rise beyond a 100 m radius, there is marginal non-compliance for the shoreline discharge option for a 800MW power plant. For a 1600 MW power plant the non-compliance is more extensive, however, a 3°C temperature rise is not exceeded beyond a radius of 300 m. There is compliance, by default, with the World Bank guideline for biocides, *i.e.* the concentrations at the point of discharge are below the World Bank guidelines.

#### 6.7.8 Mitigation and monitoring measures

The discharge of the heated brine from the proposed CCGT power plant is unavoidable, and no mitigation is feasible. However, the outfall characteristics (extent and duration of the plume “footprint”) could be optimised through the use of the most effective diffuser design. The impacts due to biocides



can be mitigated by de-chlorination of the purge water before discharge into the marine environment. This would, however, be associated with a significant cost.

Recommendations that follow from the assessment are:

- Depending on the final location of the discharge pipe, a more detailed study may be required to ensure that relative to the seawater intake, the discharge point is located so as to limit or prevent in re-circulation of the effluent.
- The engineering and environmental implications of the infrastructure associated with the cooling water system need to be carefully studied as there are high structural risks associated with locating these structures in such a dynamic environment.
- Although this assessment used the results of the CORMIX model for the discharge of purge water from a 1600 MW nominal capacity power plant, a re-assessment of the impacts, incorporating the knowledge gained during the operation of the 800 MW nominal capacity power plant, should be conducted prior to the upgrading of the power plant.
- An appropriate physical monitoring program needs to be initiated, which includes both baseline measurements and subsequent operational monitoring.

More specifically, this should include:

- Regular reporting on the volume and composition of the discharge.
- Water column monitoring including measurements of biocides and aromatic hydrocarbons on a regional scale in order to improve the understanding of the environmental fate of the effluent.
- Bioaccumulation monitoring using mussels (possibly in combination with membrane-based techniques – see Prest *et al.*, 1995; Peven *et al.*, 1996; Hofelt and Shea, 1997) as indicator organisms due to their ability to accumulate trace levels of pollutants from the water column.
- An appropriate biological monitoring program needs to be initiated, which includes both baseline measurements and subsequent operational monitoring.
- Given the important role of the surf-zone and immediate subtidal habitats in the ecosystem functioning of the region, should the surf-zone discharge option be considered, the following should be incorporated:
  - A baseline survey of the zooplankton and ichthyoplankton along the Oranjemund coast to elucidate species distributions and seasonal variations.
  - A baseline survey, and subsequent monitoring, of the beach macrofaunal communities, and surf-zone fish communities in the vicinity of the discharge.
  - A range of toxicity tests for the most sensitive biota in the surf-zone to determine their vulnerability to elevated salinity and biocides.
- At present, the southern limit of the southern rock lobster fishing grounds are approximately 11 km north of the proposed discharge location. However, the possibility of a future extension of the fishing grounds further south, however remote, cannot be excluded. It is thus recommended to liaise with the rock lobster fishing industry on this issue to avoid potential confrontation in the future. In this context and given that it is possible for BTEX compounds to taint rock lobster flesh (with possible consequences for the industry), it is important that a conservative discharge design is adopted and that there is strict compliance with appropriately stringent guidelines for the discharge of hydrocarbons.

- The water discharged from the gas conditioning plant should be characterised, to confirm that it will, indeed, have a negligible environmental impact when co-discharged with the cooling purge water. This gas conditioning plant discharge should be analysed on a regular basis throughout the life of the project, to ensure that potential impacts on the environment do not change adversely.

### 6.7.9 Permit requirements

In terms of the proposed Pollution Control and Waste Management Bill, section 3 deals with water pollution. Water quality monitoring will be co-ordinated by an Agency in terms of water quality objectives and activities liable to cause water pollution. It is proposed that regulations under this Bill will include limits for discharges of pollutants to water and land from fixed and mobile sources, water quality objectives, standards for the pre-treatment or purification of pollutants, and procedures required for compliance with any standards. It will also prescribe offences and water quality action areas and the restriction of polluting activities in these areas, as well as require application for water pollution licences to be accompanied by an environmental assessment report, and offences. The Water Resources Management Act 24 of 2004 introduces the Polluter Pays principle through promoting environmentally responsible disposal of effluents and waste water.

# CONTENTS

---

7. CONCLUSIONS AND RECOMMENDATIONS .....	7-1
7.1 Introduction .....	7-1
7.2 Issues Affecting Oranjemund and its Environs .....	7-1
7.2.1 <i>Socio-economic Issues</i> .....	7-1
7.3 Site-specific Issues .....	7-2
7.3.1 <i>Impact of Noise</i> .....	7-2
7.3.2 <i>Impacts of Air Pollution</i> .....	7-2
7.3.3 <i>Visual Impact</i> .....	7-3
7.3.4 <i>Impacts on Terrestrial Ecology</i> .....	7-3
7.3.5 <i>Impacts of Purge Water Discharge on Marine Environment</i> .....	7-4
7.4 Conclusions.....	7-6
7.5 Recommendations .....	7-6
7.5.1 <i>Environmental Management Plan</i> .....	7-6
7.5.2 <i>Shoreline discharge: additional data</i> .....	7-6

## 7. Conclusions and Recommendations

### 7.1 Introduction

When, in 2004, the Kudu gas-to-electricity project was re-activated in response to the urgent requirement that Namibia's future electricity needs be ensured, NamPower decided that the focus of its planning would be on Site D, the selection of which was the outcome of the preliminary environmental assessment (PEA) completed in 1998. However, consideration of Namdeb's operational requirements over the medium term has led to Nampower investigating a new site at Uubvlei, about 25 kilometres north of Oranjemund. Thus the EIA, commenced in March 2005, was required to address the potential impacts of a combined cycle gas turbine (CCGT) electricity generating plant at Uubvlei and its environs.

The EIA addresses issues raised in the original PEA, those identified during stakeholder consultation meetings held in June 2004 and March 2005, and issues raised by Namdeb staff in their official capacity. Essentially the issues fall into two main groups:

- Those primarily identified by the stakeholders or interested and affected parties (I&APs) which mainly concerned the impact on Oranjemund and its environs; and
- Issues specific to the CCGT site itself.

### 7.2 Issues Affecting Oranjemund and its Environs

#### 7.2.1 Socio-economic Issues

The introduction of a large "foreign" workforce (up to 1 300 personnel at the peak of construction activities) into the closed community of Oranjemund gave rise to a number of concerns of a socio-economic nature.

##### 7.2.1.1 Impact on the Central Business Area

There was a concern that the town could become unpleasantly crowded when large numbers of construction workers are present e.g. on Saturday mornings. It has been suggested that a shop should be opened within the construction workers' camp to cater for their day-to-day needs thereby reducing pressure on the town. Clearly the prices charged would have to be competitive otherwise the objective of having an on-site shop would be defeated. However, since the workers will be housed 25 kilometres away from the town, this concern can be mitigated by devising a transport schedule from Uubvlei to Oranjemund that smooths out the surges in influx over the periods of concern.

##### 7.2.1.2 Impact on Recreational Facilities

It has been proposed that at least two soccer fields be laid out next to the workers' accommodation to allow for informal football games to be played. It is likely that these fields will satisfy much of the need for recreational facilities. However, in the event that this does not satisfy all the workers, recreational facilities in Oranjemund can be requested to open their doors to the temporary workers for the duration of the construction of the power plant.

##### 7.2.1.3 Impact on Roads and Traffic

###### Construction Vehicles

Construction vehicles will not be permitted in the residential and central business areas of the town.

### Private Vehicles

Since the workers will be housed 25 kilometres away, use of their private vehicles will not add significantly to the traffic in town, except in the vicinity of the shopping centre for the short periods when they visit town to do their shopping.

#### **7.2.1.4 Impact on Security**

Whenever a large number of "foreign" people join a community there is a concern that crime such as theft and assaults (at bars) will increase. However, since the workers will not be housed close to the town, the opportunities for such incidents can be regulated through the transport arrangements used to ferry the workers from the Uubvlei site.

### **7.3 Site-specific Issues**

#### **7.3.1 Impact of Noise**

Since the power plant will be 25 kilometres away from Oranjemund, noise from both its construction and operation will not have an impact on the town.

##### **7.3.1.1 Impact of Construction Noise**

A variety of noise sources will be present during construction. The one factor that they will have in common is that they will not be individually constant i.e. they will rise and fall depending on the particular activity being conducted. Those impacted by such noise at the CCGT site will be the construction workers themselves, who are protected from excessive noise levels by regulations under the Labour Act of 1992.

##### **7.3.1.2 Impact of Power Plant Operational Noise**

Unlike the noise generated by construction, that which is produced while the power plant is operating will be constant. As with the noise generated by construction, the impact of this noise on workers will also be regulated by the Labour Act of 1992.

#### **7.3.2 Impact of Air Emissions**

The air quality study was undertaken to address the generation and subsequent dispersion of air emissions from the proposed power plant. Air emissions of concern selected for this study were the major ones typically emitted from combined cycle gas turbine power production operations; quantitative health risk assessments were done for SO<sub>2</sub>, NO<sub>x</sub> and particulate matter (PM). The main emissions of concern from the proposed power station will be the oxides of nitrogen.

The World Health Organisation (WHO) guidelines for NO<sub>x</sub>, World Bank standard and the proposed new ambient air quality standards for South Africa were used for the assessment of impacts on human health. Risks were evaluated for a child of 10 years and an adult of between 18-65+ years of age at the CCGT site only. Maximum average annual and 1-hour ambient concentrations for NO<sub>x</sub> from No.2 fuel oil and, as well as those for gas fired scenarios were modelled, and hazard quotients based on these results were mostly below the safety margin of 1 for the acute and chronic NO<sub>2</sub> exposure scenarios at the CCGT site. The health risk assessment for SO<sub>2</sub> exposure scenarios showed that it would be unlikely for any individual to develop adverse health effects due to SO<sub>2</sub> exposure at the modelled concentrations. However, for 1-hour SO<sub>2</sub> concentrations from the oil stack at double capacity, individuals at the site are at risk. Concentrations modelled for total suspended particulate matter (TSP) from the oil stack after NO<sub>2</sub> mitigation were all well below international and proposed South African guidelines

Comprehensive air quality modelling and risk assessments showed that impacts from emissions from the proposed Kudu CCGT power station are limited to the immediate area surrounding the plant, they will however persist for the lifetime of the plant, but the intensity of the impacts are low.

NO<sub>x</sub> was identified as important in terms of potential damage to vegetation in the study area. The modelling of NO<sub>x</sub> emissions indicated that levels would be well below those that would indicate potential for impact. However, confidence levels for the assessment were low due to lack of data on effects that may occur in the specialised vegetation that is characteristic of the study area. However, the overall assessment of the impact of the proposed development on vegetation indicates that the significance of impacts are low based on emission loads and the distribution of the vegetation types on a regional (Namibian coast) scale.

In summary, emissions from the proposed Kudu CCGT power plant will conform to the emission requirements of the World Bank when operating under natural gas and No. 2 fuel oil. Emissions from the gas conditioning plant will be negligible.

### 7.3.3 Visual Impact

Consideration needs to be given to whether the large power plant structure, with its associated cooling towers and the plume emanating from them would have a significant visual impact on the ambience of the future Sperrgebiet national park.

The power plant, located at the CCGT site, would not be visually intrusive from more than about 7 kilometres away. In addition, the power plant can be painted so that it blends into the surrounding landscape. In clear weather conditions, i.e. approximately 200 days per year, the plume is visually intrusive, and resembles a small cloud around the cooling towers. However, once people understand that it is water vapour being emitted, and not smoke or chemical emissions, the significance of the plume's visual impact decreases.

### 7.3.4 Impacts on Terrestrial Ecology

The proposed site of the power plant is in the previously mined area, where land is already disturbed. Construction here will have little further impact on the vegetation and flora.

Any of the other structures that will be associated with the power station, such as a fuel depot, access roads, a materials lay-down area, and possible temporary accommodation for the construction workforce, should be situated on disturbed land. Due to the possible presence of amphibians and reptiles of conservation concern, and the trend of gradual reduction of their habitat, all activities should be confined (as far as possible) to areas that are already disturbed. They should not be situated on undisturbed land.

Likely accommodation that will be used to house the workforce during construction is the Namdeb hostel situated less than one kilometer from the Uubvlei site. If, for some reason, the hostel will not be used, then it is recommended that the accommodation site be situated immediately south of and adjacent to the power station site, on land that has already been disturbed for mining.

Similarly, the proposed lay-down area is recommended to be immediately south of and adjacent to the power station site, on land that has already been disturbed by mining.

Impacts on particularly low hummock and coastal plain vegetation type may be expected during construction and operational phases. In order to minimize disturbance, routes (preferably a single route) and turning points, should be identified and demarcated before construction activities commence. The environmental management plan should provide for the prohibition of new tracks being made, where the surface of the original track has become corrugated. Impacts such as clearing for roads and other structures on any remaining pristine or less disturbed hummock vegetation in the

direct surrounds of the CCGT site should be minimized in the hope of later recolonisation of the habitat. If sufficient control is exercised, later natural recolonisation of damaged areas (as may already be seen within the mining area) may be expected, which will reduce long-term defacement and enable the natural restoration of the environment.

