ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT FOR THE PROPOSED #GAINGU PV POWER PLANT AND ASSOCIATED INFRASTRUCTURE

Final Environmental and Social Impact Assessment Report

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Project Manager Email	sstrauss@slrconsulting.com
Author	Stephanie Strauss
Reviewer	Marline Medallie
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Stephanie Strauss
(Project Manager)

Marline Medallie
(Reviewer)

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NON-TECHNICAL SUMMARY

[Separate Document]

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ACRONYMS AND ABBREVIATIONS

Acronym / Abbreviation	Definition
AC	Alternating Current
BESS	Battery Energy Storage System
BID	Background Information Document
CBMRN	Community Based Natural Resource Management
CCA	Central Coastal Area
CITES	Convention on International Trade in Endangered Species
COSDEC	Community Skills Development Centre
CRM	Cultural Resource Management
CSP	Concentrated Solar Power
CTAN	Coastal Tourism Association of Namibia
DC	Direct Current
DEA	Directorate of Environmental Affairs
DoD	Depth of discharge
DRFN	Desert Research Foundation of Namibia
EAP	Environmental Assessment Practitioner
ECC	Environmental Clearance Certificate
ECN	Engineering Council of Namibia
EIA	Early Iron Age
EMA	Environmental Management Act (No 7 of 2007)
ESA	Earlier Stone Age
ESF	Environmental and Social Framework
ESIA	Environmental and Social Impact Assessment
ESMP	Environmental and Social Management Plan
ESMS	Environmental and Social Management System
ESS	Environmental and Social Standards
FPIC	Free, Prior, and Informed Consent
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GHI	Global Horizontal Irradiation
GIIP	Good International Industry Practice
HPP	Harambee Prosperity Plan
I&APs	Interested and Affected Parties
ICP	Informed Consultation and Participation
IFC	International Finance Corporation

Acronym / Abbreviation	Definition
ILF	ILF Consulting Engineers
ILO	International Labour Organization
IPF	Investment Project Financing
IUCN	International Union Conservation of Nature
IWRM	Integrated Water Resource Management
LIA	Late Iron Age
LSA	Later Stone Age
LV	Low Voltage
masl	Meters above sea level
MCB	Main Control Building
MEFT	Ministry of Environment, Forestry and Tourism
MHS	Ministry of Health and Social Services
MIA	Middle Iron Age
MME	Ministry of Mines and Energy
MMS	Module Mounting Structures
MSA	Middle Stone Age
MURD	Ministry of Urban and Rural Development
MV	Medium Voltage
NACOMA	Namibian Coast Conservation & Management Project
NACSO	Namibian Association of Community Based Natural Resource Management Support Organisation
NamPower	Namibia Power Corporation (Pty) Ltd
NamWater	Namibia Water Corporation
NBRI	National Botanical Research Institute
NCO	Nature Conservation Ordinance, 1975 (No. 4 of 1975)
NDP	National Development Plan
NIMT	Namibian Institute of Mining and Technology
NMC	Nickel Manganese Cobalt
NNF	Namibia Nature Foundation
NPC	National Planning Commission
NTA	National Training Technology
NUST	Namibia University of Science and Technology (NUST)
PERC	Passivated Emitter Rear Contact
PF	Power factor
PPAH	Pollution Prevention and Abatement Handbook
PPP	Public Participation Process

Acronym / Abbreviation	Definition
PS	Performance Standards
PV	Photovoltaic
RE	Renewable Energy
RMU	Ring Main Unit
RUL	Rössing Uranium Limited
SAIEA	Southern Africa Institute for Environmental Assessment
SCADA	Supervisory Control and Data Acquisition
SEA	Strategic Environmental Assessment
SLR	SLR Environmental Consulting Namibia (Pty) Ltd
SME	Small and Medium Enterprise
SWAPO	South West Africa People's Organization
UN	United Nations
UNAM	University of Namibia
UNCBD	United Nations Convention on Biological Diversity
UNDRIP	United Nations Declaration on the Rights of Indigenous Peoples
UPS	Uninterruptible Power Supply
WWF	World Wildlife Fund

Environmental and Social Impact Assessment for the Proposed #Gaingu PV Power Plant and Associated Infrastructure

1. INTRODUCTION

This chapter provides a brief description of the project background and location, describes the objectives and purpose of this report, outlines how to comment and describes the structure of the report.

1.1 PURPOSE OF THIS REPORT AND OPPORTUNITY TO COMMENT

This Draft Environmental and Social Impact Assessment (ESIA) Report and Environmental and Social Management Plan (ESMP) has been compiled as part of the ESIA process that is being undertaken for the proposed #Gaingu Photovoltaic (PV) Power Plant and associated infrastructure.

This report provides:

- An introduction to the proposed project;
- The legal and policy framework;
- The ESIA approach and methodology;
- Details of the public participation process;
- The need for the proposed project;
- A description of the proposed project activities and alternatives being considered;
- A description of the key characteristics of the receiving (baseline) environment;
- An assessment of potential impacts of the proposed project;
- Mitigation and management measures necessary to avoid or reduce potentially significant impacts, which are included into an ESMP; and
- Recommendation and conclusion regarding the issuing of an Environmental Clearance Certificate (ECC) for the proposed project.

The compilation of this Final ESIA Report and ESMP has been informed by comments received following the distribution of the draft report for a 30-day comment period (22 September to 23 October 2023, extended from 20 November to 6 December 2023) and those raised during public information-sharing meetings. Comments received by SLR on or before 6 December 2023 are recorded and responded to in a Comments and Responses Report (see Appendix C.5). It should be noted that all significant changes to the Draft ESIA Report are underlined and in a different font (Times New Roman) to the rest of the text.

This Final ESIA Report and ESMP is submitted to the Ministry of Mines and Energy (MME): Department of Water Resource Management for consideration and review. In terms of Section 32 of the Environmental Management Act, 2007 (No. 7 of 2007), MME is required to make a recommendation on the acceptance or rejection of the report to the Ministry of Environment, Forestry and Tourism (MEFT): Directorate of Environmental Affairs (DEA), who will make the final decision.

1.2 PROJECT BACKGROUND

The Namibia Water Corporation Limited (hereafter referred to as "NamWater") is the national water utility of Namibia. NamWater undertook a Feasibility Study for the proposed development of a desalination plant and a water carriage system to supply water to the Central Coast, Windhoek and en-route users (Arandis, Usakos, Karibib and Okahandja). The primary objective of the Feasibility Study, which was informed by the findings of the Scoping phase, was to investigate feasible and affordable water supply options, also looking at relevant power supply options, that would diversify and secure supply alternatives to the target areas and identify the preferred project alternative(s) to be considered in the Impact Assessment phase. The development and implementation of the desalination plant to meet the water demands of the Central Coastal Area (CCA) (Supply Scenario 1 (SS1)) was found to be imperative and considered to be the most viable project. Based on the findings of the Feasibility Study, NamWater has thus decided to proceed with SS1 only.

