2024

ENVIRONMENTAL MANAGEMENT PLAN FOR THE OPERATION AND MAINTENANCE OF THE EXISTING 350KV GERUS – ZAMBEZI TRANSMISSION LINE ASSOCIATED INFRASTRUCTURES.

THE DOCUMENT IS PREPARED BY AND FOR:

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1 LIST OF TERMS, ACRONYMS AND ABBREVIATIONS

APD	Anti-Perching Devices
BFD	Bird Flight Diverters
EAP	Environmental Assessment Practitioner
ECC	Environmental Clearance Certificate
EIA	Environmental Impact Assessment
EMA	Environmental Management Act no 7 of 2007
EMP	Environmental Management Plan
GIS	Geographical Information System
HIV/AIDS	Human immunodeficiency virus/ acquired immunodeficiency syndrome
MEFT	Ministry of Environment, Forest and Tourism
NHC	National Heritage Council
SHE	Safety, Health and Environment
SHEW	Safety, Health, Environment and Wellness
kV	Kilovolt

2 INTRODUCTION

In order to carry out its mandate of transmission and distribution of electricity, NamPower's has a transmission networks across all regions countrywide. The continuous operation of the transmission networks allow NamPower to provide uninterrupted supply of electricity to regions to enable economic development. The 350kV Gerus – Zambezi transmission line is part of this network and it is one of NamPower's important lines as it transmits the imported power from Zambia.

The 350kV Gerus – Zambezi High Voltage Direct Current (HVDC) powerline was constructed in 2010 with 533 V - Towers and is 953km in length. This transmission line transmit 350kV of High Voltage Direct Current (HVDC) electricity between Gerus substation in Otjozondjupa Region and Zambezi Substation station in Zambezi Region. As part of this transmission like with any other HVDC power line or transmission system, a Converter Station is required at the transition point between HVDC and High Voltage Alternating Current (HVAC) to enable distribution or further transmission. The converter stations are located at Gerus and Zambezi transmission stations are beyond the scope of the EMP as they are included in the EMP for the two transmissions.

The infrastructures associated with this line include the six repeater stations as well as the earth electrode line and station (Zambezi Earth Electrode line and station). Repeater stations are required at various intervals along the transmission line to restore and amplify 'attenuated' and time smeared signals in a typical signal carrying installation. Figure 1 shows the locality map for the 350kV Gerus – Zambezi transmission line ad associated infrastructures.

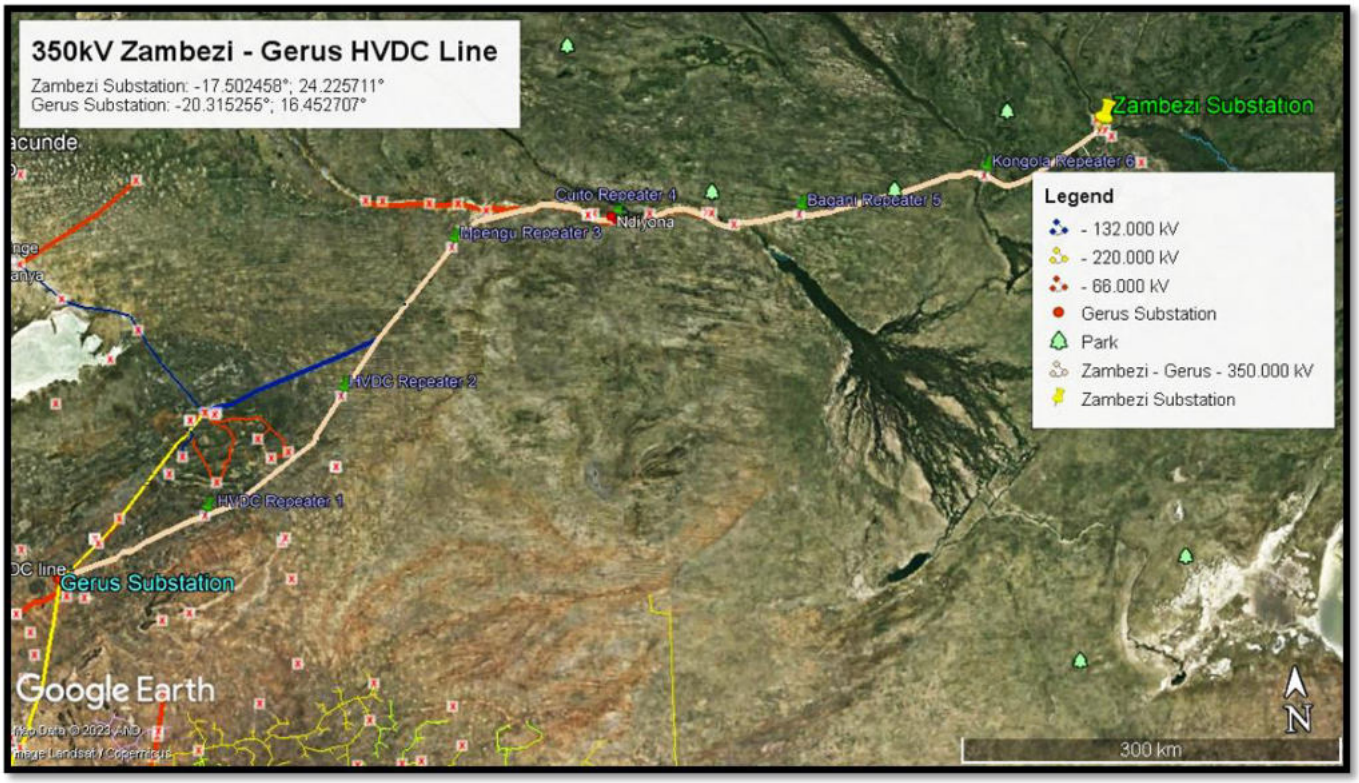

Figure 1: Locality map showing the 220kV Gerus- Zambezi – Gerus transmission line

2.1 General area description

This power line route runs through various land use zones. These land use zones include privately owned farms and communal land between Otjikoto and Rundu. The remainder of the route runs through communal land and the Bwabwata National Park. River crossings are made at two points along the power line route, i.e. the Okavango River and the Kwando River. It is important to note that there were a detailed Environmental Impact Assessment studies conducted prior to the construction of this transmission line and some of the documents are attached as supporting documents.

The 350kV Gerus - Zambezi transmission line covers a distance of 953km and due to its length, the description of the area has been divided into 6 sections: Katima-Kongola; Kongola-Divundu; Divundu-Rundu; Rundu-Mururani; Mururani-Otavi and Otavi-Otjiwarongo as described in the ecological reports by Cunningham, 2019.

Zambezi Substation to Kongola – This section passes through communal land with anthropogenic disturbances (e.g. tracks, quarantine camps, etc.). The route passes through seven “hotspot” areas i.e. 6 sections viewed as “high” sensitivity and 1 section as “medium”

sensitivity. The 3.7% of this section is viewed as “medium” sensitivity; 9.1% of the route is ranked as high and/or medium sensitivity, while 90.9% is ranked as low. Unique and/or important biodiversity features along the route are viewed as the various ephemeral pan systems and perennial Kwando River. The active fields are also listed as high sensitivity and inactive fields are listed as medium sensitivity, not for biodiversity purposes, but rather for agricultural purposes.

Kongola to Divundu – This section passes through Bwabwata National Park with anthropogenic disturbances (e.g. tracks, etc.). The 1.9% of this section is viewed as high and/or medium sensitivity and 98.1% is ranked as low Unique and/or important biodiversity features along this section are viewed as the various ephemeral pan systems and irrigated fields. The fields are listed as medium sensitivity, not for biodiversity purposes, but rather for agricultural purposes.

Divundu to Rundu – This section passes through communal land with anthropogenic disturbances (e.g. various tracks, tar road, Mushare Agriculture, urban area [Divundu & Rundu], etc.). The section is passing through 10 “hotspot” areas i.e. 5 sections viewed as “high” and “medium” sensitivity. The 6.2% of this section is viewed as high and/or medium sensitivity and 93.8% is viewed as low. Unique and/or important biodiversity features along the route are viewed as the various ephemeral omuramba systems and the Kavango River and fields and urban areas (Divundu). The fields are listed as medium sensitivity, not for biodiversity purposes, but rather for agricultural purposes.

Rundu to Mururani – This section passes through communal land with anthropogenic disturbances (e.g. various tracks, fenced off fields/areas, urban area (Rundu), etc.). The 0.8%) is viewed as “high” sensitivity and 43.2% viewed as “medium” sensitivity and 56% viewed as low. Unique and/or important biodiversity features along the route are viewed as the various borrow pit areas (artificial but now a water source) and active fields and fallow fields. The fallow fields are listed as medium sensitivity, not for biodiversity purposes, but rather for agricultural purposes.

Mururani to Otavi – This section passes through freehold (commercial) land with anthropogenic disturbances (e.g. various roads, tracks, fences, etc.). There are some ground dams, ephemeral drainage lines, etc. that can be classified as “high” and/or “medium” sensitivity. Such unique and/or important biodiversity features would have to avoided when

applying chemicals. The detailed description of the area is included in the Environmental Impacts Assessments reports from the studies conducted prior to construction.

Otavi to Otjiwarongo – This is the final section of the Gerus – Zambezi powerline. This section passes through freehold (commercial) land with anthropogenic disturbances. There are some pans, ground dams, ephemeral drainage lines, etc. that can be classified as “high” and/or “medium” sensitivity. Such unique and/or important biodiversity features would have to avoided when applying chemicals. The detailed description of the area is included in the Environmental Impacts Assessments reports from the studies conducted prior to construction.

The photos below shows some of the sensitive areas found along the 350 kV Gerus – Zambezi transmission line. It is important to note that some of the sensitive areas such as fields are not permanent while some like drainage lines, rivers are permanent.

Figure 2. The various ephemeral pans are vied as “high” sensitive areas.

Figure 3. The perennial Kwando River habitat is viewed as “high” sensitive area.

Figure 4. Active fields are viewed as “high” sensitive areas.

Figure 5. Ephemeral pan systems are viewed as unique habitats and classified as "high" sensitive areas.

Figure 6. Irrigation areas close to Divundu are viewed as "high" sensitive areas.

Figure 7. The Omuramba Omatako situated between Rundu and Divundu is viewed as an important habitat i.e. “high” sensitive area.

Figure 8. Smaller omuramba areas are also viewed as “high” sensitive areas.

Figure 9. The perennial Kavango River is one on Namibia's few large rivers and classified as "high" sensitive habitat.

3 OBJECTIVES AND SCOPE OF THIS ENVIRONMENTAL MANAGEMENT PLAN (EMP)

The operation of the transmissions line can have a negative impact on the receiving environment. However, the impacts are limited to the line servitude. It is thus important that good management measures are implemented to ensure that environmental damage is minimized. This Environmental Management Plan (EMP) seeks to manage and keep to a minimum the negative impacts associated with the transmission line and at the same time, enhance the positive and beneficial impacts.

The scope of this EMP include all activities associated with the operation of the transmission line. It is necessary to highlight that the EMP is a living document that should be periodically reviewed and updated. It should also be noted, that the EMP should be read in conjunction with laws and regulations outlined in section 5, Table 1 and all other applicable laws.

The aim of this EMP is to detail the management actions required to implement the mitigation measures identified thereby ensuring that any operational phase activity is carried out in a manner that takes cognizance of environmental protection and is in line with National legislation.

This EMP has the following objectives:

- To outline mitigation measures to be implemented during the operation phase, in order to manage and minimize the extent of environmental impacts.
- Minimize negative impacts and enhance positive impacts associated with the operations.
- To ensure that the operational activities do not result in undue or reasonably avoidable adverse environmental impacts, and ensure that any potential environmental benefits are enhanced.
- To identify key personnel who will be responsible for the implementation of the measures, outline functions and responsibilities.
- To propose mechanisms for monitoring compliance and preventing long term or permanent environmental degradation.
- To ensure that the concerns and complaints of Interested and Affected Parties (I&APs) with regards to the operational activities are addressed effectively and timely.
- Ensure compliance to legislative requirements.

4 POLICY AND LEGISLATIVE FRAMEWORK

Table 1 The legislative requirements which are applicable to the operational and maintenance activities include but not limited to:

Legislation:	**Section (s) applicable:**	**Implications:**
Environmental Management Act no 7 of 2007	Section 3	• All activities performed should be in line with the following principles: o Interested and affected parties should have an opportunity to participate in decision making o Listed activities should be subject to an EIA

	Section 27 Section 33 onwards And all other applicable sections.	○ Polluter should pay for rehabilitation ○ Pollution should be minimized • Environmental assessments should be carried out for listed activities. The proposed activity can be classified under the following range of activities: ○ Generation of electricity ○ Transmission of electricity • These sections details the process to be followed in order to obtain a clearance certificate. • All existing listed activities must obtain a clearance certificate within one year of the law coming into effect. Therefore, all existing activities which can be considered a listed activity should apply for clearance.
EMA Regulations GN 28-30 (GG 4878) (February 2012)	• Listed activity: • 5.1 • 6 – 9; 13; 15; 21 -24 • Any other applicable sections	• This activity can be considered as electricity generation and transmission. • These sections details the process to be followed in terms of producing an Environmental Assessment and this process should be adhered to during the generation of information for this document.
No. 156 Labour Act, 1992: Regulations relating to the health and safety of employees at work .	All applicable regulations	All regulations applicable to different activities must be complied to.
Labour Act no 11 of 2007	• Section 3 • Section 4	• Children under the age of 16 may not be employed

	• Section 9 • Section 39 – 42 • All other applicable sections	• Forced labour may not be used. • Basic conditions of employment as stipulated by the law must be met. • The employer shall ensure the health and safety of all employees and non-employees on site. Employees must fulfil their duties in order to ensure their own health and safety and that of other employees and persons. Employees may leave the work site if reasonable measures to protect their health are not taken.
Electricity Act no 4 of 2007	• Section 33	• Installations used for the provision of electricity should be operated with due compliance with the requirements of laws relating to health, safety and environmental standards. Therefore – any company involved within the Electricity Supply Industry must adhere to the laws covering the previously stated aspects or stand to lose their licenses to operate.
Water Act no 54 of 1956	• Section 21 and 132 • Section 23 • All other sections applicable to different activities.	• Conditions in terms of the disposal and management of effluent are to be adhered to. • Any person causing pollution to a water source shall be guilty of an offence.
Public and Environmental Health Act no 1 of 2015	• Section 52 • Section 53 • All other sections applicable to different activities.	• A person generating waste must ensure that the waste generated is kept and stored under conditions that causes no harm to human health or damage to the environment. • Waste must only be disposed of at a waste disposal site, including an incinerator approved by the local authority concerned.

Water Resources Management Act no 24 of 2013	• Section 89 • All other sections applicable to different activities.	• The owner or occupier or other person in control of land where an incident that causes or is likely to cause a water resource to be polluted must take all reasonable measures to contain and minimize the effects of the incident; and to clean up polluted areas and remedy the effects of the incident.
Hazardous Substances Ordinance 14 of 1974	• Section 27 • All other sections applicable to different activities.	• To provide for the control of substances which may cause injury or ill-health to or death of human beings, by reason of their toxic, corrosive, irritant, strongly sensitizing or flammable nature or the generation of pressure thereby in certain circumstances; • To provide for the division of such substances into groups in relation to the degree of danger; • To provide for the prohibition and control of the importation, manufacture, sale, use, operation, application, modification, disposal or dumping of such substances; and • To provide for matters connected therewith.
Fertilizers, farm feeds, agricultural remedies and stock remedies Act no 36 of 1947	• Definitions • Section 7 • Section 10 • All other sections applicable to different	• Arborocides application is defined as an agricultural remedy under this Act • Only registered pesticide may be used. • May only buy herbicides in a container that complies with the prescribed requirements and is sealed and labelled. • Only allowed to use herbicides in the prescribed manner. • Land owners must be notified about applications, and the following information

	activities.	must be supplied: o Purpose of administration o Registered name and number of the product • Precautions to be taken before, during and after each administration.
The Nature Conservation Ordinance (1975) as amended through the Nature Conservation Amendment Act of 1996.	• Chapter 11: Game Parks, Nature Reserves, Conservancies and Wildlife Councils	• Permits are required to enter the National Park. Permits are also required for the removal of any protected plant or tree. It also stipulates that no damage may be done to any object of geological, ethnological, archaeological, historical or other scientific interest without the appropriate permits**.**
National Heritage Act No 27 of 2004	• Section: 46, 48, 55 • All other sections applicable to different activities.	• All heritage resources are to be identified and either protected or removed/mitigated with a permit from the National Monuments Council, before any development may take place • A chance find procedure should be followed in case of discovery of a heritage resource.
Soil Conservation Act no 76 of 1969	• Section 4 • Section 13 • Section 21 • And other applicable sections	• Institutions may be ordered by the relevant Minister to construct soil conservation works when and where necessary. • Fire protection schemes may be implemented to regulate the prohibition of veld burning as well as the prevention, control and extinguishing of veld and forest fires. • It is illegal to damage, destroy / fail to maintain any soil conservation works; fire belts; works constructed in terms of a fire protection scheme.
Forest Act no 12 of 2001	• Section 132 • Section 41	• Vegetation may not be removed within 100 m of a river, stream or water course

	• And other applicable sections	• A person shall be liable for damage caused by any fire which arises as a result of activities carried out on site without having taken reasonable measures to prevent a fire.

5 ROLES AND RESPONSIBILITIES

It is the responsibility of NamPower and/or contractor to ensure that all the environmental management actions are carried out effectively and timeously. It is important to note that the successful implementation of the EMP is, however dependent on clearly defined roles and responsibilities by several stakeholders. Below are the key employees that are responsible for the management of environmental and social issues during the operational phase:

Table 2: The roles and responsibilities for operational and maintenance activities:

Responsible person	Responsibilities
The Area Superintendent	• Is responsible for the enforcement of the EMP • To ensure that environmental requirements are adequately covered in any external service provider contracts. • To ensure that SHE requirements are included in the tender documents sent to the contractors. A copy of this EMP should also form part of the tender documents. • To ensure that corrective actions are implemented for non-compliances. • To ensure that appropriate records and information regarding compliance with environmental requirements are maintained. • To ensure that the line remain in compliance with the requirements of this EMP, through regular communication and monitoring. • To ensure that all incidents, accidents and complaints are

	reported. To also ensure that incidents and accidents are investigated to prevent re-occurrence.
Project Manager	• Is responsible for the enforcement of the EMP. • To ensure that SHE requirements are included in the tender documents sent to the contractors. • Must ensure that the contractor remains in compliance with the requirements of this EMP.
NamPower SHEW	• To ensure that all requirements with regards to this EMP are fulfilled. • Communicate NamPower SHEW requirement to the contractors and NamPower employees. • Provides SHEW inductions to NamPower and contractor employees. • Implement monitoring, conduct inspections and audits in consultation with the Project Manager/Area Superintendent. • Document and communicate monitoring, audit and inspection findings to project manager and area superintendent. • Communicate the final inspection report to the Project manager on contractor compliance to the EMP before the project close-off and final payment is made to the contractor.
Contractor	• Is responsible for the implementation of the EMP • To appoint as SHE officer responsible for the implementation of this EMP. • To ensure that all tasks undertaken under the scope of work, are in accordance both with NamPower's SHEW policies and procedures as well as to the requirements of this EMP. • Ensure that employees are regularly trained and awareness

	built relating to environmental and social management. • To ensure that all incidents, accidents and complaints are reported to the project manager. The contractor to ensure that incidents and accidents are investigated to prevent re-occurrence. • Ensuring that all employees receive a SHEW induction before the start of the project. • Ensuring that the work being done does not create a nuisance to any being working, residing or living on adjacent properties or within the immediate surroundings of the site.

6 DESCRIPTION OF OPERATIONAL ACTIVITIES TO BE UNDERTAKEN AND ASSOCIATED IMPACTS

The activities associated with operational and maintenance (the socio-economic and environmental impacts) include but not limited to:

Table 3: Description of the activities related to the operational activities.

Activity	Description	Associated potential impacts
General functioning and presence of the transmission line.	• Physical presence and functional characteristics of the powerline.	• Animal (including birds) mortalities through collisions and electrocution. • Visual impact. • Community impacts in a form fatalities or injuries caused by electrocution. • Meeting electricity demand (positive impact).
Maintenance of the line	• The maintenance of the line entails but not limited	• Soil and water contamination • Waste generation leading to filling

	to: • General line components repairs. • Construction or repairing of access roads. • Repair or replacement of towers or tower components and others.	up of landfill space • Loss of biodiversity • Loss of sensitive habitats, flora and fauna. • Social issues related to the introduction of new workers in the area, e.g. HIV/AIDS spreading • Loss of human life (through electrocution)
Periodic inspections and monitoring	• Inspecting the line and substation conditions and assess compliance to procedures and legal requirements.	• Soil and ground water contamination as a result of oil spills • Soil contamination as a result of improper waste handling and disposal. • Loss of biodiversity if existing access roads are not put to use.
Installation of Optic Fiber networks	• Design, Supply, Delivery, Installation and Commissioning of Optic Fiber networks for communication purposes.	• Loss of biodiversity • Soil contamination as a result of improper waste handling and disposal. • Loss of sensitive plants and habitats.
Vegetation Management	• Removal of trees and bushes to maintain access to the line servitude.	• Loss of biodiversity • Conflict with stakeholders • Loss of topsoil • Soil and water contamination • Loss or damage to heritage and

		cultural resources.

7 MANAGEMENT AND MITIGATION MEASURES

In order to ensure that the potential impacts are eliminated and/or minimised, it is necessary to ensure that the various activities related to the operation and maintenance of the power lines are adequately managed and monitored. Table 4 below outline mitigation measures as well as objectives to be achieved. A responsible person (s) have been assigned to each mitigation measure (s).

Table 4: Proposed mitigation measures for the general operational activities

ASPECT	MANAGEMENT AND MITIGATION MEASURES/COMMITMENTS	RESPONSIBLE PERSON
Safety Health and Environmental (SHE) Awareness	• All employees should undergo SHE induction before work commences onsite. • All employees are to be made aware of their individual roles and responsibilities in achieving compliance with the EMP. • SHE toolbox talks to be conducted and records to kept onsite.	• Area superintendent • Project manager • SHEW • Contractor
Safety Management	• NamPower procedures, policies and legal requirements pertaining to safety must be complied with. • Appropriate warning signs must be placed on the facilities. • SHE file to be submitted in case of projects in accordance with NamPower SHE requirements.	• Area superintendent • Project manager • Contractor
Fire Management	• Eliminate the presence of potential sources of ignition and provide appropriate equipment to minimize fire risk. • Fire extinguishers to be readily available onsite and in vehicle. • Regular servicing of fire extinguishers.	• Area superintendent • Project manager • Contractor

ASPECT	MANAGEMENT AND MITIGATION MEASURES/COMMITMENTS	RESPONSIBLE PERSON
	• Firefighting training to be provided to employees. • Maintain fire breaks.	
Air Quality	• Dust generation from all activities must be minimised. • Excavation, handling and transportation of erodible materials shall be avoided under high wind conditions or when a visible dust plume is present. • Speed limit to be enforced to control dust emissions. • Dust suppression measures shall be implemented when necessary. • Vehicle, machinery and equipment shall be maintained in good working order in order to minimise exhaust fume emissions. • Vehicle, machinery and equipment must be serviced by competent personnel and records must be filed.	• Area superintendent • Project manager • Contractor
Resources Efficiency	• Minimise water wastage and record water usage. • Avoid wasteful use of materials. • Source goods and services locally were possible	• Area superintendent • Project manager • Contractor

ASPECT	MANAGEMENT AND MITIGATION MEASURES/COMMITMENTS	RESPONSIBLE PERSON
Waste Management	• Minimise the generation of waste by applying the waste hierarchy. • Line servitude to be kept free of waste. • No burning, burying or dumping of any waste materials shall be permitted onsite. • Labelled waste bins with lids must be provided at campsites (in case of a project) for all waste streams and ensure that waste is disposed at nearest approved waste disposal site. • Ensure that waste segregation is done at source. • Hazardous waste shall be disposed of at a registered hazardous waste disposal site. • Safe disposal certificates for hazardous waste must be kept in the SHE file. • Concrete waste must not be dumped on site.	• Area superintendent • Project manager • Contractor
Wastewater management	• Water containing environmental pollutants shall be collected and removed from site. • No waste water runoff or uncontrolled discharges from the site/working areas shall be permitted.	• Project manager • Contractor • Area superintendent

ASPECT	MANAGEMENT AND MITIGATION MEASURES/COMMITMENTS	RESPONSIBLE PERSON
	• Mobile toilets or septic tanks should be used in remote areas.	
Hazardous Substances	• The use, handling, storage and disposal of the hazardous chemical must be in accordance with the MSDS. • Containers must be clearly marked to indicate contents and quantities. • Hazardous substances storage areas must be bunded. A bund should be able to contain 110% of the volume of the largest container stored within it. • Diesel and other liquid fuel, oil and hydraulic fluid must be stored in appropriate storage tanks or in bowsers with secondary containment. • Inspect and maintain hazardous storage areas and bund walls to avoid overflows. • Ensure that drip trays are available, to be use in case of leaking equipment. • Spill kit and absorbents must be available to clean – up a spill. • Hazardous substance storage areas must display safety symbolic signs. • All spills must be reported, cleaned and remediated to in compliance with SHEW requirements.	• Area superintendent • Project manager • Contractor

ASPECT	MANAGEMENT AND MITIGATION MEASURES/COMMITMENTS	RESPONSIBLE PERSON
Social Impact	• NamPower/ Contractor must sign land permission form and agreement with land owners 14 days prior to commencement of work onsite. • Maintain good communications and relations with farm owners and local communities. • In communal areas, work through the local and traditional authority structures. • All site employees shall be instructed to ensure that fences / gates are closed and not left unattended while open. • Employees should be properly educated about the impact of HIV / AIDS and pregnancies. • The use of intoxicating liquor or drugs of any kind by the employees is strictly prohibited. • Ensure that all queries and complaints are documented, investigated and dealt with. • A register shall be kept of all complaints from stakeholders, this should also the actions taken to rectify the complaints.	• Area Superintendent • Project Manager • All NamPower employees • Contractor
Archaeology	• Should a heritage site or archaeological site be uncovered or discovered during the operation phase, a “change find” procedure in appendix 8 should be applied.	• Area superintendent • Project Manager

ASPECT	MANAGEMENT AND MITIGATION MEASURES/COMMITMENTS	RESPONSIBLE PERSON
	• Any chance finds must be reported to NamPower environmental section. • In an event of discovery of human remains or other artefacts the work shall cease. A professional archaeologist is to be consulted and carry out investigation.	• SHEW • Contractor
Fauna and Flora	• Ensure that the site is kept clean and free of rubbish that could potentially attract animals and pests • No harvesting of plants is allowed. • Poaching or capturing of any animal (wild or domestic) is prohibited. • Bird nests may not be disturbed unless interfering with the normal operation of the line/station. • No domestic animals may be kept onsite as they can introduce diseases or interbreed with the animals occurring naturally in the area. • Vehicles driving along the lines should engage four wheel drive to prevent spinning and consequent impacts on soil surface. • Do not destroy, damage, collect any protected flora species that may be encountered unless interfering with the normal operation of the line/station.	• Area superintendent • Project Manager • Contractor

ASPECT	MANAGEMENT AND MITIGATION MEASURES/COMMITMENTS	RESPONSIBLE PERSON
	• Minimize disturbances to the sensitive areas. • Only remove/prune trees/bushes directly affecting the transmission line; • Identify potential bird collision prone areas (i.e. habitats). • Bird flight diverters (BFD's) must be installed in collision prone areas. • Monitor all bird mortalities encountered under the transmission line. • All wildlife and electrical infrastructure interactions such as (animal/bird deaths) must be reported to the SHEW section.	
Water Resources	• Care must be taken to ensure that pollution of water does not occur. • Naturally occurring water resources may not be used for any personal hygiene. • Water may only be taken from a private or government property based on an agreement between the NamPower, contractor and custodian of the water source.	• Area superintendent • Project Manager • Contractor
Erosion	• Implement and maintain erosion control measures within the line servitude where required. • Rehabilitate eroded areas.	• Area superintendent • Project Manager

ASPECT	MANAGEMENT AND MITIGATION MEASURES/COMMITMENTS	RESPONSIBLE PERSON
		• Contractor
Campsite Establishment	• Adequate ablution facilities must be provided onsite in relation to the number of employees in compliance with the applicable legislations. • Septic tanks/ or similar polluted water containment methods must be used in remote areas. • Ablution facilities must not be located within 100m of any river, stream channel, pan, dam or borehole • Fire extinguishers, first aid kits, assembly point, emergency numbers and other facilities as required by the legislation must be available onsite. • Waste must be managed in accordance with waste management requirements outlined in this EMP.	• Area superintendent • Project Manager • Contractor
Manual and Mechanical Vegetation Removal	• Obtain a permit from the Ministry of Environment, Forestry and Tourism to remove protected trees as per the Forest Act No. 12 of 2001. • Measures must be put in place to avoid erosion especially at rivers, stream channel crossings, and at places where existing erosion scars and dongas are encountered to avoid any further erosion. • Avoid mechanical bush clearing in sensitive areas. • Measures must be put in place to preserve the topsoil structure	• Area superintendent • Project Manager • SHEW • Contractor

ASPECT	MANAGEMENT AND MITIGATION MEASURES/COMMITMENTS	RESPONSIBLE PERSON
	• The disturbed soil must be levelled. • Do not remove wood cut on site as this would affect the recycling of nutrients locally as well as lead to a potential industry in firewood targeting the better quality tree species. • Where clearing is done near a river, the contractor/NamPower must ensure that no felled bushes/branches/shrubs are left behind in the riverbed. • No burning of bush cleared materials is allowed onsite. • Manual and mechanical vegetation removal should be done in accordance with NamPower Procedures. • Avoid the cutting down of protected tree species [Forestry Ordinance No. 37 of 1952) not directly affecting the power lines during the line clearing operation.	
Herbicide Use	• Prevent the application of selected herbicide(s) in sensitive areas – e.g. “high” & “medium” sensitivity areas (See section 2.1). Sensitive areas are known/expected to have higher biodiversity or may have high social value. • Avoid the spraying of protected tree [Forestry Ordinance No. 37 of 1952) not directly affecting the power lines during the line clearing operation. • Eradicate all invasive alien species potentially associated with the line. This	• Area superintendent • Project Manager • SHEW • Contractor

ASPECT	MANAGEMENT AND MITIGATION MEASURES/COMMITMENTS	RESPONSIBLE PERSON
	would indicate overall environmental commitment. • Avoid spraying herbicide during windy days/periods. See the general product requirements for herbicide used. This could affect non-target areas and species. • Only recommended herbicides should be used. • Ensure that the Herbicide application is done in accordance with manufacturer's instructions. • Implement strict control over the storage, protective measures & application of the selected herbicide(s) throughout. • Always consult and adhere to the MSDS requirements for the herbicide • Herbicide must be handled in accordance with the requirements outlined in NamPower Procedures.	
Site Rehabilitation (progressive and post rehabilitation)	• Progressive rehabilitation when project work is in progress. Post project rehabilitation must also be done. All materials, equipment and waste must be removed from site. • An audit prior to the contractor/project team leaving site must be conducted. Non – conformance to be rectified before the contractor/project team leave the site.	• Area superintendent • Project Manager • SHEW • Contractor

8 REPORTING, MONONITORING AND AUDITING

The environmental monitoring, inspections and audits must be conducted in line with supporting procedures, laws and requirements of this plan. Monitoring and inspection\audit reports detailing the monitoring and audit results shall be prepared by the SHEW section and communicated to the Area Manager or Superintendent or Project Manager. Records of monitoring and inspection\auditing report shall be kept.