Dust raised by construction activities will probably not increase dust levels significantly more than the area already experiences from mining activities. Plants, lichens and animals that inhabit this area are frequently exposed to strong sand-laden winds. Dust suppression should, however, be practised for the new construction. In regard to oil spill accidents, contractors must be familiar with steps to avoid such accidents, and what to do in the event it happens.

The impact of operations on the affected area will need to be monitored. It is suggested that plants and lichens in the affected area and in a 'control' area be individually marked and monitored on a regularly to assess this. .

The mined-out foreshore zone and ponds habitat is an unnatural habitat, and has already been extensively compromised, to such an extent that none of the proposed construction would compromise it any further. Beyond prevention of unnecessary collateral damage, no mitigation measures are suggested for this area.

### 7.3.5 Impacts of Purge Water Discharge on Marine Environment

The investigation of the purge water discharge showed that, with proper design criteria, the proposed pipeline discharge beyond the surf-zone from the power plant will comply with World Bank guidelines for effluent disposal in terms of temperature and biocides. No World Bank Water Quality guideline could be located for salinity; however the impacts are assessed to be low based on other Water Quality guidelines deemed to be of relevance (e.g. RSA DWAF, 1995).

The potential impacts on biological communities by an effluent discharge will vary depending on the type of cooling water system installed, the position of the discharge pipeline, and the design of the diffuser. The impacts are the greatest for scenarios where a reduced seawater temperature rise in the effluent of 5°C is assumed (i.e. evaporative cooling system). Although the thermal impacts are somewhat reduced, the effluent is more dense, resulting in more limited mixing of the effluent with the receiving waters. This reduced mixing results in a slightly larger thermal plume "footprint" within which the guidelines for biocides are exceeded. Consequently there is a greater impact by the biocides in the effluent discharged into the marine environment.

Although the impacts are greater for a 1 600 MW nominal capacity power plant, the impacts associated with the discharge beyond the surf-zone of a heated brine from both a 800 MW and 1600 MW power plant are considered to be of low significance. However, the impacts increase on moving inshore, i.e., shortening the discharge pipe length.

The alongshore dimensions of the spatial area of the plume that exceeds the various Water Quality guidelines is substantially greater for a shoreline discharge into the surf zone than those for an offshore pipeline discharge. This is primarily due to the surf-zone trapping that occurs, resulting the extensive spreading of the plume alongshore.

Based on the World Bank Water Quality guideline of not exceeding a 3°C temperature rise beyond a 100m radius, there is marginal non-compliance for the shoreline discharge option for a 800MW power plant. For a 1600 MW power plant the non-compliance is more extensive; however a 3°C is not exceeded beyond a radius of 300 m. There is compliance, by default, with the World Bank guideline for biocides, i.e. the concentrations at the point of discharge are below the World Bank guidelines.

For a shoreline discharge, at maximum temperature condition, biota may suffer mortality but are expected to have a fast recovery rate. The significance of the potential salinity impacts on beach and surfzone benthic communities is considered to be low, however the impacts of elevated salinity on

physiological function of larval fish and invertebrates is uncertain. Based on the precautionary principle these impacts presently should be considered to be of medium significance until shown otherwise.

The plume extent for biocides is significantly more extensive for a shoreline discharge than for a pipeline discharge offshore of the surfzone and based on the sensitivity of marine biota and the likely extent of the biocide plume, the potential impact of this co-discharge on the marine biota in the surfzone should be considered to be of medium significance. The cumulative effect of elevated salinity and temperature, and of co-discharged substances on the larval stages is not known but could well be greater than the sum of the individual impacts

Elevated salinities and temperatures in the surfzone may have a significant barrier effect on larvae of fishes and invertebrates that are transported by the littoral drift. The extent and significance of this impact is highly uncertain. Elevated salinities and temperatures in the surfzone also may have a significant impact of the cueing effect that guides larval/juvenile fish to nursery areas such as the Orange River estuary. The extent of impact is highly uncertain.

The exact nature and quantity of the oily water waste streams are relatively uncertain, however they should be able to be managed to comply with the relevant water quality guidelines before discharge. With appropriate design of the discharge and mitigation measures, the discharges from the gas conditioning plant and the HRSG effluent are expected to meet water quality guidelines at the point of discharge or in close proximity (< 20 m) of the discharge. It should be noted that substances with the lowest tainting thresholds, should these substances be present in the gas conditioning plant effluent, may result in tainting of flesh in marine biota. However, this will only be within a conservatively estimated of approximately 500 m of the discharge, possibly 1 km at the most for the proposed optimal discharge of the gas conditioning plant effluent as proposed.

For a shoreline discharge into the surf-zone, all potential environmental impacts as assessed in this study are considered to be of low significance, except for:

- The potential impacts of elevated salinity on physiological function of larval fish and invertebrates.
- Impacts due to biocides associated with a larger and more persistent plume in the surf-zone.
- Elevated temperatures and salinity acting as a barrier for the movement of the larvae of fishes and invertebrates that are transported by the littoral drift.
- Potential impacts on the cueing effects that guide larval/juvenile fish to nursery areas such as the Orange River estuary.

There is considerable uncertainty in the significance of these impacts. Based on this uncertainty, the lack of information on the sensitivity of marine biota and the likely extent and persistence of the plume, the precautionary principle requires that these potential impacts be considered of medium significance or greater until proven otherwise.

At present, the southern limit of the southern rock lobster fishing grounds are approximately 11 km north of the proposed discharge location. Although substantial extension of these grounds further southwards is considered unlikely due to the scarcity of suitable fishing reefs south of Mittag (MFMR, Lüderitz, pers. comm.), this possibility cannot be excluded. It is therefore recommended to liaise with the rock lobster fishing industry on this issue to avoid potential confrontation in the future. Given that it is possible for BTEX compounds to taint rock lobster flesh (with potentially serious consequences for the rock lobster export market), the importance of strict compliance with the most stringent guidelines for the discharge of hydrocarbons is emphasized.



## 7.4 Conclusions

The environmental impact assessment focused on the CCGT site and addressed potential impacts in terms of those which might have an effect on the CCGT site and its environs, those which might have an effect on the marine environment, and any spillover socio-economic impacts on the town of Oranjemund.

The EIA confirms the following factors that favour Uubvlei as the preferred site for the proposed CCGT power plant:

- Socio-economic and biophysical impacts on Oranjemund and its environs:
  - The power plant will not be a visual distraction for Oranjemund residents, nor for any proposed tourist route;
  - The power plant will not interfere with any aircraft flight paths;
  - Both construction and operational noise from the power plant will have no impact on the town of Oranjemund;
  - Air emissions from both the power plant and gas conditioning plant will have no impact on the town of Oranjemund, nor on any workers properly protected under occupational health regulations; and,
  - Uubvlei is not within walking distance of the town. The social impact of the workforce is more of a spillover effect, and it can be regulated and mitigated through judicious transport arrangements from Uubvlei to Oranjemund.
- Issues specific to the CCGT site itself:
  - Since the CCGT site and its environs have already been extensively disturbed by mining operations, its impact on the terrestrial and marine ecology and archaeology is low;
  - Air emissions from both the power plant and gas conditioning plant will have no impact on the ecology of the site;
  - For the purge water discharge, the two offshore discharge options both meet World Bank water quality guidelines for effluent disposal. The shoreline discharge into the surf zone, however, requires further investigation in terms of its impact on larval and juvenile fishes and larval invertebrates which may use the littoral drift as a transport/dispersal mechanism. This is of concern as a result of the proximity of the Orange River Estuary which services as a nursery for a number of marine fish species. However, information from such an investigation may allow for even this option to be adopted.

## 7.5 Recommendations

### 7.5.1 Environmental Management Plan

An Environmental Management Plan (EMP) will be prepared to address the management of all the impacts arising from the construction and operation phases of the CCGT power plant life cycle. It is recommended that the substance of this EMP be communicated to all the contractors and their workers and to the residents of Oranjemund. In particular, the procedures to be followed when non-compliance with the requirements of the EMP is identified must be communicated clearly to all concerned.

### 7.5.2 Shoreline discharge: additional data

#### 7.5.2.1 Plankton survey

It is recommended that, before a shoreline purge water discharge is adopted, a survey of the surf-zone ichthyoplankton and zooplankton be undertaken. Monthly sampling for a full year should be done

in order to determine the importance of the surfzone to the larvae and the juveniles of fishes and invertebrates as a transport and dispersal system and whether the brine plume would act as a barrier to such movements.

#### **7.5.2.2 Toxicity study**

Toxicological studies of the effect of the residual biocide on selected larval candidates in elevated temperature and salinity conditions should be undertaken in order to determine whether the brine plume will be toxic (lethal and/or sub-lethal effects) to the larvae and juveniles of invertebrates and fishes.

# CONTENTS

---

8. REFERENCES ..... 8-1

---

## 8. References

- ANZECC (2000) Australian and New Zealand guidelines for fresh and marine water quality. Volume 2, Aquatic ecosystems. National water quality management strategy; no.4. *Australian and New Zealand Environment and Conservation Council, Agriculture and Resource Management Council of Australia and New Zealand*
- Bally, R. (1987) The ecology of sandy beaches of the Benguela ecosystem. *S. Afr. J. mar. Sci.*, 5, 759-770.
- Bamber, R.N. (1995) The influence of rising background temperature on the effects of marine thermal effluents. *J. Therm. Biol.*, 20(1/2), 105-110.
- Blakemore, F.B., Davies, C. and Isaak, J.C. (1998). The effects of changes in the UK energy demand and environmental legislation on atmospheric pollution by carbon dioxide. *Applied Energy*, 59 (4), 273-303.
- Blakemore, F.B., Davies, C. and Isaak, J.C. (2001). Effects of changes in the UK energy-demand and environmental legislation on atmospheric pollution by oxides of nitrogen and black smoke. *Applied Energy*, 68 (1), 83-117.
- Boyd, A.J. and J.J. Agenbag (1985) Seasonal trends in longshore distribution of surface temperature off South-western Africa 18°S-34°S, and their relation to subsurface conditions and currents in the area 21°-24°S. In: *International Symposium on the Most Important Upwelling Areas off Western Africa (Cape Blanco and Benguela)* [Barcelona, 1983]1. Bas, C., Margalef, R. and P. Rubiés (Eds.) Barcelona, Instituto de Investigaciones Pesqueras, 119-148.
- Boyd, A.J. and G.P.J. Oberholster (1994) "Currents off the west and south coast of South Africa." *S.Afr. Shipping News and Fish. Ind. Rev.*, 49, 26-28
- Bremner, J.M. J. Rogers and J.P. Willis (1990) Sedimentological aspects of the 1988 Orange River floods. *Trans. Roy. Soc. S. Afr.*, 47, 247-294.
- Buonicore, A.J.; Davis, W.T. (Eds.) *Air Pollution Engineering Manual*. New York: Van Nostrand Reinhold, 1992; pp. 207-254.
- Burke, A. (1998). Vegetation in the Oranjemund Area. Unpublished report for Walmsley Environmental Consultants for the purposes of the Preliminary Environmental Assessment of the proposed Kudu Power Plant. 12 pp.
- Carter, R.A. and R.C. van Ballegooyen (1998) Preliminary Kudu Power Plant environmental assessment: the discharge of hot water effluent into the marine environment, CSIR Report ENV/S-C 98017, 43pp.
- Central Bureau of Statistics (CBS) (2001) Housing and Population Census: Basic Analysis with Highlights, National Planning Commission, GRN, July 2003.
- CCME (1987) Canadian Water Quality Guidelines. Water Quality Objectives Division, Water Quality Branch, Environment, Canada.
- Chapman, P. and L.V. Shannon (1985) The Benguela Ecosystem Part II: Chemistry and related processes. *Oceanogr. Mar. Biol. Ann. Rev.*, 23, 183-251.
- Craven, P. (Ed.) 1999. Checklist of Namibian Plant Species. SABONET Report No. 7. SABONET, Windhoek.

CSIR (1996) Coastal evolution due to the disposal of dredger tailings in the G68-G90 region. *CSIR Report EMAS-C96022*, 45pp + figures.

CSIR (1997a) Dredge Project Modelling and data Study 1997: Interim Reportback, CSIR Report ENV/s-C97068.

CSIR (1997b): "Possible use of seawater cooling by Saldanha Steel: Three dimensional modelling of the thermal plume and assessment of ecological impacts." *CSIR Report ENV/S-C97058*, 66pp + figures

CSIR (2002) A decision support tool: Operational time for the Namdeb inshore mining project. CSIR Report ENV-S-C 2002-120

DEAT 2004. Criteria for determining Alternatives in EIA, Integrated Environmental Management, Information Series 11, Department of Environmental Affairs and Tourism (DEAT), Pretoria.

Deloitte & Touche (D&T), Strategy Towards the Establishment of an Oranjemund Development Corporation (ODC), Namdeb, September 1999.