During the Feasibility Study, different solutions for providing a Renewable Energy (RE) power supply in combination with the national utility supply were considered for the different supply scenarios of the desalination plant.

This report discusses the power supply option related to SS1, which is the development of the proposed #Gaingu PV Power Plant and associated infrastructure which is proposed to be located within the #Gaingu Conservancy as shown in Figure 1-1. The new desalination facility and components are discussed and assessed in a separate ESIA report.

The proposed project triggers a number of listed activities in terms of the EIA Regulations 2012, and as such requires an ECC before such activities can commence. SLR Environmental Consulting (Namibia) (Pty) Ltd has been appointed as the independent Environmental Assessment Practitioner (EAP) to undertake the ESIA and develop the ESMP for the proposed #Gaingu PV Power Plant and Associated Infrastructure.

1.3 STRUCTURE OF THIS REPORT

This report has been prepared in compliance with Section 8 of the EIA Regulations 2012. An overview of the structure and content of this report is given in Table 1-1 below.

Table 1-1: Structure and content of the Final ESIA Report

Section	Contents
VOLUME 1	**MAIN REPORT**
Executive Summary	Provides a synopsis of the ESIA Report.
Chapter 1	**Introduction** Describes the purpose of this report, provides a brief description of the project background and location, outlines how to comment, and describes the structure of the report.
Chapter 2	**Environmental Legal and Policy Framework** Provides an overview of relevant Namibian legislation and policy, describes the international treaties, industry standards and guidelines applicable to the EIA process for the project.

Section	Contents
Chapter 3	**ESIA Approach and Methodology** Presents the ESIA Project Team, ESIA assumptions and limitations, and outlines the approach and process followed during the ESIA.
Chapter 4	**Public Consultation Process** Presents and describes the public participation process undertaken during the ESIA process.
Chapter 5	**Project Description** Provides general project information, provides an overview of the need and desirability for the project and a detailed description of the proposed activities and associated project alternatives.
Chapter 6	**Receiving Environment** Describes the existing physical, biological, socio-economic and cultural environment that could potentially be affected by the proposed project activities.
Chapter 7	**Environmental Impact Assessment** Describes key issues and impacts associated with the proposed project.
Chapter 8	**Environmental Impact Statement and Conclusions** Provides conclusions to the ESIA and summarises the project controls, mitigation and monitoring measures that would be implemented for the proposed project.
Chapter 9	**References** Provides a list of the references used in compiling this report.
Appendices	Appendix A: Curriculum Vitae of ESIA Project Team Appendix B: Authority Documents Appendix C: Public Participation Documents Appendix C.1: Stakeholder Database Appendix C.2: Advertisements and Site notices Appendix C.3: Notification Letters Appendix C.4: Minutes of Public Meetings Appendix C.5: Comments and Responses Report Appendix D: Surface Hydrology Impact Assessment, SLR 2023 Appendix E: Terrestrial Biodiversity and Ecology Impact Assessment, Henriette Potgieter 2023 Appendix F: Avifauna Impact Assessment, African Conservation Services 2023 Appendix G: Heritage Impact Assessment, Beyond Heritage 2023 Appendix H: Visual Impact Assessment, Green Tree Environmental 2023 Appendix I: Noise Impact Assessment, SLR 2023 Appendix J: Socio-economic Impact Assessment, Ashby and Associates 2023 Appendix K: Climate Change Risk Assessment, SLR 2023 Appendix L: Greenhouse Gas Emissions Assessment, SLR 2023 Appendix M: Environmental and Social Management Plan

