

ENVIRONMENTAL FIELD SURVEY

UPGRADE OF THE RAILWAY LINE IN BETWEEN
KRANZBERG STATION TO TSUMEB AND OTAVI TO
GROOTFONTEIN

PHASE 1 – RAILWAY LINE BETWEEN KRANZBERG
STATION AND OTJIWARONGO TOWN

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TABLE OF CONTENT:

- 1 INTRODUCTION 1**
- 2 METHODOLOGY 1**
- 3 OBSERVATIONS 2**
 - 3.1 GEOGRAPHICAL FEATURES 2
 - 3.1.1 Mountains/Inselbergs: 2
 - 3.1.2 Outcrops..... 3
 - 3.1.3 Rivers and Drainage lines: 4
 - 3.2 AIR QUALITY..... 5
 - 3.3 SOIL 6
 - 3.4 BIO-PHYSICAL ENVIRONMENT 7
 - 3.4.1 Flora:..... 7
 - 3.4.2 Fauna..... 10
 - 3.5 LAND USE 12
 - 3.5.1 Commercial farmland 12
 - 3.5.2 Urban Areas 13
 - 3.6 ENVIRONMENTAL DEGRADATION AND/OR IMPACTS 15
 - 3.6.1 Railway Line Servitude 15
 - 3.6.2 Bush Encroachment 16
 - 3.7 INFRASTRUCTURE 16
 - 3.7.1 Roads..... 16
 - 3.7.2 Powerlines..... 17
 - 3.7.3 Water supply 18
 - 3.7.4 Stations 18
 - 3.7.5 Sidings 19
 - 3.8 HEALTH AND SAFETY..... 19
- 4 FINDINGS AND CONCLUSIONS:..... 21**
 - 4.1 POTENTIAL SENSITIVE AREAS IDENTIFIED 21
 - 4.1.1 Rocky outcrops..... 21
 - 4.1.2 Rivers and drainage lines 22
 - 4.2 POTENTIAL ENVIRONMENTAL IMPACTS IDENTIFIED:..... 22
 - 4.2.1 Habitat Destruction and Loss of Biodiversity..... 22
 - 4.2.2 Ground and Surface Water Pollution 22
 - 4.2.3 Soil Erosion & Sedimentation 23
 - 4.2.4 Natural Resources (water & energy)..... 23
 - 4.2.5 Socio-Economic 23
 - 4.2.6 Visual Aesthetics and Sense of Place 23
 - 4.2.7 Change in Land Use..... 23
 - 4.2.8 Health and Safety..... 23
- 5 REFERENCES 24**

LIST OF FIGURES

Figure 1 – Diagram of Railway Line with Stations and Sidings

LIST OF PHOTOS

Photo 2.1.1 – Rail trolley used during field survey and Project Team

Photo 3.1.1 – Erongo Mountains to the west of the railway line

Photo 3.1.2 – Examples of outcrops along the railway line

Photo 3.1.3 – Khan River and Omaruru River

Photo 3.1.4 - Epako River Bridge and Erundu River Bridge

Photo 3.2.1 – Maintenance vehicles on the service road cause dust emissions

Photo 3.2.2 – Charcoal burning cause some form of air pollution in a small scale

Photo 3.3.1 – Soil cover that expose underlying bedrock

Photo 3.4.1 – Grassland with dispersed small to medium shrubs north of Kranzberg Station

Photo 3.4.2 – *Acacia* shrubs become woody and dense north of Omaruru

Photo 3.4.3 – Taller trees and shrubs near Otjiwarongo Station

Photo 3.4.4 – Bridge over tributary of the Khan River and tributary of Erundu River

Photo 3.4.5 – Ant hills indicate termite activity

Photo 3.4.6 – Martial eagles observed during the field survey

Photo 3.5.1 – Livestock fence and game fence along servitude

Photo 3.5.2 – Cattle farming and coal production is the predominant farming activity

Photo 3.5.3 – Local people chopping wood in the servitude

Photo 3.5.4 – Electrified game fence of an estate south of Omaruru

Photo 3.5.5 – Kalkfeld

Photo 3.5.6 - Industrial area south of Omaruru and auction pens north of Omaruru

Photo 3.6.1 – Old embankment east of current railway line Section 1 Sample 1

Photo 3.6.2 – Bush encroachment in Section 1 and Section 2

Photo 3.7.1 – A Service Road runs east and west of the railway line

Photo 3.7.2 - C 33 runs parallel to the west of the railroad between Omaruur and Otjiwarongo

Photo 3.7.3 – Powerlines cross railway line near Kranzberg & runs // east of line in Section 1

Photo 3.7.4 – Powerline crossing north of Norman Siding and south of Parasis Siding

Photo 3.7.5 – NamWater pipeline on the eastern side of the railway line & borehole close by

Photo 3.7.6 – Omaruru Station with storage facility and Otjiwarongo Station with crane

Photo 3.7.7 – Examples of sidings between stations

Photo 7.8.1 – Broken rail near Erundu Siding & Replacement of rail near Norman Siding

Photo 3.8.2 – Original steel sleepers and Skeleton tracks

Photo 3.8.3 – Culverts are being reconstructed between Okozongoro and Etuo Siding

Photo 3.8.3 – Maintenance staff transport bus and maintenance material transport trucks

APPENDICES

APPENDIX A – FIELD SURVEY SAMPLES

1 INTRODUCTION

This Environmental Field Study Report gives an overview of the physical and bio-physical conditions of the Project Site itself. It reports on what was observed by the Environmentalist on site and covers geographical features, air quality, soil, the bio-physical environment (predominant fauna and flora observed), land use, environmental degradation and/or impacts and infrastructure development that exist. It also mentions health and safety issues observed.

The objective of the field survey was to screen the entire Project Site to identify potential sensitive areas or hot spots that would elicit further investigation and mitigation during the Environmental Impact Assessment. The Project Site (referred to in this report) stretches from Kranzberg Station to Otjiwarongo Station, which is Phase 1 of the upgrade of the railway line between Kranzberg Station to Tsumeb and Otavi to Grootfontein. Phase 1 was further divided into Section 1 (Kranzberg Station to Omaruru Station) and Section 2 (Omaruru Station to Otjiwarongo Station).