Diaz, R.L. and R. Rosenberg (1995) Marine benthic hypoxia: a review of its ecological effects and the behavioural responses of benthic macrofauna. *Oceanogr. Mar. Biol. Ann. Rev.*, 33, 245–303.

Eco.plan 2003. Pre-feasibility Study for the Popa Falls Hydro Power Project: Preliminary Environmental Assessment. Report prepared for Water Transfer Consultants by Eco.plan (Pty) Ltd.

Energy Management News, March 2002, Energy Research Institute.

<http://www.eri.uct.ac.za/Energy%20Management%20News/march%202000/emn%20march%202000.htm> visited on 18 June 2004.

EPA (1986) Quality criteria for water. EPA 440/5-86-001. United States Environmental Protection Agency, Washington, USA.

Giess, W. (1971) A preliminary vegetation map of Namibia Dinteria 4: 5-114.

Greenwood, C. and J. Taunton-Clarke (1992) An "atlas" of mean monthly and yearly average sea surface temperatures around the southern African coast. *Sea Fisheries Research Institute Internal Report*, 124, 44pp.

Greenwood, C. and J. Taunton-Clarke (1994) Time series of monthly mean sea temperatures around the South African coast: an addendum to No. 124. *Sea Fisheries Research Institute Internal Report*, 124A, 36pp.

Griffin, M. (1993) "Annotated checklist and conservation status of mammals, reptiles and amphibians of the Sperrgebiet, Southern Namib Desert, Namibia." *Unpublished internal report, Ministry of Wildlife, Conservation and Tourism, Windhoek, Namibia*

Griffin, M. (1997a) "Checklist and provisional conservation status of amphibians, reptiles and mammals known or expected to occur in Namibia (seventh revision, April, 1997)." *Unpublished internal report, Ministry of Environment and Tourism, Windhoek, Namibia*

Griffin, M. (1997b) "Mammalogical and herpetological reconnaissance of the Sperrgebiet pocket beaches, between Chamais and Bakers Bay." *Unpublished internal report, Ministry of Environment and Tourism, Windhoek, Namibia*

Griffin, M. (1998) Expert opinion on mammals, reptiles and amphibians. Appendix 2.H in: Nampower (1998). Kudu Gas Power Project Preliminary Environmental Assessment.

Griffin, M. (1999) Checklist and provisional national conservation status of amphibians, reptiles and mammals known or expected to occur in Namibia. Unpublished manuscript, Ministry of Environment and Tourism.

GTZ (Undated) Background document on wind energy studies in Namibia and Morocco. Gesellschaft für Technische Zusammenarbeit GmbH. Available at <http://www.gtz.de/wind/deutsch/namibia.html> (accessed on 25 August 2004).

IFC (1998) *Procedure for the Environmental and Social Review of Projects* (version dated December 1998 available from [www.ifc.org](http://www.ifc.org), at [http://ifcln1.ifc.org/ifcext/enviro.nsf/Content/ESRP%5C\\$FILE%5CEnv&SocReviewProc.pdf](http://ifcln1.ifc.org/ifcext/enviro.nsf/Content/ESRP%5C$FILE%5CEnv&SocReviewProc.pdf), accessed on 6 October 2004).

Jehl, J.R., and Cooper, C.F. (Eds.) (1980). Potential effects of space shuttle booms on the biota and geology of the California Channel Islands: research reports. Center for Marine Studies, San Diego State University, San Diego, CA, Tech. Rep. 80-1. 246 pp.

Jirka, G.H., R.L. Donecker and S.W. Hinton (1996) User's Manual for Cormix: A hydrodynamic mixing model and decision support system for pollutant discharges into surface waters. *DeFrees Hydraulics Laboratory*, School of Civil and Environmental Engineering, Cornell University, Ithaca, New York.

Jirka, G.H. (1982) Multi-port diffusers for heat disposal: A summary. *Journal of the Hydraulics Division (ASCE)*, 108, 1425-1468.

Kamstra (1985) Environmental features of the southern Benguela with special reference to the wind stress. In: *South African Ocean Colour and Upwelling Experiment*. Shannon L.V. (Ed.), Sea Fisheries Research Institute, Cape Town, p13-27.

McCormick, A., (1997) *Acid Earth – The Politics of Acid Pollution*. Earthscan Publications Ltd. 190pp

Marais, E. (1998) Entomological profile of the Oranjemund area, and considerations for selecting a site for the Kudu Power Station. Appendix 2.1 in: Nampower (1998). Kudu Gas Power Project Preliminary Environmental Assessment.

Mannheimer, C. A. (2004) Proposed Kudu Combined Cycle Gas Turbine Power Plant At Orjemund : Vegetation Study Report, Prepared for Envirodynamics (Pty) Ltd. 12pp, Unpublished

Ministry of Agriculture, Water and Rural Development (2000) National Water Policy White Paper, Republic of Namibia.

McLachlan, A., E. Jaramillo, T.E. Donn and F. Wessels (1993) Sandy beach macrofauna communities and their control by the physical environment: a geographical comparison. *J. coastal Res. Spec. Issue*, 15, 27-38.

Mansfield, T. A. and McCune, D.C. (1987) Problems of Crop Loss Assessment when there is Exposure to two or more Gaseous Pollutants. In Heck W W, Clifton Taylor O and Tingy D T (Eds), *Assessment of Crop Loss from Air Pollutants*, Elsevier Science Publishing Co., Inc.: 317-344

Ministry of Environment and Tourism (2001). *The Sperrgebiet Land Use Plan* (2nd Draft). Directorate of Environmental Affairs, Windhoek.

Namang (1998) Lower Cunene Hydropower Scheme Feasibility Study: Final feasibility report. Part B 1, Technical Feasibility – Summary.

Namibia Development Consultants (NDC), Karas Regional Development Plan, *National Planning Commission, GRN, 2001.*

Nampower (2002) Preliminary Generation Investment Plan for Nampower: The way forward. Windhoek.

NamPower (Undated) Siting considerations for the Kudu CCGT Power Plant in two phases of 800 MW each. *Internal memorandum.*

Nelson, G. (1989) "Poleward motion in the Benguela area. In: Polewards flow along eastern ocean boundary currents." *Coastal and Estuarine Studies*, 34, eds. S.J. Neshyba, C.N.K. Mooers, R.L. Smith and R.T. Barber, Springer-Verlag, Berlin, p110-130

Nelson, G. and Hutchings (1983) "The Benguela Upwelling Area." *Prog. Oceanogr.*, 12, 333-356

Olbrich, K. A. and van Tienhoven, A. M. (1998) The Sensitivity of South African Ecosystems to Acid Deposition : An Overview of Relevant Research: 10pp, Unpublished.

Pallett J. (Ed.) (1995) *The Sperrgebiet. Namibia's least known wilderness. An environmental profile of the Sperrgebiet or Diamond Area 1, in south-western Namibia.* DRFN and Namdeb, Windhoek, Namibia.

Pawson, M.G. and D.R. Eaton (1999) The influence of a power station on the survival of juvenile sea bass in an estuarine nursery area. *J. Fish Biol.*, 54(6), 1143-1160.

Proops, L. R., Gray, P. W, Speck, S. and Schoder, T. (1996) The lifetime pollution implications of various types of electricity generation. *Energy Policy*, 3, 229–237.

Pulfrich, A (2002) The potential effects of sediments derived from proposed pocket-beach mining in the Bogenfels Licence Area on intertidal and subtidal benthic communities. *Specialist Study prepared for Namdeb Diamond Corporation by Pisces Environmental Services*, 116 pp.

Ramsey, S. H. (Undated) Climate change-driven market opportunities for combined-cycle gas turbines. *Trinity Consultants Paper #143.* Houston, Texas. 9 pp.

Robin, J.-P. (1991) Assessment of juvenile flounder catches at the Cordemais power station water intake in the Loire Estuary, France. *Netherlands J. Sea Res.*, 27(3/4), 317-323.

Rogers, J. (1979) Dispersal of sediments from the Orange River along the Namibian desert coast. *S. Afr. J. Sci.*, 75(12), p 567

RSA DWAF (1995) South African Water Quality guidelines for coastal marine waters: Vol. 1: Natural environment. Departments of Water Affairs and Forestry, South Africa.

RSA DWAF (2004a) *Water Quality Management Series Sub-Series No. MS 13.2.* Operational policy for the disposal of land-derived water containing waste to the marine environment of South Africa. Department of Water Affairs and Forestry, Pretoria.

RSA DWAF. (2004b). *Water Quality Management Series Sub-Series No. MS 13.3.* Operational policy for the disposal of land-derived water containing waste to the marine environment of South Africa: Guidance on Implementation. Edition 1. Pretoria.

SAWB, (1990) *Climate of South Africa*, Weather Bureau, Department of Environmental Affairs and Tourism, WB42, ISBN o 621 098647

Shannon, L.V. (1985) The Benguela Ecosystem. Part 1: Evolution of the Benguela physical features and processes. *Oceanogr. Mar. Biol. Ann. Rev.*, 23, 105-182.

Shillington, F.A., G.B. Brundrit, J.R.E. Lutjeharms, A.J. Boyd, J.J. Agenbag and L.V. Shannon (1990) The coastal current circulation during the Orange River flood, 1988. *Trans. Roy. Soc. S. Afr.*, 47(3), 307-330.

Stenton-Dozey, J.M.E. and A.C. Brown (1994) Exposure of the sandy-beach bivalve *Donax serra* Röding to a heated and chlorinated effluent. II Effects of chlorine on burrowing and survival. *J. Shellfish Res.*, 13(2), 451-454.

Summer, W, O. Schmidt and W. Zhang (1994) Buoyant surface discharges analysed by the expert system CORMIX and compared with Delft Hydraulics Laboratory data under varying flow conditions. *Hydroinformatics '94 Conf. Proc.*, Balkema, Rotterdam.

Simmons, R.E; Brown, C.J; and Griffin, M. (eds.) (1991) "The status and conservation of wetlands in Namibia." *Madoqua* 17/2: pp 55-254

Stubenrauch Planning Consultants (SPC), Feasibility Study on the Proclamation of Oranjemund, Namdeb, September 1998.

Teylingen, van K; McLachlan, A; Richard, C; and Kerley, G. (1993) "Conservation status of the vertebrate fauna of the coastal dunes in South Africa." *Biodiversity series report no. 1, Department of Environment Affairs, Pretoria*

van Ballegooyen, R.C., C.N. Steffani and P.D. Morant (2004) Kudu Power Plant Environmental Impact Assessment: Assessment of a proposed cooling water discharge into the marine environment. *CSIR Report ENV-S-C 2004-086*, 62pp+ 26 pp. Appendix.

Walmsley Environmental Consultants (WEC), Kudu Gas Power Project: Preliminary Environmental Assessment: Volume 1: *Final Report, NamPower, June 1998*.

Walmsley Environmental Consultants (1998) Kudu Gas Power Project Preliminary Environmental Impact Assessment: Final Report. Volume 1. *Job Ref. W334, June 1998*. Walmsley Environmental Consultants (Pty) Ltd. Rivonia.

Walmsley Environmental Consultants (WEC), The Sperrgebiet: Proposed National Park: Information Leaflet: Ministry of Environment and Tourism, GRN, 2003.

Whitfield, A and Marais, H (1999). The ichthyofauna. In: B R Allanson and D Baird (eds.) *Estuaries of South Africa*, pp 209 - 233. Cambridge University Press.

Williamson, G. (1997) Preliminary account of the Floristic Zones of the Sperrgebiet (Protected Diamond Area) in southwest Namibia *Dinteria* 25: 1-68.

World Bank (1998) Pollution Prevention and Abatement Handbook. Thermal Power: Guidelines for New Plants. WORLD BANK GROUP, p413-426.