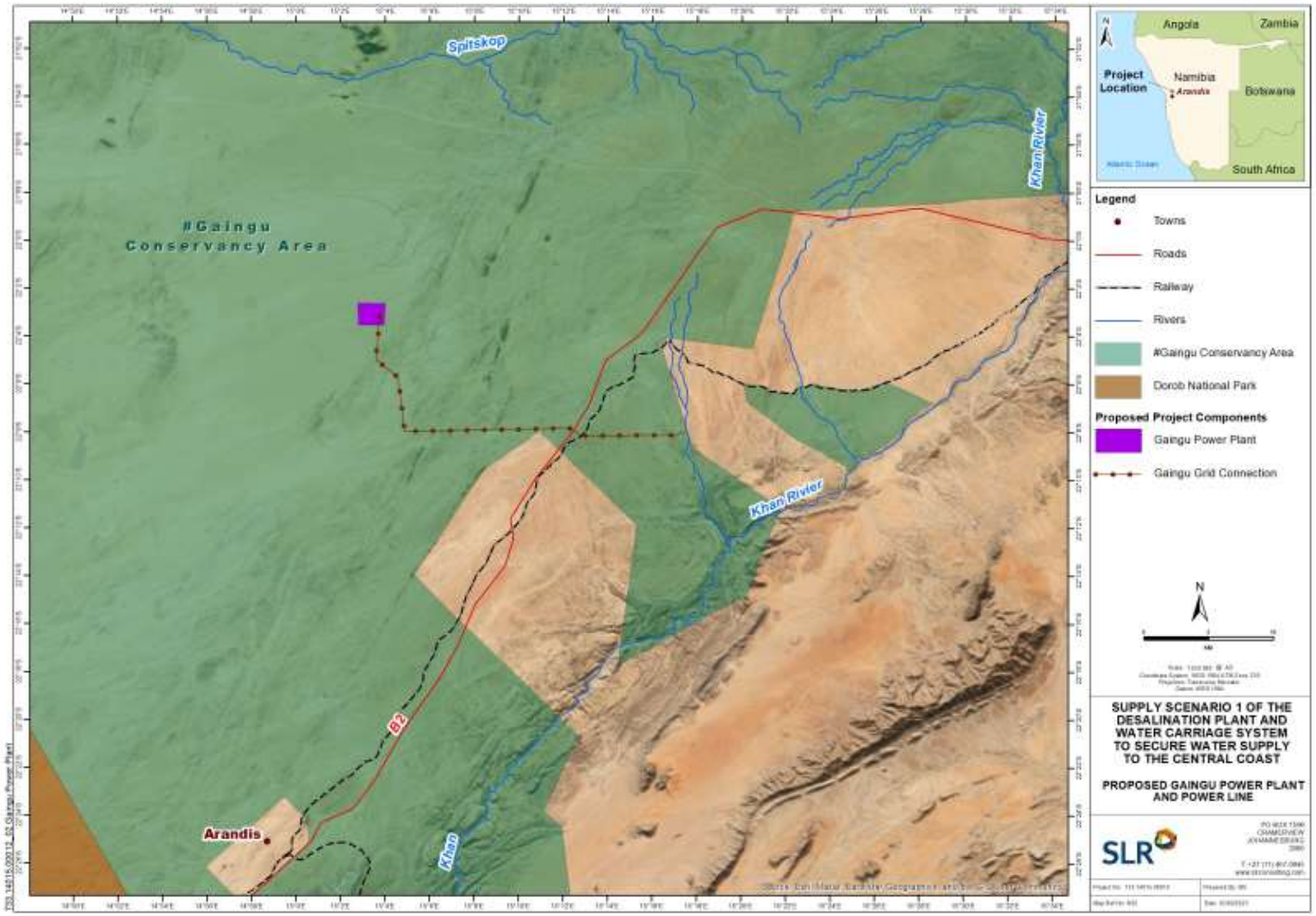


Figure 1-1: Locality of proposed #Gaingu PV Plant and grid connection

2. ENVIRONMENTAL LEGAL AND POLICY FRAMEWORK

In accordance with the EIA Regulations, all legislation and guidelines that have been considered in the ESIA process must be documented. This chapter provides an overview of relevant Namibian legislation and policy, summarises the Namibian administrative framework and describes the international treaties, industry standards and guidelines applicable to the ESIA process for the proposed project. Furthermore, potential gaps in relevant environmental legalisations and standards within Namibia are highlighted.

2.1 NAMIBIAN INSTITUTIONAL AND ADMINISTRATIVE STRUCTURE

2.1.1 Introduction

The Namibian Constitution makes provision for the creation and enforcement of applicable legislation. Namibia has five tiers of law which include the following:

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

At Independence in 1990, the Government of the Republic of Namibia recognized the importance of the environment, by including the protection of natural resources in the Constitution. Within this context, and in accordance with the Constitution, Namibia has passed numerous laws intended to protect the natural environment and to mitigate against adverse environmental impacts.

A number of the Acts, as well as various policies, are relevant to the proposed PV Plant project. This section details the institutional framework responsible for implementing the relevant legislation (described in Section 2.2).

2.1.2 Ministry of Mines and Energy

The MME comprises six directorates; one of which is the Directorate of Energy. The Directorate of Energy consists of 2 divisions:

- Electricity Division
- Renewable Energy Division

The Directorate of Energy enforces the compliance of legal requirements of energy legislation (Electricity Act, 2007) and regulations and conducts research on new and renewable sources of energy.

The National Integrated Resource Plan is a 20-year development plan for Namibia's Electricity Supply Industry, spanning the period between 2016 and 2035.The Directorate conducts functions such as:

- Implementation of Rural Electrification
- Implementation of Off-Grid Energisation Master Plan

The mandate of the Energy directorate is to ensure the adequate and affordable energy supply in a sustainable manner taking advantage of Namibia's natural resources in support of the nation's socio-economic development.

A recent directive from MEFT (March 2017) requires that applications for Environmental Clearance Certificates for projects relating to energy generation be submitted to MME, as the Competent Authority. As part of the ESIA process, MME is required to make a recommendation to MEFT on the application for Environmental Clearance, who will make the final decision.

2.1.3 Ministry of Environment, Forestry and Tourism

The mission of the MEFT is to promote biodiversity conservation in the Namibian environment through the sustainable utilization of natural resources and tourism development for the maximum social and economic benefit of its citizens. MEFT develops, administers and enforces environmental legislation and policy.

The MEFT's DEA is mandated to give effect to Article 95L of the Constitution by promoting environmental sustainability. The Environmental Commissioner serves as head of the DEA. The DEA is responsible for, inter alia, the administration of the EIA process undertaken in terms of the Environmental Management Act, 2007 and the EIA Regulations 2012.

The DEA will be responsible for issuing a decision on the application for an ECC, based on the recommendations from MME. If approved, the DEA will issue an Environmental Clearance Certificate.

2.1.4 Ministry of Agriculture, Water and Land Reform

The Ministry of Agriculture, Water and Land Reform (MAWLR) has as its mission the realization of the potential of the Agricultural, Water and Land Reform sectors towards the promotion of an efficient and sustainable socio-economic development for a prosperous Namibia. The MAWLR is mandated to promote, develop, manage and utilize agricultural and water resources.

The MAWLR is a key stakeholder in the project and the ESIA process due to the proposed PV Plant which will supply power to the proposed new desalination plant.

2.1.5 Namibia Water Corporation

NamWater, the project applicant, supplies water in bulk to industries, government institutions, municipalities, local authorities, commercial entities, such as mines, and to the Directorate of Water Supply and Sanitation in the MAWLR. The Directorate in turn supplies water to rural communities.

NamWater is a commercialized water entity, wholly owned by the Government of the Republic of Namibia. NamWater's mandate is to provide quality water and related services to the satisfaction of all stakeholders, taking cognizance of the environment, scarcity of and dependency of all on water. The Board of Directors ensures that NamWater utilizes the scarce water resources in the best interests of Namibia and the Namibian People.

2.1.6 Namibia Power Corporation

The Namibia Power Corporation (Pty) Ltd ("NamPower") is Namibia's national power utility, whose core business is the generation, transmission and energy trading and its mission is to provide for the energy needs of its customers. NamPower supplies bulk electricity to regional electricity distributors, mines, farms and local authorities throughout Namibia.

NamWater will need to consult with NamPower regarding new powerlines. The proposed powerlines associated with the proposed project will form part of the overall ESIA process, ESIA Report and ESMP for the project. However, at a later stage, NamPower might apply for a transfer of the ECC for relevant activities associated with the powerlines, from MEFT: DEA. This would be dependent on further agreements between NamWater and NamPower.

2.2 NAMIBIAN LEGAL FRAMEWORK

The relevant Namibian legislation, with regard to environmental aspects, that was considered during the ESIA is documented.

2.2.1 The Constitution of the Republic of Namibia

The Constitution of the Republic of Namibia (1990) provides the set of foundational principles according to which Namibia is governed. Article 95 (l) of the Constitution commits the state to promote sustainable development by "*maintenance of ecosystems, essential ecological processes and biological diversity of Namibia and utilization of living natural resources on a sustainable basis for the benefit of all Namibians both present and future…"*.

The constitutional recognition of environmental concerns triggered widespread legislative reform relating to the management of natural resources in Namibia. The country's environmental protection effort is currently comprised of the Environmental Management Act, 2007 (No. 7 of 2007) (EMA) and its Regulations (2012).

Article 16 states that the State or a competent body or organ authorised by law may expropriate property in the public interest subject to the payment of just compensation; thus, landowners impacted by any project infrastructure on their land must be compensated.

2.2.2 Namibia's Environmental Impact Assessment Policy

The Environmental Impact Assessment (EIA) Policy of 1995 promotes accountability and informed decision making through the requirement of EIAs for listed programmes and projects (activities). The EIA Policy is currently enforced through the EMA and the EIA Regulations of 6 February 2012. Refer to sections 2.2.3 and 2.2.4.