The following general monitoring indicators and guideline are recommended should herbicides be used to do vegetation management along the line:

Table 5: General monitoring indicators and guideline recommended after herbicide application

Monitor trees adjacent the cleared area after herbicide application	A survey in year 1 (i.e. 6 months after application of herbicide) should be conducted along the affected route to determine the effect of the herbicide on non-target areas i.e. adjacent vegetation. Focus on protected tree species along the route
Monitor coppicing and regrowth after herbicide application	A survey in year 2 (i.e. 1 year after application of herbicide) should be conducted along the affected route to determine the effect of the herbicide on bush clearing. This would indicate the success of the herbicide used as well as indicate the necessity of follow-up treatment.
Sample any open surface water after herbicide application	Very few open water sources are located along the route and although it is recommended that herbicides not be used in “high” and “medium” sensitivity areas, monitoring this would be viewed as a good practice. Take water samples from any surface water encountered and have these analysed to determine if herbicide used has entered these sources.

9 NON-COMPLIANCE AND CONFLICT MANAGEMENT PROCEDURES

The Area Superintendent and Contractor shall ensure that the employees and external service providers comply with the requirements outlined in this EMP. In the event of non-compliance the following recommended process shall be followed:

- Non – compliances will be identified during inspections or audits and reported to the Area manager, Superintendent or Project Manager for corrective actions.
- Area Superintendent / Project Manager shall notify the responsible stakeholders about the non-compliance.
- Corrective and preventative actions must be implemented on an agreed timeframes.
- Follow – up inspections/audits shall be conducted to assess whether the corrective and preventative actions were implemented effectively.

The contractor shall notify NamPower of the following:

- Conflicts arising with any landowner / representative.
- Any special conditions requested by a landowner / representative.

NamPower has the right to stop all contractor's activities if it is found that a gross violation of the EMP is taking place.

10 RECORD KEEPING

Record keeping is important for the effective functioning and implementation of an EMP. EMP documentation must be kept in both the hard copy and electronic format for safe keeping. These must include but not limited to:

- Copy of the Environmental Clearance Certificate
- A copy of an EMP
- EMP implementation activities
- Induction records
- Audit and Inspection reports
- Other related documents

In case chemical vegetation management is conducted, the following records should be kept:

- Date of application
- Herbicide applied
- Persons responsible for application
- Supervisor
- Type of herbicide used
- Method of application
- Time of application
- Equipment used
- Concentration of herbicide used

11 CONCLUSION

All management measures and legal requirements outlined in this EMP should be implemented in order to ensure environmental compliance by all parties undertaking the operational and maintenance activities. This will ensure that potential negative impacts are identified, avoided or mitigated and positive impacts are enhanced. The implementation management measures and legal requirements outlined in this EMP will reduce the likelihood of any fatal flaws as a result of the operational and maintenance activities and it is therefore recommended that the ECC is issued.

12 REFERENCES

1. Cunningham, P. (2019). Vegetation assessments within NamPower transmission line servitudes [Rapid Vegetation Assessment] Gerus – Zambezi (Katima Mulilo to Otjiwarongo area).
2. ECO Plan (2006) . Environmental Impact Assessment Addendum for The proposed Otjikoto – Katima Mulilo Transmission Line Addendum.
3. ECO Plan (2006). Environmental Impact Assessment Of the Proposed Gerus – Mururani Gate 350 kV Transmission Line, Volume 2 Environmental Assessment Report Final Report.

Annexure 2: Herbicide application guideline

Management requirement
Recommended herbicide for the control of woody plants: Access 240 SL or any similar product with picloram or tricoplyr as active ingredients should be used
Recommended Application method: Foliar application – spray or paint-on-stump –is recommended as this is target specific. Access mixed with water and Actipron (wetting agent).
Technique: The herbicide can be applied directly to the plant – stem or leaves – as a spray. Trees and shrubs with a stem diameter <10cm can be sprayed directly, but trees with a stem diameter >10cm should be felled before treatment of the cut surface for best results. Treatment should be done as soon as possible after felling and the entire cut surface and stump should be wetted. Coppice growth can also effectively be controlled.
Use: Active growing season – i.e. September to April (best in early growing season – September to November – before main rains) has best results.
Concentration Foliar application = 350ml/100l water + Actipron Super 500ml/100l spray mix. Cut stump application = 2l/100l water + Actipron Super 2l/100l spray mix.
Application repeatability ▪ Year 1: Apply herbicide (early growing season) ▪ Year 2: Follow-up to target any regrowth and coppicing (early growing season) ▪ Thereafter: As required – i.e. dependent on coppicing potential of various species. This could be determined during routine line inspections.

Annexure 3: Monitoring checklist for bush clearing and herbicide application

Activity: Bush clearing **Site:**	**Compliance**	
	Yes	No
Manual clearing conducted		
Mechanical clearing conducted		
Area adequately cleared – i.e. 12m from centre line		
Protected tree species on 12m boundary only trimmed		
Protected tree species not affecting line left *in situ*		
Raptor and vulture nesting sites left undisturbed		
Overall access improved		
Activity: Chemical application		
Active ingredient used = Triclopyr		
Application method used = spray		
Application technique used = spray leaves/cut stumps		
Application season = Sep to April (Sep to Nov = best)		
Application conditions = no wind		
Application procedures = protective masks/equipment used		
Application knowledge = certified users only		
Storage = safe/secure		
Storage = chemical register maintained		
Storage = equipment clean/functional		
Concentration: Foliar application = 350ml/100l water + Actipron Super 500ml/100l spray mix		
Concentration: Cut stump application = 2l/100l water + Actipron Super 2l/100l spray mix		
Repeatability: Year 1		
Repeatability: Year 2		

Repeatability: Year 3		
Sensitive “hotspot” areas avoided		
Water – open surface water encountered		
Water – open surface water samples taken		
Collateral damage observed (i.e. non target areas/species affected)		
Any complaints from landowners		

Annexure 4: Protection of Ecology & Vegetation

Activity: Protection of Ecology & Vegetation	**Compliance**	
	Yes	**No**
Track discipline		
Evidence of new tracks		
Evidence of off-road driving		
Evidence of oil spills		
Evidence of waste		
Evidence of litter		
Illegal collection/damage of flora		
Evidence of illegal plant collection		
Evidence of vehicle damage to plants		
Erosion		
Evidence of erosion along route		
Evidence of recovery at rehabilitated sites		
Invasive alien plants		
Evidence of invasive alien plants along route		
Bird mortalities		
Record all dead birds encountered below the line		

Annexure 5: Landowner permission form

Landowner Permission Form

Landowner name:	Contact number:
Representative name:	
Farm name:	
Contractor:	
Representative name:	Contact number:

General Notice

This form is to be used prior to a contractor entering a landowner's property to commence any work related to the construction or maintenance of power-line structures and servitudes.

The form must be completed by either the landowner or his / her legal representative onthe property.

Section A: Before activities commence

Activities to be undertaken on the property (completed by the contractor):

Use of water resources		Camping Bush	
Powerline erection Powerline		clearing	
refurbishment Trimming of		Herbicide application	
vegetation Use of other		Access road usage	
infrastructure(please specify)		Rehabilitation	

Specific conditions to be met on the property (as stipulated by the landowner):

Dates when access is needed:

From: **To:**

Signatures (prior to entry)

Landowner/Representative

Contractor representative

Date

Date

Section B: Upon completion of work and prior to leaving the property

Remarks on compliance or misconduct (upon completion of activities):

Issues still to be resolved upon completion of activities:

Signatures (upon completion)

Landowner/Representative	Contractor representative
Date	Date

Annexure 6: pre-application consent form for herbicide/pesticide application

PRE-APPLICATION CONSENT FORM	
Name of Landowner / Representative:	
Contact Details:	
Name of Farm:	
Name of Contractor:	
Name and Details of Contact Person:	
Herbicide/pesticide to be used:	
Period of Application:	
NamPower District Supervisor:	
Contact Details:	
NamPower Installation to be Treated:	
Comments from Landowner/Representative:	
Signed:	
Landowner/ Representative:	NamPower Representative:
Date:	Date:

Annexure 7: Post application review form for herbicide/pesticide applications

POST-APPLICATION REVIEW FORM	
Name of Landowner / Representative:	
Contact Details:	
Name of Farm:	
Name of Contractor:	
Name and Details of Contact Person:	
Herbicide/pesticide to be used:	
Period of Application:	
NamPower District Supervisor:	
Contact Details:	
NamPower Installation to be Treated:	
Outstanding Issues:	
Signed:	
Landowner/ Representative:	NamPower Representative:
Date:	Date:

Annexure 8: Chance find procedure

Definition: The “chance finds” procedure covers the actions to be taken from the discovery of a heritage site or item, to its investigation and assessment by a trained archaeologist or other appropriately qualified person.

Compliance: The “chance finds” procedure is intended to ensure compliance with relevant provisions of the National Heritage Act (27 of 2004), especially Section 55 (4): “a person who discovers any archaeological object must as soon as practicable report the discovery to the Council”. The procedure of reporting set out below must be observed so that heritage remains reported to the NHC are correctly identified in the field.

Procedure:

Action by person identifying archaeological or heritage material

a) If operating machinery or equipment stop work

b) Identify the site with flag tape

c) Determine GPS position if possible

d) Report findings to foreman

Action by foreman

a) Report findings, site location and actions taken to superintendent

b) Cease any works in immediate vicinity

Action by superintendent

a) Visit site and determine whether work can proceed without damage to findings

b) Determine and mark exclusion boundary

c) Site location and details to be added to project GIS for field confirmation by archaeologist

Action by archaeologist

a) Inspect site and confirm addition to project GIS

b) Advise NHC and request written permission to remove findings from work area

c) Recovery, packaging and labelling of findings for transfer to National Museum

In the event of discovering human remains

a) Actions as above

b) Field inspection by archaeologist to confirm that remains are human

c) Advise and liaise with NHC and Police

d) Recovery of remains and removal to National Museum or National Forensic Laboratory, as directed

N144

October 2006

ENVIRONMENTAL IMPACT ASSESSMENT ADDENDUM FOR THE PROPOSED OTJIKOTO – KATIMA MULILO TRANSMISSION LINE

EA ADDENDUM

CONTENTS

LIST OF FIGURES

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APPENDICES

1 LIST OF ABBREVIATIONS

EA	Environmental Assessment (also known as an Environmental Impact Assessment)
EMP	Environmental Management Plan
HVAC	High Voltage Alternating Current
HVDC	High Voltage Direct Current
I&APs	Interested & Affected Parties (stakeholders)
kV	Kilovolts (1 kilovolt = 1000 volts)
MET	Ministry of Environment and Tourism
PPP	Public Participation Process (a component of the EA study)
SADC	Southern African Development Community

2 BACKGROUND AND INTRODUCTION

NamPower proposes to construct a new transmission power line, which will run from Otjikoto (west of Tsumeb) to Mururani Gate to Rundu to Katima Mulilo. The power line will form part of a larger transmission route which will run from Auas Sub-Station (near Windhoek) via Gerus Sub-Station (north of Otjiwarongo) to Mururani Gate to Rundu to Katima Mulilo. The EA for the overall transmission line has been conducted in three phases and within each phase a separate Environmental Assessment (EA) is being/has been conducted. The EA's have been conducted as follows:

- Phase 1: Auas – Otjikoto – Lifa 400kV Transmission Line
- Phase 2: Gerus - Mururani Gate 400kV Transmission Line
- Phase 3: Otjikoto - Katima Mulilo 400kV Transmission Line.

Refer to Figure 1 for a map illustrating the three proposed power line routes assessed in the EA processes.

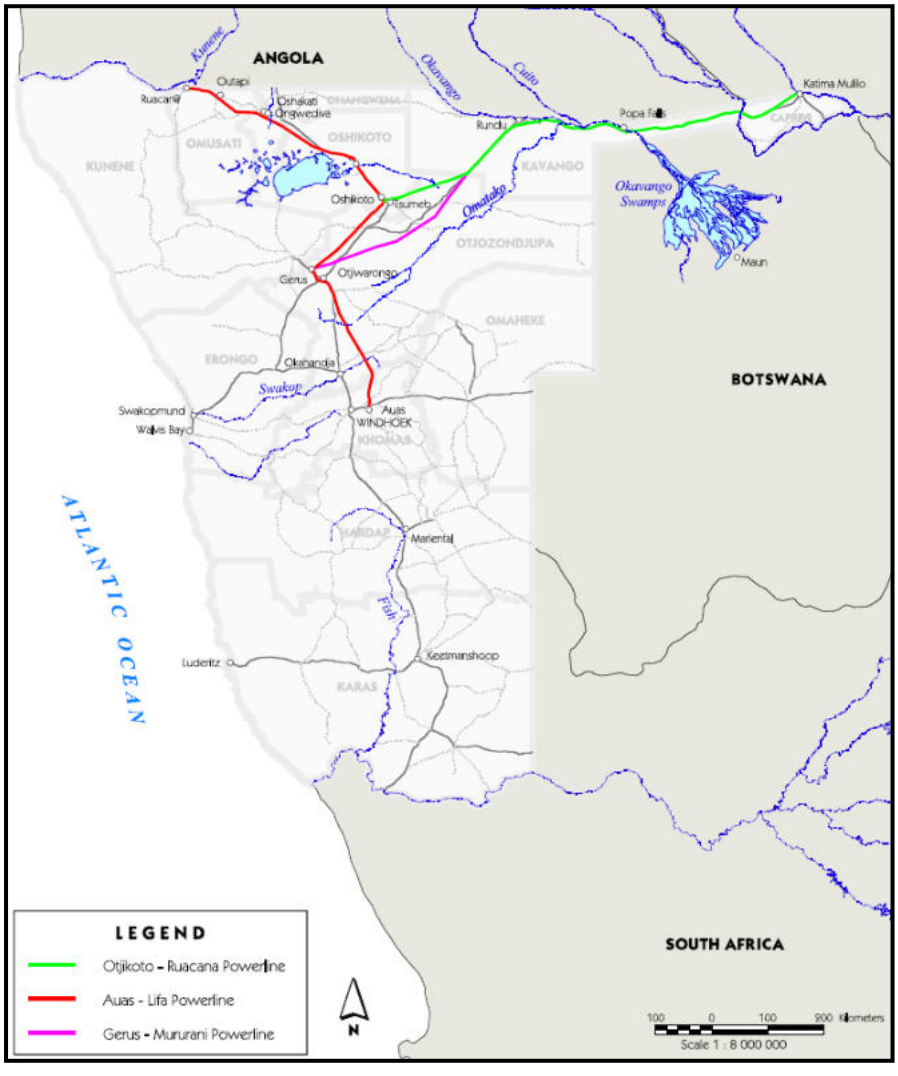

Figure 1: Power Line Route from Auas to Katima Mulilo

The transmission power line is to be constructed in 2007, but will not however use the full routes assessed in the EA's as listed above. Sections of each route assessed in the EA's will be constructed forming the power line route running from Auas Sub-Station (near Windhoek) via Gerus Sub-Station (north of Otjiwarongo) via Rundu and ending at Katima Mulilo. The remainder of the routes assessed will be constructed at a later date in accordance with demand and supply considerations.

The final transmission power line will be modified to transmit 350kV of High Voltage Direct Current (HVDC) electricity, which is very similar to the originally proposed High Voltage Alternating Current (HVAC) power line as part of the three above-mentioned EA's. HVDC will entail a slight modification, to that of a HVAC, at the start and end of the power lines due to the requirement for *earth electrode sites*, *repeater stations* and *converter stations* at the sub-stations.

The proposed overall transmission power line is planned as part of a greater plan to meet the need for growth in power demand and supply in Namibia and the greater SADC Region.

3 OTJIKOTO - KATIMA MULILO ENVIRONMENTAL ASSESSMENT ADDENDUM

The EA undertaken for the Otjikoto – Katima Mulilo section of the power line has been completed and exists as the following documents:

- Volume 1: Route Evaluation and Scoping Report (October 2005);
- Volume 2: Environmental Assessment (June 2006); and
- Volume 3: Environmental Management Plan (June 2006).

The proposed route begins at the Otjikoto sub station, near Tsumeb, and continues north eastwards along an existing power line route to Mururani Gate. From there it continues along the national road (B8) through communal farming and woodland areas ending south of Rundu. From Rundu the power line will turn eastwards and follow the national road (B8) to Divundu, where it will make its first river crossing over the Okavango River and then proceed through the Caprivi Game Park. It will then make its second river crossing over the Kwando River. The power line will follow the road north eastwards through the State Forest to a planned sub station at Katima Mulilo. The proposed power line route is illustrated in Figure 2.

The proposed power line route runs through various land use zones. These land use zones include privately owned farms and communal land between Otjikoto and Rundu. The remainder of the route runs through communal land and the Caprivi Game Park. River crossings are made at two (2) points along the proposed power line route, i.e. the Okavango River and the Kwando River.

During the EA process route evaluation, a detailed environmental impact assessment of the proposed route was undertaken. Both positive and negative impacts of the proposed route were identified and assessed. As part of the route evaluation and environmental impact assessment the original power line route proposed by NamPower was adjusted in response to environmental issues, however despite these adjustments **significant negative environmental impacts** were identified in Volume 2: Environmental Assessment. The most significant of these negative impacts occur at the river crossings, where various bird species are severely affected, and consequently, the overhead power line crossing of the rivers was determined to be a fatally flawed option for the power line. Underground power line cables were recommended as an alternative and mitigation measure for the river crossings.

Underground river crossings were therefore further evaluated by NamPower and found to be non-feasible from a technical and economic perspective. For this reason an EA Addendum has been conducted by Eco.plan (this document) in order to identify and assess alternatives and possible mitigation measures for the power line river crossings.

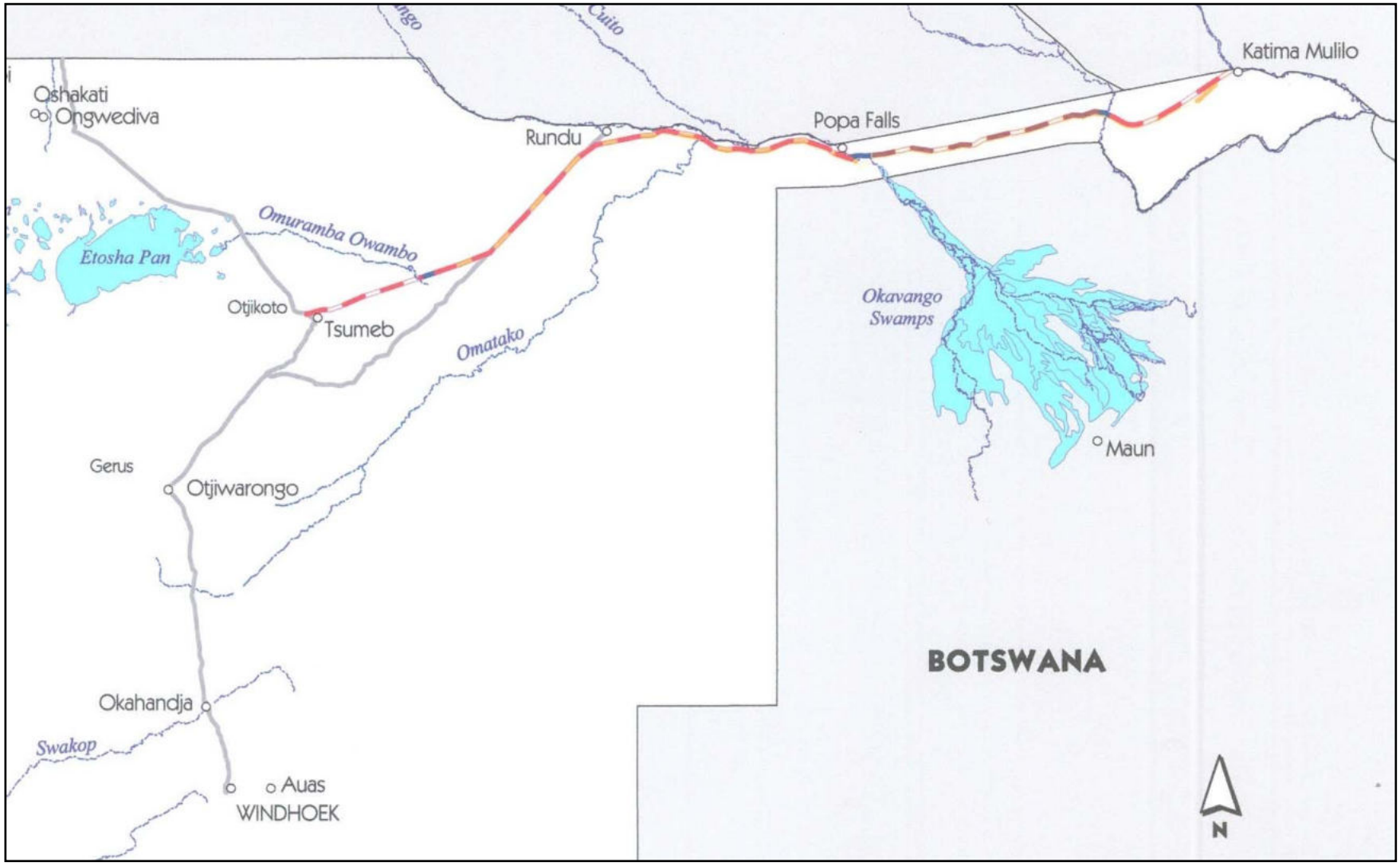

Figure 2: Otjikoto – Katima Mulilo Power Line Route

3.1 EA Addendum Methodology

This EA Addendum was produced to determine power line alternatives and mitigation measures primarily for the river crossings. The EA Addendum focuses specifically on the fatal flaws identified in EA report and river crossings.

The following was undertaken as part of the EA Addendum:

- Alternatives to the HVAC overhead power line river crossing;
- Identification and description of feasible HVAC power line options / alternatives;
- Public Participation Process undertaken to inform Interested and Affected Parties (I&AP's);
- Identification of the affected environment;
- Environmental Impact Assessment of the preferred option; and
- Environmental Management Plan for the preferred option.

The power line structures were assessed for the river crossings; these alternatives include cabling to cross under the river rather than above the river or HVDC lines to cross above the river, which have fewer strands than the AC lines.
Further mitigation measures were assessed such as visual deterrents i.e. flags or reflectors for the birds to be placed on the overhead lines. The alternatives and possible mitigation measures where assessed by means of specialist consultations and site visits and are described in Section 4 and Section 7.

The final and preferred option for the river crossings is described in Section 5. This section includes a description of the supporting infrastructure required for the preferred option.

I&AP's were consulted as part of the identification of new alternatives and options and this Public Participation Process is detailed in Section 6.

The affected environments associated with the revised and preferred river crossing option are described in Section 7, and a detailed environmental impact assessment included in Section 8. This is supported by an Environmental Management Plan in Section 9.

The EA Addendum is to be read in conjunction with the Route Evaluation and Scoping Report, Environmental Impact Assessment Report and Environmental Management Plan (original Otjikoto – Katima Mulilo EA). It is important to note that the EA Addendum only includes information that is new, revised and different from the Route Evaluation and Scoping Report, Environmental Impact Assessment Report and Environmental Management Plan.

4 ALTERNATIVES TO HVAC OVERHEAD POWER LINE RIVER CROSSINGS

The overhead power line river crossings of the Okavango and Kwando Rivers, as described in the original Otjikoto – Katima Mulilo EA Report, was determined to be fatally flawed in the environmental impact assessment. For this reason, NamPower investigated alternative river crossings, as the construction of this power line is critical for national benefit and continued power supply to Namibia.

The following alternatives / options were considered:

- Underground power line cables for the river crossings;
- Overhead HVDC power line cables for the river crossings;
- Re-evaluation of the river crossing positions; and
- Modification of the HVDC power lines for the river crossings.

4.1 Underground Power Line Cables

Underground cables were assessed, by NamPower and specialist consultants, PB Power on the following aspects:

1. Technical Viability; and
2. Economic Feasibility.

4.1.1 Technical Feasibility

Technical feasibility is not a limiting constraint in theory, and is practiced in some European countries; however, in practice from an African perspective, and the nature of the power line location and routing, this option is **not technically viable** for the following reasons:

- This technology is new to Africa (not just sub-saharan Africa or Namibia) and has not been implemented or tested;
- There are no local (Africa) contractors and suppliers (or expertise) for the manufacture and installation of the underground cable technology. This would need to be imported, which has significant cost and timing implications. These cost (as discussed below) and timing implications are prohibitive;
- Faults or damages on an underground cable are very difficult to identify in terms of cause and locality due to the nature of the cable and transmission in this scenario. Identification of faults would therefore be significantly delayed, which has time implications in the repair of the cable, and power supply to Namibia will be cut and significantly reduced, until faults are identified and repairs are complete. The estimated time for fault identification could be as long as one week and Namibia cannot be without power, especially not for such a long period of time;

- There are no local (Africa) contractors and suppliers (or expertise) for the maintenance and repair of such cables. Should a cable be damaged, or fault, no local resources are available for the repair. Repair would therefore require the important of specialists, which has time implications in the repair of the cable, and power supply to Namibia will be cut and significantly reduced, until repairs are complete. The estimated time for repairs is one week and Namibia cannot be without power, especially not for such a long period of time;
- Significant associated infrastructure would be required to convert the transmitted electricity into a suitable form for underground transmission before and after each river crossing. This infrastructure has significant cost and environmental implications;
- The laying of an underground cable in a river, riverine and floodplain environment will have significant environmental impacts and risks; and
- Access to the cable will be difficult due to the nature of the substrate in which it will be buried, i.e. river, riverine and floodplain environments.

This option is simply not viable or suitable and cannot be implemented from a technical perspective.

4.1.2 Economic Feasibility

PB Power, in association with NamPower undertook a cost estimate to determine the cost implications of river (only) crossings using underground cables (approximately 3,5km in total) in comparison with the overall power line route.

The proposed cost for the construction of the entire HVDC power line route from Gerus to Katima Mulilo (950km) is approximately [N$ 850 million].
The cost of the implementation of underground cables at the river crossings is approximately [N$ 116 million] for the two river crossings.

This cost estimate has therefore been determined to be prohibitive. This cost would make the project impossible to payback, as it would be funded by donors, and as a loan that would need to be repaid by the Namibian government and tax payers (along with the cost of the actually electricity purchased). This cost makes the project no longer viable and therefore not an option for the supply of electricity to Namibia.

4.2 Overhead HVDC Power Pine Cables for the River Crossings

A **HVDC power line transmission option** would result in the transmission of electricity in a different phase (or form), i.e. HVDC would transport electricity as a **direct current** within the conductors, whereas HVAC would transport electricity as an **alternating current** within the conductors. This distinction has one significant differentiation from a physical or environmental perspective, which is the reduced amount of conductors, the spacing between the conductors and therefore the reduced electrocution risk. The other differences between HVAC and HVDC are purely technical. The resultant

output of HVDC is, however, more efficient as there are **less electricity losses**, over long distances, if the HVDC transmission option is utilised. Furthermore, HVDC is more **cost effective** in terms of construction and maintenance costs, over long distances. The HVDC option is preferred for the transmission of electricity for the overall Auas to Katima Mulilo power line including, Gerus to Katima Mulilo due to less electricity loss and cost effectiveness of construction and operation. This option does not, however, significantly mitigate the risk to birds and therefore needs to be utilised in conjunction with another option(s).

4.3 Re-Evaluation of the River Crossing Positions

The originally proposed power line routes crossed the Okavango and Kwando Rivers at existing sites of infrastructure – i.e. bridges across these river systems.
In an attempt to address the risk to birds, other locations for the river crossings were determined. **No suitable alternative sites were found**, primarily for the following reasons:

- The narrowest portions of the river systems (both Okavango and Kwando Rivers) were at the existing sites of infrastructure and other alternative sites were wider thus representing more risk to birds;
- Some of the straightest sections of the river (particularly the Okavango River) occurred at the existing infrastructure sites. This ensures that one river crossing of a power line or bridge or other infrastructure at the straightest section does not disturb additional areas due to loops, bends and meanders in the river;
- Other possible alternatives were not technically viable to access due to deviations from existing infrastructure, roads etc;
- Deviations from the B8 national road and associated river crossings would result in additional biophysical environmental impacts; and
- A new river crossing location would not significantly reduce the risks to birds, it would merely re-locate the risks.

4.4 Modification of the HVDC Power Lines

Modification of the HVDC power line is the only supporting option for the river crossings should underground cables not be utilised. This modification would be a technical and possibly structural solution and would need to eliminate the single most significant risk to birds – the earthwire. Fortunately, innovative technology is available for small tower spans or distances, and would be suitable for areas such as the Okavango and Kwando River Crossings. The technical and economic constraints associated with this option are not prohibitive and therefore the option is viable. This option entails **relocating the earthwire** and is described in detail in Section 5.