## APPENDICES

<i>Appendix A</i>	STAKEHOLDERS LIST
<i>Appendix B</i>	BACKGROUND INFORMATION DOCUMENT
<i>Appendix C</i>	MINUTES OF MEETINGS
<i>Appendix D</i>	WORLD BANK (IFC) ENVIRONMENTAL AND SOCIAL REVIEW REQUIREMENTS

## APPENDIX A

### STAKEHOLDERS LIST

NAME	ORGANISATION	DEPT	TEL:	FAX:	ADDRESS &/or E-MAIL	SENT BY FAX:	SENT BY E-MAIL:
MINEWIDE E-MAIL	Namdeb				<a href="mailto:Ndb-minewide@namdeb.com">Ndb-minewide@namdeb.com</a>	✓	
<i>Ms. B. Beukes</i>	Namdeb	E-media Communications Officer	063-239111		<a href="mailto:Belinda.beukes@namdeb.com">Belinda.beukes@namdeb.com</a> (send via internal mail to colleagues)	✓	
<i>Mr. Marais Loubser</i>	Namdeb	Geology			<a href="mailto:Marais.loubser@namdeb.com">Marais.loubser@namdeb.com</a>	✓	
<i>Ms. Fiona Olivier</i>	Namdeb	Environmental			<a href="mailto:Fiona.Olivier@namdeb.com">Fiona.Olivier@namdeb.com</a>	✓	
<i>Bob Burrell</i>	Namdeb	Mineral resources, Geologist	063-235322		<a href="mailto:Bob.burrell@namdeb.com">Bob.burrell@namdeb.com</a>	✓	
<i>Ms. Dawn Jones</i>	Namdeb	Secretary to Mr. Burrell	063-235322		<a href="mailto:Dawn.jones@namdeb.com">Dawn.jones@namdeb.com</a>	✓	
D. Duvenhage	Namdeb		063-235331	063-235155	<a href="mailto:Dewald.duvenhage@namdeb.com">Dewald.duvenhage@namdeb.com</a>	✓	
R. Duvenhage	Namdeb		063-235744	063-235719	<a href="mailto:Riana.duvenhage@namdeb.com">Riana.duvenhage@namdeb.com</a>	✓	
T. De Klerk	Namdeb		063-236736		<a href="mailto:Tobie.deklerk@namdeb.com">Tobie.deklerk@namdeb.com</a>	✓	

NAME	ORGANISATION	DEPT	TEL:	FAX:	ADDRESS &/or E-MAIL	SENT BY FAX:	SENT BY E-MAIL:
A.C. Darne	Namdeb		063-237459	063-237521	<a href="mailto:Andrew.darne@namdeb.com">Andrew.darne@namdeb.com</a>	✓	
T. Conry	NCCI		063-232551	063-232551	<a href="mailto:elodo@mweb.com.na">elodo@mweb.com.na</a>	✓	
Anca Burger	Namdeb		063-2335807	063-235719	<a href="mailto:Anca.burger@namdeb.com">Anca.burger@namdeb.com</a>	✓	
Wicus Burger	Namdeb & ORM Flying Club		063-238650	063-238603	<a href="mailto:wicus.burger@namdeb.com">wicus.burger@namdeb.com</a>	✓	
E.S. Iita	MUN		063-235763 0811229435	063-235283	<a href="mailto:Eliphas.iita@namdeb.com">Eliphas.iita@namdeb.com</a>	✓	
D. Popyeinawa	MUN		063-235237 0812422613	063-235283	<a href="mailto:popyeinawad@namdeb.com">popyeinawad@namdeb.com</a>	✓	
S. Haulofu	MUN		0811284565		<a href="mailto:haulofus@namdeb.com">haulofus@namdeb.com</a>	✓	
A.N. Gully Muteka	Namdeb		063-233692 0812890038 8	063-235719	<a href="mailto:Gully.muteka@namdeb.com">Gully.muteka@namdeb.com</a>	✓	
A. Shanyenge	Namdeb		063-235919	063-235719	<a href="mailto:Abisai.shanyenge@namdeb.com">Abisai.shanyenge@namdeb.com</a>	✓	
R. Burger	Namdeb		063-235475	063-235719	<a href="mailto:Riaan.burger@namdeb.com">Riaan.burger@namdeb.com</a>	✓	
C. Burger	Namdeb		0834544690	063-232301	<a href="mailto:cburger@mweb.com.na">cburger@mweb.com.na</a> <a href="mailto:info@omd.chcafrica.com">info@omd.chcafrica.com</a>	✓	
<b>L. Mauritius</b>	MUN		063-235922 0812776888			✓	
J.K. Kandundu	Namdeb		0812540215	063-238359	<a href="mailto:joey.kandundu@namdeb.com">joey.kandundu@namdeb.com</a>	✓	
H.A. Cokes Hindjou	MUN		063-235952 0812426754	063-238359	<a href="mailto:heinrich.hindjou@namdeb.com">heinrich.hindjou@namdeb.com</a>	✓	

NAME	ORGANISATION	DEPT	TEL:	FAX:	ADDRESS &/or E-MAIL	SENT BY FAX:	SENT BY E-MAIL:
R. Burrell	Namdeb		063-235322	063-235460	<a href="mailto:bob.burrell@namdeb.com">bob.burrell@namdeb.com</a>	✓	
<b><u>GOVERNMENTAL AUTHORITIES:</u></b>							
F. Amulungu, MHSS P. Silishebo, MME O. Helandjo, MME N. Elias, MME F. Sikabonga, MET I. Mulunga, MME J. litenge, MWTC T. Nghitila, MET Dr. S. De Wet, MAWRD Dr. R. Roeis, MAWRD	Inter-Ministerial Review Group				<a href="mailto:famulungu@mhss.gov.na">famulungu@mhss.gov.na</a> <a href="mailto:psilishebo@mme.gov.na">psilishebo@mme.gov.na</a> <a href="mailto:ohelandjo@mme.gov.na">ohelandjo@mme.gov.na</a> <a href="mailto:nelias@mme.gov.na">nelias@mme.gov.na</a> <a href="mailto:freddy@dea.met.gov.na">freddy@dea.met.gov.na</a> <a href="mailto:imulunga@mme.gov.na">imulunga@mme.gov.na</a> <a href="mailto:jiitenge@mwtc.gov.na">jiitenge@mwtc.gov.na</a> <a href="mailto:nghitila@dea.met.gov.na">nghitila@dea.met.gov.na</a> <a href="mailto:wetsd@mawrd.gov.na">wetsd@mawrd.gov.na</a> <a href="mailto:roeis@mawrd.gov.na">roeis@mawrd.gov.na</a>	✓	
Mr. Kevin Roberts	MAWRD – Dept Water Affairs		061-208 7111	061-2087160	<a href="mailto:robertsk@mawrd.gov.na">robertsk@mawrd.gov.na</a>	✓	
Dr G Maggs-Koelling	MAWRD-National Botanical Research Institute	Director	061-2022167	061-279602	<a href="mailto:gmk@mweb.com.na">gmk@mweb.com.na</a>	✓	
Mr Burger Oelofsen	MFMR – Resource Management South Area	Director			<a href="mailto:boelofsen@mfmr.gov.na">boelofsen@mfmr.gov.na</a>	✓	
Mr. Booyesen	Ministry of Works, Dep. Of Maintenance	Windhoek	061 2088207	061-2088634	Private Bag 12005, Ausspannplatz, Windhoek		
Mr. Sem Shikongo	MET, Directorate of Environmental Affairs	Environmental Affairs		240339	<a href="mailto:sts@dea.met.gov.na">sts@dea.met.gov.na</a>	✓	
Mr H Kolberg	MET, Department of Tourism	Conservation Scientist			<a href="mailto:hertak@mweb.com.na">hertak@mweb.com.na</a>	✓	
Library	MET – Department of Environmental Affairs		061-249015	061-240339	<a href="mailto:smitw@dea.met.gov.na">smitw@dea.met.gov.na</a>	✓	
Mr. Trygve Cooper	Ministry of Environment & Tourism (MET)	Nature Conservation –	063 202811	063 204188	Box 426, Lüderitz <a href="mailto:metlud@iway.na">metlud@iway.na</a>	✓	

NAME	ORGANISATION	DEPT	TEL:	FAX:	ADDRESS &/or E-MAIL	SENT BY FAX:	SENT BY E-MAIL:
		Director of Parks & Wildlife					
Mr Patrick Lane	MET	Chief Warden Southern Parks	063-222510	063-225621	Keetmanshoop <a href="mailto:metlud@iway.na">metlud@iway.na</a>	✓	
Mr. Nico Kisting	MET				<a href="mailto:niko@dea.met.gov.na">niko@dea.met.gov.na</a>	✓	
Mr. Theo Nghithila	MET - DEA	Acting Director	249015	240339	<a href="mailto:nghitila@dea.met.gov.na">nghitila@dea.met.gov.na</a>	✓	
Ms Connie Claasen	MET - DEA	EEU	061-249015	061-240339	<a href="mailto:connie@dea.met.gov.na">connie@dea.met.gov.na</a>	✓	
Mr. Ben Beittel	MET Directorate Parks, Wildlife Management	Director		061-263195	<a href="mailto:bbeitell@mweb.com.na">bbeitell@mweb.com.na</a>	✓	
Mr. Mike Griffin	MET				<a href="mailto:ssaurus@iafrica.com.na">ssaurus@iafrica.com.na</a>	✓	
Dr G Schreider	MME, Geological Survey	Director	2085205	249144/ 238643		✓	
Dr A Macuvele	MME, Mining Commissioner	Mining Commissioner		238643		✓	
Mr. Simasiku	MME		061-226571	061-220386	Private Bag 13297 Windhoek	✓	
Mr. Louis Esterhuizen	Ministry of Regional and Local Government and Housing	297 5179			<a href="mailto:lesterhuizen@mrlgh.gov.na">lesterhuizen@mrlgh.gov.na</a>	✓	
Mr. P. Swart	MRLGH	297 5111			<a href="mailto:pswart@mrlgh.gov.na">pswart@mrlgh.gov.na</a>	✓	
Mr. J. Sell	MWTC, Directorate Civil Aviation		2082217 0811241423	234100	<a href="mailto:catco@mweb.com.na">catco@mweb.com.na</a>	✓	
Mr. P. Heyns	MAWRD- Department of Water Affairs	Director: Investigations and Research	061-2969111	061-232861	Private Bag 13193 Windhoek	✓	

NAME	ORGANISATION	DEPT	TEL:	FAX:	ADDRESS &/or E-MAIL	SENT BY FAX:	SENT BY E-MAIL:
Mr. Eric Tordiffe	MAWRD – Department of Water Affairs, Geohydrology		061-2087145	061-2087149	<a href="mailto:TordiffE@mawrd.gov.na">TordiffE@mawrd.gov.na</a>	✓	
Mr T Parkhouse	Namibian Chamber of Commerce	Managing Director	061-222000	061-233690		✓	
<b><u>NAMPORT</u></b>						✓	
Cpt. Gusev	NamPort	Port Captain	063-200203	063-200218		✓	
Mr. W Ernt	NamPort	Port Engineer	063-200217	063-200218		✓	
Leon	NamPort				<a href="mailto:leon@namport.com.na">leon@namport.com.na</a>	✓	
<b><u>REGIONAL AND LOCAL AUTHORITIES</u></b>						✓	
Hon. Mr Fluksman Samuehl	Karas Regional Council	Councillor of Lüderitz	063-2028000	063-226121	<a href="mailto:fsamuehl@iway.na">fsamuehl@iway.na</a>	✓	✓
Hon Mr Goliath	Karas Regional Council	Regional Governor		063-223538		✓	✓
Mr. J. Stephanus	Karas Regional Council	Regional Officer		063-223538		✓	✓
Ms. Leonora Joodt	Karas Regional Council		063-223723	063-223538	<a href="mailto:leonorabj@webmail.co.za">leonorabj@webmail.co.za</a>		✓
Epson Jossop	Keetmanshoop Municipality		063-221224	063-223818	<a href="mailto:pro@keetmanshoopmun.org.na">pro@keetmanshoopmun.org.na</a>	✓	
Mr. George Kozonguizi	City of Windhoek, Environmental Division		061-290 2371		<a href="mailto:Gkk@windhoekcc.org.na">Gkk@windhoekcc.org.na</a>	✓	
<b><u>FISHING INDUSTRY:</u></b>							✓
M Clay	Seaflower Group	Managing Director			<a href="mailto:jalp@seaflower.com.na">jalp@seaflower.com.na</a> (distributed to all fishing co's)	✓	

NAME	ORGANISATION	DEPT	TEL:	FAX:	ADDRESS &/or E-MAIL	SENT BY FAX:	SENT BY E-MAIL:
<b>NGO's:</b>						✓	
Dr Mary Seely	(DRFN) Desert Research Foundation	Director - Desert Ecologist	061-229855	061-230172	<a href="mailto:drfn@drfn.org.za">drfn@drfn.org.za</a> <a href="mailto:mseely@drfn.org.za">mseely@drfn.org.za</a>	✓	
Mr. Aboobakar	NDC	Managing Director	2062111	223854		✓	
Mr. J. C Rogers	Chamber of Mines		061-237925	061-222638	P.O. Box 2895 Windhoek	✓	
Mr. Nicolaas Du Plessis	Namwater	Environmental Manager			<a href="mailto:PlessisN@namwater.com.na">PlessisN@namwater.com.na</a>	✓	
	Hospitality Association of Namibia (HAN)		061-222904	061-222904	<a href="mailto:han@mweb.com.na">han@mweb.com.na</a>	✓	
	Namibian Academy for Tourism and Hospitality (NATH)		061-259288	061-259221	<a href="mailto:nath@naminet.com">nath@naminet.com</a>	✓	
	Tourism Related Namibian Business Association (TRENABA)		061-236191	061-245756	<a href="mailto:africuri@mweb.com.na">africuri@mweb.com.na</a>	✓	
Mr G Fuller	TASA	Chairperson	061- 238423	061-238424	<a href="mailto:tasa@iafrica.com.na">tasa@iafrica.com.na</a>	✓	
Mr J Midgley	NAMCO	Environmental Manager			<a href="mailto:namone@iafrica.com.na">namone@iafrica.com.na</a> (mailed back, wrong address)	✓	
Mr J Maizenge	NAMCOR	Managing Director			<a href="mailto:namcor@namcor.com.na">namcor@namcor.com.na</a>	✓	
Mr Roger Swart McG Miler, Dr Roy	NAMCOR		061-221699	061-221785	Private Bag 13196 Windhoek	✓	
Mrs E Burkhard	TAN, Tour Guide Association	Chairperson			<a href="mailto:henniefo@mweb.com.na">henniefo@mweb.com.na</a>	✓	
	Namibia tourism Information				<a href="mailto:info@nambiatourism">info@nambiatourism</a>	✓	