2.2.3 Environmental Management Act, 2007

The EMA was promulgated in December 2007 and came into effect on 6 February 2012. Part 1 of the EMA describes the various rights and obligations that pertain to citizens and the Government. The main objectives of the Act are to ensure that:

- Significant effects of activities on the environment are considered carefully and timeously;
- There are opportunities for timeous participation by I&APs throughout the assessment process; and
- Findings are taken into account before any decision is made in respect of activities affecting the environment.

Part 2 of the EMA sets out a number of principles of environmental management which give effect to the provisions of the Constitution for integrated environmental management. Decision-makers must take these principles into account when deciding whether or not to approve a proposed project. In terms of this legal framework certain identified activities may not commence without an environmental clearance certificate (or amendment thereto) that is issued by the office of the environmental commissioner in the MEFT.

2.2.4 EIA Regulations

The EIA Regulations, promulgated on 6 February 2012 in terms of Section 56 of the EMA provides for the control of certain listed activities. These listed activities are provided in Government Notice (GN) No. 29 and are prohibited until an ECC has been obtained from MEFT. Such ECCs, which may be granted subject to conditions, will only be considered once there has been compliance with the EIA Regulations 2012 published in GN No. 30. These EIA Regulations sets out the procedures and documentation that need to be complied with in undertaking an EIA process. Listed activities applicable to the proposed project are presented in Table 2-1.

Table 2-1: List of Applicable Activities in terms of the EIA Regulations, 2012

Listed Activity	Project Component
1. Energy generation, transmission and storage activities	
1. The construction of facilities for - *(a) the generation of electricity.* *(b) the transmission and supply of electricity.*	Construction of a new Solar PV Plant or similar for feeding energy into the national grid for the project.
3. Mining and quarrying activities	
3.2 Other forms of mining or extraction of any natural resources whether regulated by law or not.	Various borrow pits would be required for the supply of suitable material for the foundations of the project infrastructure.
4. Forestry activities	
4. The clearance of forest areas, deforestation, afforestation, timber harvesting or any other related activity that requires authorisation in terms of the Forest Act, 2001 (No. 12 of 2001) or any other law.	During the construction of the various project components, certain areas will have to be cleared, and protected trees species might have to be removed, depending on the final project layout.
9. Hazardous substance treatment, handling and storage	
9.1 The manufacturing, storage, handling or processing of a hazardous substance defined in the Hazardous Substances Ordinance, 1974	Various hazardous substances would either be stored, handled and/or processed on site.

2.2.5 Other relevant Namibian legislation

Table 2-2 below provides a summary of other relevant environmental and social legislation that may be applicable to the proposed project.

Table 2-2: Other applicable Namibian environmental legislation

Sector	Law	Key Provisions and relevance to the Project
Petroleum	*Petroleum Products and Energy Act, 1990 (No. 13 of 1990) and relevant regulations*	This Act provides for the application of environmental standards and the avoidance of environmental harm caused by the keeping, handling, conveying, using and disposing of petroleum products. No person may without authorisation discard, destroy or otherwise dispose of oil or possess or store or transport oil in containers that are not suitable for preventing destruction, loss or waste of the oil. Every person is obliged to take such precautions and exercise such care as may be reasonable in the circumstances in the storing, handling, conveying, disposing of any petroleum product in order to prevent risk of significant environmental harm. Provision is also made in the regulations for the disposal of petroleum products in a manner and at a place intended for the safekeeping of dumping thereof in accordance with good petroleum industry practices. Petrol, diesel and other hydrocarbons will likely be stored/ handled at relevant sites during the construction phase of the project. Where volumes of such materials exceed the relevant thresholds then activities will have to comply with the requirements of the Act.
Transport	*Road Traffic and Transport Act, 1999 (No. 22 of 1999)*	This Act provides for the control of traffic on public roads, the licensing of drivers, the registration and licensing of vehicles, and the control and regulation of road transport across Namibia's borders. Vehicles supplying goods and services to the project during construction and operation will have to comply with the requirements of the Act.
	Civil Aviation Act, 2016 (No. 6 of 2016) and associated regulations	This Act consolidates the laws relating to civil aviation and civil aviation offences. The proposed PV plant is not located nearby any aerodrome which could potentially be impacted.
Pollution/ Waste	*Pollution Control and Waste Management Bill (3rd Draft September 2003)*	This Bill promotes sustainable development and provides for the prevention and regulation of the discharge of pollutants to the air, water and land; regulation of noise, dust and odour pollutions; and the establishment of a system of waste planning and management. Hazardous and non-hazardous waste will be generated during all project phases and consideration should be given of the requirements of the bill.
	Atmospheric Pollution Prevention Ordinance (Ordinance 11 of 1976)	This Ordinance provides for the prevention of the pollution of the atmosphere. Construction activities, creating dust near third parties need to be controlled in terms of the requirements of the Ordinance.
Environmental/ Conservation/ Land	*National Heritage Act, 2004 (No. 27 of 2004)*	This Act provides for, *inter alia*, the protection and conservation of places and objects of heritage significance. A National Heritage Council has been established to identify, conserve, manage, and protect places and objects of heritage significance. Permits are required for the removal, damage, alteration or excavation of heritage sites or remains. Any person who discovers an archaeological site should notify the National Heritage Council. These aspects could be relevant during the construction activities of the proposed project and has been assessed in this ESIA.

Sector	Law	Key Provisions and relevance to the Project
	National Monuments Act, 1969 (No. 28 of 1969)	This Act establishes a National Monuments Council and provides for the preservation of certain property as National Monuments and the maintenance of certain burial grounds.
	Nature Conservation Ordinance, 1975 (No. 4 of 1975)	This Ordinance consolidates and amends the laws relating to the conservation of nature; the establishment of game parks and nature reserves; and the control of problem animals. The Ordinance is expected to be replaced by the Wildlife and Protected Areas Management Act in the near future (latest draft 2018). The study area for the desalination plant, which is being considered in a separate ECC application and ESIA process (See Desalination Plant ESIA Report) overlaps the Dorob National Park.
	The Nature Conservation Amendment Act, 1996 (No. 5 of 1996) and amended by Act No. 5 of 2017	These Acts enable communities to apply to Government to be registered as a conservancy. The study area for the PV Plant overlaps the #Gaingu Conservancy (refer to Section 6).
	Forest Act, 2001 (No. 12 of 2001), as amended, and Regulations (Government Gazette No. 5801)	This Act provides for the protection of the environment/ natural vegetation and the control and management of forest fire. The Regulations includes the list of protected plant species. No person shall on any land which is not part of a surveyed erven of a local authority area cut, destroy or remove any living tree, bush or shrub growing within 100 m of a river, stream or watercourse, except under a licence from the Directorate of Forestry.
	Communal Land Reform Act, 2002 (No. 5 of 2002)	This Act provides for the allocation and administration of all communal land and makes provision for the prevention of land degradation and for mitigating the impacts of, amongst others, water provision on the natural environment. The Act gives certain rights to communal farmers and traditional authorities and makes provision for regulations to address issues pertinent to conservation and sustainable management of water and water courses, of woods and to the combatting and prevention of soil erosion.
	Agricultural Pests Act, 1973 (No. 3 of 1973)	This Act provides for the control and destruction in certain proclaimed areas of exotic animals and plants infected with insects or plant diseases; and the control of the importation of plants, insects, plant diseases, honeybees, honey and exotic animals.
	Plant Quarantine Act, 2008 (No. 7 of 2008)	This Act provides for the preventing, monitoring, controlling and eradication of plant pests; and to facilitate the movement of plants, plant products and other regulated articles within and into or out of Namibia.
	Soil Conservation Ac, 1969t (No. 76 of 1969)	The Act makes provision for the prevention and control of soil erosion and the protection, improvement and conservation of soil, vegetation and water supply sources and resources, through directives declared by the Minister. Care is to be taken in identifying any potential impacts on soil, vegetation, water supply sources and resources by firstly trying to avoid these impacts. Where they can't be avoided, management measures should be implemented to reduce the significance of the impact(s).
Hazardous Substances	*Hazardous Substances Ordinance, 1974 (No. 14 of 1974)*	These provide for the control of toxic substances which may cause injury, ill health or death of human beings. Various chemicals would be used and stored; and hydrocarbons used during the construction activities of all project components.