4.5 Preferred Option / Alternative

The preferred option is therefore a combination of options, i.e. Option 4.2 HVDC power lines and Option 4.4 Modification of HVDC power lines.

NamPower therefore propose to construct a **HVDC overhead power line** from **Mururani Gate to Katima Mulilo**. The HVDC power line will tie into a planned power line from Gerus (near Otjiwarongo) to Mururani Gate as part of the overall Auas – Katima Mulilo power line.

The proposed HVDC power line will be required to transmit electricity at a voltage of 350 kv and will therefore be designed accordingly. The **river crossings will be structured differently** to the remainder of the power line to **mitigate the effects on birds** at the Okavango and Kwando Rivers.

This HVDC power line is described in more detail in Section 5.

5 PROPOSED HVDC POWER LINE

The preferred option is a HVDC overhead power line from Mururani Gate to Katima Mulilo, which will tie into a planned power line from Gerus (near Otjiwarongo) to Mururani Gate as part of the overall Auas – Katima Mulilo power line. The HVDC power lines will be modified at the Okavango River and Kwando River crossings.

5.1 HVDC Power Line: Conductors and Towers

The HVDC power line will look very similar to that of a HVAC power line as described in the original Otjikoto- Katima Mulilo EA Report. The construction and operation of the HVDC power line will be exactly the same as that of a HVAC power line and is therefore not re-assessed in this EA Addendum. The proposed towers for a 350kV HVDC power line will be approximately 40m high. The preferred construction design is the cross rope suspension tower, which is shown in Figure 3. This design minimises the amount of steel used and is therefore most cost-effective. Self-supporting suspension towers and straining towers are used in conjunction with cross rope suspension towers, especially in areas where the foundation or ground surface is unstable, and at bend points. Self-supporting structures have four legs as shown in Figure 4. Straining towers are required at all bend points. A straining tower also has four legs and looks very similar to the self-supporting suspension tower. The HVDC power line will have an insulator structure for the conductors on the self-supporting and straining towers which will differentiate it from an HVAC power line. A straining tower is shown in Figure 5.

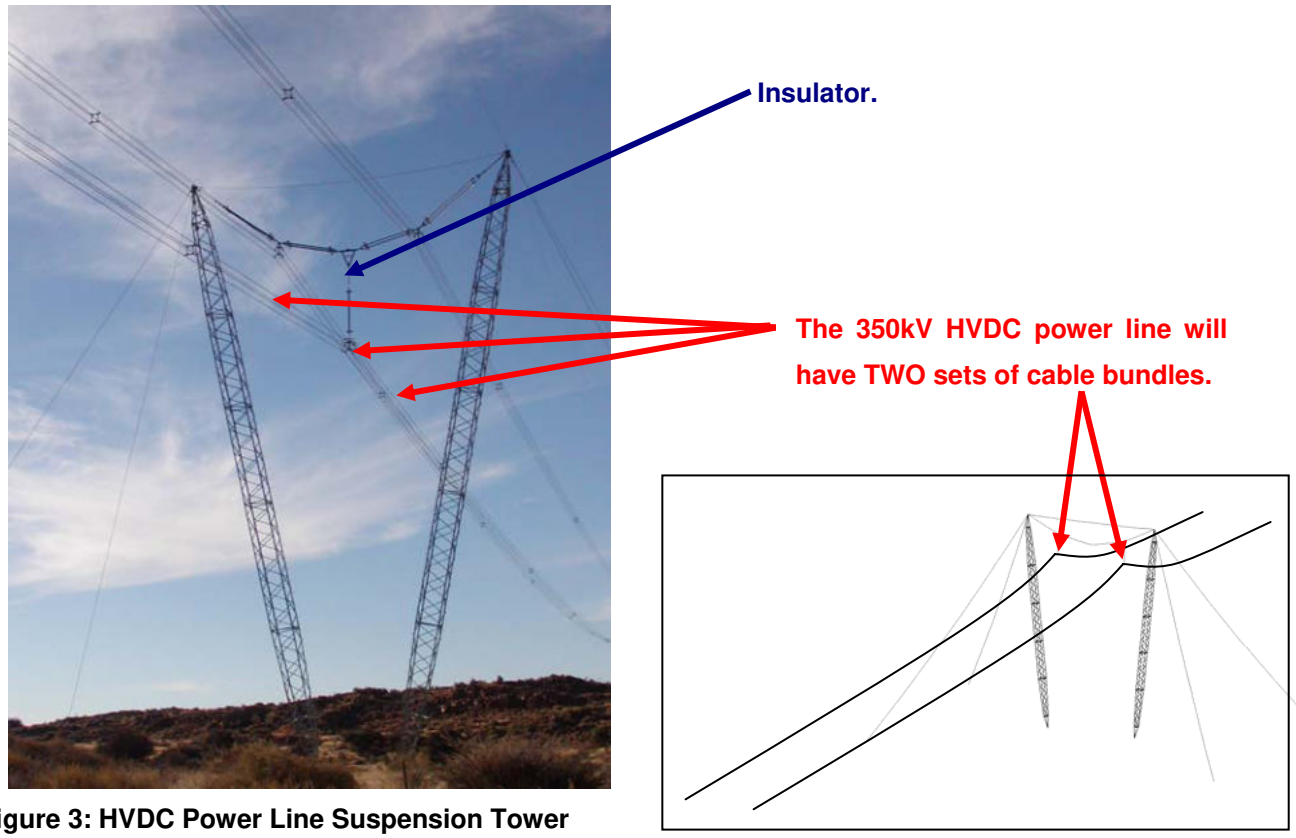

Figure 3: HVDC Power Line Suspension Tower

Figure 4: Self Supporting Tower

Figure 5: Straining Tower

5.2 HVDC Power Line: Earth Electrode Sites

As part of any HVDC power line or transmission system, an earth electrode site needs to be established for the electricity '*return*' and for *earthing* purposes. An earth electrode site is required at the start and at the end of a transmission line. In this case, the start is at Gerus and therefore beyond this scope of work. The end is at Katima Mulilo and such a site will need to be constructed. The earth electrode site will be along the power line route approximately 25km from the end. The Katima Mulilo site will be situated in the State Forest near the Katima Mulilo sub station.

The earth electrode site consists of an open area in which earth electrodes (approximately 5-20m in length and 10cm in diameter) are buried vertically below the earth surface. The earth electrodes are connected to the transmission line through over head cables, and the earth electrode area will be fenced off. Infrastructure and other structures cannot be constructed within the fenced of area, which is approximately 1km x 1km.

A typical earth electrode is shown in Figure 6 below.

5.3 HVDC Power Line: Repeater Stations

Repeater stations will be required for the HVDC transmission line. Repeater stations are required at various intervals along the transmission line to restore and amplify 'attenuated' and time smeared signals in a typical signal carrying installation.

Figure 6: Earth Electrode in Fenced Off Area

5.4 HVDC Power Line: Converter Stations

As part of any HVDC power line or transmission system, a Converter Station is required at the transition point between HVDC and HVAC, which will be utilised for domestic distribution or further transmission. In this case, the first transition from HVAC to HVDC is at Gerus and therefore beyond this scope of work. The next transition from HVDC back to HVAC is at Katima Mulilo and therefore a converter station will be coupled to the planned sub station at Katima Mulilo.
From an environmental and socio-economic consideration, the converter station is very similar to a typical HVAC sub station and will have no new or other environmental impacts.

A typical converter station is shown in Figure 7 below.

Figure 7: Converter Station

5.5 HVDC Modifications for the Okavango and Kwando River Crossings

The overhead power line crossing of the Okavango and Kwando Rivers has significant implications for the birds of these areas. A typical HVAC (and possibly HVDC) power line crossing would be fatally flawed in terms of the risk to the birds at the Okavango and Kwando River crossings, and this risk is typically caused by the earthwire.

Trans Africa Projects (TAP), who will design the proposed HVDC power line, in association with NamPower, have therefore re-designed the HVDC power line towers and associated conductors and earthwire to mitigate this risk. This will be implemented at the river crossings, in association with anti-collision devices as described below, to mitigate and reduce the risk to birds as much as possible.

5.5.1 Power Line Towers, Conductors and Earthwire

Research has shown that bird collisions occur mainly due to the earthwire, due to the relatively poor visibility of this wire in comparison to the large diameter phase conductor bundles at lower levels.

The proposed method for river crossings therefore involves **lowering the earthwires** to the **same level of the phase conductors** on the span crossing the river.

This will be achieved by using a stronger mast design which can absorb the point load of the earthwire lower down on the mast. The mast will utilise a landing plate at the appropriate level, and the earthwire will be routed through the earth peak, down to the level of the lower attachment plate.

This option is only suitable for short tower spans (up to 650m) and can therefore only be effectively applied at the river crossings. This arrangement is illustrated diagrammatically in Figure 8 below.

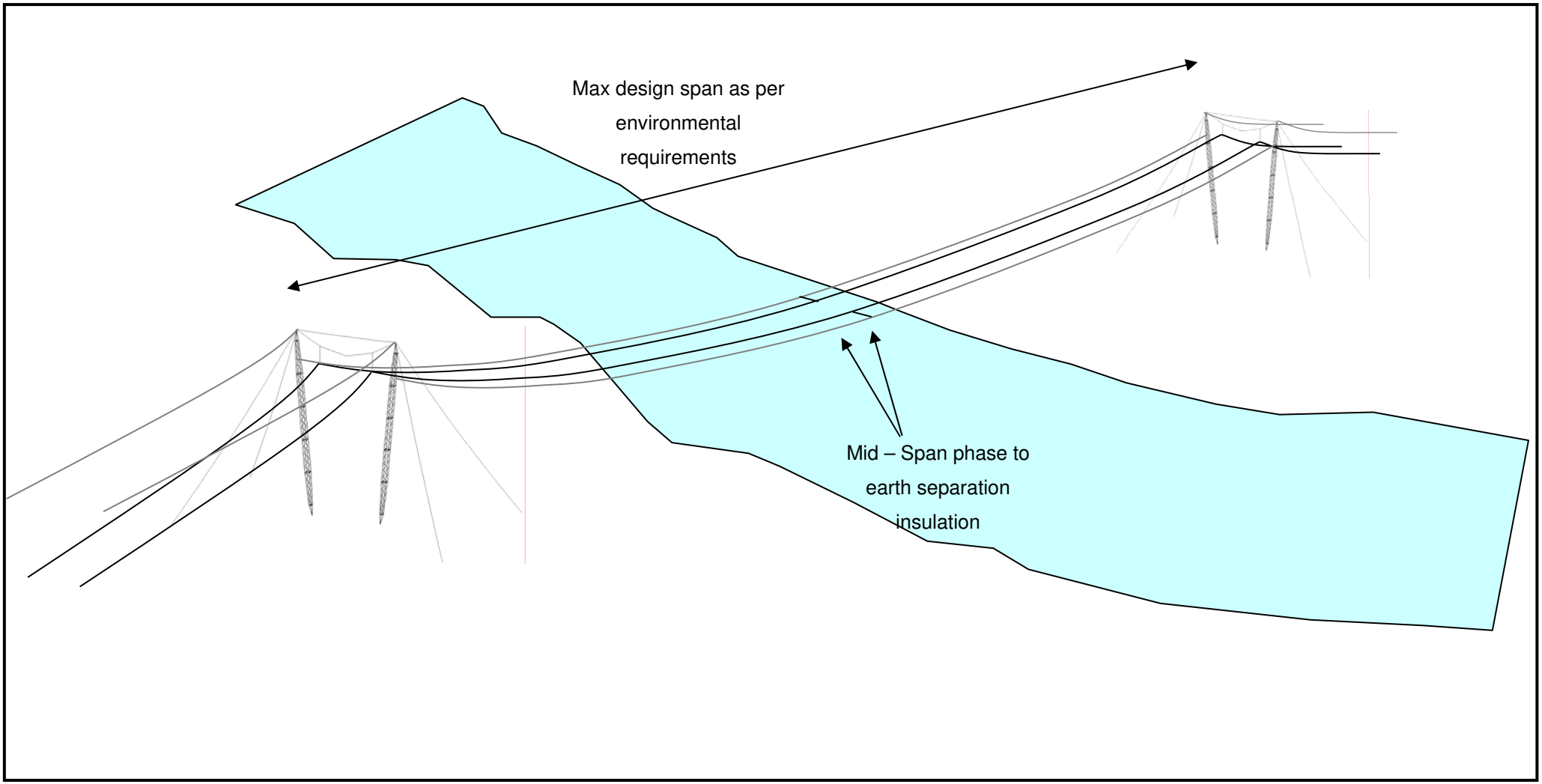

Figure 8: Modified HVDC Power Lines for the River Crossings.

5.5.2 Anti-Collision Devices

To further reduce risk of collision with the power lines the earthwire will need to be marked with anti-collision devices. This section is an outcome of the specialist investigation undertaken by Dr Chris van Rooyen (refer to Appendix A for more detailed information). This measure has been proved to be reasonably successful in reducing collisions, with success rates of up to 60% reduction in mortality and even more documented. There are several devices available in southern Africa for the marking of power lines. Some are dynamic devices (usually called bird flappers), and some are static. Both have advantages and disadvantages. Dynamic devices are very effective in reducing collisions as the birds seem to see them very well, probably because of the movement that attracts attention. The disadvantage of dynamic devices is that they are subject to extensive wear and tear, inevitably limiting the lifespan of the device. This has obvious cost implications if a line needs to be re-marked at intervals of a few years. No solution to that problem has been found to date and it must be accepted as a constraint.

Static devices are mechanically more durable because they lack the element of wear and tear that moving parts inevitably have. However, in South Africa, static devices, particularly the so called Bird Flight Diverter (also known as the pigtail) has had limited success (Anderson 2001). The most obvious reason seems to be that they are simply less visible, especially the small ones. A better option would be to use the bigger pigtail, although it is still not the preferred option if utilised in isolation to prevent bird mortality.

A new static product that shows great potential is the Inotec BFD88, a reflective stainless steel sphere of 70mm diameter. Experiments have shown the visibility of this device to be superior to coloured (red, yellow, white, black) objects especially during the low light conditions at dawn and dusk when birds may be flying from roosting areas to feeding areas and back. Due to the spherical shape, the device reflects any available light in all directions and is therefore visible from all directions including above or below the diverter. The diverter does not require direct sunlight and is effective during overcast conditions and the low light conditions before sunrise and after sunset. When viewed during these low light conditions the device is particularly visible against dark backgrounds such as the ground, trees or high ground. It is also particularly visible against bright cloud when viewed from below. An option could be to string the Inotec NFD88 diverters close enough to form a dotted line on each earthwire on those spans crossing the river. Due to the relatively small size of the spheres, it would need to be spaced very close together to make it effective, maximum 5 metres apart on both earthwires.

The phase conductors should be fitted with fluorescent tubes (bird lights) to reduce the risk of nocturnal collisions. The tubes are energized by the ambient electricity field and produce a row of lights at night. This technology has been successfully tried in Botswana and South Africa. The lights will, however, need replacement at regular intervals. Currently, only one product is available on the market, the Mace Bird Lite.

6 PUBLIC PARTICIPATION PROCESS (PPP)

6.1 Description of the Public Participation Process Activities

The PPP for the EA Addendum was conducted in order to inform the I&AP's and authorities of the developments of the EA conducted for the proposed power line. The PPP informed the I&AP's and authorities of the EA Addendum and provided an opportunity for the I&AP's to submit issues and concerns that they may have regarding the EA Addendum. The issues and concerns raised were considered when conducting the EA Addendum process.

The main activity carried out as part of the PPP was the e-mailing, faxing and posting of I&AP letters. An I&AP database was compiled during the PPP of the original EA and the same I&AP's were contacted and informed on the EA Addendum. A copy of the EA Addendum Letter is included in Appendix B.

6.2 Results of the Public Participation Process: Issues and Concerns Raised

The outcome of the PPP is presented in the Issues and Concerns table below. All issues and concerns raised by I&AP's were recorded in the table as the participants raised them. The response to the issues or concerns is found in the table.

Table 1: Issues and Concerns Raised during the PPP

Issue and Concerns	Commentator	Source	Response
The river crossings are important, however please do not down play the importance of the whole West Caprivi. Namibia's cabinet has approved two things: 1. that the West Caprivi Game Park be linked to the Mahango Park (on the Okavango in Kavango) and the Mudumu and Mamili Parks (on the Kwando in East Caprivi) and that the whole complex then be upgraded to National Parks status; and 2. that Namibia must proceed to sign the Kavango – Upper Zambezi Transfrontier conservation (KaZa) Agreement between five nations, to establish the largest contiguous protected area complex in Africa. The West Caprivi is essentially the "key" linking these five states together. The potential for wealth and job creation from this new development is immense – far exceeding agriculture, by orders of magnitude. The power line development must take into account, and ensure that there is no visual impact across this core component of the KaZa development. It should also be borne in mind that the whole West Caprivi supports dozens of inter-dune valleys running west-north-west to east-south-east, which fill with water in the rainy season and support high numbers of bustards and korhaans, and secretary birds. These species are all highly vulnerable to collision with power lines. The point that I am making is that, not only must the important bird issues be taken into account but perhaps just as important, or even more so, is the KaZa and National Park issues, future land uses and the need to vigorously protect this core area from visual impacts and loss of "sense of place". I would strongly promote an underground line across the Caprivi, and either under the rivers or attached to the sides of bridges.	Mr. Chris Brown Namibia Nature Foundation (NNF) 26/04/2006.	Response to EA Addendum Notification Letter.	This comment has been noted and incorporated in the EA Addendum

Issue and Concerns	Commentator	Source	Response
Is the power line going to run from Otjikoto Lake or you mean Oshikoto the name of the region where Tsumeb falls within? Otjikoto is a lake not an area as it appears in your letter. The name of the area is Oshikoto.	Nashipili Ndinomwaameni Ministry of Agriculture, Water and Rural Development 26/04/2006	Response to EA Addendum Notification Letter.	The proposed power line would run from the Otjikoto Sub Station. Otjikoto, in the letter, refers to the sub station in the Oshikoto Region near Tsumeb.
For sometime now I have not been involved in Namibia and would appreciate it if you could direct all your correspondence to Sydney Chimunda.	Derek Philips Siemens Ltd 25/04/2006	Response to EA Addendum Notification Letter	Noted.
I am no longer working for IRDNC. The best person to contact is Graeme Wilson.	Richard W Diggle 26/04/2006	Response to EA Addendum Notification Letter	Noted.
Would it be possible to get power from the line if it runs past my property?	Mr. Gordon Vorster, 11/05/2006	Response to EA Addendum Notification Letter	The power line is intended for bulk transmission of electricity and not localised distribution of electricity. Power will not be distributed from the transmission line to properties along the route.

6.3 Further Opportunity for I&AP Input

The EA Addendum Report will be made available for the public and authorities to comment on at a suitable date and location. Written submissions can be made to Eco.plan in response to the EA Addendum if people believe that their issues and concerns have not been captured in this report, or have additional concerns.

7 AFFECTED ENVIRONMENT

The following environments are potentially affected due to the change in the type of power line (HVDC and not HVAC) and the overhead power line river crossings:

- Visual impacts at the Caprivi Game Park due to the use of overhead power lines;
- Ornithological (birds) impacts at the overheads power line river crossings; and
- Land Use (including vegetation) impacts at the proposed earth electrode sites.

The affected environments are described in detail in the original Otjikoto – Katima Mulilo EA. The description of the affected environments (below) supplements those EA reports and should be read in conjunction with those EA reports.

7.1 Visual Impacts

Visual impacts focus on the Caprivi Game Park where overhead power lines will be used along the B1 road that traverses the park, as well as the river crossings at the Okavango and Kwando River.

The following must be considered in terms of the Caprivi Game Park:

- The West Caprivi Game Park may be linked to the Mahango Park (on the Okavango in Kavango) and the Mudumu and Mamili Parks (on the Kwando in East Caprivi) and that the whole complex will then be upgraded to National Parks status; and
- Namibia will proceed to sign the Kavango – Upper Zambezi Transfrontier conservation (KaZa) Agreement between five nations, to establish the largest contiguous protected area complex in Africa.

The West Caprivi is essentially the “key” linking these five states together. The potential for wealth and job creation from this new development is immense – far exceeding agriculture, by orders of magnitude.

The power line development will therefore have an effect on the visual impact across this component of the KaZa development. The KaZa and National Park and associated future land uses should be vigorously protect this core area from visual impacts and loss of “sense of place”.

7.2 Ornithological (Birds)

Dr Chris van Rooyen (Endangered Wildlife Trust) undertook a specialist investigation to determine the potential impact (in detail) of the proposed overhead power line river crossings.

The Okavango and Kwando Rivers were re-visited as part of this specialist investigation and were investigated. The distance of the Okavango River crossing is about 500 metres wide at the bridge. The Kwando River floodplain is about 2.2km wide at the bridge.

Photographs were also taken of the general environment and specifically at the Kwando River crossing to assess the habitat from a bird perspective. These photos are included below:

Figure 9: Kwando River Crossing showing the Extensive Floodplain.

Figure 10: A Strong Flowing Channel in the Kwando River

The Okavango River environment at the bridge differs substantially from the Kwando in that the river channel is very well defined. There is also an existing telephone line and small power line crossing the river already. The Kwando River channel is less well defined at the bridge crossing, with several

channels and pools within the wider floodplain. From a bird risk perspective, this should not make much of a difference in that birds commute up and down the rivers all the time, in the case of the Kwando using the entire floodplain. Temporary pools in the floodplain near the proposed crossing will probably increase the risk of collision as it leads to large concentrations of birds preying on fish and other organisms concentrated in the contracting pools. Bird concentrations were observed in the Kwando floodplain during the field visit.

Figure 11: Picture of typical bird concentrations at temporary pool in Zambesi floodplain (similar to Kwando floodplain).

From this investigation, it is important to clearly state the risks that this power line could pose to birds as far as the overhead power line river crossings are concerned. These are the following:

- **Collisions with the earthwire** of the line. Here it is important to distinguish between the conductors and the overhead earthwire (also called the shield wire). The latter is a thin steel conductor which is strung right at the top of the towers. The live conductors are much bigger than the earthwire in diameter and bundled together, making them a lot more visible. It has been proven convincingly that the earthwire constitutes the main threat to birds from a collision point of view (see Ferrer and Janns 1999);

- **Habitat destruction of sensitive riverine vegetation** (especially for the Whitebacked Night-heron, African Finfoot, Pels Fishing Owl and to a lesser degree the Western Banded Snake-eagle). As the pervious reports states, it is vital that riverine vegetation not be destructed in any way if possible;

- **Disturbance of sensitive species** during the **construction phase** (Whitebacked Night-heron, African Finfoot, Pel's Fishing Owl). This could lead to breeding failure or territories being temporarily or permanently vacated; and
- **Electrocution is NOT a RISK** to birds on the proposed line, as the clearances are too big for a bird to bridge and cause a flashover.

7.3 Land Use at the Earth Electrode Sites (including Vegetation)

The earth electrode site will be situated along the power line route, at the end of the route at Katima Mulilo. The site will be situated in a geologically and topographically suitable area along the last 25km at the end of the power line route. The earth electrode sites are described in Section 5 of this report, as well as the potentially effected area.

The land use at the end of the power line route was found to be part of the Maningimanzi river woodlands, with, amongst others, *Lonchocarpus capassa* (rain tree), *Kigelia africana* (sausage tree) and *Acacia nigrescens* (knobthorn). This unit is very localised and sensitive to disturbance. The end of the power line route is located within the redundant agricultural fields, which from the weedy state of the fields (some weeds definitely being perennial), this field is not fully utilised and will be utilised for the sub station, and save the cost of clearing and avoid unnecessary destruction of woodland.

Before the Maningimanzi river woodlands begin, the power line runs through "Teak shrublands" and "Teak woodlands" occur of the Katima State Forest. Although the Katima State Forest is highly degraded, there are sections of shrublands and woodlands, which have been found to be highly diverse with species like *Albizia versicolor* (large-leafed false-thorn), *Pterocarpus lucens* (thorny teak) and *Pterocarpus rotundifolius* (round-leafed teak) occurring in these woodlands. These species occur in the higher rainfall areas of the country only, and although not legally protected, should be seen as rare species worthy of protection.

Sections of "Omuramba grasslands" running through Sachinga, may also be found in this area. These sections are generally extensively cropped and should be avoided for the earth electrode site of the power line route (as addressed in the original Otjikoto – Katima Mulilo EA Report).

The earth electrode site will most likely be situated within an approximate 1km^2 area in the Katima State Forest shrubland or woodland area.

It is important to note that an earth electrode site will be constructed at the start of the overall power line route as well. The power line route will start in Gerus, near Otjiwirongo, and will continue from Mururani Gate as described in the original Otjikoto – Katima Mulilo EA Report. The earth electrode site at Gerus will be addressed in the Gerus – Mururani Gate EA Report (currently being undertaken).

The section of power line from Otjikoto to Mururani Gate (as described in the original Otjikoto – Katima Mulilo EA Report) will only be constructed and utilised at a later date, based on demand requirements of the area. This area will therefore only be affected at a later date.

8 ENVIRONMENTAL ASSESSMENT OF THE HVDC POWER LINE

The environmental impact assessment of the proposed power line route is described in detail in the original Otjikoto – Katima Mulilo EA Report. The environmental impact assessment (below) considers the changes in the power line route (i.e. overhead power line river crossings, overhead power line through the Caprivi Game Park and the need for the earth electrode sites) and supplements (or where applicable replaces) that in the Otjikoto – Katima Mulilo EA report. This section should be read and utilised in conjunction with those EA reports.

The potential environmental impacts associated with HVDC power line and associated modifications were evaluated according to their extent, duration, intensity, probability of occurrence and finally the significance of the impact.

The system used for ranking the impacts is the same as that used in the original EA environmental impact assessment and is described below.

Extent

Site:	Impact limited to the proposed power line (within the 500m corridor).
Local:	Impact limited to a 5km radius of the power line.
Region:	Impact affecting areas outside the 5km radius of the power line.

Duration

Short term:	Impact less than 2 years
Medium term:	Impact over 2-5 years.
Long term:	Impact over >5 years.

Probability of Occurrence

Possible:	Unlikely that the impact will occur.
Probable:	Impact may occur.
Definite:	Impact will definitely occur.

Impact Significance:

Low:	Small impact and/or disturbance over small area.
Medium:	Moderate impact expected and/or disturbance over small area.
High:	Significant impact expected and/or disturbance over a larger area.
Fatal flaw:	Impacts of a significance that prevents the project from proceeding.
Undefined:	Cannot be determined.

The impacts have also been identified as **positive** or **negative**.

Without Mitigation Measures:

The significance of the impact is rated as if mitigation measures are not put in place.

With Mitigation Measures:

The significance of the impact is rated as if mitigation measures are in place.

Table 2: Environmental Impact Assessment

Impact Description	Phase	Extent	Duration	Probability of Occurrence	Significance		Mitigation Measures
					Without Mitigation	With Mitigation	
Impacts on Visual Aspects (Caprivi Game Park)							
The power line will disturb the visual landscape along which it is aligned. Should the KaZa National Park be formed, a major transmission power line will run along the main road through this park.	All phases.	Local	Long Term	Definite	High Negative	Medium Negative	The power line should be kept as close to existing structures, such as the national road (B8) from Divundu to Kongola.
Tourism could be affected by the overhead power line river crossings from a visual perspective.	All phases	Local / Region	Long Term	Probable / Definite	High Negative	High Negative	The power line should be kept as close to existing structures, such as the national road (B8) from Divundu to Kongola, or telecommunication structures or infrastructure.
Impacts on Ornithological Environment (Birds) at the Okavango and Kwando River Crossings							
OPTION 1 Collisions, of birds, with the earthwire of the power line.	Operational phase	Region	Long Term	Definite	Fatal Flaw	Low Negative	The power line should be routed underground with the entire cable for the river crossings. This remains the most favourable option for mitigating the collision risk, but the technical and financial constraints associated with this option are prohibitive. It is therefore not a viable mitigation measure.

Impact Description	Phase	Extent	Duration	Probability of Occurrence	Significance		Mitigation Measures
					Without Mitigation	With Mitigation	
OPTION 2 Collisions, of birds, with the earthwire of the power line.	Operational phase	Region	Long Term	Definite	Fatal Flaw	High Negative	Management measures could be implemented: **Mark the earthwire of the line with anti-collision devices.** This measure has been proved to be reasonably successful in reducing collisions, with success rates of up to 60% reduction in mortality and even more documented (see Ferrer and Janns 1999). There are several devices available in southern Africa for the marking of power lines. Some are dynamic devices (usually called bird flappers), and some are static. Both have advantages and disadvantages. Dynamic devices are very effective in reducing collisions as the birds seem to see them very well (van Rooyen unp. data) probably because of the movement that attracts attention. The disadvantage of dynamic devices is that they are subject to extensive wear and tear, inevitably limiting the lifespan of the device. This has obvious cost implications if a line needs to be re-marked at intervals of a few years. No solution to that problem has been found to date and it must be accepted as a constraint. Appendix A shows examples of bird flappers currently available.

Impact Description	Phase	Extent	Duration	Probability of Occurrence	Significance		Mitigation Measures
					Without Mitigation	With Mitigation	
OPTION 3: PREFERRED OPTION Collisions, of birds, with the earthwire of the power line.	Operational phase	Region	Long Term	Probable	Fatal Flaw	Medium Negative	This mitigation measure removes the primary cause of death / impact on the bird environment and involves the earthwire. **Re-position the earthwire** at conductor height for the **spans crossing the river** and **mark the conductors with bird lights**. As explained above the earthwire constitutes the main threat to birds from a collision perspective. If the earthwire could be re-positioned at conductor height, it would benefit from the greater visibility of the bundled conductors and would be effectively out of harms way. This possibility is viable and is described in Section 5 above. This solution would be a major break-through as far as mitigation of collision hot-spots is concerned and a first for southern Africa and possibly in the world. In addition, the phase conductors should be fitted with **fluorescent tubes** (bird lights) to reduce the risk of nocturnal collisions. The tubes are energized by the ambient electricity field and produce a row of lights a night. This technology has been successfully tried in Botswana and South Africa. The lights need replacement at regular intervals. Currently, only one product is available on the market, the Mace Bird Lite (see Appendix A).