2 METHODOLOGY

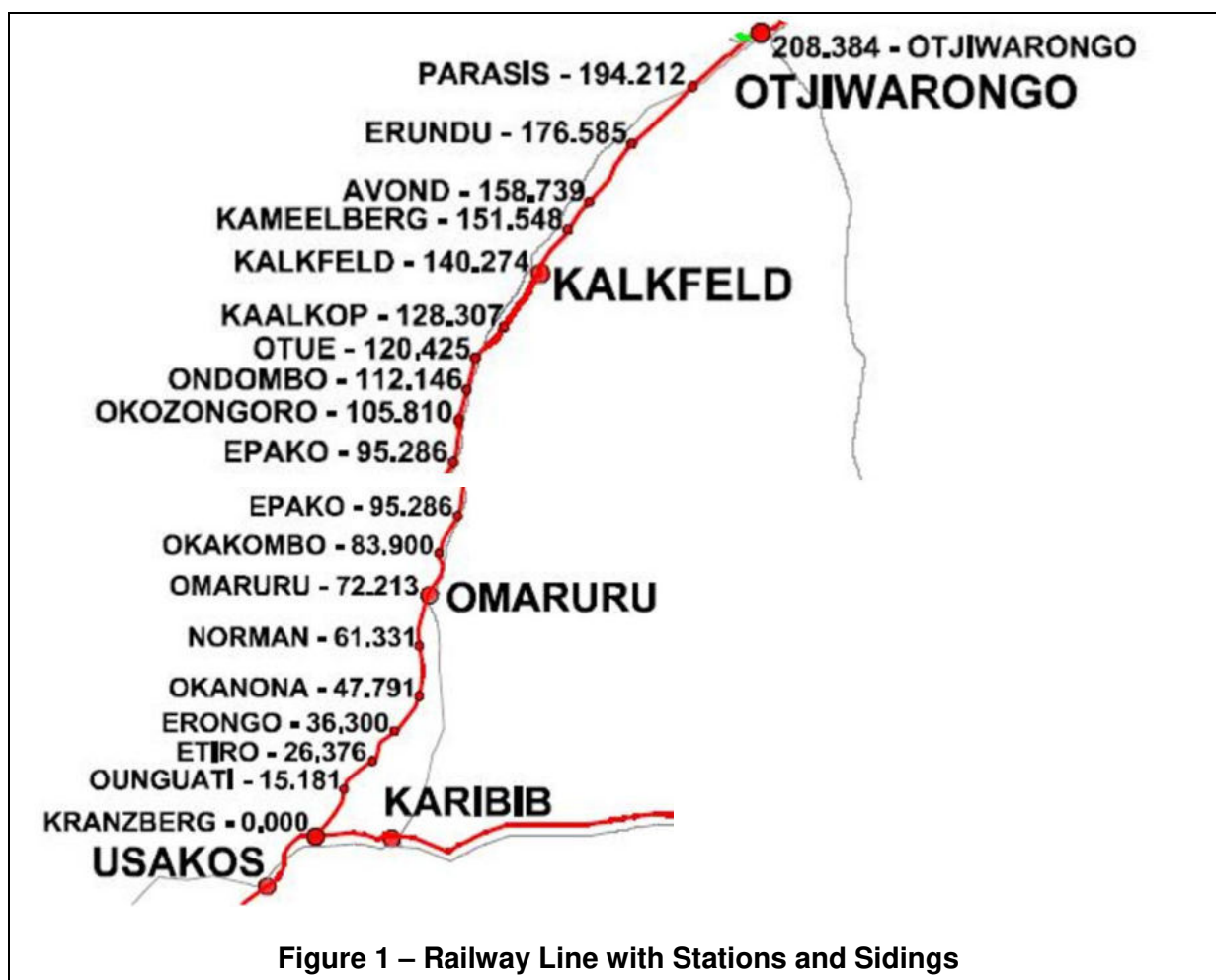
A two-day field visit was conducted during April 2022 after the rain season along the railway line from Kranzberg Station to Omaruru Station and from there to Otjiwarongo Station (referred to as Section 1 and 2 of Phase 1).



Photo 2.1.1 – Rail trolley used during field survey and Project Team accompanying Specialists

The field survey was undertaken on a rail trolley that moves between 40-60 km/h on the railroad tracks and enabled the specialists to get an overview of the entire Project Site. General sampling was done by dividing the railway line into 16 samples of approximately 10 – 18 km within the 60 m wide servitude between consecutive sidings. Observations in each sample area are noted in Appendix A.

The EIA Specialists were accompanied by 4 Engineers of WCE as well as a representative of TransNamib to provide project information. The conditions of the railway line were also inspected during this trip.



3 OBSERVATIONS

3.1 GEOGRAPHICAL FEATURES

Given the limitations of the horizontal gradient at which railroad infrastructure can operate, the railway line winds through the relative flat plains of central western Namibia in Section 1 and 2. On its way it passes hills, outcrops and mountains/inselbergs.

3.1.1 MOUNTAINS/INSELBERGS:

Section 1 pass the *Erongo Mountain* on its eastern side. Surmounting the surrounding dissected plains by up to 1000 m, the Erongo mountain is a prominent feature situated at the eastern edge of the Namib Desert in central-western Namibia. It has a roughly circular outline and measures approximately 40 km across.

The mountain is known for its unique ecology and archaeological treasures, but the railway line construction and operation is not in close proximity of the mountain.



Photo 3.1.1 – Erongo Mountains to the west of the railway line

3.1.2 OUTCROPS

The railway line passes outcrops along its way in both Section 1 and 2. Deviations in the railway line in some places move towards some of these outcrops, but do not necessarily cross them. In other cases, outcrops may be partly in jeopardy.

These were marked for further investigation.



Photo 3.1.2 – Examples of outcrops along the railway line

3.1.3 RIVERS AND DRAINAGE LINES:

The *Khan River* flows along the Erongo Mountain's eastern side and parallel with the railway line for the first few kilometers north of Kranzberg Station. The Khan River is a west flowing ephemeral river that crosses the central Namib and is a main tributary of the Swakop River that drain into the Atlantic Ocean. The catchment area includes tributaries such as the Slang and Etiro Rivers as well as the Erongo Mountain and is approximately 8 400 square kilometers (*Jacobson, P. et.al 1995*).

From Kranzberg the railway line runs parallel to the Khan River's eastern side and then crosses it and its tributaries a few times with culverts and bridges along Section 1.

The *Omaruru River* crosses western central Namibia from east to west pass the northern side of the Erongo Mountain and reaches the Atlantic Ocean north of Henties Bay. It is an ephemeral river with a mean run-off of roughly 40 million cubic metres per annum. It forms an underground delta of the Namib Desert and its catchment area is estimated between 11 579 and 13 100 square kilometers (*Jacobson, P. et.al 1995*).