Sector	Law	Key Provisions and relevance to the Project
Labour	*Labour Act, 2007 (No. 11 of 2007) and its amendment: No. 2 of 2012*	These Acts stipulate, amongst other things, sound labour relations, employment equity, fair employment practices, training, minimum basic conditions of service, workplace health and safety and retrenchment. Compliance is enforced and monitored by the Ministry of Labour through the office of the Labour Commissioner.
	Social Security Act, 1994 (No. 34 of 1994, as amended	
	Employees Compensation Act, 1995 (No. 5 of 1995)	
	Regulations relating to the health and safety of employees at work (GN 156 of 1997)	These Regulations establish health and safety regulations for the workplace.
	Affirmative Action (Employment) Act, 1998 (No. 29 of 1998)	This Act aims to achieve equal opportunity in employment by redressing, through appropriate affirmative action plans, the conditions of disadvantage in employment experienced by persons in designated groups arising from past discriminatory laws and practices.
	Anticorruption Act, 2003 (No. 8 of 2003)	This Act provides for the prevention and punishment of corruption.
Electricity	*Electricity Act, 2007 (No. 4 of 2007)*	This Act provides for the requirements and conditions for obtaining licences for the provision of electricity and to provide for the powers and obligations of licensees.

2.2.6 Other relevant Namibian Policies

Namibia's policies provide the framework to the applicable legislation. Whilst policies do not often carry the same legal recognition as official statutes, policies are used in providing support to legal interpretation or guidance for civil servants and other stakeholders in the implementation of government objectives. Relevant policies (other than the aforementioned policies) currently in force include the following:

- National Development Plan 5 and Vision 2030;
- National Integrated Resource Plan (NIRP 2016);
- National Forest Policy (1992);
- National Agricultural Policy (2015);
- National Land Policy, the National Resettlement Policy, the Agricultural (Commercial) Land Reform Act (1995);
- Land Tax and Communal Land Reform Act (2002);
- Poverty Reduction Strategy for Namibia (1998);
- White Paper on Energy Policy (1998);
- National Industrial Policy (2012);
- Policy for the Conservation of Biotic Diversity and Habitat Protection (1994);
- National Policy on Human Wildlife Conflict management (2009);
- Namibia's Integrated Water Resources Management (IWRM) Plan (2010); and
- The National Climate Change Policy of Namibia (2011).

2.2.6.1 Climate Change Policy

Namibia's National Climate Change Policy takes a cross-sectoral approach and elaborates on climate change adaptation and mitigation in Namibia. The policy outlines a coherent, transparent and inclusive framework on climate risk management in accordance with Namibia's national development agenda, legal framework, and in recognition of environmental constraints and vulnerability. After a long process of stakeholder consultation, the MEFT launched the National Climate Change Strategy and Action Plan.

2.2.7 The Namibia Vision 2030

The principles that underpin Vision 2030[1], a policy framework for Namibia's long-term national development, comprise the following:

- Good governance;
- Partnership;
- Capacity enhancement;
- Comparative advantage;
- Sustainable development;
- Economic growth;
- National sovereignty and human integrity;
- Environment; and
- Peace and security.

Vision 2030 states that natural environments are disappearing quickly. Consequently, the solitude, silence and natural beauty that many areas in Namibia provide are becoming sought after commodities and must be regarded as valuable natural assets. Vision 2030 emphasises the importance of promoting healthy living which includes that the majority of Namibians are provided with safe drinking water. The importance of developing wealth, livelihood, and the economy is also emphasised by Vision 2030. This includes infrastructure provision like transport, communication, water, and electricity.

2.2.8 Coastal Strategic Environmental Assessments

Two Namibian coastal Strategic Environmental Assessments (SEAs) were undertaken between 2006 and 2008, i.e., one for the northern regions of Kunene and Erongo and another for the southern regions of Karas and Hardap. These draw on international experience and were undertaken at a time of mounting production sector pressures within Namibia. Being an initiative of the Namibian Government through MEFT, the two SEAs seek to inform political and technical decision makers at local, regional and national levels.

The 2008 "SEA for the coastal areas of the Erongo and Kunene Regions" compiled by the Namibian Coast Conservation & Management Project (NACOMA) is aimed at ensuring informed decisions on issues related to biodiversity conservation, land use planning and socio-economic development planning in the Kunene and Erongo coastal regions.

[1] Derived from Namibia's Green Plan drafted by MET in 1992 and followed by the sequence of National Development Plans.

2.2.9 International Conventions

Relevant international conventions to which Namibia is a signatory are summarised below:

- Convention on Biological Diversity, 1992;
- United Nations Framework Convention on Climate Change, 1992;
- The Convention on International Trade in Endangered Species (CITES) of 1973;
- Convention to Combat Desertification 1994;
- National Rangeland Management Policy and Strategy of 2012;
- National Biodiversity Strategy and Action Plan 1 and 2 (draft);
- Vienna Convention for the protection of the ozone layer (1985);
- Montreal Protocol on substances that deplete the ozone layer (1987);
- United Nations Convention on Biological Diversity (UNCBD); and
- United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP) 2007.

2.3 OVERVIEW OF RELEVANT INTERNATIONAL STANDARDS

The proposed project may be reliant on finance through loans from international lending institutions and as such there is need for the proposed project to be undertaken in such a manner that complies with the World Bank Group's Environmental and Social Standards. Relevant international criteria and standards requiring consideration through the ESIA process are described in the sections below.