Impact Description	Phase	Extent	Duration	Probability of Occurrence	Significance		Mitigation Measures
					Without Mitigation	With Mitigation	
Construction activities at the Okavango and Kwando Rivers may interfere with the riverine systems.	Construction Phase	Local	Medium Term	Possible	Medium Negative	Low Negative	Construction Activities at the river crossings must be kept to a minimum and all supporting facilities (such as site camps) may not be located at the rivers.
							No riverine woodland vegetation may be disturbed.
							It is imperative that construction methods are used that minimise the impact on vegetation, the removal of large trees should especially be avoided. The role of the Environmental Control Officer will be crucial in this respect to ensure strict compliance with the EMP.
							Disturbance of sensitive species during the construction phase. This is unavoidable and the best that can be done is to try and keep the disturbance to a minimum.
Impacts on Land Use near Katima Mulilo at the Earth Electrode Site							
Construction activities may disturb adjacent grazing land or communal farm land.	Construction Phase (Blading and Construction)	Site	Short Term	Possible	Medium Negative	Low Negative	Contractors are to disturb as little land as possible and are to be restricted to the development corridors only.
							No contractor material or equipment is to be stored, utilised or repaired on cultivated land.
Unnecessary destruction of large trees, may occur.	Construction Phase (Blading and Construction)	Local	Long Term	Possible	Medium Negative	Low Negative	Plants outside the 12m corridor in the final alignment must not be damaged or removed.

Impact Description	Phase	Extent	Duration	Probability of Occurrence	Significance		Mitigation Measures
					Without Mitigation	With Mitigation	
Loss of timber trees	Construction Phase (Blading and Construction)	Local	Long Term	Possible	Medium Negative	Low Negative	Where felling of trees cannot be avoided, all timber and firewood must be made available to the farm owners (commercial farms) or local communities (communal farming areas).
Removal of sensitive trees and other plant species.	Construction Phase	Local	Medium Term	Possible	Medium Negative	Low Negative	It is recommended that staff of the National Botanic Institute / National Botanical Research Institute be tasked to undertake rescues of any *Aloe* populations, and/or other succulents encountered. These staff can also assist in areas of uncertainty with regards to tree felling and vegetation clearing.
Additional trees may be felled, or vegetation removed during maintenance.	Maintenance	Site	Long Term	Possible	Low Negative	Low Negative	No additional tree felling or vegetation removal may be undertaken unless it is to remove encroaching and invasive species.
Socio – Economic Impacts							
The use of a HVDC overhead power line will ensure the economic and technical viability of the project. This will ensure the supply of power (electricity) to Namibia, which is of national significance and is required for a continuous power supply for the county.	All phases	Region	Long Term	Definite	High Positive	High Positive	The power line must be constructed and utilised to ensure a continued supply of power (electricity) to Namibia.
Other Impacts							
Impact of the birds on the proposed power line. It is important to mention that birds could have an impact on the line, primarily through streamers produced by large raptors and herons roosting at night above the phases on strain towers. They will not be able to roost on the suspension towers, but it could be a problem on the strains. This will be limited problem in that the earthwire assembly at the top of the strain towers does offer good perching space which will most likely be used more than the perching space on the cross-arms. Nevertheless, the situation will have to be monitored to see how many bird related faults occur. If the problem is excessive, bird guards could be fitted to selected towers above the phases after the line has been energized.							

The following environments will not be affected any differently from that addressed in the original Otjikoto – Katima Mulilo EA Report. The environmental impact assessment contained in the original Otjikoto – Katima Mulilo EA Report is therefore correct and valid:

- Impacts on Soils;
- Impacts on Land Use and Land Capability (other than described above);
- Impacts on Vegetation;
- Impacts on Animals and Birds (other than described above);
- Impacts on Sites of Archaeological Significance;
- Impacts on Sensitive Landscapes;
- Impacts on Visual Aspects (other than described above); and
- Socio-Economic Impacts.

9 ENVIRONMENTAL MANAGEMENT PLAN (EMP)

The EMP arises out of the Otjikoto – Katima Mulilo EA Report, which identified a number of potential environmental impacts that need to be managed during the project cycle: This EMP has been amended where relevant for the purposed EA Addendum and should be implemented in conjunction with the Volume 3: Environmental Management Plan (June 2006) produced as part of the overall Otjikoto to Katima Mulilo Power Line EA as well as NamPower's General Environmental Management Plan for the Construction of Power Lines (March 2006) as contained in Appendix C.

This EMP outlines the roles and responsibilities of all parties who can influence or give effect to the recommendations or specifications that follow. It is important that all parties should understand the guidelines / specifications, and the reasons for them. This EMP should therefore also be read in conjunction with the environmental impact assessment undertaken in Section 8.

10 SUMMARY AND CONCLUSION

The primary reason for this EA Addendum is to addressed the fatally flawed option of an HVAC overhead power line crossing. NamPower proposed to utilise a range of options to ensure that these risks are mitigated to acceptable limits and to ensure that the power line can be constructed to supply Namibia with electricity as existing sources can no longer meet these requirements.

The findings of the EA Addendum environmental impact assessment are as follows:

Tourism and the visual aesthetics of the area will be negatively affected by the proposed overhead power line. It is imperative that the power line route is located along the existing B8 national road to reduce this risk as much as possible.

The disturbance of birds during the construction phase is inevitable, but this should be temporary impact. However, the disturbance of riverine vegetation must be prevented. and no riverine vegetation may be removed.

The greatest threat that the proposed power line will pose at the Kwando and Okovango River crossings would be collision of bird with the earthwires of the line and ideally the best option would be to bury the line at the river crossings, but this option is not viable from a financial and technical point of view. A possible compromise that would greatly reduce the risk of collision mortality would be to string the earthwire at conductor height at the two river crossings. This would reduce the risk of collisions substantially as the earthwire will not be at the level of the bundled conductors, which is a lot more visible to birds. An additional measure would be to fit anti-collision devices and fluorescent lights to the phase conductors to reduce the risk of collisions.

Report compiled by Charlene Wrigley and Leigh Bennett for Eco.Plan.

11 ACKNOWLEDGEMENTS

Eco.plan's team of sub-consultants are kindly thanked for their efforts: -

Charlene Wrigley, Eco.Plan (Project Manager)
Leigh Bennett, Eco.Plan (Environmental Consultant)
Chris van Rooyen, Endangered Wildlife Trust (Ornithological Studies)
GeoBusiness Solutions (Mapping and Map Production)

In addition to the study team, the following people have also contributed to this report in various ways.

Pal Strauss (NamPower)
Johan Stadler (NamPower)
Horst Mutschler (NamPower)

All members of the public and authorities who attended Public Meetings, provided written submissions or information, or participated in any other way are thanked for their effort. Their input has made a significant contribution towards a more environmentally acceptable project, and this is gratefully acknowledged.

Appendix A

Environmental Assessment Addendum of the Proposed

Otjikoto – Katima Mulilo 350kv HVDC

Ornithological Component

Appendix B:

EA Addendum Notification Letter

Appendix C:

NamPower General Environmental Management Plan

N144

October 2006

ENVIRONMENTAL IMPACT ASSESSMENT OF THE PROPOSED GERUS – MURURANI GATE 350 kV TRANSMISSION LINE

VOLUME 2: ENVIRONMENTAL ASSESSMENT REPORT FINAL REPORT

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LIST OF ABBREVIATIONS

EA	Environmental Assessment (also known as an Environmental Impact Assessment)
EMF	Electromagnetic Field
EMP	Environmental Management Plan
HVAC	High Voltage Alternating Current
HVDC	High Voltage Direct Current
I&APs	Interested & Affected Parties (stakeholders)
kV	Kilovolts (1 kilovolt = 1000 volts)
MET	Ministry of Environment and Tourism
NBC	Namibian Broadcasting Corporation
PPP	Public Participation Process (a component of the EA study)
SADC	Southern African Development Community
SADF	South African Defence Force (prior to Namibian independence)

1 EXECUTIVE SUMMARY

Namibia faces a potential power shortage by the year 2007. The hydro power station at Ruacana generates about half of Namibia's power, while the rest is currently imported from South Africa. The growing demand in South Africa is expected to use up their surplus power generation capacity by 2007. As a result of the future shortage in power supply, Namibia is looking to alternative power sources.

Various alternatives have been assessed in order to address the future power supply shortage. It is expected that the proposed Kudu Gas power station at Oranjemund will be operational around 2009. Kudu Gas will supply sufficient power for Namibia's needs for 20 years or more with spare capacity to export some of its power. The Kudu Gas power station will be suitable for generating the base load requirements, while Ruacana (like most hydro power stations) is able to vary its power output rapidly and is therefore very suitable to supply peak demand periods (e.g. early evening is a peak demand period).
NamPower are currently expanding their national electricity transmission grid in an attempt to provide for future power generation and transmission requirements, which forms part of the greater plan to meet the need for growth in power demand and supply in Namibia and the greater SADC Region.

The power line will form part of a larger transmission route which will run from Auas Sub-Station (near Windhoek) via Gerus Sub-Station (north of Otjiwarongo) to Mururani Gate to Rundu to Katima Mulilo. The EA for the overall transmission line has been conducted in three phases and within each phase a separate Environmental Assessment (EA) is being/has been conducted. The EA's have been conducted as follows:

- Phase 1: Auas – Otjikoto – Lifa 400kV Transmission Line
- Phase 2: Gerus - Mururani Gate 350kV Transmission Line
- Phase 3: Otjikoto - Katima Mulilo 350kV Transmission Line.

The proposed Gerus-Mururani Gate Power line is situated in the Otjozondjupa Region in Namibia. The route starts at Gerus Transmission sub station (north of Otjiwarongo) from there the line runs through the Otjozondjupa Region in a north-easterly direction, where the line ties in with the existing line at Mururani Gate.

The Environmental Assessment process undertaken for this process consisted of 3 phases:

- Scoping Phase;
- Environmental Assessment; and
- Environmental Management Plan.

The Scoping Phase or Volume 1 Route Evaluation and Scoping Report considered the need for the power line and contained details of the proposed and alternative routes and technology. An account of

the public participation process was given and the issues and concerns that were raised by interested and affected parties (I&AP's) were included.

The Environmental Assessment Phase, Volume 2, considered the following:

- Further public participation activities, and results, following the distribution of the Scoping Report;
- Description of the power line construction, operation and maintenance phases in detail;
- Details of the environments affected along the final route and includes the results of the specialist studies and reports undertaken;
- An assessment of the impacts and recommendations for the mitigation of potential environmental impacts; and
- A summary of the environmental issues and the mitigation measures.

The Environmental Management Plan, Volume 3, arises out of Phase 2, which identified a number of potential environmental impacts that need to be managed during the three important stages of the project cycle:

- Ground Survey & Design stage;
- Construction stage; and
- Operation & Maintenance stage.

For each stage mentioned above, the Environmental Management Plan also outlines the roles and responsibilities of all parties who can influence or give effect to the recommendations or specifications that follow.

The findings of the environmental impact assessment include both positive and negative impacts. The route alignment has mitigated potential impact on soils and land use and capability, and where possible, the final route should be adjusted slightly (within the 500m assessment corridor) to ensure that this impact is further minimised.

The impact on vegetation will however need to be actively managed during construction as the route alignment will result in the loss of woodland and the clearing of vegetation. Where possible, sensitive vegetation areas have been avoided and the route has been aligned accordingly.

There will be little to no impact on sites of archaeological significance, as the sites of interest, where they do occur, have little to no significance.

The power line is of strategic importance to Namibia. It is therefore recommended that with the mitigation and management measures, the establishment will ensure a project that is viable in terms of the environment and impact to biophysical and socio-economic aspects.

2 PREFACE: THE CONTEXT OF THIS REPORT

This report is Volume 2 of the Environmental Impact Assessment for the proposed Gerus - Mururani Gate transmission line. Volume 1 was a Route Evaluation and Scoping Report for the project (Eco.plan, August 2006).

Volume 1 explained the need for the power line and contained details of the proposed and alternative routes and technology. An account of the public participation process (PPP) was given and the issues and concerns that were raised by interested and affected parties (I&AP's) were included. Volume 1 also contained brief descriptions of the affected environments, and it identified potential environmental impacts and mitigation measures. Most importantly, Volume 1 provided a rationale for alternative routes and technology, where it was necessary to deviate from the route or technology that was originally proposed by NamPower, to avoid or minimise environmental impacts. An overview of the whole planning process in determining the power line route was thus given in Volume 1.

3 INTRODUCTION

3.1 The Project Proposal

3.1.1 Location

The proposed Gerus-Mururani Gate Power line is situated in the Otjozondjupa Region in Namibia. The route starts at Gerus Transmission station (north of Otjiwarongo) from there the line runs through the Otjozondjupa Region in a north-easterly direction, where the line ties in with the existing line at Mururani Gate. The route associated with the newly proposed power line is illustrated in Figure 1 below.

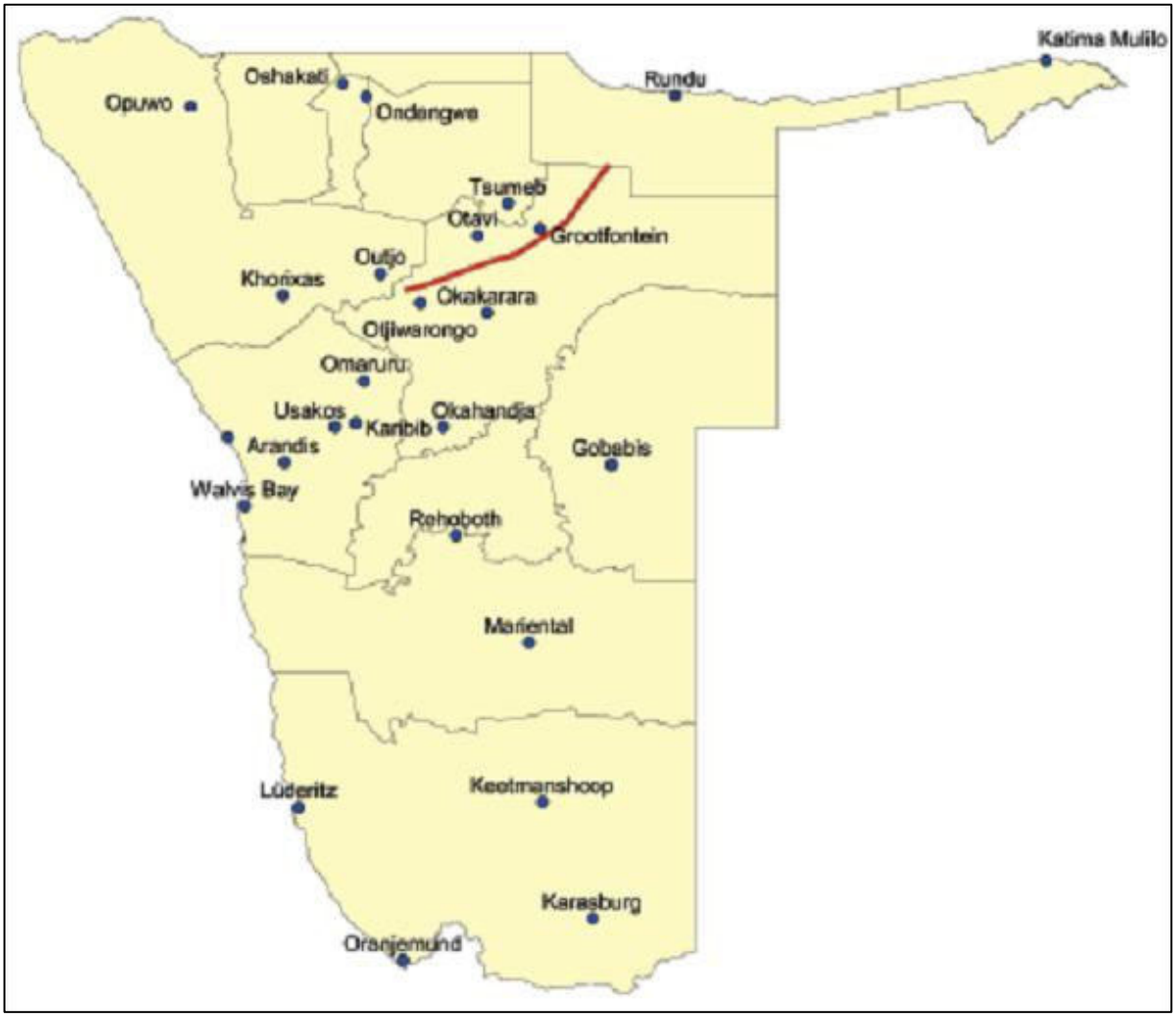

Figure 1: Regional Location of the Route Alignment

3.1.2 Motivation for the Project

Namibia faces a potential power shortage by the year 2007. The hydro power station at Ruacana generates about half of Namibia's power, while the rest is currently imported from South Africa. The growing demand in South Africa is expected to use up their surplus power generation capacity by 2007. As a result of the future shortage in power supply, Namibia is looking to alternative power sources.

Various alternatives have been assessed in order to address the future power supply shortage. It is expected that the proposed Kudu Gas power station at Oranjemund will be operational around 2009. Kudu Gas will supply sufficient power for Namibia's needs for 20 years or more with spare capacity to export some of its power. The Kudu Gas power station will be suitable for generating the base load requirements, while Ruacana (like most hydro power stations) is able to vary its power output rapidly and is therefore very suitable to supply peak demand periods (e.g. early evening is a peak demand period).

NamPower are currently expanding their national electricity transmission grid in an attempt to provide for future power generation and transmission requirements, which form part of the greater plan to meet the need for growth in power demand and supply in Namibia and the greater SADC Region (refer to Figure 2).

The phases of expanding the national electricity transmission grid are as follows:

1. Phase 1: Auas – Otjikoto – Lifa Transmission Line;
2. Phase 2: Gerus - Mururani Gate Transmission Line; and
3. Phase 3: Otjikoto - Katima Mulilo Transmission Line.

The proposed Gerus - Mururani Gate power line is intended to meet the following objectives:

- To provide the necessary bulk transmission infrastructure to transport power from the new and existing sources of generation to areas where it is needed;
- To strengthen the Namibian national power grid, and ensure stability of supply to areas of consumption;
- To capture economic growth opportunities in northern Namibia by having sufficient transmission capacity available;
- To make optimal use of resources to ensure lowest price to consumers;
- Explore alternative energy sources, however alternatives are not always viably available, and therefore power lines and transmission are required in the region;
- Strive to be self sufficient in power generation and transmission;
- Aim to ensure efficient transmission of power with less energy losses; and
- Aim to potentially export power as a result of the supplementation of power.

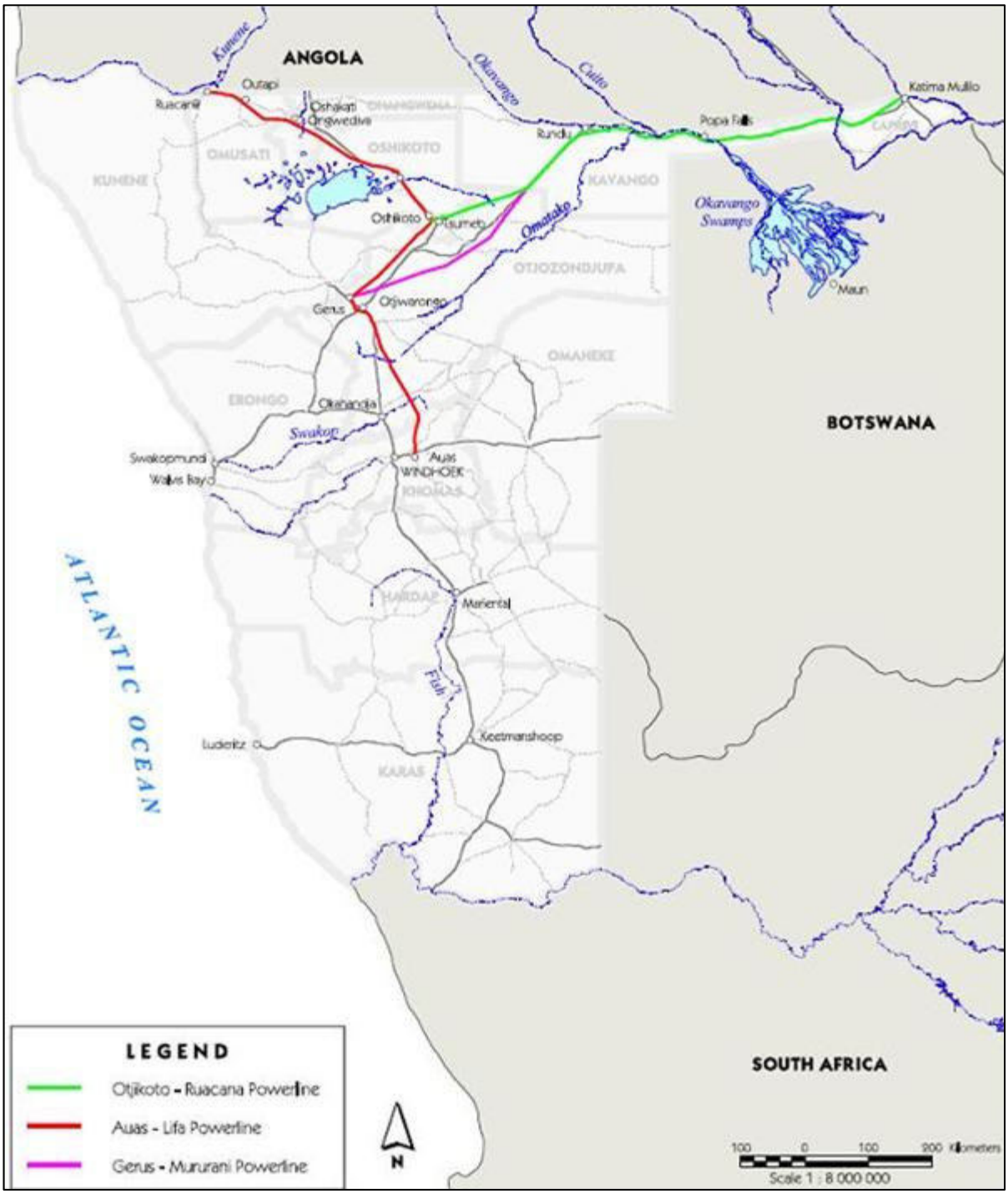

Figure 2: NamPower's national electricity transmission grid current expansion projects

The proposed high voltage transmission line is intended for bulk transmission of power. It will not supply power directly to the communities through which it is routed because the voltage is too high for reticulation to individual consumers. The cost of sub-stations to transform this power to usable voltages is very high. Indirectly, however, by strengthening the national grid, it will be possible for utility companies to be supplied with power for distribution to consumers.

3.1.3 Review of the Power Line Route

A transmission power line (350 kilovolts (kV)), for which the required environmental studies are already underway, is planned from Otjikoto (near Tsumeb) to Katima Mulilo in the Caprivi Region. In support of the transmission line (and purely for transmission purposes), another 350 kV High Voltage Direct Current (HVDC) transmission line is planned from Gerus to Mururani Gate, which will tie into the Otjikoto to Katima Mulilo transmission line at Mururani Gate. Refer to Figure 3 for a Locality Map of the proposed power line.

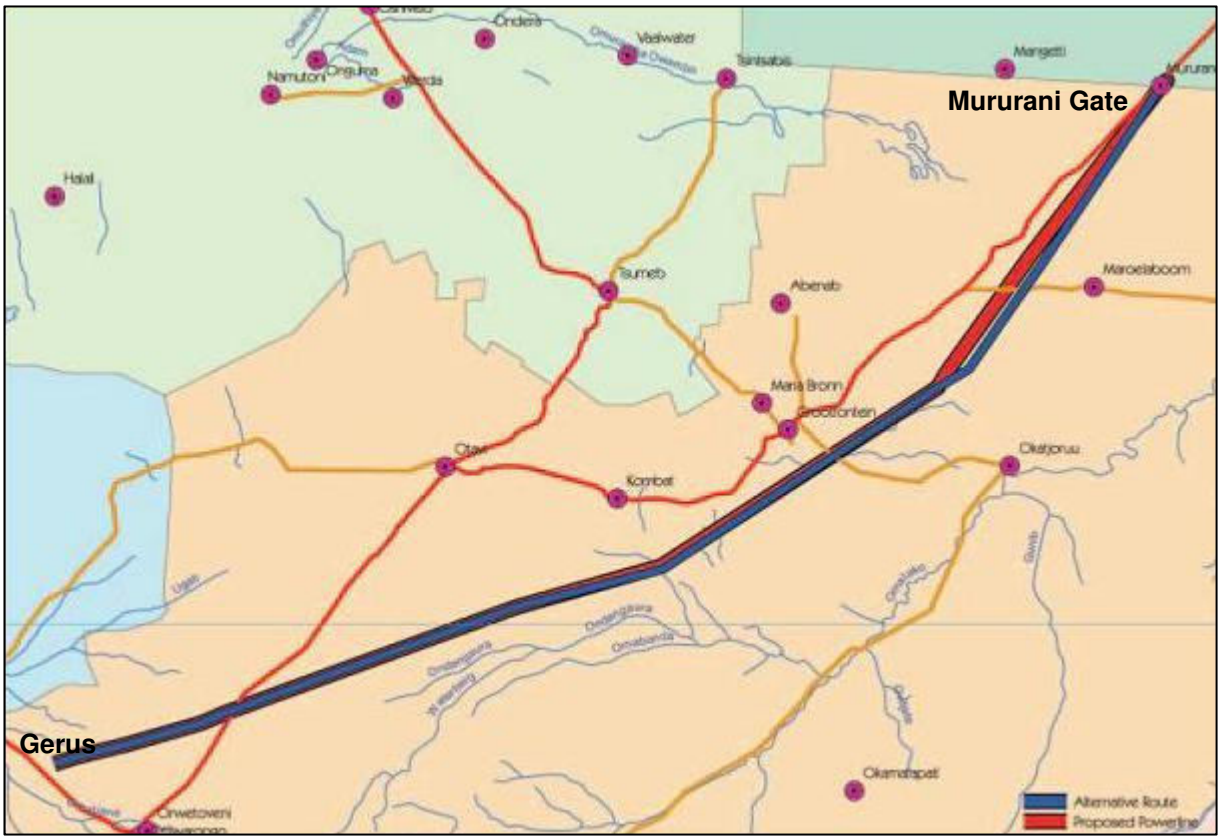

Figure 3: Final Route Alignment Locality Plan

The proposed 350kV power line runs from Gerus Transmission sub station (north of Otjiwarongo) from there the line runs through the Otjozondjupa Region in a north-easterly direction, where the line ties in with the existing line at Mururani Gate.

During the Scoping Phase of the Environmental Assessment (EA) for this project, some changes were made to the original route proposed by NamPower in response to environmental issues raised during the consultation phase. The major concern raised was the occurrence of a clump of Tambotie Trees on the south eastern corner of the farm Gaikos, near Grootfontein and the landing strip risk and nearby vulture population at the farm Omarassa. The final power line route is indicated by the blue line on Figure 3.

The route starts in the Gerus Transmission sub station and proceeds north eastwards along an existing power line route to Mururani Gate. Along this route the alignment traverses various commercial farms.

During the Scoping Phase mapping of the proposed route and alternatives was undertaken at a scale of 1:250 000. Thereafter, during the EA Phase, mapping was reviewed at a larger scale on a basemap of digital orthophotos. The objective was to "fine tune" the alignment in order to avoid obstacles such as clumps of large trees and densely spaced settlements, and to make the alignment compatible with existing roads and power lines. These maps will be provided to NamPower and Ministry of Environment and Tourism (MET), and will be available for the public to view. The large volume of printing and the large format of these maps make it impractical to reproduce a set of 1: 50 000 orthophotos with every copy of the report.

The recommended final alignment represents the outcome of specialist studies (vegetation, birds and archaeology), input from the PPP, and consideration of physical and socio-economic constraints upon power line construction.

Co-ordinates of the bend points for the whole power line route are contained in Appendix A. The EA is undertaken for this final route. This is because alternative alignments had already been considered and selected in response to the key environmental issues during the Scoping Phase.

3.1.4 Power Line Alternatives

The power line alternatives were evaluated in the Scoping Phase of this project and primarily considered route alignment, and technological alternatives.

Minor adjustments, which may also be considered alternatives are also undertaken in this phase – the EA phase and are re-iterated in the third phase – the EMP. These alternatives or minor adjustments are 'tweaks' within the route alignment or corridor.

3.1.5 Brief Description of the Power Line and Related Infrastructure

NamPower proposes to design the power line for a maximum of 350kV, but it may be operated at a lower voltage until the full capacity is required. All the sections of the power line route will consist of overhead cables.

In terms of the proposed overhead transmission lines, the proposed towers for a 350kV power line will be approximately 40m high. The construction design preferred by NamPower is the cross rope suspension tower. This design minimises the amount of steel used and is therefore most cost-effective. Self-supporting suspension towers and straining towers are used in conjunction with cross rope suspension towers, especially in areas where the foundation or ground surface is unstable, and at bend points (refer to Figure 4). Straining towers are required at all bend points (refer to Figure 5). A straining tower also has four legs and looks very similar to the self-supporting suspension tower, but the conductors are not suspended, in fact the tower is used to put the conductors in tension.