The railway line crosses the Omaruru River with a bridge south of Omaruru town in Section 1.

The *Kanona River*, in Section 1, and the *Epaku River* and the *Erundu River* in Section 2 are drainage lines that the railway line also crosses with culverts and/or bridges.

The railway line currently crosses all drainage lines and rivers with culverts and/or bridges that will be reconstructed during the upgrade construction phase. The ephemeral drainage lines and rivers carry surface water only occasionally during the rain season in November and/or February/March. For the rest of the year they are dry riverbeds. These dry riverbeds play an important role in the ecology of this arid area. The rivercrossings of the railway line was marked for further investigation, due to protected trees species present, possible fauna endemism here and possible surface and groundwater pollution during construction.



Photo 3.1.3 – Khan River



Omaruru River



Photo 3.1.4 - Epako River Bridge



Erundu River Bridge

3.2 AIR QUALITY

The air quality in Section 1 and 2 is good, since the railway line runs through rural environment for most of the way. The only nuisance in the servitude is occasional dust from maintenance vehicles on the service road next to the railway line as well as smoke from charcoal burning.



Photo 3.2.1 – Maintenance vehicles on the service road cause dust emissions



Photo 3.2.2 – Charcoal burning cause some form of air pollution on a small scale

Around Omaruru and Otjiwarongo towns the railway line passes through industrial area, but no manufacturing or air emissions are present here. Refer to Photo 3.4.6 in Section 3.4.2.2.

3.3 SOIL

For most part of Section 1 and 2, the railroad runs over *Eutric Regosols*. This is relative fertile soil with high base saturation. Regosols are medium- or fine-textured soils of actively eroding landscapes. The thin layers lie directly above the rock surfaces from which they are formed. These soils do not reach depths of more than 50 cm and Photo 3.3.1 shows where the calcrete rock surfaces.

Dust suppression will be required during construction for this soil type and where there is a degree of slope this soil type is susceptible to erosion.



Photo 3.3.1 – Soil cover that expose underlying bedrock

3.4 BIO-PHYSICAL ENVIRONMENT

3.4.1 FLORA:

The project area falls within the *Tree and Shrubland Savanna* Biome of Africa. The vegetation of Section 1 from Kranzberg to Omaruru forms part of the *western highlands* of Namibia and vegetation type in Section 2 from Omaruru to Otjiwarongo change to *Thornbush Shrubland* (Mendelson et al. 2002). To this effect vegetation changes from grassland with dispersed small to medium shrubs and solitary trees in the south-western part of Section 1 to more woody *Acacia* shrub vegetation that become encroached in some areas as one move north-eastwards toward Section 2. In Section 2 towards Otjiwarongo the vegetation become further encroached with *Acacia* shrubs that become taller shrubs and trees in the north-eastern part.



Photo 3.4.1 – Grassland with dispersed small to medium shrubs north of Kranzberg Station



Photo 3.4.2 – *Acacia* shrubs become woody and dense north of Omaruru



Photo 3.4.3 – Taller *Acacia* trees and shrubs near Otjiwarongo Station

Vegetation along cross-cutting ephemeral rivers and drainage lines, mentioned in Section 3.1.3, are mostly riverine trees.



Photo 3.4.4 – Bridge over tributary of the Khan River and tributary of Erundu River

3.4.1.1 Grasses:

Grass species observed are mostly *Stipagrostis sp.* which can be classified as climax grass in healthy soil as well as pioneer species that grow in disturbed veld, along road sides or old cultivated lands such as *Eragrostis sp.* and *Enneapogon sp.* An extensive grass species list is provided in the Ecology Baseline Report Section 3.6 Table 6.

It is envisaged that the servitude of the railway line will be cleared of vegetation during construction phase for Health and Safety reasons during the operational phase. However, given the vast area that will comprise servitude (for Section 1 and 2, it will be 208,384 km x 0.06 km width = 12,5 km²), it is recommended that top soil be conserved during the construction phase and grass cover in the servitude area be rehabilitated afterwards to stabilise soil against erosion and to conserve the healthy soil micro-organisms.

3.4.1.2 Shrubs

Shrubs in the south-western parts of Section 1 are lower and more dispersed. Towards Omaruru Station, shrubs become more woody and dense. Near Otjiwarongo shrubs are taller and become small trees dispersed amongst taller tree species. More than 90% of all shrubs present in the servitude belong to *Acacia sp.* and in some areas become encroached. For shrubs that might occur in the general area, refer to Appendix A of this report and to the Ecology Baseline Report Section 3.5, Table 5.

Vegetation clearance for the servitude, quarries and deviations will mostly uproot Acacia shrubs and thickets. None of these Acacia shrubs are of conservation concern. No other shrub species of conservation concern were noticed in the servitude during this field survey.

De-bushing during construction will cause loss of biomass in the area. De-bushing by means of fire is not allowed, but de-bushing might be co-ordinated with coal harvesting in the area, to prevent wastage of this biomass. This was noted for public consultation with local communities and farmers.

3.4.1.3 Trees

Trees are more prominent towards the north-east of the Project Site near Otjiwarongo as well as in the ephemeral rivers and drainage lines. The most predominant tree species observed within the servitude are listed in Appendix A. An extensive list of tree species that may occur in the general project area is provided in the Ecology Baseline Report Section 3.5 Table 5.

*Protected species observed within the servitude and riverine vegetation are *Boscia albitrunca*, *Ziziphus mucronata*, *Acacia erioloba* and *Faidherbia albida* in both Sections 1 and 2. These are protected under the Forest Act No. 12 of 2001 and a permit is required to remove them. Invasive*

*Protected species observed on outcrops are *Commiphora sp.* and *Aloc litoralis* (protected under Nature Conservation Ordinance No. 4 of 1975).*

It is recommended that these be replaced with the same species in favourable habitat, should any of them be removed during construction.

Prosopis trees were also noted in rivers and drainage lines and these must be removed.

3.4.2 FAUNA

3.4.2.1 Insects

Termite activity only became evident in Section 2, north of Omaruru and is evident in ant hills next to the railway line and in the adjacent area.



Photo 3.4.5 – Ant hills indicate termite activity

3.4.2.2 Reptiles

A Southern Africa Python (*Python natalensis*) was seen next to the railroad and a Leopard tortois (*Geochelone pardalis*) that was previously trampled on the railroad, was observed. Both these species are listed as vulnerable, peripheral and protected under the Namibia Nature Conservation Ordinance No. 4 of 1975.