2.3.1 World Bank

2.3.1.1 World Bank Environmental and Social Framework (2018)

The World Bank's Environmental and Social Framework (ESF) enables the World Bank and Borrowers to better manage environmental and social risks of projects and to improve development outcomes. The ESF offers broad and systematic coverage of environmental and social risks. It makes important advances in areas such as transparency, non-discrimination, public participation, and accountability—including expanded roles for grievance mechanisms. It brings the World Bank's environmental and social protections into closer harmony with those of other development institutions.

The ESF consists of:

- the World Bank's Vision for Sustainable Development
- the World Bank's Environmental and Social Policy for Investment Project Financing (IPF), which sets out the requirements that apply to the Bank
- the 10 Environmental and Social Standards (ESS), which set out the requirements that apply to Borrowers
- Bank Directive: Environmental and Social Directive for IPF
- Bank Directive on Addressing Risks and Impacts on Disadvantaged or Vulnerable Individuals or Groups

2.3.1.2 World Bank Environmental and Social Standards (2018)

The World Bank's Environmental and Social Standards (ESS) consist of eleven standards as summarised below. The applicability of each standard to the project is also indicated.

Table 2-3: World Bank E&S Standards and their applicability to the Project

World Bank Environmental and Social Standards (ESS)	Applicability to this project
ESS1 Assessment and Management of Environmental and Social Risks and Impacts sets out the Borrower's responsibilities for assessing, managing and monitoring environmental and social risks and impacts associated with each stage of a project supported by the Bank through IPF, in order to achieve environmental and social outcomes consistent with the ESS.	Yes
ESS2 Labour and Working Conditions recognizes the importance of employment creation and income generation in the pursuit of poverty reduction and inclusive economic growth. Borrowers can promote sound worker-management relationships and enhance the development benefits of a project by treating workers in the project fairly and providing safe and healthy working conditions.	Yes
ESS3 Resource Efficiency and Pollution Prevention and Management recognizes that economic activity and urbanization often generate pollution to air, water, and land, and consume finite resources that may threaten people, ecosystem services and the environment at the local, regional, and global levels. This ESS sets out the requirements to address resource efficiency and pollution prevention and management throughout the project lifecycle.	Yes
ESS4: Community Health and Safety addresses the health, safety, and security risks and impacts on project-affected communities and the corresponding responsibility of Borrowers to avoid or minimize such risks and impacts, with particular attention to people who, because of their particular circumstances, may be vulnerable.	Yes
ESS5: Land Acquisition, Restrictions on Land Use and Involuntary Resettlement - involuntary resettlement should be avoided. Where involuntary resettlement is unavoidable, it will be minimized and appropriate measures to mitigate adverse impacts on displaced persons (and on host communities receiving displaced persons) will be carefully planned and implemented.	Yes
ESS6: Biodiversity Conservation and Sustainable Management of Living Natural Resources recognizes that protecting and conserving biodiversity and sustainably managing living natural resources are fundamental to sustainable development and it recognizes the importance of maintaining core ecological functions of habitats, including forests, and the biodiversity they support. ESS6 also addresses sustainable management of primary production and harvesting of living natural resources and recognizes the need to consider the livelihood of project-affected parties, including Indigenous Peoples, whose access to, or use of, biodiversity or living natural resources may be affected by a project.	Yes
ESS7: Indigenous Peoples/ Sub-Saharan African Historically Underserved Traditional Local Communities ensures that the development process fosters full respect for the human rights, dignity, aspirations, identity, culture, and natural resource-based livelihoods of Indigenous Peoples/ Sub-Saharan African Historically Underserved Traditional Local Communities. ESS7 is also meant to avoid adverse impacts of projects on Indigenous Peoples/ Sub-Saharan African Historically Underserved Traditional Local Communities, or when avoidance is not possible, to minimize, mitigate and/ or compensate for such impacts. No indigenous peoples were identified to be considered for the proposed project.	No

World Bank Environmental and Social Standards (ESS)	Applicability to this project
ESS8: Cultural Heritage recognizes that cultural heritage provides continuity in tangible and intangible forms between the past, present and future. ESS8 sets out measures designed to protect cultural heritage throughout the project lifecycle.	Yes
ESS9: Financial Intermediaries (FIs) recognizes that strong domestic capital and financial markets and access to finance are important for economic development, growth and poverty reduction. FIs are required to monitor and manage the environmental and social risks and impacts of their portfolio and FI subprojects, and monitor portfolio risk, as appropriate to the nature of intermediated financing. The way in which the FI will manage its portfolio will take various forms, depending on a number of considerations, including the capacity of the FI and the nature and scope of the funding to be provided by the FI.	No
ESS10: Stakeholder Engagement and Information Disclosure recognizes the importance of open and transparent engagement between the Borrower and project stakeholders as an essential element of good international practice. Effective stakeholder engagement can improve the environmental and social sustainability of projects, enhance project acceptance, and make a significant contribution to successful project design and implementation.	Yes

2.3.1.3 World Bank's Pollution Prevention and Abatement Handbook

The Pollution Prevention and Abatement Handbook (PPAH) promotes the concepts of sustainable development by focusing attention on the benefits, both environmental and economic, of pollution prevention, including cleaner production and good management techniques. In many cases, the guidelines provide numerical targets for reducing pollution, as well as maximum emissions levels that are normally achievable through a combination of cleaner production and end-of-pipe treatment. The guidelines are designed to protect human health, reduce mass loadings to the environment, draw on commercially proven technologies, be cost effective, follow current regulatory trends and promote good industrial practices, which offer greater productivity and increased energy efficiency.

2.3.2 International Finance Corporation Performance Standards

The International Finance Corporation (IFC) has adopted eight (8) Performance Standards (PS) on Social and Environmental Sustainability to manage social and environmental risks and impacts and to enhance development opportunities.

PS 1 establishes the importance of:

- Integrated assessment to identify the environmental and social impacts, risks, and opportunities of projects;
- Effective community engagement through disclosure of project-related information and consultation with local communities on matters that directly affect them; and
- The client's management of environmental and social performance throughout the life of the project.

PS 2 to 8 establish objectives and requirements to avoid, minimize, and where residual impacts remain, to compensate/ offset for risks and impacts to workers, affected communities, and the environment. While all relevant environmental and social risks and potential impacts should be

considered as part of the assessment, PS 2 to 8 describe potential environmental and social risks and impacts that require particular attention. Where environmental or social risks and impacts are identified, the client is required to manage them through its Environmental and Social Management System (ESMS) consistent with PS 1.

Several cross-cutting topics such as climate change, gender, human rights, and water, are addressed across multiple Performance Standards.

- **IFC PS 1: Assessment and Management of Environmental and Social Risks and Impacts**
  PS 1 applies to all projects that have environmental and social risks and impacts. It underscores the importance of managing environmental and social performance throughout the life of a project.