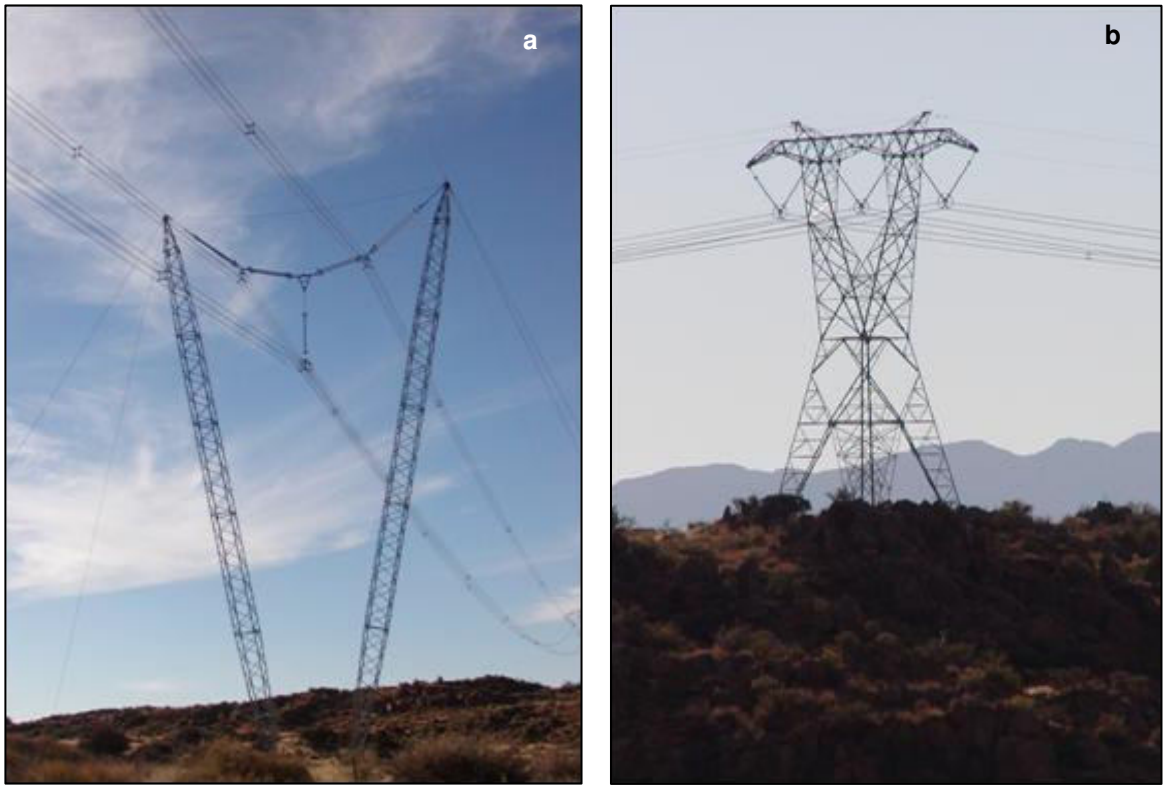

Figure 4: Cross-rope Suspension Towers (a) and Self Supporting Suspension Towers (b)

Figure 5: Typical Straining Tower

For a 350kV HCDC power line, a servitude of 55m wide is required. The servitude will be registered as an un-surveyed servitude prior to construction. Within that 55m servitude no buildings or other infrastructure will be permitted. However cultivation of crops or grazing of livestock can continue. A narrow strip of about 12 metres wide within that servitude will be cleared of trees and tall bushes before construction commences. This will be done only directly under the conductors to facilitate construction, to reduce the risk of flash-overs between the power line and trees, and to protect the power line from

fire. Veld fires increase the risk of flash-overs and power line failures due to ionisation processes in the air and smoke.

An access track of 4 - 5m wide is normally cleared within the servitude for vehicular access for construction and maintenance. Such tracks will be limited to a single route. Only bush and trees will need to be cleared from the tracks, while grass can remain. Where possible, existing public roads will be used, which will minimise the need for the creation of new tracks. Private farm roads will not normally be used.

As part of any HVDC power line or transmission system, an **earth electrode** site needs to be established for the electricity '*return*' and for *earthing* purposes. An earth electrode site is required at the start and at the end of a transmission line. In this case, the end is at Katima Mulilo and therefore beyond this scope of work. The start is at Gerus and such a site will need to be constructed. The earth electrode site will be along the power line route approximately 25km from the beginning.

The earth electrode site consists of an open area in which earth electrodes (approximately 5-20m in length and 10cm in diameter) are buried vertically below the earth surface. The earth electrodes are connected to the transmission line through over head cables, and the earth electrode area will be fenced off. Infrastructure and other structures cannot be constructed within the fenced off area, which is approximately 1km x 1km.

A typical earth electrode is shown in Figure 6 below.

Repeater stations will be required for the HVDC transmission line. Repeater stations are required at various intervals along the transmission line to restore and amplify 'attenuated' and time smeared signals in a typical signal carrying installation.

As part of any HVDC power line or transmission system, a **Converter Station** is required at the transition point between HVDC and HVAC, which will be utilised for domestic distribution or further transmission. In this case, the end / last transition from HVAC to HVDC is at Katima Mulilo and therefore beyond this scope of work. The first / beginning transition from HVDC back to HVAC is at Gerus and therefore a converter station will be coupled to the planned sub station at Gerus.

From an environmental and socio-economic consideration, the converter station is very similar to a typical HVAC sub station and will have no new or other environmental impacts.

A typical converter station is shown in Figure 7 below.

Figure 6: Earth Electrode Site

Figure 7: Typical Converter Station

3.2 Environmental Assessment Study / Report

3.2.1 Approach and Methodology for the Environmental Assessment Phase of the study

Most of the key environmental issues were addressed through the selection of the best environmental option for the power line route during the Scoping Phase.

In the EA Phase the following tasks were carried out: -

- The Scoping Report was made available to all landowners in the commercial farming areas, and the Regional Councils of all the affected regions.
- Feedback from Interested & Affected Parties on the Scoping Report was considered in the EA Phase.
- Further consultations were held with some of the I&APs.
- Field surveys were undertaken by specialist sub-consultants.
    - J. Kinahan undertook archaeological surveys at sensitive or representative locations along the selected power line route.
    - B. Strohbach undertook a botanical survey along the selected route to establish whether there were any sensitive areas, and to make recommendations for minor adjustments of the route where necessary.
    - C. van Rooyen undertook ornithological surveys to investigate the impact on birds of a new 350kV DC transmission line.
- Specialist reports were compiled by each of the above-mentioned specialists
- In response to the specialist studies and fieldwork, the route of the power line was reviewed and adjusted where necessary. The final alignment is shown at a scale of 1: 500 000 in Appendix B.
- The power line construction, operation and maintenance activities are discussed in detail.
- This EA report was then compiled for the final route. In cases where potentially significant impacts could not be avoided by adjusting the route, recommendations are made in this Volume 2 for mitigation of impacts.

3.2.2 The Structure of this Volume 2: Environmental Assessment Report

The structure of this report is as follows:

- Chapter 4
    - This chapter gives an account of Public Participation Process (PPP) activities undertaken, and results, following the distribution of the Scoping Report.
- Chapter 5
    - This chapter describes the power line construction, operation and maintenance phases in detail.
- Chapter 6
    - This chapter provides details of the environments affected along the final route and includes the results of the specialist studies and reports undertaken for this phase.

- Chapter 7
    - This chapter provides an assessment of the impacts and recommendations for the mitigation of potential environmental impacts. Once this report has been approved by the relevant government departments NamPower will be committed to ensure that the mitigation measures as stipulated within this report are implemented.
- Chapter 8
    - This chapter summarises the environmental issues and the mitigation measures.

4 FURTHER PUBLIC PARTICIPATION

4.1 The Public Participation Process

A comprehensive PPP was initiated at an early stage in the EA process in order that the concerns of I&APs, authorities, and the wider public could be established and incorporated into the EA process from the start of the process. The PPP is a continuous process to be conducted throughout the EA process. The main purpose of the PPP was to:

- Introduce the project proposal;
- Explain the PPP and EA processes;
- Understand and record public issues and concerns; and
- Provide opportunities for public input and gathering of local knowledge.

Once the concerns of I&APs had been established, the study aimed to address these concerns in the EA process, together with issues raised by the environmental specialist team.

The following activities have been carried out to date, as part of the PPP:

- The project was advertised in the Namibian press, in the following newspapers; The Namibian (9 May 2006), The Republikein (9 May 2006), and the Allgemeine Zeitung (8 May 2006). These advertisements invited people to attend the Public Meetings, and to register as I&APs. A copy of these advertisements can be found in Appendix C.
- Known individuals and groups/organisations that may be interested or affected, were also contacted by letter, fax or email to notify I&APs of the project and the EA study. A copy of the letter is shown in Appendix D.
- The farm numbers for all farms within 5km of the proposed power line alignment were determined. Then the names and contact details of the owners of those farms were obtained. A letter (as shown in Appendix E) and a map illustrating the farm boundaries crossed by the proposed power line, with the relevant farm highlighted were then sent to farm owners. The letter invited them to register as I&APs and express any concerns that they may have and to attend the Focus Group Meetings. A list of all the farmers and farm names can be found in Appendix F.
- All those who contacted Eco.plan, or who attended meetings, were registered as I&APs so that they could be kept informed about the progress of the project.
- Public meetings were held to introduce the project, and to hear and record public concerns (The presentation that was shown at the Public Meetings can be found in Appendix G). A small-scale map was displayed, illustrating the farm boundaries and the proposed power line, and a full route alignment map, at a scale of 1:250 000 was displayed at all the meetings. Contact details were also provided for responses. The meetings took place as follows: -
    - Windhoek on the 17 May 2006, at the Scientific Society, at 17:00pm;
    - Otjiwarongo on the 18 May 2006, at the Otjibamba Lodge, at 10:00am;

- Otavi on the 18 May 2006, at the Town Hall, at 14:00pm; and
- Grootfontein on the 19 May 2006, at the Town Hall, at 11:00am

- Two Focus Group meetings were held with the farm owners affected by the power line. The two meetings were held on the 19th of June in Otavi and on the 20th of June in Grootfontein. The meetings were held in order to hear and record the farmers concerns. A presentation was shown introducing the proposed project, the presentation can be found in Appendix G. A small-scale map illustrating the farm boundaries crossed by the proposed power line was displayed and a full route alignment map, at a scale of 1:250 000 was displayed at both the meetings.
- Meeting Minutes form the Public and Focus Group Meetings were sent to all who attended the meetings as well as to all affected farmers who could not make the meetings. A summary of issues and concerns were kept, where all issues and concerns received throughout the PPP are recorded. At all meetings, I&APs were invited to send written submissions if they wished to do so. The attendance lists of the Focus Group meetings are shown in Appendix H.

Supporting documents on the Public Participation Process are contained in the Appendices as follows:

- Advertisements in the press - Appendix C;
- Letter of notification to I&APs – Appendix D;
- Letter of notification to Farm owners along proposed route – Appendix E;
- List of affected farmers and farm names – Appendix F;
- Presentation presented at the Public Meetings and Focus Groups – Appendix G;
- Meeting minutes and attendance lists for Public Meetings and Focus Groups Meetings – Appendix H; and
- List of all registered I&APs – Appendix I.

The results of the PPP are contained in the following section.

4.2 Issues, Concerns and Feedback to Interested & Affected Parties

In this section, the outcomes of the PPP are presented. This section serves as a record of issues and concerns that were raised by I&APs throughout the PPP. The purpose of presenting the issues raised by participants in this section is simply to:

- Ensure transparency regarding the concerns that have been expressed; and
- Provide the list of issues that were considered during the EA.

The issues and concerns raised during the PPP are summarised below:

4.2.1 Biophysical

- The description and use of bird flappers as mitigatory measures;
- Theft of livestock and damage to agriculture fields due to access to farm land created by power line access roads;
- Disturbance of the game during construction phase;
- Possibility for poachers to access the farm due to access to farm land created by power line access roads;
- Risk of the power line crossing landing strips / runways;
- Concern regarding feeding vultures ;
- Understanding of how gates will be installed and access controlled;
- What will happen to existing fencing?
- Signing of the servitudes and subsequent timetable of events;
- The technical options of the power line i.e. HVDC and HVAC; and
- General environmental impacts.

4.2.2 Socio-Economic

- Positive support for the power line due to past experiences with NamPower;
- Availability of electricity from the transmission line;
- Power line crossing farmers land and associated disturbance; and
- Maintenance of the servitudes and access roads.

4.2.3 EA Planning Process

- Unavailability to attend Public Meetings (Focus Group Meetings were held to supplement the consultation process);
- Insufficient notification and consultation at the Scoping Phase of the project; and
- The importance of communicating issues to the relevant people.

The Scoping Report was made available for comment to the public and authorities. Written submissions were received by Eco.plan in response to the Scoping Report as captured in Table 3.1 below, along with the feedback to I&AP's.

Table 1: Feedback from I&AP's

Issues and Concerns	Feedback to I&AP's
S Schnieder – Review of Scoping Report The route alignment has subsequently been altered due to sensitive vegetation along the originally proposed route along the farms as discussed in the Scoping Report. From the realignment map it is not however clear whether our request has been met. The route has also been altered due to 'sensitive vegetation' at some other places, not necessarily 'along the mentioned farms' as stated in our request. Could you thus respond to us clearly whether the proposed power line has been shifted onto the common border line and thus run parallel with the border fences and does not run at an angle a few hundred meters away from the common straight line border over some 12 to 15 farms (from Gai Kaisa to Dornhugel). We trust that you have taken our concerns into consideration.	These concerns have been taken into consideration. The route alignment has been altered due to sensitive vegetation species, and has subsequently been moved south of the originally proposed alignment. This revised alignment, which takes vegetation into consideration, has taken your concerns into consideration but could not address all of the farms with regards to the common border area, although most farms will no longer be affected. Where possible, this route was aligned within the common border area (along existing farms), and does run within this area. It must be noted that the power line runs in a straight line and aligns with the common area where possible.

4.3 Further Opportunity for I&AP Input

The EA Report will be made available for the public and authorities to comment on at a suitable location. Written submissions can be made to Eco.plan in response to the EA Addendum if people believe that their issues and concerns have not been captured in this report, or have additional concerns.

5 DETAILED PROJECT DESCRIPTION

The proposed project comprises two major alternatives (refer to Figure 3 and Figure 8), i.e.

- Option A (Alternative Route) – in red: 350KV HCDC overhead line for the entire route; or
- Option B (Proposed Power line) – in blue: 350KV HCDC overhead line for the entire route, avoiding the farms Okaputa, Omarassa, Osombusatjuru, Ode, Gai-Kaisa and Gaikos.

Each of these alternatives is described below.

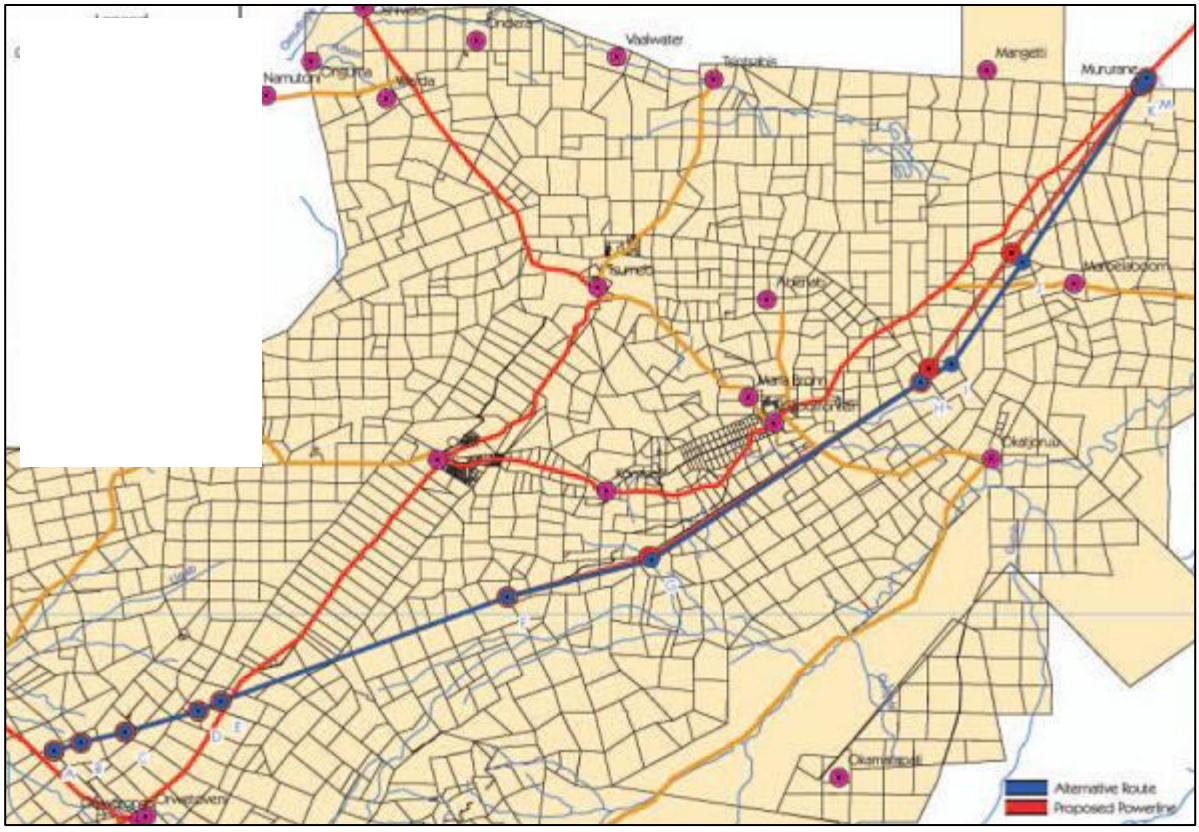

Figure 8: Location of the route alignment in terms of farm boundaries

5.1 Option A: 350KV HCDC Overhead Power Line

350KV HCDC overhead power lines will be constructed for the entire route from Gerus to Mururani Gate.

Once the 350KV HCDC power line is established, the conductors will be supported onto different types of towers: a Self-Supporting Suspension Tower and Strain Tower, similar to that depicted in Figure 4 and Figure 5 and Cross Rope Suspension Tower as shown in Figure 4.

The Self-Supporting Suspension Tower design will be used on bends and areas where the ground is unstable or compromised, while the Cross Rope Suspension will be used mostly on straight sections. In difficult terrain, either type of tower may be used. The 40m high towers will be spaced between 400m and 500m apart, depending on the topography. The 350 kV HCDC line is designed to withstand

high winds of up to 120km per hour. The Cross Rope Suspension Tower is environmentally friendlier because the delta configuration of the conductors reduces the chances of birds being electrocuted. These structures contain far less steel and utilise less space for foundations compared with the Self Supporting Towers.
In order to describe the potential impacts that may occur before, during and after construction of the power line, it is necessary to discuss in some detail, construction and maintenance activities.

Construction of a power line involves the following steps:

- Identification, evaluation and finalisation of power line route (completed at the Scoping Phase);
- Negotiation of Way leaves with land owners along the route;
- Survey and design of line;
- Installation of gates and clearing the route access road;
- Establishment of construction camps (people and equipment);
- Transportation of equipment and construction teams to tower/pylon sites;
- Erection of towers and stringing of power line; and
- Switching on / Commissioning.

5.1.1 Way Leaves

Once the route has been finalised, NamPower will contact the farmers and landowners over whose property the line is to be routed and negotiate a Way Leave with them. This entails obtaining their permission to build the line, to clear tall bushes and trees where necessary and to remove vegetation that is likely to interfere with the construction and daily operation of the power line. The positions of gates that have to be installed along the route in order to facilitate access are also negotiated. Compensation, at an agreed rate, is arranged for the corridor area of land in order to compensate for any inconvenience. This is based on the area of the servitude across each owners land.

5.1.2 Route Surveying and Clearing

The final route alignment is designed and mapped once the Way Leaves have been negotiated. The co-ordinates are then given to the surveyors to peg the line. Often the route is cleared of tall bushes and trees at the same time so that the track is clearly marked for vehicular activity. Blading entails the removal, by grader or bull dozer, of all vegetation and obstructions along the 4m wide access route in order that trucks carrying equipment may access the base of the towers. In especially sensitive, areas, depending upon the terrain, blading will be avoided. Where no current infrastructure exists near the power line route, additional access roads will have to be built. These roads are built according to civil engineering principles and follow contours to avoid erosion etc. All access roads will remain as dirt roads that are graded and will not be tarred. No borrow pits will be created or used in the construction of these access roads.

5.1.3 Power Line Construction

It is envisaged that there will be a total of ten construction camps along the route that will be used for the storage of the power line components, equipment and the housing of contractors. The storage and contractor sites typically measure 200m X 300m and are situated on land that is leased from farmers for a period of time. The sites will be selected to optimise access from the main roads to the power line route and where there is sufficient power and water available. Refuse disposal is generally in a trash pit dug nearby, and sanitation facilities comprise a pit system.

All the components for the power line construction (steel pylons, conductors, insulators, etc) will be transported to the site by road on low bed trailers. Each day the construction team will travel to the power line route by way of existing roads if they are sufficiently direct, or else along the new temporary access roads that are constructed. Once on the route, the construction teams will travel only along the route access road.

The foundations for the towers will be in concrete blocks. The anchors for the guy ropes will be drilled into hard rock, but in sandy areas, screw anchors will be used. The servitude width for the 350kV is 55m.

The steel towers will be erected on site either by using a 15 – 20 ton crane to place the pre-assembled tower into the concrete foundations, or by building up the tower from it's concrete foundation, section by section. Concrete will either be mixed or poured on site, or pre-mix will be transported to site. The conductors will be strung using heavy-duty mechanical winches.

5.1.4 Maintenance

Once a power line has been built it normally requires very little maintenance. Maintenance on a 350kV power line includes cleaning the insulators, but this will probably be done by helicopter. Live wire maintenance crews would be used along the other sections of the line if maintenance is required. Routine inspections of the lines are carried out from the air, and only vegetation that grows above 4m in the servitude will be pruned.

Access to the power lines would be in 4X4 vehicles along the access track under/alongside the towers, or by helicopter. Maintenance of the sub-station is periodic and small teams (maximum of 5) would be on site for 2 – 5 days. Obvious accidents such as lightning strikes or towers being blown over by exceptionally strong winds, will be repaired using the access roads under the line, or, in remote or inaccessible localities by helicopter.

5.1.5 Non-Standard Operating Conditions

Given the climate, vegetation cover, topography and knowledge of construction activities, the only likely non-standard operating conditions that are envisioned are:

- Accidental spills of fuel, oils and detergents outside of the recommended bunded areas; and
- Flash floods as a result of sudden downpours or floods during exceptionally high rainfall periods.

The accidental spills would be confined to the construction camps and access roads and effects of the flooding to ephemeral stream channels and river banks during the construction period. Spills will be swept up, or, if severe, the contaminated soils will be removed and disposed of at suitable sites. Damage caused by flood waters during construction will be repaired to established civil engineering standards for crossings at streams and rivers.

5.2 Option B: 350KV HCDC avoiding the farms Okaputa, Omarassa and Gaikos

All facets (i.e. Way leaves, route surveying and clearing, power line and substation construction, maintenance and non-standard Operating Conditions) with regards to Option A are relevant for Option B, however the route alignment will be slightly different from that of Option A in order to avoid the farms Okaputa, Omarassa, Osombusatjure, Ode, Gai-Kaisa and Gaikos. The reason for this is the following:

- The area is situated halfway between Otjiwarongo and Otavi, on the farms Okaputa and Omarassa contain two large ephemeral wetlands (>250h), which temporarily fill up with water during the rainy season. During the dry season the expanse of grassland that constitutes the wetlands attracts concentrations of Kori Bustard and Secretarybirds (Erpf and Eberhardt pers.comm). The Option A alignment skirts the one wetland (Omarassa Farm) and crosses directly over the second one (Okaputa Farm), which will create a serious risk of collision for several species of birds, including White Stork, Marabou Stork, Abdim's Stork, Secretarybird and Kori Bustard.
- A landing strip is present on Okaputa which is in close proximity to the Option A power line route.
- On the farms Osombusatjuru 154, Ode 156 and Gai-Kaisa 159 the Option A crosses the footslope of an outlying hill (south-west of Rietfontein), where big trees like *Sclerocarya birrea, Spyrostachys africana* and *Kirkia accuminata* occur, which are classified as endangered species (refer to Figure 13).
- The homestead of the guest farm Dornhügel 241 is characterised by a vast amount of Tambotie Trees. It was therefore opted to have the power line route follow the road at the northern side of the road (i.e. on Gaikos 729 / Damascus 735).

5.2.1 Anti-Collision Devices

To reduce risk of collision with the power lines the earthwire will need to be marked with anti-collision devices. This section is an outcome of the specialist investigation undertaken for the Otjikoto-Katima Mulilo Transmission line by Dr Chris van Rooyen. This measure has been proved to be reasonably successful in reducing collisions, with success rates of up to 60% reduction in mortality and even more documented. There are several devices available in southern Africa for the marking of power lines. Some are dynamic devices (usually called bird flappers), and some are static. Both have advantages and disadvantages. Dynamic devices are very effective in reducing collisions as the birds seem to see them very well probably because of the movement that attracts attention. The disadvantage of dynamic devices is that they are subject to extensive wear and tear, inevitably limiting the lifespan of the device. This has obvious cost implications if a line needs to be re-marked at intervals of a few years. No solution to that problem has been found to date and it must be accepted as a constraint.

Static devices are mechanically more durable because they lack the element of wear and tear that moving parts inevitably have. However, in South Africa, static devices, particularly the so called Bird Flight Diverter (also known as the pigtail) has had limited success (Anderson 2001). The most obvious reason seems to be that they are simply less visible, especially the small ones. A better option would be to use the bigger pigtail, although it is still not the preferred option if utilised in isolation to prevent bird mortality.

A new static product that shows great potential is the Inotec BFD88, a reflective stainless steel sphere of 70mm diameter. Experiments have shown the visibility of this device to be superior to coloured (red, yellow, white, black) objects especially during the low light conditions at dawn and dusk when birds may be flying from roosting areas to feeding areas and back. Due to the spherical shape, the device reflects any available light in all directions and is therefore visible from all directions including above or below the diverter. The diverter does not require direct sunlight and is effective during overcast conditions and the low light conditions before sunrise and after sunset. When viewed during these low light conditions the device is particularly visible against dark backgrounds such as the ground, trees or high ground. It is also particularly visible against bright cloud when viewed from below. An option could be to string the Inotec NFD88 diverters close enough to form a dotted line on each earthwire on those spans crossing the river. Due to the relatively small size of the spheres, it would need to be spaced very close together to make it effective, maximum 5 metres apart on both earthwires. These devices are not required for the tower stay wires.

The phase conductors should be fitted with fluorescent tubes (bird lights) to reduce the risk of nocturnal collisions. The tubes are energized by the ambient electricity field and produce a row of lights at night. This technology has been successfully tried in Botswana and South Africa. The lights will, however, need replacement at regular intervals. Currently, only one product is available on the market, the Mace Bird Lite.

6 ENVIRONMENTS ALONG THE FINAL ROUTE

This chapter provides details of the environments affected along the final route alignment and includes the results of the specialist studies and reports undertaken for this phase.

The following environments are assessed in detail below:

- Vegetation;
- Ornithological (Birds);
- Archaeological Sites;
- Electromagnetic Fields; and
- Land Use and Related Socio-Economic Issues.

6.1 Vegetation

6.1.1 Methodology and General

The vegetation survey was undertaken by Mr. B.Strohbach. The impact assessment was compiled by considering the following information sources: Written reports on the vegetation by Mendelsohn *et al.* (2000), Mendelsohn *et al.* (2002), Strohbach (2002), Strohbach 1992 and Strohbach & Müller (1990). For the National Atlas (Mendelsohn *et al.* 2002) as well as the North Central Profiles (Mendelsohn *et al.* 2000), GIS data is available from the Internet (www.dea.met.gov.na). This was used in combination with remote sensing images (2000/ 2001) and further resource data from NARIS (2001) to map the spatial extent of disturbed and sensitive areas in the study area. This was further augmented by own observations during a short field visit during May 2006 and numerous previous visits to the study area. Protection status was taken from Craven (1999).
The proposed power line will cross three major vegetation types:

- Thornbush savanna;
- Karstveld; and
- South-western part of the Woodland savannas of the northern Kalahari (Giess 1998).

Refer to Appendix K for the detailed Ecological study.

6.1.2 Description of the vegetation types

Thornbush savanna

The first part of the route, from Gerus substation until roughly south of Rietfontein / Grootfontein, runs through Thornbush savanna sensu Giess (1998). Patches of Karstveld vegetation does occur from as far west as the B1 between Otjiwarongo and Otavi, and this latter vegetation type gradually replaces the Thornbush savanna as progress is made eastwards.

Strohbach (2002) described four Thornbush savanna types as occurring in this area in a patchy, mosaic-like manner, being the:

- Acacia erioloba – Stipagrostis uniplumis semi-open bushland;
- Acacia mellifera – Stipagrostis uniplumis semi-open bushland, Acacia mellifera – Monechma genistifolia semi-open bushland;
- Acacia mellifera – Cenchrus cilliaris moderately closed bushland; and
- Lonchocarpus nelsii – Eragrostis rigidior moderately closed bushlands. The patchy nature of these makes mapping extremely difficult.

Both the *Lonchocarpus nelsii – Eragrostis rigidior* bushlands and the *Acacia erioloba – Stipagrostis uniplumis* bushlands occur on occasional sandy patches, the former more to the north under higher rainfall regimes, the latter more to the south and west under somewhat drier rainfall regimes. In both these vegetation types big *Acacia erioloba* trees are in danger of being felled, in the *Lonchocarpus nelsii – Eragrostis rigidior* bushlands also *Lonchocarpus nelsii* (the Kalahari apple leaf) (refer to Figure 9).

Figure 9: Typical *Acacia erioloba – Stipagrostis uniplumis* low semi-open bushland.

The *Acacia mellifera – Stipagrostis uniplumis, Acacia mellifera – Monechma genistifolia* and the *Acacia mellifera – Cenchrus cilliaris* bushlands are less of a concern. As the name indicates, these communities are dominated by *Acacia mellifera* shrubs, with a variety of grasses, other shrubs and dwarfshrubs and forbs. The main difference is the soil type, as determined by depth and soil chemical properties. In these bushlands large *Acacia reficiens* and *A. tortilis* tree occasionally occur (refer to Figure 10).