No other small reptiles were observed from the moving trolley, but suitable habitat was identified in outcrops, riverbeds and schrubland. Rare and endangered reptile species can be expected here. Reptiles were noted for further investigation during the EIA. The Ecology Baseline Report address these species and their conservation status in Section 3.1. Table 1 lists the reptile species expected in the area.

3.4.2.3 Amphibia

No standing water was present within the servitude and no amphibia were observed during the field survey. Amphibia is studied in the Ecology Baseline Report Section 3.2 Table 2.

3.4.2.4 Mammals

Hartman zebra, oryx, kudu, red hartebees and springbok as well as smaller antelope such as common duiker, klipspringer, Damara dik-dik and steenbok occur naturally in the area. Predators include aardwolf, brown and spotted hyena, cheetah, leopard, caracal, African wild cat, small spotted cat, bat-eared fox, Cape fox and Balck-backed jackal.

None of these species were, however, spotted during the field survey that was conducted during daytime. No meerkat or any meerkat activity or holes were noticed in the servitude during the field survey.

Mammal species are discussed in the Ecology Baseine Report Section 3.3 and an extensive mammal species list is provided in Table 3.

All the commercial farms neighbouring the railway line servitude are fenced off with either livestock or game fence, so the historic natural migration paterns of these species have been

hindered for decades and the upgraded railway line and its servitude will not impact on migration movement.

3.4.2.5 Avifauna

Thornbush savannah provides suitable habitat for avifauna and rich and abundant birdlife were observed from the railroad. Species such as Northern Black Korhaan, Cape Turtle Dove and European Roller (Near Threatened) were observed in Section 1 and Cape Glossy Starling, Grey Go-away Bird, Laughing Dove, Helmeted Guineafowl and Martial eagles (Endangered) were noted in Section 2. An extensive bird list is provided in the Ecology Baseline Report Section 3.4 Table 4.

3.5 LAND USE

3.5.1 COMMERCIAL FARMLAND

The railway line runs through commercial farmlands for most of the way in Section 1 and 2. Cattle farming forms the basis of agriculture in the region, but more and more farms replace or complement this economic activity with wildlife farming and tourism. Land use observed during the field survey comprise of cattle farming (where the servitude fence is livestock fence and cattle observed), game farming and tourism (where the servitude fence is game fence) and/or coal production (indicated by coal fires).



Photo 3.5.1 – Livestock fence and game fence along servitude



Photo 3.5.2 – Cattle farming and coal production is the predominant farming activity

The land owners of the commercial farms were identified and contacted during the Public Participation Process.

The woody biomass of the area is a natural resource that is harvested extensively for charcoal production and during the field survey local people gathering wood was also observed.



Photo 3.5.3 – Local people chopping wood in the servitude

3.5.2 URBAN AREAS

The railway line passes through Kalkfeld Settlement, Omaruru Town and Otjiwarongo Town. Omaruru and Otjiwarongo are urban areas with townlands, residential areas and industrial areas.

3.5.2.1 Townlands

South of Omaruru Town the railway line deviates to the west to encroach on a residential estate with electrified game fencing.

This incidence was noted for the Public Participation purposes.

Closer to Omaruru Town the railway line deviates to the east towards a newly erected informal settlement that was not there previously when the initial plans were drawn up.

This incidence was noted for possible re-alignment to prevent relocation of people.



Photo 3.5.4 – Electrified game fence of an estate and an informal settlement south of Omaruru

The railway line will pass through Kalkfeld settlement. Here is a station that was operational in earlier years and the settlement can be used for constructions camps, laydown areas and/or to source construction labour. The settlement can also be reached via the C33 Main Road.



Photo 3.5.5 - Kalkfeld

3.5.2.2 Industrial areas

The railroad passes conveniently through the industrial areas of Omaruru and the Project can have a positive economic impact on the transport of industrial commodities and cattle.



Photo 3.5.6 - Industrial area south of Omaruru

Auction pens north of Omaruru

3.6 ENVIRONMENTAL DEGRADATION AND/OR IMPACTS

3.6.1 RAILWAY LINE SERVITUDE

The servitude area can be described as an area that was previously disturbed and not in pristine condition any more. The railroad has been in existence for decades since early 1900 and was re-aligned and rebuilt already. The old embankment, with remains of culverts and bridge pillars are still visible in some places.

The upgrade of the railway line will be restricted to the current servitude as far as possible and deviations will only be made to ‘relax’ bends to accommodate higher train speed.



Photo 3.6.1 – Old embankment east of current railway line Section 1 Sample 1

3.6.2 BUSH ENCROACHMENT

A conspicuous form of rangeland degradation in southern African savannas is shrub encroachment resulting from heavy grazing by domestic livestock. The increase in shrubs at the cost of palatable vegetation reduces the carrying capacity of rangelands. It also has a negative impact on species diversity (*Blaum, N. et al., 2008*)

Bush encroachment is visible in areas with dense Acacia thickets in and around the servitude.



Photo 3.6.2 – Bush encroachment in Section 1 and Section 2

3.7 INFRASTRUCTURE

Infrastructure that might be of use to the Project are mentioned in this section.

3.7.1 ROADS

3.7.1.1 Service Road

The servitude of the railway line has a service road for most of the way. From Kalkfeld northwards the service road is also used by NamWater along the water pipeline.



Photo 3.7.1 – A Service Road runs east and west of the railway line

3.7.1.2 Main Road

The C33 Main Road runs parallel to the western side of the railway line from Omaruru to Otjiwarongo in Section 2. The C33 connects Karibib, Omaruru, Kalkfeld and Otjiwarongo.



Photo .3.7.2 - C 33 runs parallel to the west of the railroad between Omaruur and Otjiwarongo

3.7.2 POWERLINES

NamPower powerline runs parallel to the railway line between Karibib and Otjiwarongo and can be seen from the railway line for most of the way. Powerlines also cross the railway line at several points. *Powerline crossings were noted.*



Photo 3.7.3 – Powerlines cross the railway line near Kranzberg and runs // east of the line in Section 1



Photo 3.7.4 – Powerline crossing north of Norman Siding and south of Parasis Siding

3.7.3 WATER SUPPLY

A NamWater pipeline runs parallel east of the railway line from Kalkfeld to Erundu Siding. Boreholes with windpumps and dams are present on adjacent farms.

The water sources and availability for construction will be investigated during the EIA process.