NAME	ORGANISATION	DEPT	TEL:	FAX:	ADDRESS &/or E-MAIL	SENT BY FAX:	SENT BY E-MAIL:
Ms Bertchen Kohrs	Earthlife Namibia	Chairperson	061-2022041	061-221962	P.O. Box 24892 Windhoek, <a href="mailto:earthl@iway.na">earthl@iway.na</a>	✓	
Mr. G Fuller	Wildlife Society	Chairperson	061-241786	061-242318	P.O. Box 3508 Windhoek	✓	
Mr.Dave Joubert	Wildlife Society		061-2072462	061-2072143	<a href="mailto:djoubert@polytechnic.edu.na">djoubert@polytechnic.edu.na</a>	✓	
Ms. Birgit Eimbeck	Wildlife Society		061-275700	061-249444 0811276923	<a href="mailto:eimbeckb@namharvest.com.na">eimbeckb@namharvest.com.na</a>	✓	
Dr C Brown	Namibia Nature Foundation				<a href="mailto:cb@nnf.org.na">cb@nnf.org.na</a> <a href="mailto:mm@nnf.org.na">mm@nnf.org.na</a>	✓	
	NACOBTA				<a href="mailto:nacobta@iafrica.com.na">nacobta@iafrica.com.na</a>	✓	
Mr. Nils Wormsbacher	R3E				<a href="mailto:energy@r3e.org">energy@r3e.org</a>	✓	
Mr. Robert Schulz	R3E				<a href="mailto:energy@r3e.org">energy@r3e.org</a>	✓	
Ms. Liz Komen	NARREC				<a href="mailto:liz@narrec.schoolnet.na">liz@narrec.schoolnet.na</a>	✓	
<b>MEDIA:</b>							
Mr. Smith	Windhoek Observer	Editor	221737	221738	<a href="mailto:whkob@africaonline.com.na">whkob@africaonline.com.na</a>	✓	
Mr D Heinrich	Allgemeine Zeitung	Editor	225822	245200	<a href="mailto:azinfo@az.com.na">azinfo@az.com.na</a>	✓	
Mr. D. Vries	New Era	Editor	273300	220584	<a href="mailto:dawud@newera.com.na">dawud@newera.com.na</a>	✓	
Mr C Jacobie	Die Republikein	Editor			<a href="mailto:republkn@republikein.com.na">republkn@republikein.com.na</a> <a href="mailto:info@republikein.com.na">info@republikein.com.na</a>	✓	
Mr. Gary Munjama	NBC	Director General	2913111	216209			✓



NAME	ORGANISATION	DEPT	TEL:	FAX:	ADDRESS &/or E-MAIL	SENT BY FAX:	SENT BY E-MAIL:
Ms G Lister	The Namibian	Editor			<a href="mailto:newseditor@namibian.com.na">newseditor@namibian.com.na</a>	✓	
NAMPA	Namibian Press Agency			221713	<a href="mailto:news@nampa.org">news@nampa.org</a>	✓	
<b>ROSH PINAH</b>						✓	
Mr. Dawid Mouton	Scorpion Zinc (Namzinc)	Environmental Coordinator	063-271 2142	063-271 2526	<a href="mailto:Dmouton@skorpionzinc.com.na">Dmouton@skorpionzinc.com.na</a>	✓	
Mr. Jegg Christiaan	Rosh Pinah Zinc (Roshcor)	PRO	063-274200		<a href="mailto:Jegg.christiaan@kumbaresources.com">Jegg.christiaan@kumbaresources.com</a>	✓	
S. Du Toit	Shell South Africa	Regional Manager	063-233425	063-234171			
<b>ALEXANDER BAY</b>							
Mr. Clifford Oppel	Alexkor	Environmental	+2727 8311330		<a href="mailto:cliffordo@alexkor.co.za">cliffordo@alexkor.co.za</a>	✓	
Ms. Alana Mostert	Alexkor		+272783113 30		<a href="mailto:alanam@alexkor.co.za">alanam@alexkor.co.za</a>	✓	
Mr. Manfred Louw	Alexkor	Environmental Manager	+270839986 08		<a href="mailto:manfredl@alexkor.co.za">manfredl@alexkor.co.za</a>	✓	
<b>ORANJEMUND BUSINESS COMMUNITY:</b>							
P.S. Chikumba	Air Namibia		063-232449/ 232638	063-232225			✓
D. Van Rensburg	B&E Namibia (Pty) Ltd		063-233229/ 233681	063-233681			✓
J.J. Van Rooi	Bell Equipment		063-237502	063-234133			✓
Ministry of Mines & Energy				063-233779			✓

NAME	ORGANISATION	DEPT	TEL:	FAX:	ADDRESS &/or E-MAIL	SENT BY FAX:	SENT BY E-MAIL:
H. Iidhenga	MOF, Customs & Excise		063-233552	063-233552			✓
Ace Komeya	Mobilehome (MTC)		063-234166	063-234167			✓
P. Johr	Namibia Post		063-232315	063-232315			✓
E. Iikuyu	Namibia Police		063-232400	063-23344			✓
G. Lumley	Nashua		063-232255	063-232285			✓
M. Du Plessis	Bank Windhoek		063-233544	063-233119	<a href="mailto:oranjemunbranch@bankwindhoek.com.na">oranjemunbranch@bankwindhoek.com.na</a>	✓	
	First National Bank		063-3525211	063-232215	<a href="mailto:fnboranjemund@fnbnamibia.com.na">fnboranjemund@fnbnamibia.com.na</a>	✓	
	Karibib Mining & Construction		063-232527	063-233011	<a href="mailto:info@kaibib-mining.com">info@kaibib-mining.com</a>	✓	
	M & Z Commercial Vehicles		063-232129		<a href="mailto:mznameb@metjeziegler.com">mznameb@metjeziegler.com</a>	✓	
	Namdeb Hospital		063-238000	063-238082			✓
	Namhealth Administrators		063-232295	063-232191			✓
	Namib Mills		063-232976	063-232985	<a href="mailto:info@namibmills.com.na">info@namibmills.com.na</a>	✓	
H. Webster	Pupkewitz Megabuild		063-234300	063-234305	<a href="mailto:oramega@pupkewitz.com">oramega@pupkewitz.com</a>	✓	
A. Van Staden	Rennies Travel Services		063-233463	063-234285	<a href="mailto:Avrilvs.rennies@galileosa.co.za">Avrilvs.rennies@galileosa.co.za</a>	✓	
A.J. Christiaan	Telecom Namibia		063-232666	063-232037			✓

NAME	ORGANISATION	DEPT	TEL:	FAX:	ADDRESS &/or E-MAIL	SENT BY FAX:	SENT BY E-MAIL:
	TransNamib		063-232097	063-232225			✓
	Woker Travel Services		063-233463	063-233294			✓
Mr. G. Stubenrauch	Stubenrauch Planning Consultants		061-251189		<a href="mailto:gunther@spc.iway.na">gunther@spc.iway.na</a>	✓	
<b>OTHER:</b>							
	PRU, Oranjemund		063-232596	063-233444			✓
Mr. Ibo Zimmermann	Polytechnic of Namibia				<a href="mailto:ibozim@polytechnic.edu.na">ibozim@polytechnic.edu.na</a>	✓	
Mr. Rudi Kruger	Eskom				<a href="mailto:KrugerR@eskom.co.za">KrugerR@eskom.co.za</a>	✓	
Mr I Kalenga	SWAPO	Regional Secretary			0811248842 <a href="mailto:oms@iway.na">oms@iway.na</a>	✓	
Mr. Eliphas lita	MUN		063-232145 235763	063-232050		✓	✓
Mr. Silas Antonius	MUN		063-232145 203565	063-232050		✓	✓
Mr. S. Simasiku	Electricity Control Board	Chief Executive Officer	061-374300	220386	<a href="mailto:ssimasiku@ecb.org.na">ssimasiku@ecb.org.na</a>	✓	
Mr. R. Kapenda	National Union of Namibian Workers (NUNW)	President	061-215037		<a href="mailto:nunw@mweb.com.na">nunw@mweb.com.na</a>	✓	
Martha	UNDP – Environment Unit				<a href="mailto:mwangindgi@undp.org.na">mwangindgi@undp.org.na</a>	✓	
Buddy Kunondjo Mukona	NAMSCA		0812881449	212767	<a href="http://www.namsca.com.na">www.namsca.com.na</a>	✓	
Christelle Tromp	Environmentalist		230679/0812 443138	227406	<a href="mailto:nrc@mweb.com.na">nrc@mweb.com.na</a>	✓	

NAME	ORGANISATION	DEPT	TEL:	FAX:	ADDRESS &/or E-MAIL	SENT BY FAX:	SENT BY E-MAIL:
Kobus Coetzer	Technical		0027116172 000/2782387 0972	2368214	<a href="mailto:Kobus.coetzer@za.abb.com">Kobus.coetzer@za.abb.com</a>	✓	
Takalani Radali	Environmental Management Advisor		0832567474		<a href="mailto:Takalani.radali@eskom.co.za">Takalani.radali@eskom.co.za</a>	✓	
Sion Shifa	Environmentalist		0812781707		<a href="mailto:ndemuuda@webmail.co.za">ndemuuda@webmail.co.za</a>	✓	
Johannes Haindongo	Environmentalist		219388/0812 851192		<a href="mailto:hinyekwa@webmail.co.za">hinyekwa@webmail.co.za</a>	✓	
Nathan Kayambu	Environmentalist		264342/0812 867981		<a href="mailto:nathann@webmail.co.za">nathann@webmail.co.za</a>	✓	
Lance Williamson	Business – Skorpion Zinc		063- 2712383/278 34117882	063-2712526	<a href="mailto:lwilliamson@skorpionzinc.com.na">lwilliamson@skorpionzinc.com.na</a>	✓	
Angula Nashandi	Power Engineering student majoring projects		259777/0812 708399		<a href="mailto:S200100343.student@polytechnic.edu.na">S200100343.student@polytechnic.edu.na</a>	✓	
Derek Phillips	Business		278700/0811 277716	278701	<a href="mailto:Derek.Phillips@Siemens.com">Derek.Phillips@Siemens.com</a>	✓	
Simon Sebueng	Education		2072517/081 2807633	2072142	<a href="mailto:ssebueng@polytechnic.edu.na">ssebueng@polytechnic.edu.na</a>	✓	
Hileni Ollyn Nghinaunye	Private		0812819805		PO Box 4008, WHK	✓	
Jane Gold	Resident		252604		<a href="mailto:janegold@iafrica.com.na">janegold@iafrica.com.na</a>	✓	
Alexandra Speiser	Private	Consultant			<a href="mailto:amspeiser@yahoo.com">amspeiser@yahoo.com</a>	✓	
Mr. Andrew Clegg	Private				<a href="mailto:asclegg@mweb.com.na">asclegg@mweb.com.na</a>	✓	
Ms. Antje Burke	Enviro Science	Consultant			<a href="mailto:Antje.burke@enviro-science.info">Antje.burke@enviro-science.info</a>	✓	

NAME	ORGANISATION	DEPT	TEL:	FAX:	ADDRESS &/or E-MAIL	SENT BY FAX:	SENT BY E-MAIL:
Ms. Barbara Curtis	Namibia Tree Atlas, NBRI				<a href="mailto:treeatlas@mwe.com.na">treeatlas@mwe.com.na</a>	✓	
Mr. B. Strohbach	Private	Botanist			<a href="mailto:bens@mweb.com.na">bens@mweb.com.na</a>	✓	
Ms. Coleen Mannheimer	Private	Consultant			<a href="mailto:manfam@africaonline.com.na">manfam@africaonline.com.na</a>	✓	
Mr. Colin Christian	Eco-Plan				<a href="mailto:eco-plan@iafrica.com.na">eco-plan@iafrica.com.na</a>	✓	
Mr. Ed Barbour	Private	Geohydrologist			<a href="mailto:ebarbour@mweb.com.na">ebarbour@mweb.com.na</a>	✓	
Mr. J Goreseb	Greeninfo				<a href="mailto:greeninfo@groups.namweb.com.na">greeninfo@groups.namweb.com.na</a> <a href="mailto:jgo@windhoekcc.org.na">jgo@windhoekcc.org.na</a>	✓	
Mr. John Irish	Private	Entomologist			<a href="mailto:jirish@mweb.com.na">jirish@mweb.com.na</a>	✓	
Dr. P. Barnard	Private				<a href="mailto:barnard@nbict.nbi.ac.za">barnard@nbict.nbi.ac.za</a>	✓	
The Secretary	Scientific Society		061-225372	061-226846	<a href="mailto:nwg@iafrica.com.na">nwg@iafrica.com.na</a>	✓	
Tharina Bird	National Museum	Curator: Arachnids			<a href="mailto:tharina@natmus.cul.na">tharina@natmus.cul.na</a>	✓	
Volker Fisher-Buder	Africa Consulting Services		061-237427	061-225704	<a href="mailto:volkerfb@ssi.com.na">volkerfb@ssi.com.na</a>	✓	
Mr. Dan Singh	Port Nolloth Municipality		+2727 8511111	+2727 8511101	<a href="mailto:port@lantic.net">port@lantic.net</a>	✓	
<b>SOUTH AFRICAN GOVERNMENTAL AUTHORITIES</b>							
Mr. D. Potgieter	Department of Water Affairs (Geohydrology) (Water Quality Management)		+2753 807 4800		<a href="mailto:potgied@dwaf.gov.za">potgied@dwaf.gov.za</a>	✓	