Figure 10: Typical Thornbush savanna south of the Otavi Range, east of the trunk road

The northern Thornbush savanna types are all very susceptible to bush encroachment, if not already densely encroached (Strohbach 2002, de Klerk 2004). Especially *Acacia mellifera* is the main encroaching shrub, except in the *Lonchocarpus nelsii – Eragrostis rigidior* bushlands. Here the main encroacher is *Dichrostachys cinerea*, a shrub species with extreme coppicing ability (Strohbach 1998/9 a, b & c). Many landowners are clearing the excess bush either through bulldozing and/or herbicides. Indiscriminate use of herbicides lead to the death of desirable species, e.g. fodder shrubs like *Grewia* spp, *Tarchonanthus camphoratus*, and / or protected species like *Acacia erioloba.* Especially big trees like the Camelthorn are susceptible to the indiscriminate use of herbicides, as their roots reach comparatively far from the stem (Timberlake & Calvert 1993) (refer to Figure 11). Cleared areas are known to become habitats for plains animals e.g. cheetah. In this regard it should be noted that a Secretary bird was noted at such a cleared patch, directly along the proposed power line route (19˚ 57.948'S, 17˚ 32.167'E).

Figure 11: Bush eradication using indiscriminate aerial spraying with herbicides. Note the many dead *Acacia erioloba* trees.

Generally in the Thornbush savanna care should be taken to destroy as little as possible of the big trees found, especially the protected species *Acacia erioloba* and *A. tortilis*. After clearing the servitude by bulldozing, a hand-application of a commercial herbicide is recommended in order to prevent the coppicing of especially *Acacia mellifera* and *Dichrostachys cinerea*. Indiscriminate spraying of the cleared area should however be avoided in order to not endanger desired and/or protected plant species nearby the servitude.

Karstveld and Mountain savanna

The Karstveld is characterised by three major geomorphological features namely the Dolomite hills and mountains of the Otavi Range extending between Otavi and Grootfontein, with outliers both to the south (south of Kombat as well as towards Otjiwarongo) as well as to the east (Berg Aukas and Gaikos); the Omuramba Ovambo in the east near Maroelaboom as major drainage from the Karstveld (as well as being the ecotone to the Kalahari sand plateau); and the Intermediate plains which act as catchments for the Omuramba Ovambo.

- The Dolomite Mountains

The Dolomite Mountains are covered by vegetation characterised by tall trees of *Kirkia acuminata, Sclerocarya birrea, Moringa ovalifolia* and *Lannea discolor.* A large variety of shrub and smaller tree species, including *Croton gratissimus, Steganotenia arelacea, Commiphora glaucescens, Euphorbia guerchiana, Pachipodium leallii* and the endemic *Elephantorrhiza goetzii,* as well as various rare forbs occur here. These hills are by far the most diverse vegetation type in the area (Mendelsohn *et al*. 2000, own observations), with not only a unique phanerophyte flora (i.e.trees and shrubs), but also a very diverse, very unique herbaceous layer. Giess (1998) already mentioned that the Otavi Mountain Range

forms an important biogeographical link to the highly diverse Kaokoveld and its centres of diversity. Because of this high diversity, the dolomite hills specifically have been identified as an Important Plant Area for Namibia during a recent workshop, and thus deserve special consideration in future development planning (Hofmeyr 2004).

During the field survey it was observed that the newly proposed route smartly misses this geomorphological feature. Only at Osombusatjuru 154, Ode 156 and Gai-Kaisa 159 the route crosses the footslope of an outlying hill (south-west of Rietfontein) (refer to

Figure 12). Here big trees like *Sclerocarya birrea, Spyrostachys africana* and *Kirkia accuminata* are endangered (refer to Figure 13).

Figure 12: Vegetation on the footslopes of an outlying dolomite hill on the farm Osombusatjuru 154 southwest of Rietfontein

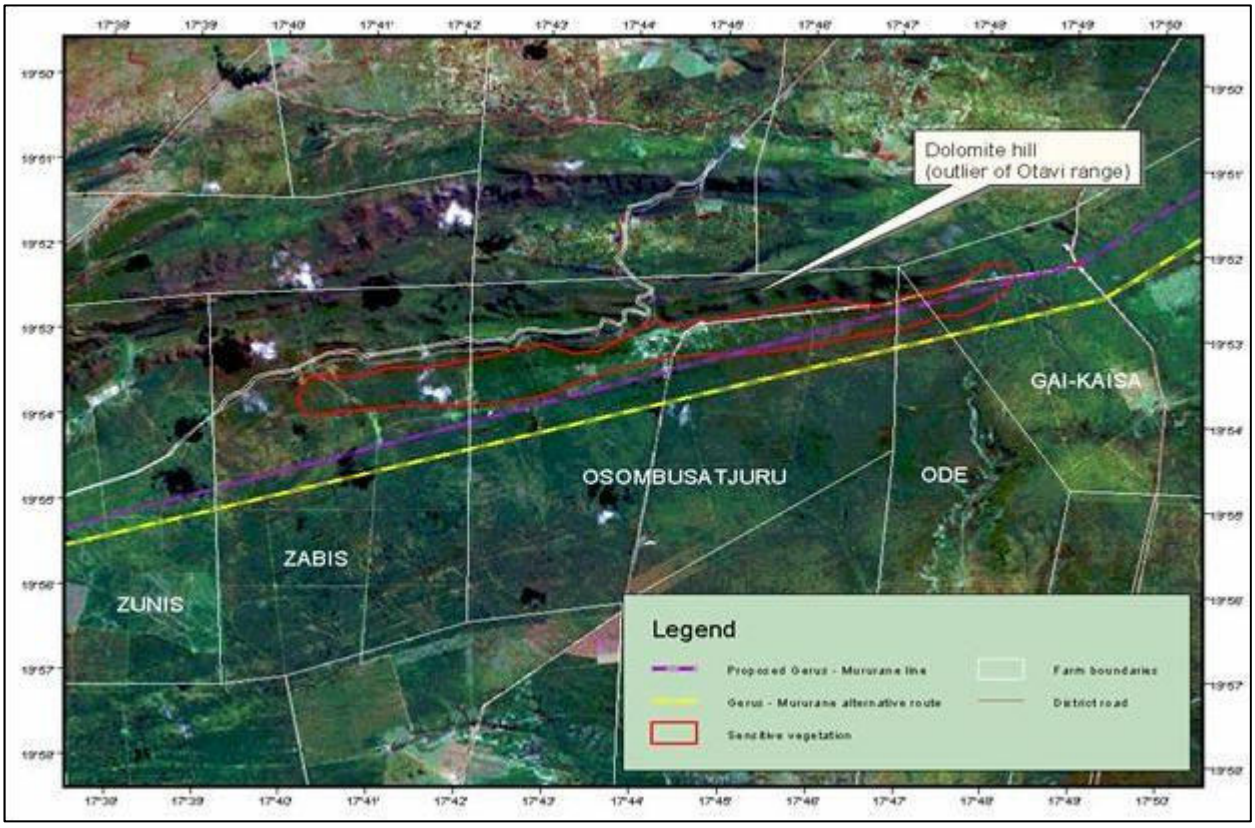

Figure 13: The proposed power line route superimposed on a satellite image to show the extent of the sensitive vegetation

The Karstveld Plains

Although Mendelsohn *et al.* (2000) makes a distinction between the *Terminalia prunioides* woodlands on calcrete and *Terminalia prunioides – Combretum apiculatum* woodlands, these are very similar in nature. They are characterised by often very densely encroached shrubs and trees, dominated by *Terminalia prunioides, Acacia mellifera* and *Dichrostachys cinerea.* The vegetation is very patchy, though. To the south of Grootfontein occurs the “Palmvlakte”, a plain characterised by *Hyphaene petersiana* palm trees (refer to Figure 14). This stretches from the west from about Uitkomst to the east to beyond Berg Aukas. This vegetation type is best developed south of Grootfontein along the Otjituuo road, well south of the power line route.

Figure 14: Typical Palmvlakte vegetation dominated by *Hyphaene petersiana*.

Further east, near the Gaikos Mountain, certain geological features cause the occurrence of *Spirostachys africana* (Tambotie) trees. These are clearly distinguishable on satellite imagery as dark red to dark green east-westerly bands, especially on the farms Damascus 735 and Neu Sachsenwald 1349 (refer to Figure 15 and Figure 16).

Overall, the vegetation is described as being densely encroached by woody species (de Klerk 2004). Clearing will have the impact of opening the vegetation again, especially for grass growth. Care should be taken to treat the remains of cut-off shrubs with a herbicide, best after construction when the shrubs are actively starting to coppice, to prevent further encroachment by especially *Dichrostachys cinerea*. Little is known about the composition of the herbaceous layer, it is however expected to show a high diversity of species (Craven 2001). For this reason, the Karstveld plains were also identified as an "Important Plant Area" worthy of further investigation and protection (Hofmeyr 2004).

In this vegetation, *Spirostachys africana* (Tambotie), *Combretum imberbe* (leadwood) and *Sclerocarya birrea* (marula) do occur, especially in the drainage channels and pans / vleis forming in the area. The drainage channels form a dense network and will be unavoidable during the construction of the power line.

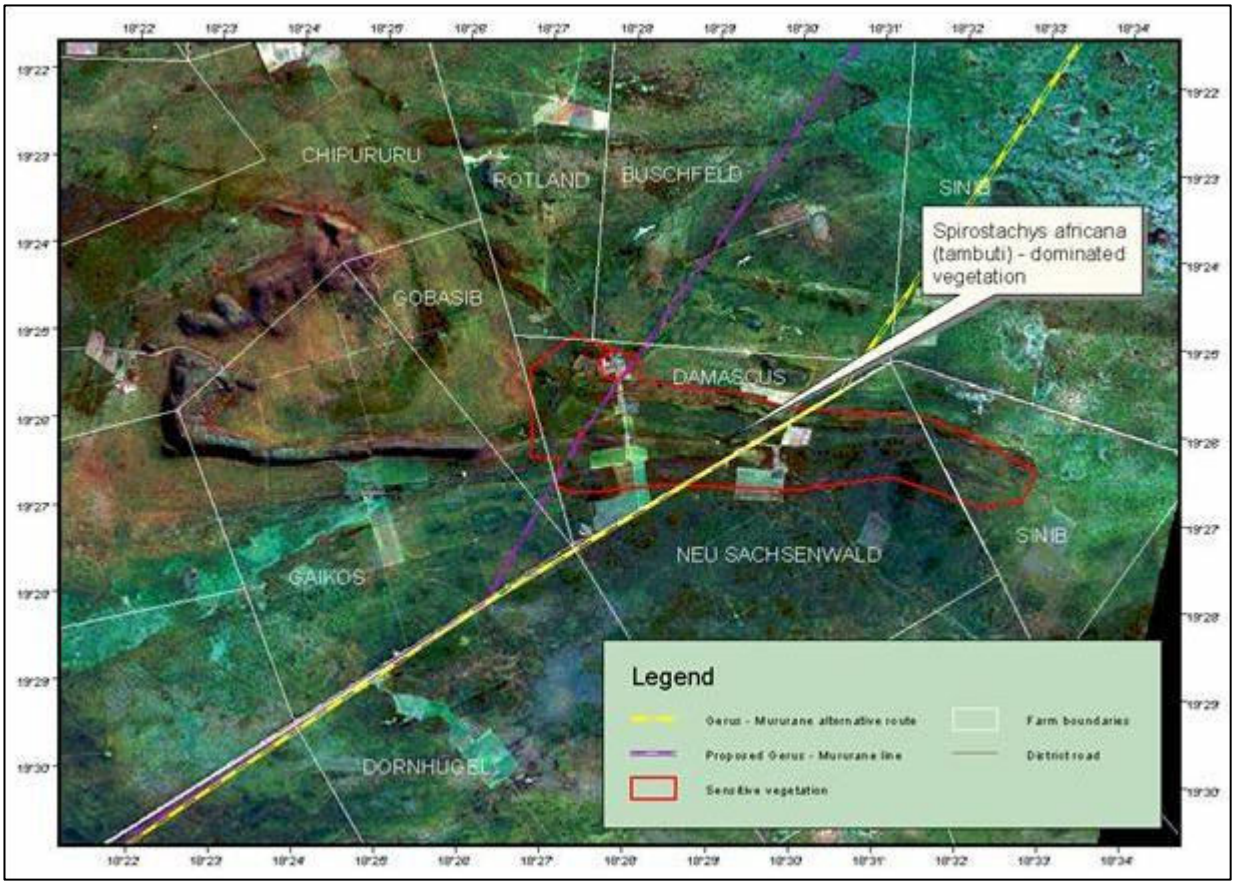

Figure 15: The proposed powerline crosses some dense *Spirostachys africana* (Tambotie) patches at Damascus and Sachsenwald

Figure 16: Typical *Spirostachys africana* (Tambotie) patch along the road at Sachensenwald

- The Omuramba Ovambo

The Omuramba Ovambo forms a transition between the Karstveld and the Woodland savannas further east. Here two habitat systems link up – the deeps sands of the Kalahari and the water-rich environment of the Karstveld, to form a series of pans and vleys with scattered bush clumps – the so-called "Parkiesveld".

Typically, open grass plains, with a low diversity of species but very specialised species are interrupted by dense bush and tree clumps surrounding water pans. This gives the landscape a park-like appearance – thus the term "Parkiesveld" (refer to Figure 17). The Parkiesveld is host to a high variety of species – nearly as diverse as the dolomite hills. Here a huge number of tree species occur – from the "ordinary" *Terminalia prunioides, Combretum apiculatum* and *Sclerocarya birrea* to *Hyphaene petersiana* (Makalani Palm) and the rare *Adansonia digitata* (Baobab) and *Elaeodendron transvaalensis* (Transvaal safran / Lepelhout) are found. The understory and herb layers are as diverse – a variety of rare forbs species, stem succulents and geophytes has been observed here.

According to the data of Mendelsohn *et al*. (2002) the Omuramba Ovambo (indicated as "North-central Omurambas") starts only further north. This is untrue, however, as the Omuramba Ovambo starts to the south-west of Maroelaboom on Neitsas 264 from water from the farm Sinib 257. Similar flood-plain systems on Begus 267 drain into the Omuramba at Nukuwis and further north-west; only from about Tsintsabis the Omuramba starts forming a channel after which talk could be of a proper river.

The proposed power line crosses these Parkies for at least 2.7 km's on the farm Olifantsput. With the proposed re-alignment at Sachsenwald (refer to Figure 15), these are missed and the power line would pass through the edge of the parkies on the farm Neitsas (refer to Figure 18).

Figure 17: Typical "Parkiesveld" of the Omuramba Ovambo. Note the open grassy plains in the foreground, and the dense, highly diverse bush clumps (bush islands) in the background.

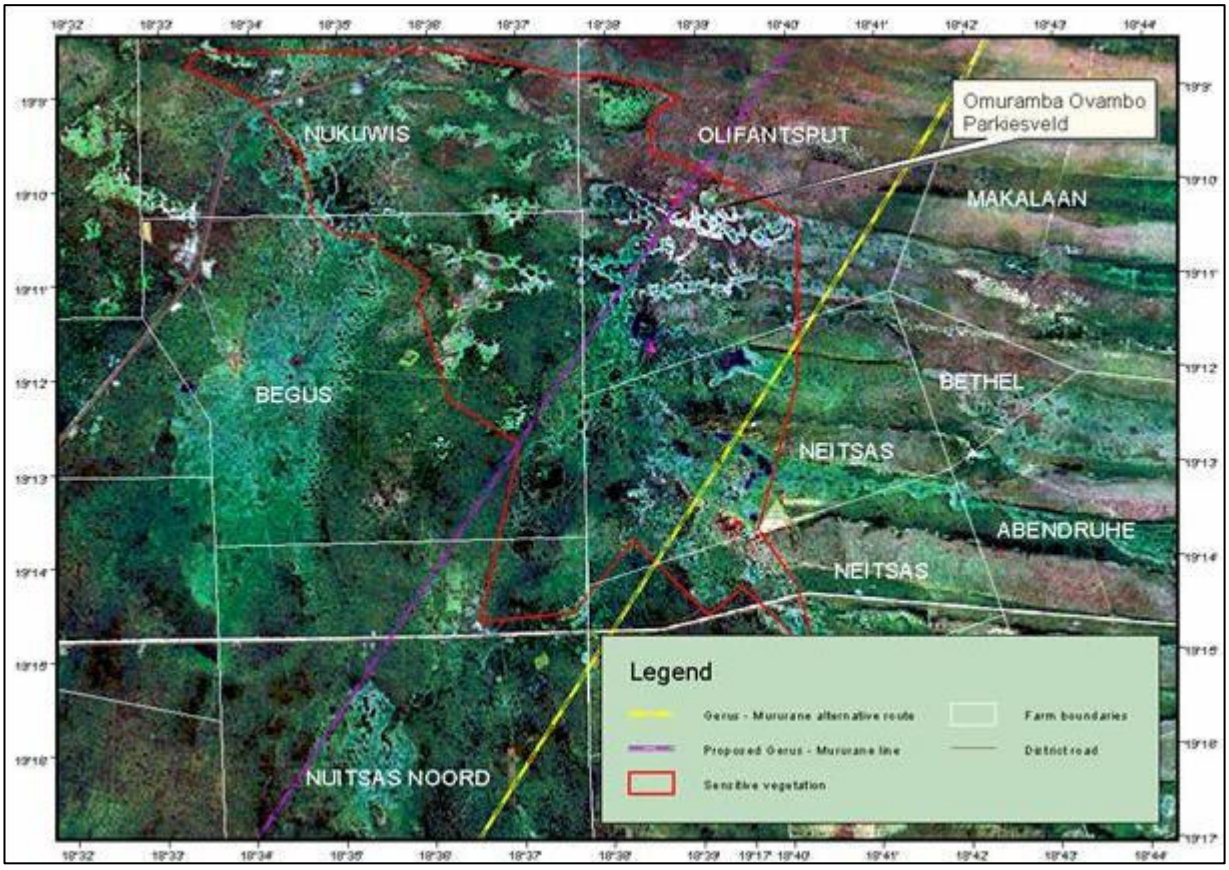

Figure 18: Satellite map of the Omuramba Ovambo near Maroelaboom

As this system is an extensive wetland system, the use of herbicides to control re-growth of shrubs and trees should be avoided in this section of the power line. Herbicides can be transported with water, meaning that trees downstream from the power line can be endangered by the injudicious use of herbicides for clearing / control.

- The Omuramba – dune association (northern Kalahari)

As the proposed power line leaves the Omuramba Ovambo, it enters a low dunefield of the Kalahari. These dunes become higher and more pronounced to the east towards (and beyond) the Mururani gate. The dunes are covered with a dense bushland dominated by *Terminalia* sericea (silver terminalia), *Burkea africana* (wild seringa) and a variety of *Combretum* species, especially *Combretum collinum* (variable bush willow). The higher dunes to the north near the Mururani gate carry also *Pterocarpus angolensis* (teak) and occasionally dense clumps of *Baikiaea plurijuga* (Zambesi teak) and/or *Schinziophyton rautanenii* (mangeti). These patches are clearly distinguishable on aerial photographs. According to remote sensing material available for this assessment, these patches are clearly missed except for those north of Mururani as the power line route joins up with the existing route (refer to Figure 19).

The interdune valleys are typically covered by an open savanna dominated by *Acacia* species, amongst others *Acacia mellifera* (blackthorn), *A. fleckii* (blade thorn) and *A. erioloba* (camelthorn). Especially the camelthorn trees develop to magnificent trees in this area. The Acacia-savanna is at its densest along the margins of the dunes. In the shade of the *Acacia* thicket a fair number of rare species, including small succulents, geophytes and even ground orchids have been found. In this area a fair number of ephemeral pans also develop (specialist observations).

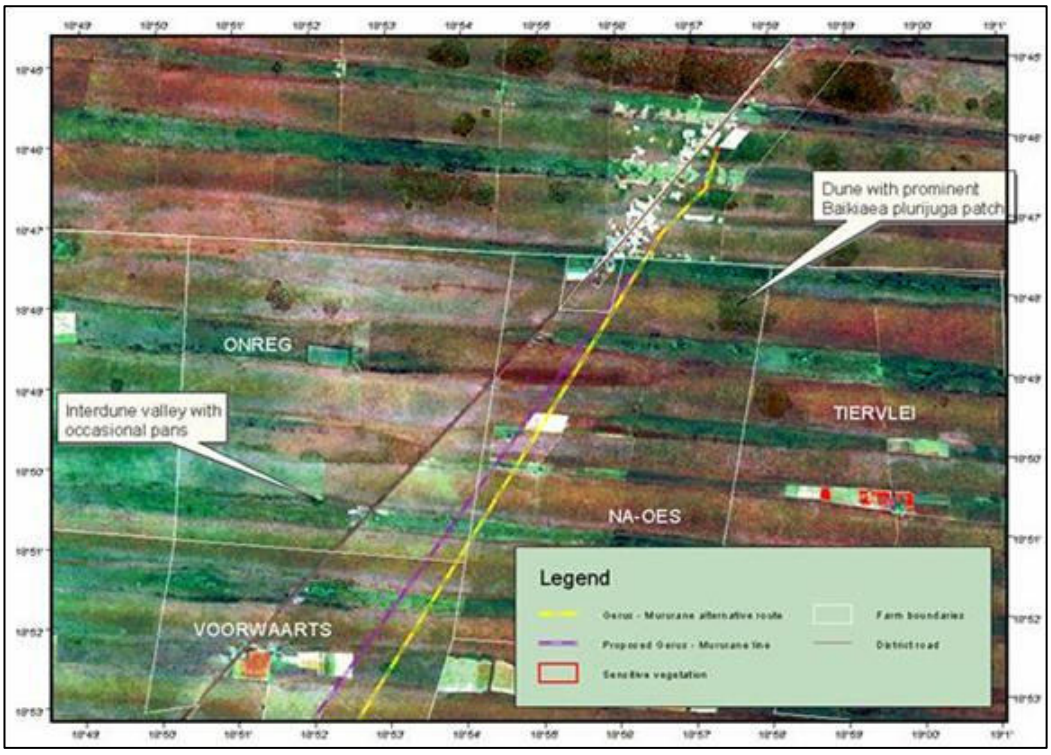

Figure 19: Satellite map of the omuramba – dune association, showing a *Baikiaea plurijuga* patch near the veterinary fence ("red line").

Bush encroachment here is mainly by *Acacia mellifera*, *A. luederitzii* and *Dichostachys cinerea* (Strohbach 1992).

6.1.3 Protected Species

The following table indicated the protected species likely to be encountered for each of the vegetation groups discussed in section 6.1.2.

Table 2: Likely Protected Species

Thornbush savanna	Karstveld and Mountain savanna			The omuramba – dune association (northern Kalahari)
	Dolomite Mountains	**Karstveld Plains**	**Omuramba Ovambo**	
Aloe littoralis (Windhoek Aloe)[NC]	*Aloe littoralis* (Windhoek Aloe)[NC]	*Aloe dinteri* [NC]	*Aloe littoralis (Windhoek Aloe)* [NC]	*Aloe zebrina (zebra Aloe)NC*
Aloe zebrina (zebra Aloe)[NC]	*Aloe zebrina* (zebra Aloe)[NC]	*Aloe littoralis* (Windhoek Aloe)[NC]	*Aloe zebrina (zebra Aloe)* [NC]	*Stapelia spp.NC*
Aloe hereroensis (Sand aloe) [NC]	*Aloe hereroensis* (Sand aloe) [NC]	*Aloe zebrina* (zebra Aloe)[NC]	*Aloe hereroensis (Sand aloe)* [NC]	*Orbeopsis lutea NC*
Cyphostemma spp. [NC]	*Cyphostemma* spp. [NC]	*Aloe hereroensis* (Sand aloe) [NC]	*Brachystelma spp.* [NC]	*Other stapeliodes NC*
Stapelia spp. [NC]	*Moringa ovalifolia* [NC]	*Brachystelma* spp. [NC]	*Stapelia spp.* [NC]	*Ceropegia spp. NC*
Acacia erioloba (camelthorn) [F]	*Pachypodium lealii* [NC]	*Stapelia* spp.[NC]	*Orbeopsis lutea* [NC]	*Habenaria spp. NC*
Albizia anthelmintica (worm cure Albizia) [F]	*Brachystelma* spp. [NC]	*Ceropegia* spp. [NC]	*Other stapeliodes*	*Eulophia spp. NC*
Boscia albitrunca (shepherd's tree) [F]	*Stapelia* spp.[NC]	*Acacia erioloba* (camelthorn) [F]	*Ceropegia spp.* [NC]	*Acacia erioloba (camelthorn)* [F]
Combretum imberbe (leadwood)[F]	*Ceropegia* spp. [NC]	*Albizia anthelmintica* (worm cure Albizia) [F]	*Acacia erioloba (camelthorn)* [F]	*Albizia anthelmintica (worm cure Albizia)* [F]
Lonchocarpus nelsii (apple leaf tree)[F]	*Acacia erioloba* (camelthorn) [F]	*Berchemia discolor* (bird plum) [F]	*Adansonia digitata (baobab)* [F]	*Baikiaea plurijuga (Zambesi teak)* [F]
Maerua schinzii (ringwood tree) [F]	*Albizia anthelmintica* (worm cure Albizia) [F]	*Boscia albitrunca* (shepherd's tree) [F]	*Albizia anthelmintica (worm cure Albizia)* [F]	*Boscia albitrunca (shepherd's tree)* [F]
	Berchemia discolor (bird plum) [F]	*Combretum imberbe* (leadwood)[F]	*Berchemia discolor (bird plum)* [F]	*Burkea africana (wild seringa)* [F]
	Boscia albitrunca (shepherd's tree) [F]	*Maerua schinzii* (ringwood tree) [F]	*Boscia albitrunca (shepherd's tree)* [F]	*Combretum imberbe (leadwood)* [F]
	Combretum imberbe (leadwood)[F]	*Olea europea* subsp. *africana* (wild olive)[F]	*Combretum imberbe (leadwood)* [F]	*Lonchocarpus nelsii (apple leaf)* [F]
	Kirkia accuminata (white seringa) [F]	*Peltophorum africanum* (weeping wattle)[F]	*Elaeodendron transvaalensis (Transvaal safran)* [F]	*Maerua schinzii (ringwood tree)* [F]
	Lannea discolor (live-long) [F]	*Sclerocarya birrea* (marula) [F]	*Ficus thonningii (common wild fig)* [F]	*Ochna pulchra (peeling plane)* [F]
	Lonchocarpus nelsii (apple leaf tree) [F]	*Spirostachys africana* (Tambotie) [F]	*Maerua schinzii (ringwood tree)* [F]	*Peltophorum africanum (weeping wattle)* [F]
	Maerua schinzii (ringwood tree) [F]		*Olea europea subsp. africana (wild olive)* [F]	*Pterocarpus angolensis (teak)* [F]
	Olea europea subsp. *africana* (wild olive)[F]		*Peltophorum africanum (weeping wattle)* [F]	*Schinziophyton rautanennii (manketi)* [F]
	Peltophorum africanum (weeping wattle)[F]		*Schinziophyton rautanennii (manketi)* [F]	*Spirostachys africana (Tambotie)* [F]
	Sclerocarya birrea (marula) [F]		*Sclerocarya birrea (marula)* [F]	
	Spirostachys africana (Tambotie) [F]		*Spirostachys africana (Tambotie)* [F]	

[NC] Protected by the Nature Conservation Ordinance (Ordinance 4 of 1975) [F] Protected by the Forestry Act (Act 12 of 2001)

This list is not exhaustive. Other protected species might also occur.

6.2 Archaeological Sites

Eco.plan (Pty) Ltd has commissioned Quaternary Research Services to carry out an archaeological assessment of the power line route. The Phase 1: Route Evaluation and Finalisation (Scoping Study) required that QRS provide co- ordinates of known archaeological sites that are near the proposed alignment options (within approximately 4km each side of each route option). The desk study was to form the basis for the Volume 2: Environmental Assessment (to be combined with the Volume 3: EMP).

Refer to Appendix L for the detailed archaeological study undertaken.

6.2.1 Phase 1: Desk study

The accompanying map (Figure 22) indicates the alignment options, with a 4km buffer, in relation to the distribution of known archaeological sites. The proposed alignment corridor does not affect any known sites. However, the area is incompletely surveyed and there are a number of locations on the alignment where there is a high probability that archaeological sites will be affected by the construction of the power line. These locations are indicated as demarcated areas “a” to “f” in Figure 22.

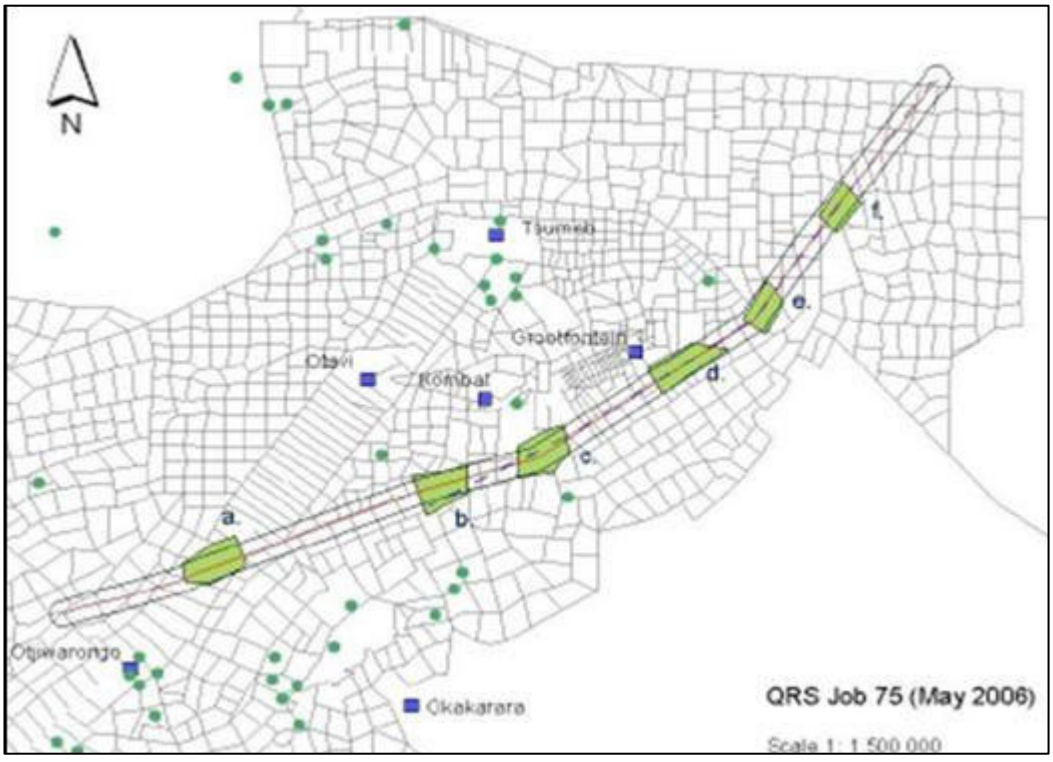

Figure 20: Known archaeological sites and possible site locations in relation to the proposed Gerus-Mururani power line route and 4km buffer.