Photo 3.7.5 – NamWater pipeline on the eastern side of the railway line and borehole next to railway line

3.7.4 STATIONS

Stations in Phase 1 that are currently operational are Kranzberg, Omaruru and Otjiwarongo.

These can be used during the construction phase. Omaruru Station has a secure fenced in area that can be used as a safe laydown area to store building material. Otjiwarongo Station has a crane that can be used for heavy lifting.



Photo 3.7.6 – Omaruru Station with storage facility and Otjiwarongo Station with crane

3.7.5 SIDINGS

There are 5 sidings in Section 1 and 9 sidings in Section 2 of Phase 1.

These sidings can be used as construction camps or laydown areas during construction. All of the sidings have a second rail where train carriages can be parked and unloaded without hinderance to normal scheduled railway activity.



Photo 3.7.7 – Examples of sidings between stations

3.8 HEALTH AND SAFETY

Maintenance and minor construction activities are on-going on the existing railway line. The railroad currently poses a threat to Health and Safety, because of its dilapidated condition in some areas.



Photo 7.8.1 – Broken rail between Erundu and

Replacement of rail near Norman Siding Avond Siding

The old steel sleepers have been replaced with concrete sleepers for most of the way from Norman Siding northwards. Sleepers are currently being replaced between Erongo and Norman Siding. From Kranzberg to Erongo Siding the original steel sleepers are still in place and poses a Health and Safety hazard.

According to the engineers this maintenance programme is expensive and not sustainable in the long run.



Photo 3.8.2 – Original steel sleepers



Skeleton tracks without ballast may not be longer than 4 km during maintenance for Health and Safety reasons



Photo 3.8.3 – Culverts are being reconstructed between Okozongoro and Etuo Siding



Photo 3.8.4 – Maintenance staff are being transported to site by bus and trucks are used to transport maintenance material.

Occupational Health and Safety as well as Public Health and Safety is identified as an Environmental Aspect that will be investigated during the EIA.

4 FINDINGS AND CONCLUSIONS:

4.1 POTENTIAL SENSITIVE AREAS IDENTIFIED

Ecological sensitive areas that were identified during the field survey are:

4.1.1 ROCKY OUTCROPS

Where possible rocky outcrops should be avoided during re-alignment of the railway line. This should happen automatically, due to the restricted gradient at which a railway line can operate. The outcrop areas have more sensitive ecology, with higher flora and fauna species biodiversity and endemism. Impacts on plains in the project area will cause less biodiversity loss and plains will recover more easily in a shorter period of time after a rainy season.

Quarries in outcrop areas will also have an adverse visual impact.

4.1.2 RIVERS AND DRAINAGE LINESS

The ephemeral rivers and drainage lines in the Project Area hosts protected tree species and provide habitat to a wide range of fauna species. It is, however, inevitable that construction will take place in these sensitive areas and appropriate mitigation measures for this must be investigated during the EIA.

4.2 POTENTIAL ENVIRONMENTAL IMPACTS IDENTIFIED:

The following environmental impacts were identified during the field survey. Mitigation measures are listed in the Ecology Baseline Report Chapter 6 and will be addressed in the ESIA and ESMP.

4.2.1 HABITAT DESTRUCTION AND LOSS OF BIODIVERSITY

Habitat destruction will take place in the servitude (that has already been cleared and damaged in the past), in deviations (through previously grazed rangeland) and quarries. This will mainly cause removal of *Acacia* shrubs and trees, which may adversely affect wildlife habitats and loss of nesting sites. None of the *Acacia* species, are however, protected, accept for *Acacia erioloba*, found mostly in drainage lines and rivers.

Construction in riverbeds and drainage lines might cause damage to tree species protected under the Forest Act No. 12 of 2001.

Construction of deviations towards outcrops might damage *Commiphora sp.* and *Aloe sp.* species that were observed, which are protected under Nature Conservation Ordinance No. 4 of 1975.

Noise disturbance of construction activities and machinery can cause fauna to move away from the area.

Animals might also be trampled by train or construction vehicles as observed during the field survey.

Poaching might increase with an influx of labour into the Project Site.

Loss of habitat will probably have the biggest impact on reptile species of which most are listed as Endemic species. (See Ecology Baseline Assessment, Section 3.1).

4.2.2 GROUND AND SURFACE WATER POLLUTION

Hazardous material and hazardous liquid will be required on the Project Site during construction. Accidental spillage or irresponsible disposal of these hazardous material (especially in/near watercourses) will cause pollutions that can infiltrate groundwater.

4.2.3 SOIL EROSION & SEDIMENTATION

Vegetation clearance and trenching or excavation will expose soil and the soil type found in the area is prone to dust and erosion. Construction activity and mixing of concrete may further cause sedimentation.

4.2.4 NATURAL RESOURCES (WATER & ENERGY)

Although the Project area has access to relative good groundwater availability, unacceptable high levels of consumption and wastage will cause pressure on a scarce resource in this arid country.

4.2.5 SOCIO-ECONOMIC

The soil type is prone to dust pollution and dust suppression measures will have to be incorporated.

Noise and vibration might be a nuisance where construction take place near settlements or towns.

Railroad traffic safety is a high priority Health and Safety issue that must be addressed in the EMP together with general Health, Safety and Security issues.

4.2.6 VISUAL AESTHETICS AND SENSE OF PLACE

It is not envisaged that this would have an adverse impact on the environment. The railway line structure is narrow and low and *Acacia* thickets will hide most of the construction activities and possible construction camps. Visual aesthetics might only become an issue with poorly planned construction sites and insensitive infrastructure design and scale.

4.2.7 CHANGE IN LAND USE

Deviations of the railway line outside the servitude will encroach on commercial rangeland. This will have an economic impact on the landowner and compensation negotiations will have to be undertaken.

The deviation south of Omaruru through a recently established informal settlement, might be altered to prevent relocation of people.

4.2.8 HEALTH AND SAFETY

Given the nature of the infrastructure development, standard Health and Safety of the construction workers and general public will be addressed in the ESIA and ESMP.