  The objectives of PS 1 are:
  - To identify and evaluate environmental and social risks and impacts of the project;
  - To adopt a mitigation hierarchy to anticipate and avoid, or where avoidance is not possible, minimize, and, where residual impacts remain, compensate/ offset for risks and impacts to workers, affected communities, and the environment;
  - To promote improved environmental and social performance of clients through the effective use of management systems;
  - To ensure that grievances from affected communities and external communications from other stakeholders are responded to and managed appropriately; and
  - To promote and provide means for adequate engagement with affected communities throughout the project cycle on issues that could potentially affect them and to ensure that relevant environmental and social information is disclosed and disseminated.

  The development and operation of the proposed project presents a risk to both the social and biophysical environments. As a result, undertaking an ESIA is critical to complying with this PS.

- **IFC PS 2: Labour and Working Conditions**
  PS 2 acknowledges that the pursuit of economic growth through employment creation and income generation should be accompanied by protection of the fundamental rights of workers. The requirements set out in PS 2 have been in part guided by several international conventions and instruments, including those of the International Labour Organization (ILO) and the United Nations (UN).

  The objectives of PS 2 are:
  - To promote the fair treatment, non-discrimination, and equal opportunity of workers;
  - To establish, maintain and improve the worker-management relationship;
  - To promote compliance with national employment and labour laws;
  - To protect workers, including vulnerable categories of workers such as children, migrant workers, workers engaged by third parties, and workers in the client's supply chain;

- To promote safe and healthy working conditions, and the health of workers; and
- To avoid the use of forced labour.

Workers will be employed particularly during the construction phase of the project, thus triggering this PS.

- **IFC PS 3: Resource Efficiency and Pollution Prevention**

PS 3 recognizes that increased economic activity and urbanization often generate increased levels of pollution to air, water, and land, and consume finite resources in a manner that may threaten people and the environment at the local, regional, and global levels.

There is also a growing global consensus that the current and projected atmospheric concentration of Greenhouse Gas (GHG) threatens the public health and welfare of current and future generations. PS 3 outlines a project-level approach to resource efficiency and pollution prevention and control in line with internationally disseminated technologies and practices. In addition, it promotes the ability of private sector companies to adopt such technologies and practices as far as their use is feasible in the context of a project that relies on commercially available skills and resources.

The objectives of PS 3 are:

- To avoid or minimize adverse impacts on human health and the environment by avoiding or minimizing pollution from project activities;
- To promote more sustainable use of resources, including energy and water; and
- To reduce project-related GHG emissions.

This standard has potential relevance to the project scope. The GHG Emissions Assessment was undertaken for the proposed project (attached as Appendix L).

- **IFC PS 4: Community Health, Safety, and Security**

PS 4 recognizes that project activities, equipment, and infrastructure can increase community exposure to risks and impacts. While acknowledging the public authorities' role in promoting the health, safety, and security of the public, PS 4 addresses the client's responsibility to avoid or minimize the risks and impacts to community health, safety, and security that may arise from project related-activities, with particular attention to vulnerable groups.

The objectives of PS 4 are:

- To anticipate and avoid adverse impacts on the health and safety of the affected community during the project life from both routine and nonroutine circumstances; and
- To ensure that the safeguarding of personnel and property is carried out in accordance with relevant human rights principles and in a manner that avoids or minimizes risks to the affected communities.

Community health, safety and security will be a topic during all phases of the project.

- **IFC PS 5: Land Acquisition and Involuntary Resettlement**

  PS 5 recognizes that project-related land acquisition and restrictions on land use can have adverse impacts on communities and persons that use this land. Involuntary resettlement refers both to physical displacement (relocation or loss of shelter) and to economic displacement (loss of assets or access to assets that leads to loss of income sources or other means of livelihood) as a result of project-related land acquisition and/ or restrictions on land use.

  The objectives of PS 5 are:
  - To avoid, and when avoidance is not possible, minimize displacement by exploring alternative project designs;
  - To avoid forced eviction;
  - To anticipate and avoid, or where avoidance is not possible, minimize adverse social and economic impacts from land acquisition or restrictions on land use by:
    - providing compensation for loss of assets at replacement cost; and
    - ensuring that resettlement activities are implemented with appropriate disclosure of information, consultation, and the informed participation of those affected.
  - To improve, or restore, the livelihoods and standards of living of displaced persons; and
  - To improve living conditions among physically displaced persons through the provision of adequate housing with security of tenure at resettlement sites.

  The property identified for the development of the #Gaingu PV Plant Project is located in the #Gaingu Communal Conservancy under the jurisdiction of the Oë ≠Gân Traditional Authority. The site is currently earmarked as a livestock priority area for use by the conservancy, as a result, compliance with PS 5 is required.

- **IFC PS 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources**

  PS 6 recognizes that protecting and conserving biodiversity, maintaining ecosystem services, and sustainably managing living natural resources are fundamental to sustainable development. The requirements set out in PS 6 have been guided by the Convention on Biological Diversity.

  The objectives of PS 6 are:
  - To protect and conserve biodiversity;
  - To maintain the benefits from ecosystem services; and
  - To promote the sustainable management of living natural resources through the adoption of practices that integrate conservation needs and development priorities.

  A detailed assessment of risks to terrestrial biodiversity and ecology has been included and a separate avifauna assessment as part of the ESIA (refer to Sections 7.3 and 7.2).

- **IFC PS 7: Indigenous Peoples**

  PS 7 recognizes that Indigenous Peoples, as social groups with identities that are distinct from mainstream groups in national societies, are often among the most marginalized and vulnerable segments of the population. In many cases, their economic, social, and legal status limits their capacity to defend their rights to, and interests in, lands and natural and cultural resources, and may restrict their ability to participate in and benefit from development.

  The objectives of PS 7 are:

  - To ensure that the development process fosters full respect for the human rights, dignity, aspirations, culture, and natural resource-based livelihoods of Indigenous Peoples;
  - To anticipate and avoid adverse impacts of projects on communities of Indigenous Peoples, or when avoidance is not possible, to minimize and/or compensate for such impacts;
  - To promote sustainable development benefits and opportunities for Indigenous Peoples in a culturally appropriate manner;
  - To establish and maintain an ongoing relationship based on Informed Consultation and Participation (ICP) with the Indigenous Peoples affected by a project throughout the project's life-cycle;
  - To ensure the Free, Prior, and Informed Consent (FPIC) of the Affected Communities of Indigenous Peoples when the circumstances described in this Performance Standard are present; and
  - To respect and preserve the culture, knowledge, and practices of Indigenous Peoples.

  No risks to indigenous people have been identified. This PS is not applicable.