- Site a. Farm Brunnental (7) and Omarassa (4) (Sheet 2016 Otjiwarongo)

On the farm Brunnental (7), the alignment traverses the northern side of a line of low rocky hills. These locations are usually of archaeological significance. Udabib Pan, on the neighbouring property Omarassa (4) is also likely to have some archaeological sites along its margins.

- Site b. Farm Ombaranga (493) (Sheet 1916 Tsumeb

Low rocky outcrops on the farm Ombaranga (493) are known to have both rock art sites as well as rock shelters with stratified archaeological deposits. Test excavations at one of these sites yielded stone tool assemblages and well preserved faunal remains which were radiocarbon dated to within the last 2 000 years. It is generally the case that such sites do not occur in isolation, and since the adjacent part of the power line buffer zone has similar terrain conditions it is very likely that further sites occur there.

- Site c. Farm Osombusatjaru (154) Gai-Kaisa (159) (Sheet 1916 Tsumeb)

A low range of rocky hills on the farms Osombusatjaru (154) Gai-Kaisa (159) lies within the power line buffer zone. The hills form a prominent topographic feature within an otherwise subdued terrain and are therefore likely to have some archaeological sites. These would probably belong to the same distribution as the Ombaranga sites.

- Site d. Berg Aukas (Sheet 1918 Grootfontein)

The Berg Aukas palaeocave outcrop is a very important fossil locality in north eastern Namibia. The site has yielded the largest Miocene-Pliocene microfossil assemblage in Africa, as well as the lower mandible of the hominoid type-fossil *Otavipithecus*. The Berg Aukas locality is adjacent to the alignment buffer zone. However, the breccia outcrop at Berg Aukas has not been completely explored and there is a likelihood that it extends into the buffer zone.

- Site e. Farm Gaikos (729) (Sheet 1918 Grootfontein)

On the farm Gaikos (729), a low range of hills projects into the alignment buffer zone and presents similar conditions to the terrain on Osombusatjaru (154) and Gai-Kaisa (159). The area also has a large number of karstic features that present similar geological conditions to those of Berg Aukas.

- Site f. Farm Taranaki (897) (Sheet 1918 Grootfontein)

The farm Taranaki (897) is bisected by a number of palaeodune alignments that are of likely archaeological significance. The interdune valleys of the Quaternary dune alignments in Namibia are frequently associated with archaeological sites, especially where minor seasonal wetlands developed in these locations.

6.2.2 Observations

- Site a. Farm Brunnental (7) and Omarassa (4) (Sheet 2016 Otjiwarongo)

The Brunnental part of area a, forms the northern margin of a broad sandy plain bounded by a range of low dolomite hills. The plain has a shallow aeolian sand deposit with outcropping calcrete and calc-silicate rocks, and very dense tree and bush cover consisting of various *Acacia-Grewia-Combretum-Terminalia* associations. An extended transect of the hill foot-slopes in the vicinity of S20.19081 E16.81978 revealed no archaeological remains. The Omarassa part of area a., comprises extensive grassy vleis, the largest being Udabib Pan, with moderately dense tree savanna characterized by an Acacia-Grewia association. The tree savanna occupies low ridges which represent erosional remnants of a more extensive planar surface. An extended transect of the proposed alignment in the vicinity of S20.16239 E16.93491 revealed no archaeological remains.

- Site b. Farm Ombaranga (493) (Sheet 1916 Tsumeb)

A discontinuous range of low dolomite hills runs parallel to the alignment on the north side where it skirts the farm Ombaranga (493). An important archaeological site is located on the farm Ombaranga, with rock art and a well preserved late Holocene deposit. The range continues in an ENE direction through the farms Fairview (488) and Harubib (489). The alignment runs through densely wooded savanna characterized by an *Acacia mellifera-Peltophorum-Terminalia* association. The properties in question could not be accessed because the gates were locked, but a long transect was made on the Harubib side using the public road D2810. No archaeological remains were noted.

- Site c. Farm Osombusatjaru (154) Gai-Kaisa (159) (Sheet 1916 Tsumeb)

The range of hills noted above extends through these two properties, of which only Gai-Kaisa (159) was accessible. The hills are covered by the same *Acacia mellifera-Peltophorum-Terminalia* association noted above. The range of hills forms the northern side of a corridor, up to 5km wide, and flanked on the south by an *omuramba* valley with extensive outcropping sandstone of the Etjo (now Twyfelfontein) Formation. In view of the known archaeological and palaeontological importance of the Etjo a further transect was made perpendicular to the corridor, across the farm Breitenbach (152). The transect confirmed the presence of archaeological remains in association with the Etjo, and the farm owner provided information to the effect that well preserved dinosaur tracks were known to exist on the neighbouring property Neudorf (155).

- Site d. Berg Aukas (Sheet 1918 Grootfontein)

The Berg Aukas palaeocave, an important Miocene-Pliocene palaeontological deposit, was located on the site of the now abandoned Berg Aukas copper mine. The palaeocave deposit formed part of a prominent dolomite ridge running in an ESE direction to intersect the alignment on the farm Lahn (228) approximately 10km east of Berg Aukas. A transect of outcropping rock was made in the vicinity of S19.52516 E18.30876 to determine whether the palaeocave breccia occurred beyond Berg Aukas. Outcropping rock on the farm Lahn was all relatively recent calcrete, however, with a thin soil cover of compact grey sandy loam. No indications of cave breccia or archaeological remains were found.

- Site e. Farm Gaikos (729) (Sheet 1918 Grootfontein)

The farm Gaikos (729) and the neighbouring property Damascus (735) lie on the south western edge of the extensive panveld terrain to the northeast of Grootfontein. On Gaikos and Damascus there are a few low outliers of the Grootfontein hills. The hills on Damascus are a finely laminated quartzite, and covered by dense woodland comprising an association of *Combretum-Commiphora- Dichrostachys-Dombeya*, with occasional *Ricinidendron*. A transect in the vicinity of S19.43589 E18.46375 located a single archaeological site, a surface scatter of stone artefact debris at S19.43664 E18.46192. The scatter covered an area 2 x 3m with a maximum density of 50 pieces/m^2 hydrothermal vein quartz. The site has a significance rating of 1, and a vulnerability rating of 1.

- Site f. Farm Taranaki (897) (Sheet 1918 Grootfontein)

Access to farm Taranaki was closed and the neighbouring property, Olifantsput (911) was used as an alternative sample site. The terrain in the vicinity of S19.15078 E18.63942 is flat panveld with a mosaic of shallow impoundments among dense thickets of vegetation consisting of Hyphanae palms in

association with *Acacia-Grewia-Peltophorum-Combretum-Terminalia* woodland. Transects through this area revealed no archaeological sites.

6.3 Ornithological (Birds)

6.3.1 Methodology and General

The Endangered Wildlife Trust was requested to perform a bird specialist study to investigate the impact on birds of a new 350kV HCDC transmission line in Namibia from Gerus substation near Otjiwarongo to Mururani Gate, approximately 120km north of Grootfontein towards Rundu. The total length of the line is around 320km. A provisional line corridor has been selected, and a general study area has been defined. This study was preceded by a desk top scoping study where areas were identified that needed further investigation.

In predicting power line impacts on birds and vice versa, one has to draw on both science and experience. In this impact study the following predictive methods were followed:

- A list of power line sensitive species occurring in the study area was compiled from the Atlas of Southern African Birds (Harrison *et.al.* 1997). Specific emphasis was placed on Red Data species, a list of which was obtained from Dr Rob Simmons, former ornithologist with the Namibian Department of Environment and Tourism and co-author of the Namibian Red Data list of birds (Simmons and Brown 2006).
- A sensitivity index was compiled for the quarter degree squares bisected by the proposed alignment using conservation status and reporting rates by Harrison *et.al.* (1997) of power line sensitive Red Data species, as parameters.
- Additional information of specific bird “hot-spots” in the study area was obtained from Dr. Rob Simmons and Dr. Ben Strohbach, vegetation ecologist with the Namibian National Botanical Research Institute.
- A combination of maps and satellite imagery was used to identify specific features in the landscape that have significance for birds e.g. water courses, cliffs, agricultural activity and dams.
- A field trip was undertaken in order to inspect the alignment, and specifically those areas that had been identified as sensitive in the pervious desk top study.
- Two landowners, Mr. Eberhardt (Omurassa Farm) and Mr. Erpf (Okaputa Farm), were visited to obtain first hand information on potential bird impacts on their farms, and bird sensitive habitat on the farms was inspected.
- Impacts were predicted based on 10 years of research in the field of bird/power line interactions by the author in southern Africa, supplemented by published research results in southern Africa and elsewhere in the world.

Refer to Appendix L for the detailed Ornithological survey.

6.3.2 Identification of Sites of Importance for Birds

Within the vegetation zones in the study area, several distinct bird micro-habitats are found. These micro-habitats are of particular importance as it may under favourable circumstances, host congregations of birds in a relatively small geographic area. These zones can be broadly categorised as follows:

- Drainage lines and wetlands (refer to Figure 23):

The drainage lines and wetlands consist mainly of temporary watercourses (omurambas), and ephemeral pans. This habitat supports a rich variety of power line sensitive water birds such as ducks, waders and storks. One area that needs special mention in this respect is the Omuramba Owambo, a small section of which is currently affected by the proposed alignment. This system flows westwards into the Fischer's Pan section of the Etosha Pan. The "catchment" consists of predominantly thin-soiled grasslands and scrub underlain by calcrete and interspersed by pans and depressions.

Large areas flood during the rainy season, forming shallow sheets of water with deeper sections and pans, known as "parkiesveld". Large numbers of wetland birds are attracted to the area during wet periods and that could create a risk of collision. (Simmons pers.comm).

The Omuramba Owambo could hold large numbers of birds due to the prevalence of wetlands (refer to Figure 24), some of which are several hectares in size. Another important wetland is situated halfway between Otjiwarongo and Otavi, on the farms Okaputa and Omarassa. The farms contain two large ephemeral wetlands (>250h) which temporarily fill up with water during the rainy season. During the dry season the expanse of grassland that constitutes the wetlands attracts concentrations of Kori Bustard and Secretary Birds (Erpf and Eberhardt pers.comm). The wetlands were particularly attractive in the previous rainy season and attracted storks of various species (Erpf pers.comm).

Due to the current alignment which traverses the one wetland (Omarassa Farm) and crosses directly over the second one (Okaputa Farm) a serious risk of collision for several species of birds, including White Stork, Marabou Stork, Abdim's Stork, Secretary Bird and Kori Bustard could be created. With this in mind serious consideration should be given to shifting the alignment at least one kilometre away from those two pans (and a third one further north) to minimize this risk. One option might be to follow the existing main road between Otjiwarongo and Otavi for a few kilometres and then cross over to join up with the currently proposed alignment (refer to Figure 25).

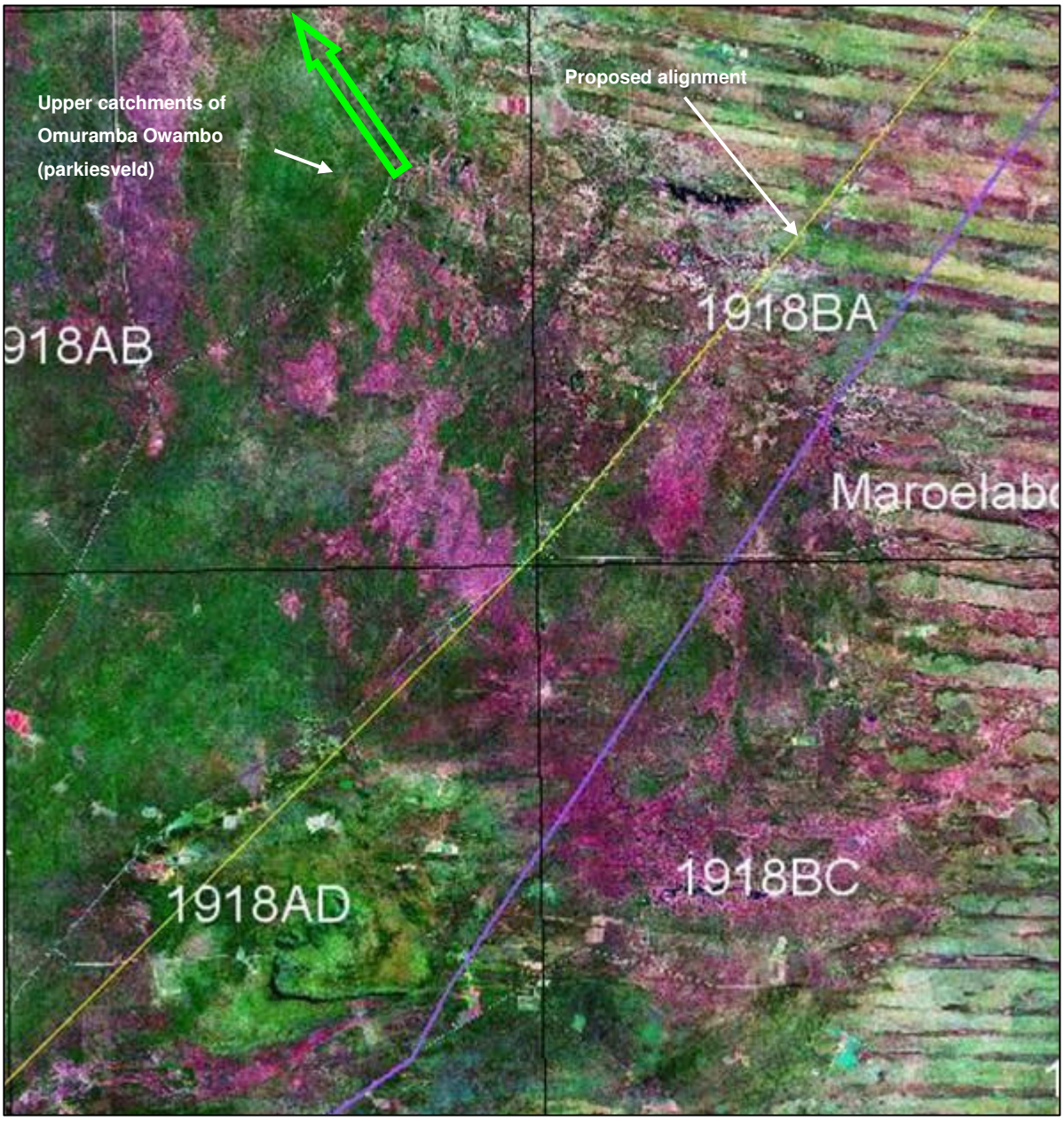

Figure 21: A satellite image of the upper catchments of Omuramba Owambo in relation to the proposed alignment. The green arrow indicates the direction of drainage.

Figure 22: An example of an ephemeral wetland in the Omuramba Owambo

Another area that was identified from satellite imagery is located north of the Waterberg Plateau. It consists of an area where several tributaries of the Omuramba Omataka is located, which, judging from the satellite imagery and the reporting rates for several Red Data wetland species, including Wattled Crane, contains open water during wet periods. Although the proposed alignment does not actually cross the area where most of the wetlands are situated, it does cross several tributaries of the Omuramba Omataka, which initially was judged to be potential fly-ways to larger ephemeral wetlands further south.

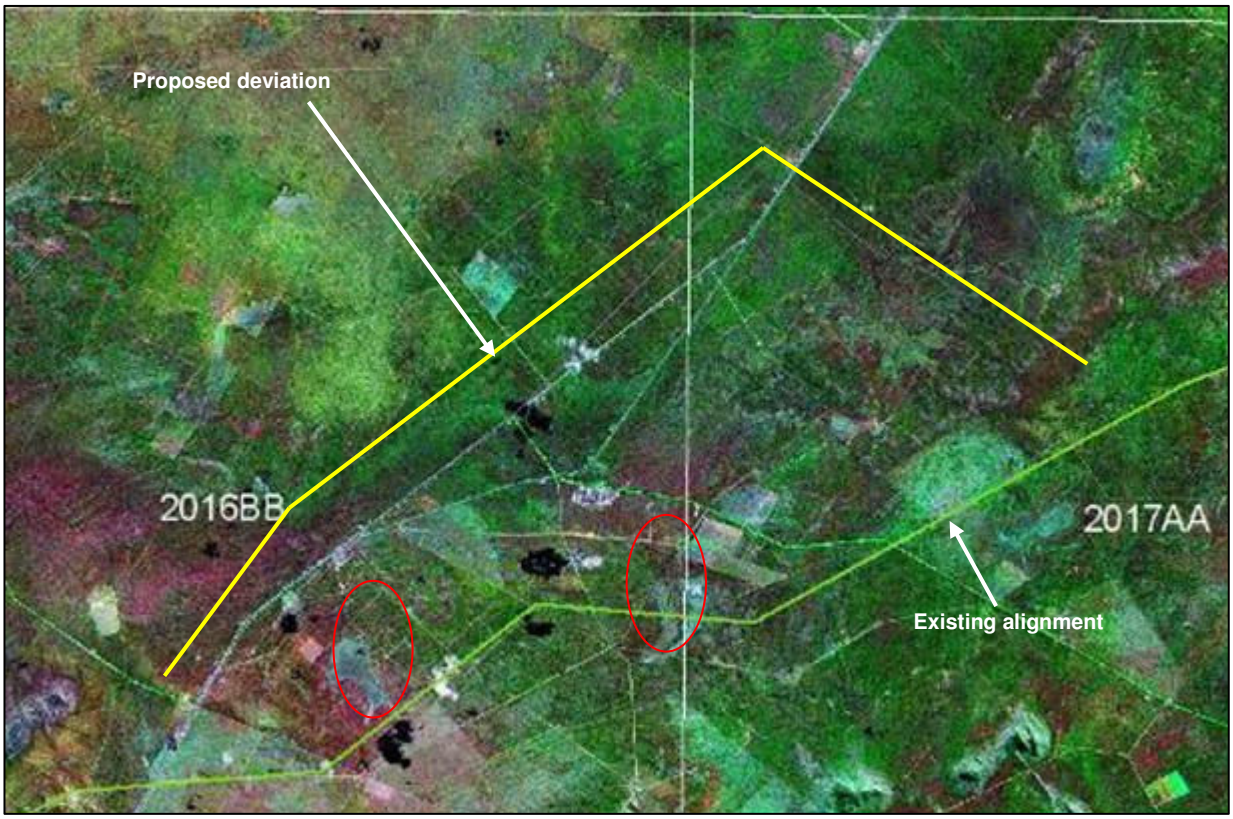

Figure 23: Map showing the wetlands on Omarassa and Okaputa Farms. A suggested alternative alignment is indicated in yellow.

- Cultivated areas:

The extent of cultivation in the study area is limited; most of the land use is cattle and game farming. Cultivated areas provide diverse habitats: they may have been recently ploughed, planted with growing crops or with stubble and weeds after harvesting. Cultivated areas may also contain fields lying fallow (with thick grass and herb cover after rain and often scrubby with growth regeneration). Species such as White and Abdim's Stork are liable to occur on ploughed fields or bare fallow lands (e.g. in 1917 DC). Extensive areas of fallow land may also be used by Secretary Birds and in this instance Kori Bustard (pers. obs). The agricultural areas near Grootfontein were inspected during the field investigation and while the visual inspection confirmed the suitability of the habitat, it was again clear that the alignment was to far away (several kilometres) from the fields to influence the birdlife that would utilize the fields.

- Hills:

The study area is generally flat country, but the Waterberg Plateau, approximately 30km east of Otjiwarongo, is an important exception that provides vital habitat for a number of power line sensitive species. The Waterberg Plateau provides the last refuge for globally threatened Cape Vulture in Namibia. The Cape Vultures used to breed in large numbers on the near vertical cliffs in the west. The colony numbered over 500 in the fifties (Simmons et.al. 2001), but has since dwindled to about 11 individuals (Diekmann 2004). The proposed power line is unlikely to impact directly on Cape Vultures as the roosting areas are at least 50km away from the alignment at the closest point. However, the birds will forage over the line and if a carcass is located close to the line, the risk of collision exists. Two

vulture restaurants were identified during the field visit, one on Omarassa Farm and one on Okaputa Farm. Both are close enough to the alignment to warrant concerns of collision with the proposed alignment, which is an additional reason why it is proposed that the alignment is shifted on those two farms.

The most important migratory species that could potentially be affected by the proposed power line are the two species of flamingos namely the Greater and Lesser Flamingos. Both species are listed as Red Data species (Simmons and Brown 2006) and occurs in large numbers at Etosha, which is one of the few places where they have bred successfully. Large concentrations are also found in the "pannetjiesveld" around Tsumkwe in Bushmanland, possibly *en route* to Sua Pan in Botswana (Simmons and Brown 2006).

The proposed power line will cut diagonally across the flight path of birds moving between Etosha and Tsumkwe and collisions, particularly nocturnal ones, can not be ruled out. During the field inspection it became apparent that any attempt at demarcating areas where flamingos will regularly cross the line would be futile. The reason for that is that the flat topography does not lend itself to obvious flight paths such as valleys, nor are there major rivers that the birds would use as navigational aids. The only assumption that can be made is that the birds are likely to follow the most direct flight path between Etosha and Bushmanland in order to conserve as much energy as possible. If that assumption is correct, it means that a sizable section of the power line (35-40km) could act as a collision risk for flamingos travelling across the line (see Figure 24). The only way to establish if this will materialise into actual mortalities would be to regularly patrol the line, which is unlikely to happen, given the difficulty of access. It has to be conceded that not much can be done in practical terms to alleviate this potential impact, unless a cost-effective method could be found to verify the extent of the actual risk and the actual geographic location.

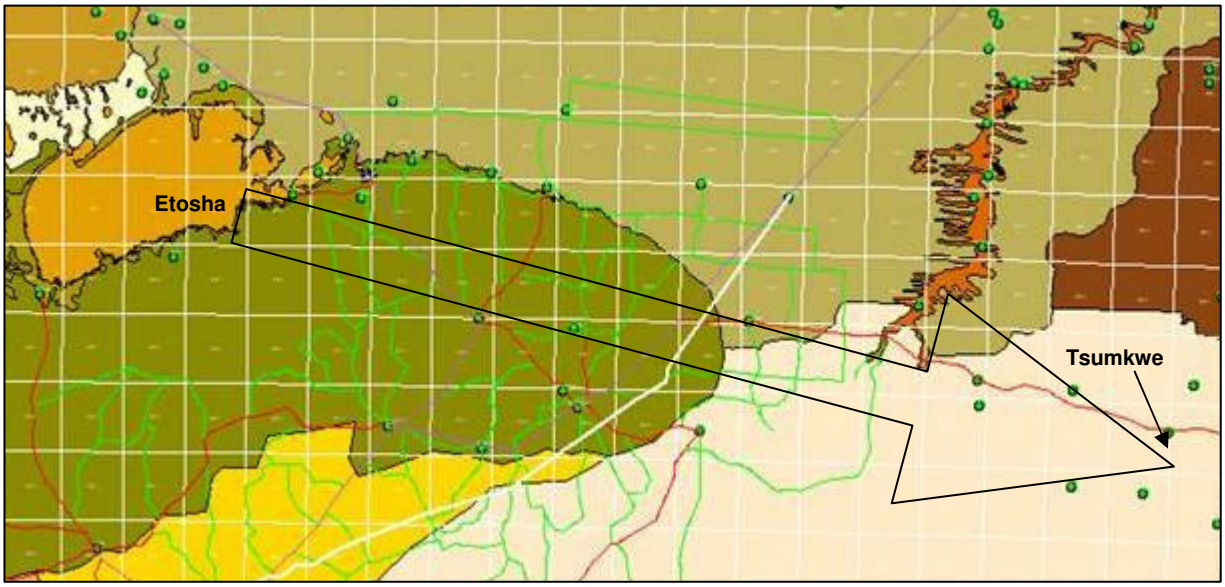

Figure 24: Speculated flight path of flamingos between Etosha and Tsumkwe

6.3.3 Identification and description of power line sensitive large terrestrial birds

The following section identifies and describes power line sensitive large terrestrial birds in the area, with specific emphasis to Red Data species.

A total of 13 power line sensitive Red Data species have been recorded in the quarter degree squares that make up the study area (refer to Table 3).
Reporting rates for each species are provided in Appendix A of the ornithological report contained in Appendix L).

Table 3: Red Data species recorded in the study area (Harrison *et.al.* 1997)

Red Data Species	Status
Cape Vulture	Critically Endangered
Bateleur	Endangered
Ground Hornbill	Endangered
Martial Eagle	Endangered
Rufousbellied Heron	Endangered
Tawny Eagle	Endangered
Wattled Crane	Endangered
Black Eagle	Near Threatened
Marabou Stork	Near Threatened
Whitebacked Vulture	Near Threatened
Greater Flamingo	Vulnerable
Lappetfaced Vulture	Vulnerable
Lesser Flamingo	Vulnerable

A Red Data sensitivity score was calculated for each square bisected by the proposed alignment (refer Figure 27).

The sensitivity index highlights 1917DC, 1917DD and 1918BA as being of particular importance. 1918BA corresponds with the expected sensitivity in the Omuramba Owambo (“parkiesveld”) and has been covered above. The sensitivity recorded in 1917DC and DD is closely linked to high densities of Red Data raptor species, which should not be impacted by the proposed power line. The proximity of the Omuramba Omataka in 1917DD can also be partially responsible for the high sensitivity in 1917DD, with reporting rates for Wattled Crane and Rufous-bellied Heron. As mentioned before, the power line should be too far away to impact these birds.

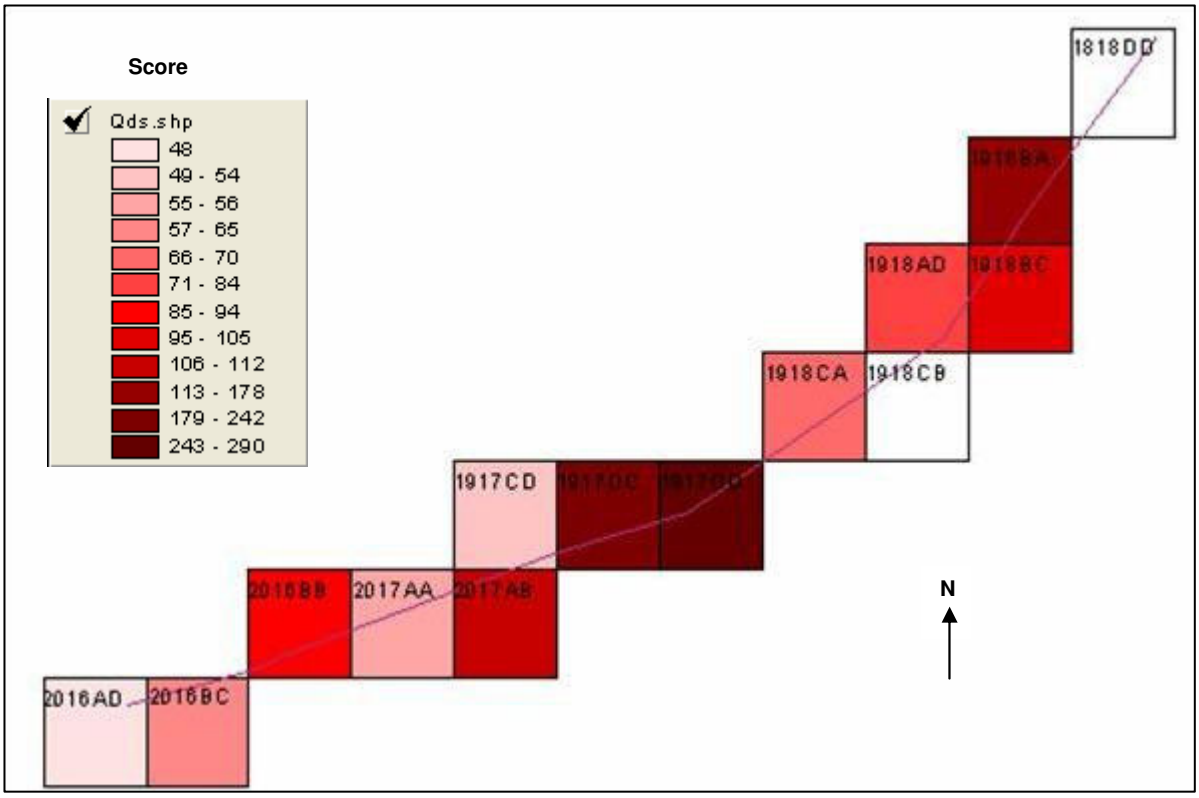

Figure 25: Relative sensitivity of the study area using the recorded presence of power line sensitive Red Data species as indicators of sensitivity.

6.3.4 Electromagnetic Fields (EMF's)

Sources of information

Since the concern of electromagnetic fields (EMF's) on human health is generally expressed when investigating the establishment of a power line, Eco.plan undertook a review of the available literature on this subject. There are many Internet sites reporting the results of research on the possible health effects of electromagnetic fields (EMFs). Some of these point to correlations between exposure to EMFs and the incidence of cancer. In most cases these studies relate to people in the work place ("occupational health"), but a few relate to the effects of power lines on the public ("environmental health").

The difficulty with these studies is that a correlation does not prove cause and effect, and it is very difficult to separate the effects of EMFs from other variables, especially the wider environment. Moreover, a correlation is meaningless without a strong theoretical basis that can explain the mechanisms of cause and effect. For this reason, Eco.plan turned their attention to reliable organisations that have conducted extensive reviews of available studies, evaluated those studies in terms of their scientific merit, and summarised their findings.