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APPENDIX A

FIELD SURVEY SAMPLES

Sample SECTION	1 Kranzberg to Ounguati (15 km)	2 Ounguati to Etiro (11 km)
Km along railway line	0 - 15.181	15.181 - 26.376
PHOTO NUMBER	112-125 - 112-090	112-089 - 112-060
FLORA (predominant): <u>Grass species:</u>	<i>Stipagrostis ciliata</i> , <i>S. uniplumis</i> <i>Eragrostis trichophora</i> , <i>E. rigidior</i> , <i>E. lehmanniana</i>	<i>Stipagrostis ciliata</i> , <i>S. uniplumis</i> <i>Aristida congesta</i> <i>Enneapogon cenchroide</i>
<u>Shrub species:</u>	Monechma genistifolium Green-hair tree (<i>Parkinsonia africana</i>) Mountain thorn (<i>Acacia hereroensis</i>) Red thorn (<i>Acacia reficiens</i>) Trumpet thorn (<i>Catophractes alexandri</i>) Camphor bush (<i>Tarchonanthus camphoratis</i>)	Trumpet thorn (<i>Catophractes alexandri</i>) Brittle thorn (<i>Phaeoptilum spinosum</i>) Mountain thorn (<i>Acacia hereroensis</i>) Red thorn (<i>Acacia reficiens</i>) Black thorn (<i>Acacia melifera</i>) Yellow bark (<i>Acacia erubescens</i>)
<u>Tree species:</u>	<i>Acacia erioloba</i> Kalahari acacia (<i>Acacia leuderitzii</i>) <u>In drainage line only:</u> Smelly shepherd's tree (<i>Boscia foetida</i>) Ebony tree (<i>Euclea pseudobenus</i>)	Kalahari acacia (<i>Acacia leuderitzii</i>) <u>Riverine vegetation:</u> Camel thorn (<i>A. erioloba</i>) Protected F# Sweet thorn (<i>A. karroo</i>) Buffalo thorn (<i>Ziziphus micronata</i>) Protected F# Ana tree (<i>Faidherbia albida</i>) Protected F#
FAUNA:	Northern Black Korhaan / Cape Turtel Dove	European Roller
RIVER:	Railroad crosses tributary of Khan River	Khan River
GEOGRAPHIC FEATURES	Khan river runs parallel to railway on its western side	Erongo Mountains west of railroad Outcrop east of railroad
DAMAGE/IMPACTS:	Previously disturbed	Yes
Rehabilitated areas / areas not rehabilitated	Yes	Old embankment runs // along eastern side of railroad
Dust plumes	Old embankment runs // along eastern side of railroad	Yes on service road
DEVELOPMENT:	Yes on service road	Yes on service road
Infrastructure - Roads	Service road runs parallel west of railroad	Service road runs parallel east/west of railroad
- Powerlines	Powerline crossing railway to run parallel east of it.	Powerline run parallel east of railroad.
- Servitudes	Broad servitude fenced with livestock fencing both sides	Servitude fenced with livestock fencing both sides
Maintenance	Original railroad and sleepers	Original railroad and sleepers
COMMENTS/POSSIBLE ISSUES:	New alignment mostly along existing railway	Deviation to east between railway and outcrop Km20

Sample SECTION	3 Etiro to Erongo (10 km)	4 Erongo to Okanona (11 km)
Km along railway line	26.376 - 36.300	36.300 - 47.791
PHOTO NUMBER	112-059 - 112-026	112-025 - 112-006
FLORA (predominant): <u>Grass species:</u>	<i>Stipagrostis ciliata</i> , <i>S. uniplumis</i>	<i>Stipagrostis ciliata</i> , <i>S. uniplumis</i>
	<i>Aristida congesta</i> <i>Eragrostis lehmanniana</i>	<i>Eragrostis lehmanniana</i>
<u>Shrub species:</u>	Camphor bush (<i>Tarchonanthus camphoratus</i>)	Campher bush (<i>Tarchonanthes camphoratus</i>)
	Brittle thorn (<i>Phaeoptilum spinosum</i>)	Trumpet thorn (<i>Catophractes alexandri</i>)
	Two colored raison bush (<i>Grewai bicolor</i>)	Mountain thorn (<i>Acacia hereroensis</i>)
	Trumpet thorn (<i>Catophractes alexandri</i>)	Red thorn (<i>Acacia reficiens</i>)
	<i>Acacia hereroensis</i> , <i>A. reficiens</i> , <i>A. nebrownii</i>	Kalahari acacia (<i>Acacia leuderitzii</i>)
	Bitter karee (<i>Rhus marlothii</i>)	Yellow bark (<i>A. erubescence</i>)
<u>Tree species:</u>	Camel thorn (<i>Acacia erioloba</i>) Protected F#	<u>Riverine vegetation:</u>
	Sweet thorn (<i>A. karroo</i>) Umbrella thorn (<i>A. tortillis</i>)	Camel thorn (<i>A. erioloba</i>) Protected F#
	Yellow bark (<i>A. erubescence</i>)	Ana tree (<i>Faidherbia albida</i>) Protected F#
	Candle pod (<i>A. hebeclada</i>)	Buffalo thorn (<i>Ziziphus micronata</i>) Protected F#
	Shepherd's tree (<i>Boscia albitrunca</i>) Protected F#	
	Smelly shepherd's tree (<i>Boscia foetida</i>)	
	Tamarisk (<i>Tamarix usneoides</i>)	Railroad crosses tributary of Khan River
	Green-hair tree (<i>Parkinsonia africana</i>)	
FAUNA:		
RIVER:		
GEOGRAPHIC FEATURES	Erongo Mountains south-west of railroad	
DAMAGE/IMPACTS:		
Previously disturbed	Yes	Yes
Rehabilitated areas / areas not rehabilitated		Debushed area
Dust plumes	Yes on service road	Yes on service road
DEVELOPMENT:		
Infrastructure - Roads	Service road runs parallel east/west of railroad	Service road runs parallel west of railroad
- Powerlines	Powerline run parallel east of railroad.	Powerline run parallel east of railroad.
- Servitudes	Servitude fenced with livestock fencing both sides	Servitude fenced with more expensive game fencing both sides
Maintenance	Original railroad and sleepers	Steel sleepers being replaced with new concrete sleepers
COMMENTS/POSSIBLE ISSUES:	Powerline crossing railway to run parallel east of it.	Maintenance taking place on railway track