NAME	ORGANISATION	DEPT	TEL:	FAX:	ADDRESS &/or E-MAIL	SENT BY FAX:	SENT BY E-MAIL:
Mr. Mark Anderson	Northern Cape Nature Conservation Service				Private Bag X6102 Kimberly, 8300 <a href="mailto:manderson@grand.ncape.gov.za">manderson@grand.ncape.gov.za</a>	✓	
Mr. P. Morant/ H. Fortuin	CSIR				<a href="mailto:pmorant@csir.co.za">pmorant@csir.co.za</a> <a href="mailto:hfortuin@csirc.co.za">hfortuin@csirc.co.za</a>	✓	
Dr. Peter Tarr	SAIEA				<a href="mailto:Peter.tarr@saiea.com">Peter.tarr@saiea.com</a>	✓	
Mr. Gerr Kegge	Energy Africa				<a href="mailto:kegge@iafrica.com.na">kegge@iafrica.com.na</a>	✓	

# APPENDIX B

## BACKGROUND INFORMATION DOCUMENT

### ENVIRONMENTAL ASSESSMENT AND ENVIRONMENTAL MANAGEMENT PLAN FOR THE PROPOSED KUDU COMBINED CYCLE GAS TURBINE (CCGT) POWER PLANT AT ORANJEMUND

#### BACKGROUND INFORMATION



### Invitation to comment on additional EIA studies for the Kudu Gas to Power Project

NamPower hereby invites all Interested and Affected persons or institutions to give their opinion on the key issues that need to be addressed in the completion of the studies aimed at assessing the environmental impacts of the Kudu Gas to Power Project.

#### Background

In view of the need to ensure that the project results in the lowest possible social, ecological and archaeological impacts, NamPower have considered a number of options for the siting of the power plant which, in turn, somewhat dictates the alignment of the power lines and the gas supply pipe line. The 1998 Preliminary EIA and the 2004 full EIA found site D to be acceptable technically and environmentally. However, NamPower has decided to also fully consider Uubvley as a possible alternative site, mainly because the routing of a gas pipeline from the gas platform to the proposed Site D will likely cause opportunity costs (because of possible diamond lock-up offshore) and inconvenience ongoing mining activities in the immediate area.

A preliminary investigation by NamPower, Namdeb and Energy Africa has identified Uubvley as probably the most suitable alternative site based on the following criteria:

- Cost implications
- Already disturbed/mined-out area (i.e. minimal impacts on biodiversity and landscapes)
- Minimal interference with Namdeb mining operations
- Availability of cooling water for the Power Station

- Good founding conditions for the Power Station and landing site for the gas pipeline and seawater intake pipeline
- Proximity to infrastructure and services
- Minimal impact on mining reserves offshore
- Suitability for the alignment of transmission lines (interconnectivity)

This decision requires additional work to be completed for all three components of the project.

### **Additional studies**

The work done so far by CSIR and Enviro Dynamics has focused mainly on Site D (south-west of Oranjemund) and on the power line routes from Site D into the Namibian and South African power grids. Much of this work is valid for the investigation of Uubvley Site, but some new studies will be needed.

Based on discussions with the consultants and various experts, the following issues have already been identified as requiring additional or new work:

- Description of the biophysical characteristics of Uubvley Site
- Options for water abstraction for cooling given the differences between Uubvley and Site D (i.e. from beach wells, ponds or directly from the ocean)
- Options for purge water discharge given the differences between Uubvley and Site D (i.e. into ponds, onto the beach/intertidal zone, or beyond the breakers)
- The suitability of existing facilities to accommodate the workforce during construction, and possibly operation.
- Options for supply of services for workers - water, electricity, recreation facilities, health services, catering, etc.
- Options for waste management – industrial waste during construction, household waste, sewerage, hazardous waste
- Maintenance of the road between Uubvley and Oranjemund
- Security issues and access to site
- Interactions with Namdeb
- Climate – implications for corrosion, dust control, etc.
- New alignments for the power lines and their social and environmental acceptability

Initial opinions are that establishing the plant at Uubvley Site will solve a number of the perceived drawbacks of Site D. These are:

- Visual distraction for Oranjemund residents
- Noise impacts for Oranjemund residents
- Pollution (specifically the impacts of pollution on people)
- The danger to people of non-standard operating situations (the unlikely event of an accident)
- Power lines in proximity to Oranjemund and bird flight paths
- Negative interactions between workers and the Oranjemund residents

### **What you can do**

NamPower respects your opinion as an Interested and possibly Affected Party, and is eager to hear from you regarding this project.



Many of you have already attended meetings during the previous round of consultations, and your opinions have been recorded in the recently completed EIAs for the Power Station and the power lines. However, you might now have additional thoughts about the project because of the possible shift to Uubvley Site.

**In addition to any general comments you might have, we are particularly keen to hear your opinion regarding the additional work that the consultants need to do regarding the Uubvley option.**

Although we face an extremely tight schedule, a public hearing meeting will be held at Oranjemund on the 31 March 2005 at the School Auditorium at 17:30. For this reason, you are requested to provide your input in writing or telephonically before the meeting takes place.

It would thus be appreciated if you could send your suggestions or comments to Mrs. Stephanie van Zyl, Enviro Dynamics: E-mail [envirod@africaonline.com.na](mailto:envirod@africaonline.com.na) – as soon as possible, but preferably before 29 March 2005. She can also be reached at 061- 223336

**Thanking you in anticipation!**

## **APPENDIX C**

# **MINUTES OF MEETINGS**



## PUBLIC CONSULTATION MEETING

### UPDATING OF THE EIA AND EMP FOR THE PROPOSED POWER STATION AND POWER LINES FROM KUDU IN THE VICINITY OF ORANJEMUND

**Date:** Thursday, 31 March 2005

**Venue:** School Auditorium, Oranjemund

**Present:** Mr. J. Langford  
Ms. M. Van der Merwe  
Mr. D. Mbidi  
Mr. G. Kegge  
Dr. P. Tarr  
Ms. S. Van Zyl  
See attached attendance list

## MINUTES

### 1. OPENING & INTRODUCTION

---

After Dr Peter Tarr had introduced the visiting team, Ms Margaret van der Merwe provided an introduction to the evening and the purpose of the visit. She stressed the fact that NamPower is committed to solid public consultation and to hear the opinions of the Oranjemund community. (Presentation attached.)

## **2. PROJECT OVERVIEW**

---

### **(i) Power Station**

---

#### *Technical presentation*

Mr John Langford provided technical details of the proposed power station at Uubvlei (presentation attached).

#### *Details of EIA*

Mrs Stephanie van Zyl presented the proposed work plan and programme for the EIA study (presentation attached).

#### *Issue identification*

Mrs van Zyl showed the meeting the list of issues for the Site D EIA compiled by the public at the previous meeting. The meeting confirmed which issues were relevant for the Uubvlei study. The list was changed to reflect these issues (see the attached issues list).

### **(ii) Power Lines**

---

#### *Technical presentation*

Mr Langford discussed the proposed power line routes originating from Uubvlei to the Obib and Oranjemond substations respectively (see attached map).

#### *Details of EIA*

Mrs Van Zyl discussed the approach and programme for the power lines EIA study (see attached presentation).

#### *Issue Identification*

Mrs Van Zyl continued to present the issues that were identified for the power line route alternatives leading from Site D at the previous public meeting. The meeting confirmed which issues were relevant for the Uubvlei study. The list was changed to reflect these issues (see the attached issues list).

### 3. CLOSING

---

Attendants informed the presenters that the Oranjemund community received their invitations to the meeting that same day. Ms van Zyl explained that the invitation was supposed to have reached the people via the mine-wide e-mail service some 2 weeks before. Mrs van Zyl extended her apologies for the late notification. Ms van der Merwe confirmed that NamPower would gladly hold another meeting, if need be, as long as it could be scheduled soon to avoid a delay in the programme. The attendants considered this possibility, and agreed that an additional public meeting would not be warranted. Previous public meetings advertised well in advance did not receive significantly greater support than this one. It was therefore decided that the one public meeting would suffice, on condition that the Councillor for that constituency agreed as such. Mrs van Zyl agreed to contact the relevant Councillor the following day. It was further agreed that the minutes of the meeting would be circulated via the mine-wide service and people invited to comment.

Finally, Ms van der Merwe closed the meeting by thanking all present for their time and by confirming NamPower's commitment to consider all inputs from the community.

The meeting adjourned at 20h30.

**ISSUE IDENTIFICATION MATRIX: UUBVLEY TRANSMISSION LINES**

1	Danger to Aviation – ICAO Standards (Uubvlei site is preferred from an Aviation
2	Bird Issues - Nesting of new species - Tower design - Especially Birds of Prey
3	Access and security, including access control for maintenance, and security at construction site
4	Visibility/aesthetics (much less of an issue than for Site D, but should be considered from a tourism perspective; impact on wilderness qualities)
5	Corrosion
6	Construction Cost
8	Vegetation Transplant
9	Impact on animal and bird migration (during construction)
10	Waste Management
11	Archaeological Sites
12	Decommissioning
14	Accommodation during construction

**ISSUE IDENTIFICATION MATRIX: UUBVLEY POWER STATION SITE**

**ISSUES RELATED TO THE OPERATION & MAINTENANCE PHASE**

ISSUES	DESCRIPTION
Corrosion	Corrosion by spray due to proximity to the ocean
Noise	Sound ratings due to plant operation (much less of an issue than for Site D)
Abrasion	Abrasion by wind blown sand on pipework and structures
Visual Impact	Much less of an issue than for Site D, but needs to be considered
New Water Act	The implications of the new Water Act on the project
Normal Health and Safety Issues	
Risk/Emergencies	Risk of spills, seepage or leaks to Oranjemund well field & Ramsar site and Explosions
Proximity to Sperrgebiet	Proximity to the to-be proclaimed National Park and tourism area
Surf Zone	Operation in the high energy surf zone
Suspended Solids	Only an issue with use of sea water
Marine Ecosystems	Impact on marine environment
Air Quality	Impact on air quality (pollution)
Managing Construction Waste	The fate of construction waste
Processed chemicals released from system	Persistence of any biocide
Use of back-up fuel	
Impact of secondary industries on town	
Integrity of EIA process – depending on up- and downstream EIAs Integration	
Impact on town's viability – economic spin-offs	Tourism aquaculture industries

## ISSUES RELATED TO THE CONSTRUCTION PHASE

ISSUES	DESCRIPTION
Corrosion	Corrosion by spray due to proximity to ocean
Abrasion	Abrasion by wind blown sand
Access-workforce/equipment	Difficulty of access for people and material, especially if the security fence remains in current position
Powerline Access	Finding a route for the powerline from the site
Surf Zone	Construction in the high energy surf zone
Road Safety	Increased traffic through town
Pipeline Access	Construction of discharge pipeline to the sea if ground water is used
Conservation Areas	Control to be imposed on conservation due to adjacent native park
Aesthetics – birds	Impact of noise and lights on birds
Terrestrial Habitat	Impact on vegetation and high value animals and welland species
Services	Impact on normal town services – sewage, water reticulation, power, etc.
Safety/Security	Personal safety and security
Community Facilities	Impact of work force on hospitals, clinics, schools, police, fire, etc.
Social Integration	Mixing of permanent work force with temporary work force
Vegetation	Direct impact on existing vegetation
Marine Habitat	Direct impact on the marine habitat
Housing	Impact on the town's housing including end of phase impact
Managing Construction Waste	Hazardous waste & reportable environmental incidents
Departure of Construction Personnel on Completion	
Road Access of Plant Equipment	
HIV/Aids	
Poaching Gemsbok	
Impact on town's viability	



## ISSUES RELATED TO THE DECOMMISSIONING PHASE

ISSUES	DESCRIPTION
Impact on town's viability	
Physical rehabilitation of site – other uses?	
Financial Contributions – eg. Trust fund	
Closure Plan	
Decommissioning impacts on other facilities elsewhere in the region	

## ADDITIONAL ISSUES RAISED FOR UUBVLEI

### **Reasons for shifting to Uubvlei**

Some sectors of the Oranjemund community represented at the meeting questioned the reason for the possible shift from Site D to Uubvlei especially in the light of the promulgation of Oranjemund as a municipality in future. To many people, the prospect of the power station at Site D was appealing. However, other persons at the meeting noted their opposition to the power station being located at Site D, because of concerns around noise, visual impacts and pollution. This opposition was submitted in the form of a petition and this petition had been recorded in the EIA report. In response, NamPower explained that the decision to abandon Site D and move to Uubvlei has not been taken yet, and even if Uubvlei is selected as the preferred alternative to Site D, public opposition will likely not be the main justification. Technical and economic considerations would also be considered.