The information contained in this section below is based on the following sources: -

1. The World Health Organisation (WHO) http://www.who.int/peh-emf
    - The WHO established the International Electromagnetic Fields (EMF) Project in 1996 and has been reviewing research results and conducting risk assessments of exposure to static and extremely low frequency (ELF) electric and magnetic fields. This includes the fields produced by power lines.
2. GreenFacts http://www.greenfacts.org/power-lines/index.htm
    - The GreenFacts website claims to be "a faithful summary of the leading scientific concensus report produced in 2002 by the IARC (International Agency for Research on Cancer)". The particular website mentioned above deals specifically with power lines, wiring and appliances.
3. The International Commission on Non-Ionizing Radiation Protection (ICNIRP) http://www.icnirp.org
4. The ICNIRP is a non-profit making body that is legally registered as such in Germany, and it is independent of industry in both membership and funding. It publishes its findings on the website www.earthprint.com.

The nature of electromagnetic fields (EMFs)

An electromagnetic field is a combination of an electric field and a magnetic field. Such fields exist in nature (e.g. lightening, and the Earth's magnetic field) as well as man-made sources (such as radio waves and the EMFs around power lines).

Electric fields are created by differences in voltage – the higher the voltage, the stronger the resultant field. Electric fields are measured in volts/metre (V/m) or kilovolts per metre (kV/m). An electric field exists wherever there is a difference in voltage. Even if a household appliance is not switched on there will be an electric field around the conductors in the wall. Electric fields are strongest closest to the device or conductors, and diminish rapidly with increased distance. Electric fields are attenuated to some degree by obstacles such as the walls of buildings and trees.

Magnetic fields are generated whenever electric current flows. The greater the current, the stronger the magnetic field. High voltage transmission lines usually transmit electricity at low current. Magnetic field strength is measured in ampere per metre (A/m) although it is usually expressed in terms of the corresponding magnetic induction measured in units of tesla (T), millitesla (mT), or microtesla (μT). Magnetic fields are also strongest closest to the power line and diminish rapidly (exponentially) with distance. However, they are not shielded by most common materials.

EMFs are defined in terms of their frequency and wavelength. The frequency is the number of cycles per second, while the wavelength is the distance between one wave and the next. These two are inversely related - the higher the frequency the shorter the wavelength. The fields around electrical conductors are at the relatively long wavelength, low frequency end of the electromagnetic spectrum.

The extremely low frequencies (ELF) associated with electricity transmission at frequencies of 50/60 Hz are the focus of attention here. ELF fields are defined as those having frequencies up to 30Hz. At such low frequencies, the wavelengths are very long – 600 km at 50 Hz or 5000 km at 60 Hz.

Sources and human exposure levels

In nature, 50/60 Hz electric and magnetic fields occur at extremely low intensities - of the order of 0.0001 V/m and 0.00001 µT. By comparison, some of the levels to which people are exposed are provided in the table below. The figures provided for "Community" are the most relevant to this study (refer to Table 4).

Table 4: EMF Exposures

Environment	Source	Electrical field strength	Magnetic field strength
Community	Directly underneath overhead transmission lines	Up to 12 kV/m	Up to 30 µT
	At generating stations and transformer sub stations	Up to 16 kV/m	Up to 270 µT
Home	Highly variable. Exposures given close to most household appliances.	Typically not exceeding 500 V/m	Typically not exceeding 150 µT
Workplace	Within generating stations and sub stations	25 kV/m	2 mT
	Welders	No information	Up to 130 mT
	Near induction furnaces or industrial electrolytic cells	No information	Up to 50 mT

Both electric and magnetic field strength decreases rapidly (exponentially) with distance from the source.

Health Effects

Unlike radiation such as X-rays or other "ionising radiation", the electromagnetic fields generated by power lines and household wiring and appliances do not carry enough energy to break any molecular bonds. The electromagnetic fields generated by power lines at 50-60 Hz have an extremely low frequency. This subset of EMFs is referred to as "extremely low frequency" fields (ELFs). The only way in which ELF fields are known to interact with living tissue is by inducing electric fields and currents in them. However, the magnitudes of these induced currents from exposure to ELF fields at levels normally found in our environment, is less than the electrical currents occurring naturally in the body.

Electric field studies thus far have found that, apart from the stimulation arising from electric charge induced on the surface of the body, the effects of exposures of up to 20 kV/m are few and have no harmful effects. Electric fields have not been shown to have any effect on reproduction or development in animals at strengths over 100 kV/m.

Magnetic field studies have produced little experimental evidence that ELF magnetic fields can affect human physiology and behaviour at field strengths found in the home or environment. Exposure to volunteers for several hours to ELF fields up to 5 mT had little effect on a number of clinical and physiological tests including blood changes, ECG, heart rate, blood pressure, and body temperature.

Since 1979, when Wertheimer & Leeper first suggested an association between childhood leukaemia and living close to power lines, a large number of studies have been carried out. These studies have been reviewed by the International Agency for Research on Cancer (IARC) in (2001) www.who.int/mediacentre/factsheets/fs263/en/ (October 2001). This review found that there is currently no consistent evidence that exposure to ELF fields experienced in our living environment causes direct damage to biological molecules, including DNA. Since it seems unlikely that ELF fields could initiate cancer, a large number of investigations have been conducted to determine whether ELF exposure could influence cancer promotion or co-promotion. Results from animal studies so far suggest that ELF fields do not initiate or promote cancer.

Two recent analyses of several epidemiological studies suggest that in a population exposed to average magnetic fields in excess of 0.3 to 0.4 µT in the home, twice as many children might develop leukemia compared to a population with lower exposures. In spite of the large-number database, some uncertainty still remains about the possibility that other factors may have accounted for the increased leukemia incidence. Childhood leukemia is a rare disease with 4 out of 100,000 children aged from 0 to 14 years being diagnosed every year. Moreover, average magnetic field exposures above 0.3 or 0.4 µT in residences are rare. A risk level of 1,5 was suggested. While every human life is very important, if the incidence of childhood leukemia increased by a factor of 1,5 the incidence of the disease would still be very rare.

Based largely on the above-mentioned evidence, the US National Institute of Environmental Health Sciences (NIEHS) has classified ELF fields as “possibly carcinogenic to humans”. This is a classification used to denote an agent for which there is limited evidence of carcinogenicity in humans, and less than sufficient evidence for carcinogenicity in experimental animals. The category is one of five categories used by the International Agency for Research on Cancer (IARC).

The IARC’s five categories are:

1. not classifiable;
2. probably not carcinogenic to humans;
3. possibly carcinogenic to humans;
4. probably carcinogenic to humans; and
5. is carcinogenic to humans.

Independent reviews of the evidence by the National Radiological Protection Board (NRPB) in the UK, and the Health Council of the Netherlands, reached similar conclusions and the same classification – that ELF fields are “possibly carcinogenic to humans”. This classification is based on the strength of scientific evidence, not on the strength of carcinogenicity or risk of cancer (in statistical terms) from the agent.

It is interesting to note that coffee and gasolene exhaust fumes are also classified by the IARC as “possibly carcinogenic to humans”.

No harmful effects on reproduction or development have been established in humans or animals as a result of exposure to that portion of the EMF spectrum associated with power lines – the extremely low frequency fields (ELF). www.greenfacts.org/power-lines/1-2/power-lines-1.htm (October 2004).
The World Health Organisation (WHO) considers that it remains possible that there are other explanations for the observed association between exposure to ELF magnetic fields and childhood leukemia. Research is ongoing, and will also consider other (non-cancer) diseases.

In the literature, the concern appears to be based on regular, prolonged exposure to EMF's – such as would occur in homes, schools and places of work. Occasional exposure, or short term exposure to the EMFs from power lines, does not appear to be of any concern.

Standards & Guidelines

The International Commission on Non-Ionising Radiation Protection (ICNIRP) has developed some guidelines on exposure limits for all EMFs. The ICNIRP guidelines are based on comprehensive reviews of all the available scientific studies. However, the limits are intended to prevent health effects related to short-term acute exposure only – such as in industrial situations. The ICNIRP considers that the scientific information on possible carcinogenicity of ELF fields is not sufficient for establishing quantitative limits on exposure.

While protective measures or access limits may be necessary for workers in certain industrial situations, the WHO considers that "…there is no need for any specific protective measures for members of the general public".

In the context of power lines, there are no standards available for chronic exposure to the effects of ELFs from power lines. The two main difficulties in setting any limits or standards for chronic exposure to EMFs is the lack of clear evidence for hazard, and a lack of understanding about the nature of the problem if a hazard does exist.

While no major committee or organisation has concluded that a hazard actually exists from low-level fields, the WHO has, however suggested some precautionary measures (WHO Background on Cautionary Policies, March 2000). Of relevance to the current power line project, the only effective way to reduce exposure to ELFs from the power line is to consider the distance from dwellings. Consultations with the affected parties, and proper dissemination of the available knowledge about possible health impacts, are also suggested by the WHO.

No standards exist (worldwide) regarding safe distances from power lines in terms of the strength of the electromagnetic fields they produce and resulting health impacts, if any. The following documents are the most authoritative technical summaries available, and they do not provide safe distances for power

lines. They focus mainly on exposure in the workplace and home situations (refer to the following websites: www.icnirp.de/documents/emfgdl.pdf and www.icnirp.de/documents/Use.htm.

Electromagnetic field strength is known to decrease rapidly with distance form the source. Greenfacts states that magnetic fields generated by high voltage power lines are reduced to background levels within 100 to 300m from the power line. Overlapping fields (from adjacent lines or multiple conductors) can strengthen or weaken the effect. (refer to the following website: www.greenfacts.org/power-lines/1-2/power-lines-1.htm; October 2004). For interest and comparison, the magnetic fields from home appliances are reduced to background levels within about 1 meter.

Although there are no established safe distances in regard to the EMFs from power lines, at least one county in California requires a statement of disclosure about possible health impacts to be recorded in the title deeds of every property within 300 feet (100m) of a high voltage power line. However, there is no prohibition on development of residential properties within that distance. The State of California has recently prohibited the construction of schools within 250 feet (83m) from power lines over 345 kV.

In the absence of any accepted standards, and based on the evidence mentioned in the preceding two paragraphs, it appears that the area of concern about health impacts is limited to areas that are very close to power lines. Nevertheless the Precautionary Principle should be applied. Based on the information provided by Greenfacts, and the approach adopted by the State of California, NamPower should consider imposing a minimum distance from the power line of 100 – 300m from all dwellings, schools, and places of work (where people spend many hours a day). Greater distances should be considered for electrical sub stations. This does not imply that health impacts would occur for people or animals living within that distance. The responsibility for decisions concerning “safe” distances from dwellings or other potentially sensitive sites (such as schools) will rest with NamPower.

6.4 Land Use and Related Socio-Economic Issues

The proposed power line will cross only commercial farming areas. With respect to the vegetation, this land use has the following effects:

Commercial farming enterprises generally have access to a multitude of resources, including access to a variety of markets to sell products and to purchase food and resources needed for the farming operation. Farmers tend to use their natural resources optimally, if not always sparingly – most areas are used for extensive livestock for meat production. Fields are only cleared on arable land, and as an economic enterprise – not as a necessity. The harvesting of woody products also is generally limited and controlled by economic and conservation principles: Wood harvesting, if done, is generally linked to the production of charcoal and the clearing of bush encroached areas for increased grazing production (de Klerk 2004). Although large parts of the commercial farming areas are shrub encroached with

consequent loss in production, these are generally in better condition than many of the more densely settled communal areas (Strohbach 2001).

Tourism (e.g. hunting, guest farming, photo safaris) is a lucrative type of land use in these areas, but depends on unscathed nature. The construction of a major power line within view of a lodge is thus a counterproductive development measure.

7 ASSESSMENT OF ENVIRONMENTAL IMPACTS ALONG THE FINAL ROUTE

The potential environmental impacts associated with power line construction and maintenance were evaluated according to their extent, duration, intensity, probability of occurrence and finally the significance of the impact (refer to Tables 6.1 to 6.2). Secondary impacts were also considered. The assessment was undertaken for both alternatives, i.e.: The system used for ranking the impacts is described in Table 5.

Table 5: Impact Rating Table

Rated Against	Determined according to	Description
Extent	Site	Impact limited to the proposed power line (within the 500m corridor).
	Local	Impact limited to a 5km radius of the power line.
	Regional	Impact affecting areas outside the 5km radius of the power line.
Duration	Short Term	Impact less than 2 years
	Medium Term	Impact over 2-5 years.
	Long Term	Impact over >5 years.
Probability of Occurrence	Possible	Unlikely that the impact will occur.
	Probable	Impact may occur.
	Definite	Impact will definitely occur.
Impact Significance	Low	Small impact and/or disturbance over small area.
	Medium	Moderate impact expected and/or disturbance over small area.
	High	Significant impact expected and/or disturbance over a larger area.
	Fatal Flaw	Impacts of a significance that prevents the project from proceeding.
	Undefined	Cannot be determined.
	The impacts have also been identified as positive or negative.	
Mitigation Measures	Without Mitigation Measures	The significance of the impact is rated as if mitigation measures are not put in place.
	With Mitigation Measures	The significance of the impact is rated as if mitigation measures are in place.

Table 6: Impact Assessment and Mitigation of the Overhead Power Line Construction Phase

Impact Description	Phase	Extent	Duration	Probability of Occurrence	Significance		Mitigation Measures
					Without Mitigation	With Mitigation	
Impacts on Soils							
Soil erosion may occur due the construction of access tracks and vegetation clearing.	Construction Phase (Route Survey, Blading and Construction)	Site	Medium Term	Probable	Medium Negative	Low Negative	Construction should remain within the demarcated area only. The surveyor is to plan access tracks in the field and record the optimum route. Design tracks to cross contours obliquely on steep slopes, not straight down slopes. No blading of the 12m corridor is allowed. Only woody tall vegetation may be removed and the ground cover of grass and small shrubs must be left intact. (This must be stated in the tender for construction). Vegetation clearing should not include grasses, but only shrubs and trees. Allow for anti-erosion control measures to be implemented to prevent erosion from occurring or recurring, such as cladding or silt catchment traps where severe erosion occurs.
The removal of ground cover may result in soil erosion.	Construction Phase (Blading)	Site	Medium Term	Probable	Medium Negative	Low Negative	Construction should remain within the demarcated area only. Blading / removal of the ground cover, grasses and low shrubs must not be permitted. Only tall woody vegetation and trees shall be removed in the 12m corridor. An Environmental Control Officer should be appointed to ensure strict compliance with the EMP.
Soil erosion may occur due to vehicle tracks. This problem will be particularly visible during and after rainfall events.	Construction Phase (Route Survey, Blading and Construction)	Site	Medium Term	Probable	Medium Negative	Low Negative	Particular care must be taken with regard to the alignment of vehicle tracks, especially in steep areas, and alluvial soils. Construction should remain within the demarcated area where possible.

Impact Description	Phase	Extent	Duration	Probability of Occurrence	Significance		Mitigation Measures
					Without Mitigation	With Mitigation	
							A single track only shall be permitted. Multiple tracks may not be permitted.
							The Contractor must maintain all tracks in a serviceable condition.
Impacts on Land Use and Land Capability							
Construction activities may disturb adjacent grazing land.	Construction Phase (Blading and Construction)	Site	Short Term	Possible	Medium Negative	Low Negative	Contractors are to disturb as little land as possible and are to be restricted to the development corridors only.
							No contractor material or equipment is to be stored, utilised or repaired on cultivated land.
							An Environmental Control Officer should be appointed to ensure strict compliance with the EMP.
Impacts on Vegetation							
Chemicals and herbicides may destroy unique herbaceous flora along the power line route and corridor.	Construction Phase (Blading and Construction)	Site	Medium Term	Possible	Medium Negative	Low Negative	Ensure that no herbicides are used for permanent clearing of vegetation (other than the removal of encroacher vegetation).
Removal and destruction of protected species.	Construction Phase (Blading and Construction	Site	Medium Term	Possible	High Negative	Low Negative	Permits are needed from the Directorate of Forestry to remove any protected trees during power line construction.
							Permits are needed from the Ministry of Environment and Tourism to remove any protected plants.
							Where protected plants or trees should be removed it is recommended that staff of the national Botanical Garden / National Botanical Research Institute be tasked to do rescue missions of any Aloe populations and/or other succulents encountered.
Unnecessary destruction of large trees, aloes, succulents & geophytes may occur.	Construction Phase (Blading and Construction)	Local	Long Term	Possible	Medium Negative	Low Negative	Plants outside the 12m corridor in the final alignment must not be damaged or removed.
Loss of timber trees	Construction Phase (Blading and Construction)	Local	Long Term	Possible	Medium Negative	Low Negative	Where felling of trees cannot be avoided, all timber and firewood must be made available to the farm owners (commercial farms) or local communities (communal farming areas).

Impact Description	Phase	Extent	Duration	Probability of Occurrence	Significance		Mitigation Measures
					Without Mitigation	With Mitigation	
Eradication of encroacher species in the 12m corridor and stockpile areas may disturb surrounding vegetation.	Construction Phase	Local	Medium Term	Possible	Medium Negative	Low Negative	Maximise the clearing of densely encroached areas for facilities such as stockpile areas and site camps. Use of selective herbicide to minimise the re-growth of encroacher species. Minimise the impact on vegetation and avoid the removal of large trees
Impacts on Animals and Birds							
Habitat destruction and disturbance	Construction Phase	Local	Medium Term	Probable	High Negative	Low Negative	Contractors are to disturb as little land as possible and are to be restricted to the development corridors only. Sensitive breeding areas should be avoided. An Environmental Control Officer should be appointed to ensure strict compliance with the EMP.
Collisions with birds and newly erected power lines will occur.	Construction Phase	Region	Short Term	Probable	Medium Negative	Low Negative	Install bird flappers at certain locations according to design specifications.
Contractors may poach or kill birds or animals for food or other reasons.	Construction Phase	Site	Short Term	Possible	Low Negative	Low Negative	Contractors may not poach, kill, trap or keep any animals or birds.
Impacts on Sites of Archaeological Significance							
The proposed alignment between Gerus and Mururani will have a very low archaeological impact. In general, the alignment avoids typically sensitive terrain settings. No specific archaeological mitigation measures will be required if the alignment follows the final route defined in this report (Refer to Appendix J).							
The excavation of trenches and footing for pylons during construction of the power line could provide a valuable opportunity to record the stratigraphic relationship between artefact-bearing gravels and adjacent deposits, resolve the local stratigraphy sequence and collect material for dating purposes.	Construction Phase	Region	Short Term	Possible	Low Positive	Low Positive	It is recommended that an archaeologist (Dr J Kinahan) be notified of construction planning and timing and be invited to undertake the necessary field investigations during construction phase. An Environmental Control Officer should be appointed to ensure strict compliance with the EMP.
Significant archaeological sites could be uncovered and disturbed during construction phase.	Construction Phase	Local	Medium Term	Possible	Medium Negative	Low Negative	All archaeological finds must be reported to the relevant authorities as required in the National Heritage Act, No 27 of 2004.

Impact Description	Phase	Extent	Duration	Probability of Occurrence	Significance		Mitigation Measures
					Without Mitigation	With Mitigation	
Socio-Economic Impacts							
Escape of stock or wildlife due to fences / gates left open.	Construction Phase	Local	Short Term	Possible	Medium Negative	Low Negative	All site staff shall be instructed to ensure that fences / gates are closed and not left unattended while open. The land owner or kraal owner must be informed at all times.
Adverse reactions from local residents, farmers or communities may be received.	Construction Phase	Local	Short Term	Possible	Medium Negative	Low Negative	Maintain good communications and relations with farm owners and local communities. In communal areas, work through the local authority structures. An incidents register must be kept to record any complaints. Construction personnel may not interfere with local people.
Noise generated by the construction activities may have an adverse impact.	Construction Phase	Local	Short Term	Possible	Medium Negative	Low Negative	Maintain vehicles and equipment (silencers etc) to prevent undue noise near dwellings where applicable.
Littering and waste material may have the following adverse effects: • Visual impact; • Plastic bag fatalities on wildlife; • Trapping of birds and animals; and • Fires caused by glass bottles.	Construction Phase	Local	Short Term	Possible	Medium Negative	Low Negative	Provide bins for refuse at all work stations. Bins must be wind and animal proof. Remove all refuse and waste materials to an approved waste disposal site.
Veld fires may be caused by smoking, welding, cooking, fires and glass bottles in the sun. Veld fires can damage grazing lands, farming land and woodlands.	Construction Phase	Local to Region	Short Term	Possible	Medium Negative	Low Negative	Make all staff aware of fire risk and causes of veld fires. Emphasise fire risk to site staff again at dry times of the year. Allow welding and cooking fires only in designated situations. Have fire-fighting equipment, especially rubber beaters, at hand at all work stations at all times. Deploy staff to fight fires immediately if a fire starts.
Social illnesses such as HIV and Aids could establish themselves within the workforce during the construction phase	Construction Phase	Local to Region	Long Term	Possible	High Negative	Medium Negative	All staff will be trained on the dangers of HIV and Aids. Staff will be encouraged to avoid the establishment of social illnesses.

Table 7: Impact Assessment and Mitigation of the Overhead Power Line Operation and Maintenance Phase

Impact Description	Phase	Extent	Duration	Probability of Occurrence	Significance		Mitigation Measures
					Without Mitigation	With Mitigation	
Impacts on Soils							
Soil erosion of the access tracks may occur.	Maintenance	Site	Medium Term	Possible	Low Negative	Low Negative	Maintain anti-erosion berms. Rehabilitate eroded areas as and when required. When removing re-growth of bushes, avoid blading as this would remove grasses and ground cover.
Impacts on Vegetation							
Additional trees may be felled, or vegetation removed during maintenance.	Maintenance	Site	Long Term	Possible	Low Negative	Low Negative	A post felling treatment of felled stumps with a herbicide should be undertaken. Broad casting of herbicides should not be undertaken due to the potential damage it could cause to other nearby trees. No additional tree felling or vegetation removal may be undertaken unless it is to remove encroaching and invasive species.
Impacts on Animals and Birds							
Collisions with endangered or threatened birds and the overhead power line may occur at river crossings.	Operation	Region	Long Term	Probably	High Negative	High Negative	Bird flappers may prevent collisions that occur during the day.
	Operation	Region	Long Term	Probably	High Negative	Low Negative	Re-alignment of the route at the Okaputa Farm will mitigate this risk.
Collisions with flying, roosting and nesting birds may occur.	Operation	Region	Long Term	Possible	Medium Negative	Low Negative	Investigate the causes of collisions. Where necessary bird flappers will need to be introduced. Devices may need to be installed to prevent / alter nesting and roosting of birds on the power lines and towers.
Socio-Economic Impacts							
Electromagnetic Fields may have an adverse impact (although this is not proven).	Operation	Site	Long Term	Possible	Undefined	Undefined	Ensure that no dwellings, schools, clinic or work stations are established within 100m to 300m of the power lines as a precautionary measure.

Impact Description	Phase	Extent	Duration	Probability of Occurrence	Significance		Mitigation Measures
					Without Mitigation	With Mitigation	
							It is suggested that NamPower should work through the Regional Councils and local headmen to achieve community awareness and co-operation with regard to not building within the minimum distance as determined by NamPower.
Escape of stock or wildlife due to fences / gates left open.	Maintenance	Local	Short Term	Possible	Medium Negative	Low Negative	All site staff shall be instructed to ensure that fences / gates are closed and not left unattended while open. The land owner or kraal owner must be informed in advance of maintenance being undertaken.
Adverse reactions from local residents, farmers or communities may be received.	Operation	Local	Short Term	Possible	Medium Negative	Low Negative	Maintain good communications and relations with farm owners and local communities. In communal areas, work through the local authority structures. An incidents register must be kept to record any complaints.
Maintenance of the 12m corridor will result in the felling of woody vegetation.	Maintenance	Local	Short Term	Probably	Low Positive	Low Positive	Ensure that any felled wood is made available to local farmer owners, communal farmers or local residents.
Littering and waste material may have the following adverse effects: • Visual impact; • Plastic bag fatalities on wildlife; • Trapping of birds and animals; and • Fires caused by glass bottles.	Construction Phase	Local	Short Term	Possible	Medium Negative	Low Negative	Provide bins for refuse at all work stations. Bins must be wind and animal proof. Remove all refuse and waste materials to an approved waste disposal site.
Veld fires may be caused by smoking, welding, cooking, fires and glass bottles in the sun. Veld fires can damage grazing lands, farming land and woodlands.	Construction Phase	Local to Region	Short Term	Possible	Medium Negative	Low Negative	Make all staff aware of fire risk and causes of veld fires. Staff should be trained in fire fighting. Emphasise fire risk to site staff again at dry times of the year. Allow welding and cooking fires only in designated areas Have fire-fighting equipment, especially rubber beaters and a mobile fire tanker, at hand at all work stations at all times. Deploy staff to fight fires immediately if a fire starts.

Impact Description	Phase	Extent	Duration	Probability of Occurrence	Significance		Mitigation Measures
					Without Mitigation	With Mitigation	
Social ills such as HIV and Aids could establish themselves within the workforce during the operation and maintenance	Operation Phase	Local to Region	Long Term	Possible	High Negative	Medium Negative	All staff will be trained on the dangers of HIV and Aids. Staff will be encouraged to avoid the establishment of social illnesses.

8 ENVIRONMENTAL MANAGEMENT PLAN (EMP)

The EMP arises out of the NamPower EMP (Appendix M) and supporting information which identifies a number of potential environmental impacts that need to be managed during the project cycle:

This EMP outlines the roles and responsibilities of all parties who can influence or give effect to the recommendations or specifications that follow. It is important that all parties should understand the guidelines / specifications, and the reasons for them. This EMP should therefore also be read in conjunction with the environmental impact assessment undertaken in Section 8.

9 SUMMARY & CONCLUSION

Namibia faces a potential power shortage by the year 2007. The hydro power station at Ruacana generates about half of Namibia's power, while the rest is currently imported from South Africa. The growing demand in South Africa is expected to use up their surplus power generation capacity by 2007. As a result of the future shortage in power supply, Namibia is looking to alternative power sources.

Various alternatives have been assessed in order to address the future power supply shortage. It is expected that the proposed Kudu Gas power station at Oranjemund will be operational around 2009. Kudu Gas will supply sufficient power for Namibia's needs for 20 years or more with spare capacity to export some of its power. The Kudu Gas power station will be suitable for generating the base load requirements, while Ruacana (like most hydro power stations) is able to vary its power output rapidly and is therefore very suitable to supply peak demand periods (e.g. early evening is a peak demand period).

NamPower are currently expanding their national electricity transmission grid in an attempt to provide for future power generation and transmission requirements, which forms part of the greater plan to meet the need for growth in power demand and supply in Namibia and the greater SADC Region. The phases of expanding the national electricity transmission grid are as follows:

- Phase 1: Auas – Otjikoto – Lifa Transmission Line;
- Phase 2: Gerus - Mururani Gate Transmission Line; and
- Phase 3: Otjikoto - Katima Mulilo Transmission Line.

The proposed Gerus - Mururani Gate power line, for which this report has been compiled, is intended to meet the following objectives:

- To provide the necessary bulk transmission infrastructure to transport power from the new and existing sources of generation to areas where it is needed;
- To strengthen the Namibian national power grid, and ensure stability of supply to areas of consumption;
- To capture economic growth opportunities in northern Namibia by having sufficient transmission capacity available;
- To make optimal use of resources to ensure lowest price to consumers;
- Explore alternative energy sources, however alternatives are not always viably available, and therefore power lines and transmission are required in the region;
- Strive to be self sufficient in power generation and transmission;
- Aim to ensure efficient transmission of power with less energy losses; and
- Aim to potentially export power as a result of the supplementation of power.

The proposed Gerus-Mururani Gate Power line is situated in the Otavi Region of Namibia. The route starts at Gerus (north of Otjiwarongo) from there the line runs through the Otavi Region in a north-easterly direction, where the line ties in with the existing line at Mururani Gate.

The Scoping Phase (Volume 1) of the overall EA considered the alignment of the route and selected the best route for the proposed power line based on environmental and technical considerations and specialist input. The Scoping Phase also undertook a detailed PPP which influenced the final route alignment.

The EA Report (Volume 2 – this document) has included continued public consultation, detailed specialist studies and field studies. The most important environmental impacts, both bio-physical and socio-economic have been avoided as far as possible through the route selection process during the Scoping Phase. The EA Report considers the environmental impacts, both bio-physical and socio-economic and has provided extensive mitigation and management measures to address these impacts. Mitigation and management measures have been made for various stages of the power line project cycle, i.e. survey & design, construction and operation.

The findings of the environmental impact assessment include both positive and negative impacts. The route alignment has mitigated potential impact on soils and land use and capability, and where possible, the final route should be adjusted slightly (within the 500m assessment corridor) to ensure that this impact is further minimised.

The impact on vegetation will however need to be actively managed during construction as the route alignment will result in the loss of woodland and the clearing of vegetation. Where possible, sensitive vegetation areas have been avoided and the route has been aligned accordingly. This has also occurred in the placement of sub stations.

There will be little to no impact on sites of archaeological significance, as the sites of interest, where they do occur, have little to no significance.
Birds, however, might be negatively impacted on by the proposed power line. The route alignment has, to a degree, mitigated some of the negative impact, and secondary mitigation measures have been recommended.

The risk of EMF's has also been considered for the proposed route. It appears that concern is limited to areas very close to power lines. In the absence of accepted standards, it is recommended therefore, that the Precautionary Principle is applied and that the power line is restricted to a minimum distance of 100m to 300m from dwellings, schools and places of work.

The proposed power line is of strategic importance to Namibia. It is therefore recommended that with the mitigation and management measures, the establishment will ensure a project that is viable in terms of the environment and impact to biophysical and socio-economic aspects.

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Appendix A: Final Route Co-ordinates

Appendix B: Final Route Alignment Map

Appendix C: Advertisements

Appendix D: Information Letters to I&APs

Appendix E: Information Letters to Farmers

Appendix F: List of Farmers and Farm Names

Appendix G: Focus Group Meeting Presentation

Appendix H: Meeting Minutes and Attendance List for Public and Focus Group Meetings

Appendix I: List of Registered I&APs

Appendix J: Ecological Survey

Appendix K: Archaeological Survey

Appendix L: Ornithological Study

Appendix M: NamPower Environmental Management Plan