Sample SECTION	5 Okanona to Norman (14 km)	6 Norman to Omaruru (11 km)
Km along railway line	47.791 - 61.331	61.331 - 72.213
PHOTO NUMBER	112-005 - 111-960	111-961 - 111-0937
FLORA (predominant): <u>Grass species:</u>	<i>Eragrostis lehmanniana</i> <i>Aristida congesta</i>	<i>Aristida congesta</i> <i>Eragrostis lehmanniana</i>
		<i>Stipagrostis ciliata</i> , <i>S. uniplumis</i>
<u>Shrub species:</u>	Black thorn (<i>Acacia melifera</i>) Red thorn (<i>Acacia reficiens</i>) Mountain thorn (<i>Acacia hereroensis</i>)	Mountain thorn (<i>Acacia hereroensis</i>) Red thorn (<i>Acacia reficiens</i>) Black thorn (<i>Acacia melifera</i>)
<u>Tree species:</u>	Yellow bark (<i>A. erubescens</i>) Candle pod (<i>A. hebeclada</i>) Kalahari acacia (<i>Acacia leuderitzii</i>) Candle pod (<i>A. hebeclada</i>) Black thorn (<i>Acacia melifera</i>)	Trumpet thorn (<i>Catophractes alexandri</i>) Kalahari acacia (<i>Acacia leuderitzii</i>) Smelly shepherd's tree (<i>Boscia foetida</i>)
	<u>Riverine vegetation:</u> Camel thorn (<i>A. erioloba</i>) Protected F# Buffalo thorn (<i>Ziziphus micronata</i>) Protected F#	<u>Riverine vegetation:</u> Ana tree (<i>Faidherbia albida</i>) Protected F# Camel thorn (<i>A. erioloba</i>) Protected F# Buffalo thorn (<i>Ziziphus micronata</i>) Protected F#
FAUNA:	<i>Prosopis</i> Invasive	<i>Prosopis glandulosa</i>
RIVER:	Okanona River	Omaruru River
GEOGRAPHIC FEATURES	Outcrop east and west of railway	
DAMAGE/IMPACTS:		
Previously disturbed	Yes	Yes
Rehabilitated areas / areas not rehabilitated	Remains of old bridge on eastern side of existing bridge	Old embankment bridge present on eastern side
Dust plumes	Yes on service road	
DEVELOPMENT:		
Infrastructure - Roads	Service road runs parallel east/west of railroad	Service road runs parallel east/west of railroad
- Powerlines	Powerline run parallel east of railroad.	Powerline cross railway at Norman siding
- Servitudes	Servitude fenced with game fencing both sides	Electrified game fencing along an estate to the west
Maintenance	Steel sleepers being replaced with new concrete sleepers Maintenance taking place in this section	Steel sleepers replaced with new concrete sleepers
COMMENTS/POSSIBLE ISSUES:	Deviation to east close to outcrop	Deviation to west through electrified fence of estate Km 66 Deviation to east through informal settlement Km 68

Sample SECTION	9 Epako to Okozongoro (11 km)	10 Okozongoro to Otue (15 km)
Km along railway line	95.286 - 105.810	105.810 - 120.425
PHOTO NUMBER	111-0879 - 111-0872	111-0871 -111-0838
FLORA (predominant): <u>Grass species:</u>	<i>Enneapogon sp.</i>	<i>Aristida sp.</i>
	<i>Eragrostis sp.</i>	<i>Stipagrostis ciliata, S. uniplumis</i>
	<i>Stipagrostis ciliata, S. uniplumis</i>	<i>Eragrostis sp.</i>
<u>Shrub species:</u>	Yellow bark (<i>A. erubescence</i>)	Trumpet thorn (<i>Catophractes alexandri</i>)
	Mountain thorn (<i>Acacia hereroensis</i>)	<i>Acacia erubescence, Acacia reficiens, A. hereroensis</i>
	Red thorn (<i>Acacia reficiens</i>)	Candle pod (<i>A. hebeclada</i>)
<u>Tree species:</u>	Sickle-bush (<i>Dichrostachys cinerea</i>)	Black thorn (<i>Acaia melifera</i>)
	Buffalo thorn (<i>Ziziphus micronata</i>)	Sweet thorn (<i>Acacia karoo</i>)
		Smelly shepherd's tree (<i>Boscia foetida</i>)
		Buffalo thorn (<i>Ziziphus micronata</i>)
		Kalahari acacia (<i>Acacia leuderitzii</i>)
<u>In outcrops next to railway line:</u>		Blue leave corkwood (<i>Commiphora glaucescens</i>) (Protected F#)
		<i>Aloe littoralis</i> (Protected F#)
FAUNA:	Cape Glossy Starling	Cattle in railroad reserve
RIVER:		
GEOGRAPHIC FEATURES		Outcrops and mountains present
DAMAGE/IMPACTS:		
Previously disturbed	Yes	Yes
Rehabilitated areas / areas not rehabilitated	Bridge pillar of old embankment	Construction still taking place. Bush encroachment in servitude
Dust plumes	Yes on service road	Yes on service road and construction area
DEVELOPMENT:		
Infrastructure - Roads	C 33 runs // west of the railroad	C 33 runs // west of the railroad
- Powerlines		Game fence both sides of railroad
- Servitudes		Steel sleepers replaced with new concrete sleepers
Maintenance	Steel sleepers replaced with new concrete sleepers	Steel sleepers replaced with new concrete sleepers
COMMENTS/POSSIBLE ISSUES:	Land expropriation Km 96 - 98	Construction on culverts taking place
		Outcrops with special tree species will be missed by deviation.
		Land expropriation Km 108, 114, 115, 116, 117
		Aloes in outcrops that must be avoided (treatened and protected)

Sample SECTION	11 Otue to Kaalkop (7 km)	12 Kaalkop to Kalkfeld (12 km)
Km along railway line	120.425 - 128.307	128.307 - 140.274
PHOTO NUMBER	111-0837 - 111-0824	111-0823 - 111-0801
FLORA (predominant): <u>Grass species:</u>	<i>Stipagrostis ciliata</i> , <i>S. uniplumis</i> <i>Enneapogon sp.</i> <i>Cenchrus ciliaris</i>	<i>Enneapogon sp.</i> <i>Stipagrostis ciliata</i> , <i>S. uniplumis</i>
Shrub species:	Brittle thorn (<i>Phaeoptilum spinosum</i>)	Yellow bark (<i>A. erubescence</i>)
<u>Shrub/Tree species:</u>	Red thorn (<i>Acacia reficiens</i>)	Candle pod (<i>A. hebeclada</i>)
	Yellow bark (<i>A. erubescence</i>)	Buffalo thorn (<i>Ziziphus micronata</i>) Protected F#
	Mountain thorn (<i>Acacia hereroensis</i>)	Red thorn (<i>Acacia reficiens</i>)
	Sickle-bush (<i>Dichrostachys cinerea</i>)	Camel thorn (<i>Acacia erioloba</i>) Protected F#
	Black thorn (<i>Acaia melifera</i>)	Water thorn (<i>Acacia nebrownii</i>)
FAUNA:		Smelly shepherd's tree (<i>Boscia foetida</i>)
RIVER:		Worm-bark false thorn (<i>Albizia anthelmintica</i>) Protected F#
GEOGRAPHIC FEATURES		Anthill indicating termite activity
DAMAGE/IMPACTS:		
Previously disturbed	Yes (the servitude only)	Yes (town development around Kalkfeld)
Rehabilitated areas / areas not rehabilitated		Fire remains of debushing
Dust plumes	Not so much	Not so much
DEVELOPMENT:		
Infrastructure - Roads	C 33 runs // west of the railroad	C 33 runs // west of the railroad
- Powerlines		
- Servitudes	Game fence both sides of railroad	Game fence both sides of railroad
Maintenance	Steel sleepers replaced with new concrete sleepers	
COMMENTS/POSSIBLE ISSUES:	Land expropriation Km 120, 121	Deviation from railway line to the east means that probable blasting must take place in outcrop area
	Possible deviation over outcrop (Km 126,5)	Suggested alternative to the western flatter area Km133-135
	Railway line runs next to outcrops with aloes that may not to be entered.	Outcrop location:
	Dust suppression needed.	S20°58'9"
	Deviation do not involve the area, just pre-caution.	E16°08'13"