The meeting noted that opposition to Site D was not unanimous within the Oranjemund community.

### **Security/Access Control**

Members at the meeting raised security and access as issues that need additional consultation and consideration should Uubvlei be chosen as the site for the power station. NamPower confirmed that these issues were high on their agenda and that they would be fully considered. The MD of Namdeb similarly gave the assurance that Namdeb interests would need to be protected and that a mutually-acceptable solution would be sought.

### **Visual and noise impacts**

There was general agreement that locating the power station at the Uubvlei site would eliminate the problem of noise and visual impacts for residents at Oranjemund. However, the meeting noted the need to ensure that noise levels inside the plant conform to international standards so that the health of workers is not jeopardized. Moreover, it was noted that the plant should blend in as much as possible with the surroundings (e.g. through appropriate paint colour), though it was acknowledged that Uubvlei site is in any case an industrial site and will thus not be part of a future tourism route.

### **Medical and other facilities**

It seems like the medical fraternity at Oranjemund is welcoming the additional work that will be created by the Kudu Project.

### **Biophysical impacts**

A number of people at the meeting suggested that the possible move to Uubvlei would require new studies relating to the impacts on flora and fauna, as the surroundings at Uubvlei are somewhat different to those at Site D. NamPower confirmed that such studies were already envisaged in the TOR and would be done. The same was mentioned regarding waste management.

### **Perceptions regarding re-use of Uubvlei accommodation**

The meeting noted that the issue of using the hostel at Uubvlei is sensitive and thus needs careful consideration. Namdeb is gradually phasing out the use of this facility for various reasons, one of which is its apparent declining suitability as decent accommodation. Thus, the project must be sure that the facilities are of an appropriate standard to house workers. This point was noted by the consultants, and it was mentioned that this issue is in any case reflected in the Terms of Reference for the study.

### **Aviation:**

The Oranjemund Flying Club stressed three points during the meeting:

1. They strongly support a move of the power station from the original "Site D" to the Uubvlei site. They believe the Uubvlei location will pose substantially lower risk to aircraft than Site D. The major risks to aircraft at Site D would be: smoke plume reducing visibility, power lines in close proximity of airfield and the height of the smoke stacks posing a risk to aircraft approaching FYOG for the north-west. These risks would be aggravated in poor visibility and at night. They believe these risks would be virtually eliminated by moving to the Uubvlei site.
2. All HT power lines crossing the Orange River must be at the same location. The deep valley of the Orange River results in high hanging power lines. Minimizing crossing points over the Orange River is of critical importance. All new power lines must cross at Oranjemund substation where the current 66kV line crosses.
3. As with the HT lines crossing the Orange River, new HT lines must follow existing power lines in the desert as far as possible. Various HT lines pose a risk to low level approaching aircraft from the north. Minimizing the number of HT crossing point will mitigate this risk

### **Access and Transport**

Some people in the meeting wanted to know which roads would be used to the site. It was mentioned that the existing access road to Uubvley from Oranjemund would probably be adequate, but that this would depend on other access and security arrangements. The issues of road access and transport of materials, goods and people to and from site would be addressed in the EIA.

ADDITIONAL EIA STUDIES FOR THE KUDU GAS TO POWER PROJECT

CONSULTATION MEETING: ORANJEMUND

**31 MARCH 2005 AT 17H30**

*ATTENDANCE LIST*

NAME	ORGANISATION	TELEPHONE	FAX	POSTAL ADDRESS	E-MAIL ADDRESS
D. Duvenhage	Namdeb	063-235331	063-235155	P.O. Box 35, ORM	<a href="mailto:Dewald.duvenhage@namdeb.com">Dewald.duvenhage@namdeb.com</a>
R. Duvenhage	Namdeb	063-235744	063-235719	P.O. Box 35, ORM	<a href="mailto:Riana.duvenhage@namdeb.com">Riana.duvenhage@namdeb.com</a>
T. De Klerk	Namdeb	063-236736		P.O. Box 35, ORM	<a href="mailto:Tobie.deklerk@namdeb.com">Tobie.deklerk@namdeb.com</a>
A.C. Darne	Namdeb	063-237459	063-237521	P.O. Box 35, ORM	<a href="mailto:Andrew.darne@namdeb.com">Andrew.darne@namdeb.com</a>
T. Conry	NCCI	063-232551	063-232551	P.O. Box 1182, ORM	<a href="mailto:elodo@mweb.com.na">elodo@mweb.com.na</a>
Anca Burger	Namdeb	063-2335807	063-235719	P.O. box 604, ORM	<a href="mailto:Anca.burger@namdeb.com">Anca.burger@namdeb.com</a>
Wicus Burger	Namdeb & ORM Flying Club	063-238650	063-238603	P.O. Box 604, ORM	<a href="mailto:Wicus.burger@namdeb.com">Wicus.burger@namdeb.com</a>

NAME	ORGANISATION	TELEPHONE	FAX	POSTAL ADDRESS	E-MAIL ADDRESS
E.S. Iita	MUN	063-235763 0811229435	063-235283	P.O. Box 985, ORM	<a href="mailto:Eliphas.iita@namdeb.com">Eliphas.iita@namdeb.com</a>
D. Popyeinawa	MUN	063-235237 0812422613	063-235283	P.O. Box 222, ORM	<a href="mailto:popyeinawad@namdeb.com">popyeinawad@namdeb.com</a>
S. Haulofu	MUN	0811284565		P.O. Box 332, ORM	<a href="mailto:haulofus@namdeb.com">haulofus@namdeb.com</a>
A.N. Gully Muteka	Namdeb	063-233692 08128900388	063-235719	P.O. Box 1144, ORM	<a href="mailto:Gully.muteka@namdeb.com">Gully.muteka@namdeb.com</a>
A. Shanyenge	Namdeb	063-235919	063-235719	P.O. Box 1844, ORM	<a href="mailto:Abisai.shanyenge@namdeb.com">Abisai.shanyenge@namdeb.com</a>
R. Burger	Namdeb	063-235475	063-235719	P.O. Box 1619, ORM	<a href="mailto:Riaan.burger@namdeb.com">Riaan.burger@namdeb.com</a>
C. Burger	Namdeb	0834544690	063-232301	P.O. Box 1703, ORM	<a href="mailto:cburger@mweb.com.na">cburger@mweb.com.na</a> <a href="mailto:info@omd.chcafrica.com">info@omd.chcafrica.com</a>
L. Mauritius	MUN	063-235922 0812776888		P.O. Box 320, ORM	
J.K. Kandundu	Namdeb	0812540215	063-238359	P.O. Box 149, ORM	<a href="mailto:Joey.kandundu@namdeb.com">Joey.kandundu@namdeb.com</a>
H.A. Cokes Hindjou	MUN	063-235952 0812426754	063-238359	P.O. Box 1169, ORM	<a href="mailto:Heinrich.hindjou@namdeb.com">Heinrich.hindjou@namdeb.com</a>
R. Burrell	Namdeb	063-235322	063-235460	P.O. Box 253, ORM	<a href="mailto:Bob.burrell@namdeb.com">Bob.burrell@namdeb.com</a>

## **APPENDIX D**

# **WORLD BANK (IFC) ENVIRONMENTAL AND SOCIAL REVIEW REQUIREMENTS**

## **IMPLICATIONS FOR THIS PROJECT OF THE INTERNATIONAL FINANCE CORPORATION'S (IFC) ENVIRONMENTAL AND SOCIAL REVIEW REQUIREMENTS**

The proposed Kudu CCGT Power Plant is envisaged as a private sector investment. Considering that the International Finance Corporation (IFC) focuses on investment in private sector projects, the requirements of the IFC are potentially relevant to this project.

The purpose of this section is to provide a brief overview of the relevant IFC procedures, policies and guidelines; and an identification of potential implications for the proposed project. The following aspects of the IFC's requirements (and, where relevant, those of the World Bank Group) are discussed below:

- IFC Policies (including Environmental and Social Safeguard Policies)
- IFC Procedure for Environmental and Social Review of Projects
- IFC and World Bank Guidelines (including the World Bank's *Pollution Prevention and Abatement Handbook*)
- IFC Guidance Notes.

### **1. INTRODUCTION TO THE IFC**

The International Finance Corporation (IFC) is a member of the World Bank Group. It is IFC policy that all its operations are carried out in an environmentally and socially responsible manner. To this end, IFC projects must comply with applicable IFC environmental, social and disclosure policies. In addition, IFC applies World Bank Group environmental, health and safety guidelines to all projects.

The IFC's *Procedure for the Environmental and Social Review of Projects* (IFC, December 1998) presents the process by which IFC determines the adequacy of the project sponsor's environmental assessment for a proposed project and works with the project sponsor to address environmental and social issues and opportunities associated with the project. This process is supported by a suite of Policies, Guidelines, Guidance Notes, as well as World Bank guidelines and technical papers.

IFC does not finance project activities that would contravene country obligations under relevant international environmental treaties and agreements, as identified during the EA. For an overview of the implications of relevant international treaties and agreements, refer to Section 2 of the Environmental Impact Report.

### **2. POLICIES**

IFC environmental and social policies are fundamental to the project appraisal, approval and supervision process. Applicable operational policies are listed in Table 1, which includes a brief summary of the important aspects of each policy and the implications for the Kudu CCGT Power Plant.

**Table 1: IFC's Environmental and Social Safeguard Policies**

<b>Policy</b>	<b>Description</b>	<b>Implications for this project</b>
<b>OP 4.01, Environmental Assessment</b>	IFC policy on environmental assessment (EA) states that all projects proposed for IFC financing require an EA to ensure that they are environmentally and socially sound and sustainable. OP 4.01 also sets forth the minimum requirements for public consultation and public disclosure for projects.	In this case, the EIA and EMP are being prepared according to Namibian legislation (and international best practice) prior to any IFC involvement. The IFC may require revision to the EIA and the EMP. Potential areas for revisions are highlighted elsewhere in this section. It is not certain whether these revisions would then require approval by the Namibian authorities, to ensure they agree with the revisions.
<b>OP 4.04, Natural Habitats</b>	This policy affirms IFC's commitment to promote and support natural habitat conservation and improved land use, and the protection, maintenance, and rehabilitation of natural habitats and their functions in its project financing.	The siting of the project on land that has already undergone human-induced transformation is in keeping with IFC's policy to endeavour to site projects in already disturbed areas. Potential impacts on natural habitats have been investigated in the EIA and no negative impacts of high significance were identified.
<b>OP 4.09, Pest Management</b>	IFC supports the use of biological or environmental control methods rather than the use of pesticides where there is a need for pest management.	Not relevant to this EIA, and not investigated.
<b>OD 4.20, Indigenous Peoples</b>	[forthcoming]Pending finalization of this OP, IFC projects must comply with the World Bank's OD 4.20, <i>Indigenous Peoples</i> , as appropriate in a private sector context.	Not relevant to this EIA, since no indigenous people live on the site.
<b>OPN 11.03, Safeguarding Cultural Property in IFC-Financed Projects</b>	[forthcoming]Pending finalization of this OP, IFC projects must comply with the World Bank's OPN 11.03, <i>Cultural Property</i> , as appropriate in a private sector context.	Not relevant, as the selected site for the power plant is already been mined out and there are no archaeological/paleontological features left.
<b>OD 4.30, Involuntary Resettlement</b>	[forthcoming]This policy is applied wherever land, housing or other resources are taken involuntarily from people.	Not relevant to this EIA, because no peoples need to be involuntarily resettled or moved from the site for the project.
<b>OP 4.36, Forestry</b>	IFC involvement in the forestry sector aims to reduce deforestation, enhance the environmental contribution of forested areas, promote afforestation, reduce poverty, and encourage economic development.	Not relevant to this EIA, because no there is no forestry on the site.
<b>OP 4.37, Safety of Dams</b>	This policy sets forth IFC's requirements for projects where dams are to be constructed.	Not relevant to this EIA, as no dams will be constructed as part of the project.
<b>OP 7.50, Projects on International Waterways</b>	This policy sets forth required agreements and notifications regarding projects that are situated on international waterways.	Not relevant to this EIA, as the project will not be situated on an international waterway, and cooling water options will exclude interfering with the ecological functioning of the Orange River mouth.