Sample SECTION	13 Kalkfeld to Avond (18 km)	14 Avond to Erundu (18 km)
Km along railway line	140.274 - 158.769	158.739 - 176.585
PHOTO NUMBER	111-0764 110-800	111-0759 - 111-0721
FLORA (predominant): <u>Grass species:</u>	<i>Eragrostis sp.</i> <i>Enneapogon sp.</i> <i>Stipagrostis ciliata, S. uniplumis</i>	<i>Stipagrostis ciliata, S. uniplumis</i> <i>Eragrostis sp.</i>
<u>Shrub species:</u>	Campher bush (<i>Tarchonanthes camphoratus</i>) Red thorn (<i>Acacia reficiens</i>) Mountain thorn (<i>Acacia hereroensis</i>) Sickle-bush (<i>Dichrostachys cinerea</i>) Black thorn (<i>Acaia melifera</i>)	Campher bush (<i>Tarchonanthes camphoratus</i>) Kudu bush (<i>Combretum apiculatum</i>) Sandpaper raisin (<i>Grewia flavescens</i>) <i>Acacia reficiens, A. hereroensis, A. melifera, A. hebeclada</i> Sickle-bush (<i>Dichrostachys cinerea</i>) Wild pear (<i>Dombeya rotundifolia</i>)
<u>Tree species:</u>	Camel thorn (<i>Acacia erioloba</i>) Protected F# Kalahari acacia (<i>Acacia leuderitzii</i>)	Camel thorn (<i>Acacia erioloba</i>) Protected F# Kalahari acacia (<i>Acacia leuderitzii</i>) Sweet thorn (<i>Acacia karroo</i>)
FAUNA:	Boergoats and dogs in Kalkfeld	
RIVER:		
GEOGRAPHIC FEATURES		
DAMAGE/IMPACTS:		
Previously disturbed	Yes (the servitude only)	Yes (the servitude only)
Rehabilitated areas / areas not rehabilitated	No	No
Dust plumes	Not so much	Not so much
DEVELOPMENT:		
Infrastructure - Roads	Service Road runs west of railway line	Service Road runs west of railway line
- Powerlines	Yes	
- Water Pipeline	NamWater Pipeline starts here and runs // with railroad	NamWater Pipeline runs // east of railroad
Maintenance	Steel sleepers replaced with new concrete sleepers	Steel sleepers replaced with new concrete sleepers
COMMENTS/POSSIBLE ISSUES:	Railroad runs along existing alignment here Bush encroachment in servitude	Land expropriation at Km 166, 167, 168 Bush encroachment in servitude

Sample SECTION	15 Erundu to Parasis (18 km)	16 Parasis to Otjiwarongo (14km)
Km along railway line	176.585 - 194.212	194.212 - 208.384
PHOTO NUMBER	111-0720 - 111-0677	111-0671 - 111-0643
FLORA (predominant): <u>Grass species:</u>	<i>Stipagrostis ciliata</i> , <i>S. uniplumis</i>	<i>Stipagrostis ciliata</i> , <i>S. uniplumis</i>
	<i>Eragrostis sp.</i>	
<u>Shrub species:</u>	Camper bush (<i>Tarchonanthus camphoratis</i>)	Yellow bark (<i>A. erubescence</i>)
	Sickle-bush (<i>Dichrostachys cinerea</i>)	Campher bush (<i>Tarchonanthus camphoratus</i>)
	Red thorn (<i>Acacia reficiens</i>)	Buffalo thorn (<i>Ziziphus micronata</i>) Proteted F#
	<i>Acacia hereroensis</i> , <i>A. erubescence</i>	Sickle-bush (<i>Dichrostachys cinerea</i>)
	Black thorn (<i>Acaia melifera</i>)	Red thorn (<i>Acacia reficiens</i>)
	Candle pod (<i>A. hebeclada</i>)	Mountain thorn (<i>Acacia hereroensis</i>)
<u>Tree species:</u>	Kudu bush (<i>Combretum apiculatum</i>)	Black thorn (<i>Acaia melifera</i>)
	Water thorn (<i>A. nebrownii</i>)	Candle pod (<i>A. hebeclada</i>)
	Kalahari acacia (<i>Acacia leuderitzii</i>)	Water thorn (<i>A. nebrownii</i>)
	Camel thorn (<i>Acacia erioloba</i>) Protected F#	Wild pear (<i>Dombeya rotundifolia</i>)
	Wild pear (<i>Dombeya rotundifolia</i>)	Kalahari acacia (<i>Acacia leuderitzii</i>)
FAUNA:	Martial Eagle; Go-away; Ginneafowl, Laughing Dove; Nests	Anthill indicating termite activity
RIVER:	Erundu River	
GEOGRAPHIC FEATURES		
DAMAGE/IMPACTS:		
Previously disturbed	Yes (the servitude only)	Yes (the servitude only)
Rehabilitated areas / areas not rehabilitated	No	
Dust plumes	Not so much	Not so much
DEVELOPMENT:		
Infrastructure - Roads	Service road runs west and east of railway line	B1 crosses railroad south of Otjiwarongo
- Powerlines	Powerline crossing over railroad	Powerline runs // on eastern side of railroad
Maintenance	Steel sleepers replaced with new concrete sleepers	Powerline crossing at B1 crossing
		Steel sleepers replaced with new concrete sleepers