### 3. PROCEDURE FOR ENVIRONMENTAL AND SOCIAL REVIEW OF PROJECTS

IFC's environmental and social review procedure outlines the process by which IFC determines the adequacy of the project sponsor's environmental assessment for a proposed project and works with the project sponsor to address environmental and social issues and opportunities associated with the project. The purpose of the environmental and social review is to ensure that the project complies with applicable IFC environmental and social policies and meets the applicable guidelines. In sectors where no appropriate IFC policies or guidelines exist, IFC applies internationally recognized standards. The project sponsor must ensure compliance with host country requirements. The requirements of this process are described in the document entitled *Procedure for Environmental and Social Review of Projects* (IFC, 1998). The main elements of this process are the:

- project evaluation cycle followed by the IFC
- description of responsibilities of each party at each step of the review cycle
- supporting documents, guidelines and guidance notes.

#### 3.1 Project evaluation cycle

Timing of IFC involvement in a project can vary significantly. IFC's initial involvement in a project normally occurs after a feasibility study has been completed (i.e. after site selection, preliminary design work, etc.). In the case of the Kudu CCGT Power Plant, the EIA and EMP are being completed prior to potential IFC involvement.

The sequential stages in the IFC project evaluation and investment cycle are described below. This process assumes that the EIA process runs parallel to the IFC's review and investment process.

- **Project Identification and Assignment of IFC Project Team:** The IFC establishes their project team, which includes their environmental and social specialists as appropriate.
- **Early Review:** The purpose of the Early Review is for IFC to give a quick decision to a project sponsor on whether the Corporation is interested in engaging in the project. As a basis for this decision, the IFC prepares a Project Data Sheet Early Review, which contains a project description, details of the potential investment, highlights any policy issues and potential deal-breakers, and reviews IFC's role in the project and development impact.
- **Project Appraisal:** Appraisal is the stage in which IFC staff conduct a detailed evaluation of the project in terms of business potential and environmental, social and technical concerns, and review information provided by the project sponsor. The category of project is ascertained. If IFC is satisfied that the project can comply with appropriate IFC requirements, then an Environmental and Social Clearance Memorandum (ESCM) is issued.
- **Investment Review Meeting:** Based on the Appraisal stage, an Investment Review Meeting is held to review the recommendations of the IFC project team and the updated Project Data Sheet Early Review, and to discuss any outstanding issues.
- **Management Approval:** When all issues have been satisfactorily addressed, IFC management grants approval to proceed with the project.
- **Negotiations:** IFC negotiates with the project sponsor to establish the primary terms and conditions of IFC participation in the project, including environmental and social aspects.
- **Board Approval:** IFC projects can be submitted to the Board using *regular* or *streamlined* procedures. The environmental and social due diligence process and the public disclosure requirements do not vary according to procedure; only the documentation submitted to the Board varies. All significant environmental and social issues must be satisfactorily addressed prior to submission of project documents to the Board.
- **Signing of Legal Agreements (Commitment):** Signing constitutes the formal acceptance by the project company, IFC, and other parties (if any) of the terms and conditions under which IFC will finance the project.

- **Disbursement:** Disbursement occurs on the terms and conditions contained in the legal documentation.
- **Supervision:** IFC monitors the performance of all active projects in its portfolio to ensure compliance with environmental, social and other conditions. Annual environmental monitoring reports are required, and must be verified by an independent consultant acceptable to the IFC.
- **Evaluation:** In project evaluations, environmental and social performance is fully taken into account as an important element in the performance of IFC, the company and the project. Evaluations are required of the actual environmental and social impacts of the project, and the effectiveness of the mitigation measures.

Based on a review of the requirements of the above IFC project cycle, the following key implications are identified for the Kudu CCGT Power Plant:

- The project proponent needs to bear in mind that the IFC will require revision of the EIA and EMP to meet their specified report formats, terminology and additional content requirements (e.g., the need to include cost estimates of mitigation, management and monitoring actions). These requirements will require rework of existing documents, in order to meet IFC specifications.
- If the IFC is a potential investor, then the project proponent needs to confirm with the IFC as soon as possible whether the existing EIA process is adequate to meet their requirements.
- Revisions to the EIA, due to IFC requirements, may require further approval by the Namibian authorities to ensure they agree with any revisions.

### ***3.2 Annexes to the Environmental and social review procedure***

Six annexes are provided to the *Procedure for Environmental and Social Review of Projects* (IFC, 1998), not all of which are of relevance to the Kudu CCGT Power Plant project. The key item of relevance is Annex B, which lists categories of projects and associated levels of Environmental Assessment required.

In terms of the IFC categories, the power plant would be classified as a “large thermal and hydropower development”. It would therefore be a *Category A project*, which implies that it is likely to have “significant adverse environmental impacts” and consequently requires a full Environmental Assessment that:

- examines the project’s positive and negative impacts;
- compares them with those of feasible alternatives (including the “without project” scenario); and
- recommends measures needed to prevent, minimise, mitigate, or compensate for adverse impacts and improve performance.

## **4. GUIDELINES**

### ***4.1 IFC Guidelines***

The IFC provides guidelines for a range of projects. None of the guidelines are directly relevant to the project as a whole, though the following guidelines are potentially relevant to aspects of the project:

- Electricity Power Transmission and Distribution
- Hazardous Materials Management
- Wastewater Reuse.

### ***4.2 World Bank Guidelines: Pollution Prevention and Abatement Handbook***

The World Bank Group’s *Pollution Prevention and Abatement Handbook* applies to all

projects directly financed by IFC. This handbook includes more than 40 guidelines for various types of industrial and other projects.

The *Thermal Power Guidelines for New Plants* are directly relevant to the project. These guidelines specify thresholds or maximum emissions levels for all fossil fuel-based thermal power plants with a capacity of 50 or more megawatts of electricity (MWe) that use coal, fuel, oil or natural gas. Levels are specified for atmospheric emissions, liquid waste, solid waste and noise. These levels are discussed in the impact assessment in Chapter 5

### **4.3 Occupational Health and Safety Guidelines**

The IFC applies provisions set forth in the World Bank *Group's Occupational Health and Safety Guidelines*, which cover those industries and pollutants most frequently encountered in IFC projects. (Note: These guidelines are focused on the "internal" workings of the plant, and are therefore not included in the EIA, which focuses on the "external" impact of the plant on the surrounding environment. Nonetheless, the OH&S guidelines are raised as an IFC requirement that the project proponent needs to take into account.)

### **4.4 Additional Reference Materials**

IFC consults a number of other reference materials in reviewing projects

- Techniques for Assessing Industrial Hazards: A Manual. World Bank Technical Paper No. 55, 1988.
- The Safe Disposal of Hazardous Wastes: Volumes I, II and III, World Bank Technical Paper No. 93, 1989.
- Environmental Considerations for Port and Harbor Developments, World Bank Technical Paper No. 126, 1990.
- Environmental Assessment Sourcebook, Volumes I, II and III, World Bank Technical Paper No. 139, 1991.
- Resettlement as Development: A World Bank Sourcebook for Good Practice, World Bank (forthcoming).
- Doing Better Business Through Effective Public Consultation and Disclosure: A Good Practice Manual, International Finance Corporation.

## **5. GUIDANCE NOTES**

The following suite of six *Guidance Notes* is provided by the IFC:

- Guidance Note A: Checklist of potential issues for an EIA
- Guidance Note B: Content of an Environmental Impact Assessment Report
- Guidance Note C: Outline of an Environmental Action Plan (EAP)
- Guidance Note D: Outline of a Project Environmental Audit
- Guidance Note E: Outline of a Project Specific Major Hazard Assessment
- Guidance Note F: Guidance for preparation of a Public Consultation and Disclosure Plan (PCDP).

The following section contains a brief overview of the scope of each of these Guidance Notes, and the potential implications for the EIA process for the proposed power station project.

### **5.1 Guidance Note A: Checklist of potential issues for an EIA**

Where applicable, the EA should address a range of issues, taking cognisance of relevant IFC guidelines. Table 2 below summarises main issues relevant for this power station project, with a comment on how it is addressed in the EIR.

**Table 2: Review of issues in IFC checklist that are relevant to this EIA**

Potential issue to be addressed in EIA	Comment with regards to EIA for the Kudu CCGT Power Plant
<b>Biological diversity</b> - conservation of species, habitats and protected areas	Covered in Section 6 of the EIR
<b>Coastal and marine resources</b> - including wetlands	Covered in Section 6 of the EIR
<b>Cultural properties</b> - such as archaeological and paleontological or other sites of cultural value	Not covered the EIR
<b>Energy efficiency</b> - where appropriate, the IFC might require review of the options for improved energy efficiency	Alternatives reviewed in Section 4.
<b>Environmental guidelines</b> - in particular, the World Bank Group's <i>Pollution Prevention and Abatement Handbook (PPAH)</i>	The relevant guidelines from the PPAH are included in the impact assessment sections in Section 6
<b>Hazardous and Toxic Materials</b> – issues relating to safe manufacture, use, transport, storage, and disposal must be addressed, where relevant	Covered in Section 3 of the EIR
<b>Induced development and other socio-economic aspects</b> – such as secondary developments around major projects	Covered in Section 6 of the EIR
<b>International treaties and agreements on the environment and natural resources</b> – to be included in the project's environmental studies	Covered in Section 2 of the EIR
<b>Major hazards</b> – all projects which involve dangerous materials in sufficient quantities to represent a significant hazard with the potential for an incident of major consequence, are required to complete a major hazard assessment and establish formal management processes.	This would need to be prepared, as a requirement of the Occupational Health and Safety regulations, and approved by Dept of Labour.
<b>Natural hazards</b> – review whether the project may be affected by natural hazards, such as earthquakes or floods	Not relevant.
<b>Occupational health and safety (OH&amp;S)</b> – formal plans are required to promote OH&S, in accordance with the WBG's <i>OH&amp;S Guidelines</i>	Operational and construction issue in terms of health and labour regulations.
<b>Restoration and rehabilitation of disturbed land</b> – a comprehensive plan is required for future rehabilitation and restoration after the life of the project	An EMP requirement, as specified by mitigation and minimization recommendations.

### **5.2 Guidance Note B: Content of an Environmental Impact Assessment Report**

This Guidance Note sets out the language requirements and scope for the EIA report. The report must contain the following items:

- Executive summary
- Policy, legal and administrative framework
- Project description
- Baseline data
- Environmental and social impacts
- Analysis of alternatives (including site, technology, design and operational alternatives; as well as the “without project” alternative)
- Environmental Action Plan (EAP)

- Appendixes (eg. project team, references, meeting notes, additional data).

The EAP is essentially a management plan that contains the mitigation, monitoring and implementation measures to reduce or eliminate significant adverse environmental and social impacts. It needs to be updated regularly by the project sponsor/proponent.

### **5.3 Guidance Note C: Outline of an Environmental Action Plan (EAP)**

Every IFC Category A project must have an EAP that must include the following components:

- **Environmental management**, including environmental and social policies, allocated resources, responsibilities and operational arrangements.
- **Mitigation and development**, to reduce adverse impacts and promote benefits.
- **Monitoring**, during project implementation and including annual reporting.
- **Implementation schedule and cost estimates**, for environmental management, mitigation and monitoring.
- **Integration of EAP with Project**, to ensure the EAP is implemented effectively.
- **Consultation and disclosure**, to achieve ongoing consultation with stakeholders.

### **5.4 Guidance Note D: Outline of a Project Environmental Audit**

This is usually required for existing projects that involve expansion, modernization, privatization or a corporate investment. With the CCGT Power Plant being a greenfields project, this *Guidance Note* is not considered relevant to the project at this stage.

### **5.5 Guidance Note E: Outline of a Project Specific Major Hazard Assessment**

A major hazard assessment is required for projects that involve the transporting, storage, handling, and processing of dangerous (flammable, explosive, reactive or toxic) materials. The threshold quantities and further details are contained in the World Bank Group's manual entitled *Techniques for Assessing Industrial Hazards: A Manual* (Technical Paper No. 55, Washington, D.C., 1988). This assessment is usually prepared by an independent consultant having extensive industrial experience in the area of risk assessment and control of major hazards.

### **5.6 Guidance Note F: Guidance for preparation of a Public Consultation and Disclosure Plan (PCDP)**

The IFC requires that project sponsors (i.e. in this case, the project proponent) are required to consult meaningfully with stakeholders on the preparation and results of the EIA. Ongoing consultation is also required during the construction and operation phases of the project. A Public Consultation and Disclosure Plan (PCDP) is required, that specifies the approach to this consultation. The *Guidance Note* specifies the principles to be included in this process and the contents of the PCDP.

It is expected that the existing stakeholder engagement process undertaken for the EIA in terms of Namibia's EA Policy is adequate to meet the IFC requirements for work done to date. However, IFC may require that information from this process be packaged in a way that meets their requirements. This would need to be clarified with the IFC, should they be a potential lender. The project proponent needs to take cognisance of the IFC's requirements for ongoing consultation during the construction and operation phases.

## **References**

IFC, 1998, *Procedure for the Environmental and Social Review of Projects* (version dated December 1998 available from [www.ifc.org](http://www.ifc.org), at [http://ifcln1.ifc.org/ifcext/enviro.nsf/Content/ESRP%5C\\$FILE%5CEnv&SocReviewProc.pdf](http://ifcln1.ifc.org/ifcext/enviro.nsf/Content/ESRP%5C$FILE%5CEnv&SocReviewProc.pdf), (accessed on 6 October 2004).