- **IFC PS 8: Cultural Heritage**

  PS 8 recognizes the importance of cultural heritage for current and future generations. Consistent with the Convention Concerning the Protection of the World Cultural and Natural Heritage, PS 8 aims to ensure that clients protect cultural heritage during their project activities. In addition, the requirements of this PS on a project's use of cultural heritage are based in part on standards set by the Convention on Biological Diversity.

  The objectives of PS 8 are:

  - To protect cultural heritage from the adverse impacts of project activities and support its preservation; and
  - To promote the equitable sharing of benefits from the use of cultural heritage.

  Earthworks and construction activities could pose a risk to cultural heritage. This Performance Standard is triggered (refer to Section 7).

2.3.3 IFC Environmental Health and Safety Guidelines

World Bank Group Environmental, Health, and Safety Guidelines (known as the "EHS Guidelines") are technical reference documents with general and industry-specific examples of Good International Industry Practice (GIIP). The EHS Guidelines are technical reference documents with general and

industry-specific examples of GIIP and are referred to in the World Bank's Environmental and Social Framework and in IFC's Performance Standards. The World Bank Group requires borrowers/ clients to apply the relevant levels or measures of the EHS Guidelines. When host country regulations differ from the levels and measures presented in the EHS Guidelines, projects will be required to achieve whichever is more stringent.

The EHS Guidelines applicable to this project include:

- The General EHS Guidelines, 2007: The EHS Guidelines contain the performance levels and measures that are generally considered to be achievable in new facilities by existing technology at reasonable costs (some of the monitoring aspects will not apply to the construction phase of the project).

2.3.4 Namibian legislation compared with the World Bank Environmental and Social Standards

Table 2-4 provides a summary of gaps identified in the Namibia legislation when compared with the World Bank Environmental and Social Standards.

Table 2-4: Gap Analysis of Namibian legislation versus World Bank Environmental and Social Standards

No.	Guideline	Requirements	Equivalent Namibian Legislation	Gap
1	WB ESS 1: Assessment and Management of Environmental and Social Risks and Impacts	• Policy and Environmental and Social Management System (ESMS) • Identification of Risks and Impacts • Management Programs • Organizational Capacity and Competency • Emergency Preparedness and Response • Monitoring and Review • Stakeholder Engagement • External Communications and Grievance Mechanisms • Ongoing Reporting to Affected Communities	1. Environmental Management Act, 2007 (No. 7 of 2007) 2. EIA Regulation GN 30, 18 January 2012. 3. List of activities that may not be undertaken without Environmental Clearance Certificate: Environmental Management Act, 2007	• No requirement for a Policy and an ESMS, although there is a requirement for an ESMP. • The ESIA process requires the identification and assessment of impacts (refer to Section 8 for the assessment of impacts). • Typically, an ESMP includes an organogram and roles and responsibilities to implement the various mitigation measures. Although this does not necessarily tie back to the implementing organisation's ability to provide sufficient capacity to undertake the necessary actions. • The need for an Emergency Preparedness and Response is not a requirement of the EIA Regulations. • While specific requirements are listed in the EIA Regulations, it does require for effects on the environment to be mitigated, controlled and monitored. Monitoring and review is typically included in the ESMPs. • Stakeholder engagement is a key component of the EIA Regulations, although there is no specific reference to the need for a Stakeholder Engagement Plan, engaging with vulnerable groups or groups based on gender. The preparation of a Stakeholder Engagement Plan (SEP) was, however, included in the current ESIA. • There is no requirement for a Grievance Mechanism in the EMA. A Grievance Mechanism is, however, included in the Stakeholder Engagement Plan for the ESIA. • Unless specified as a commitment in the ESMP, there is no requirement in the EIA Regulations for ongoing reporting to affected communities. Ongoing communication is specified in the project SEP.
2	WB ESS 2: Labour and Working Conditions	• Working Conditions and Management of Worker Relationship • Protecting the Work Force • Occupational Health and Safety • Workers Engaged by Third Parties • Supply Chain	1. Labour Act, 2007 (No. 11 of 2007) 2. Social Security Act, 1994 (No. 34 of 1994, as amended 3. Employees Compensation Act, 1995 (No. 5 of 1995) 4. Regulations relating to the health and safety of employees at work (GN 156 of 1997)	• These Acts and regulations stipulate, amongst other things, sound labour relations, employment equity, fair employment practices, training, minimum basic conditions of service, workplace health and safety and retrenchment. Compliance is enforced and monitored by the Ministry of Labour through the office of the Labour Commissioner. • The legislation and regulations are broadly considered comprehensive and adequately compare to the WB ESS and industry guidelines.
3	WB ESS 3: Resource Efficiency and Pollution Prevention and Management	• Resource Efficiency • Pollution Prevention and Management	1. Water Resources Management Act, 2013 (No. 11 of 2013 2. Pollution Control and Waste Management Bill (3rd Draft September 2003)	• There are a number of laws that govern resource efficiency and pollutions (air, land and water). Key aspects relevant to this project are as follows: o GHG emissions o Hazardous substances o Waste management.

No.	Guideline	Requirements	Equivalent Namibian Legislation	Gap
			3. Atmospheric Pollution Prevention Ordinance (Ordinance 11 of 1976) 4. Agricultural Pests Act, 1973 (No. 3 of 1973) 5. Hazardous Substances Ordinance, 1974 (No. 14 of 1974)	• There is no specific requirement to quantify GHG emissions and to develop management strategies to reduce GHG emissions, should this be necessary. A Climate Change Risk Assessment and a Greenhouse Gas Emissions Specialist Report have been prepared as part of the current ESIA (Refer to Appendix K and L, respectively).
4	WB ESS 4: Community Health and Safety	• Community Health and Safety • Security Personnel	1. Environmental Management Act, 2007 (No. 7 of 2007) 2. EIA Regulations GN 30, 18 January 2012.	• The EIA regulations, 2012 allow for the identification and assessment of social impacts or impacts on community health and safety. • Issues regarding security personnel is not specifically required or routinely addressed as part of ESIAs. These requirements are considered in the Socio-Economic Assessment (Refer to Appendix J).
5	WB ESS 5: Land Acquisition, Restrictions on Land Use and Involuntary Resettlement	• Project Design, Compensation and Benefits for Displaced Persons, Community Engagement, Grievance Mechanism, Resettlement and Livelihood Restoration Planning and Implementation • Physical Displacement, Economic Displacement • Private Sector Responsibilities Under Government-Managed Resettlement	1. Namibia Laws on expropriation or compensation for land that is taken away. • Article 21 of the Namibian Constitution, as amended by the Constitution Amendment Act 2010. • Communal Land Reform Act, 2002 (No.5 of 2002), as last amended by the Communal Land Reform Amendment Act, 2005 (No. 11 of 2005). 2. National Resettlement Policy	• No involuntary resettlement is required for the proposed development.
6	WB ESS 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources	• General • Protection and Conservation of Biodiversity - Modified Habitat, Natural Habitat, Critical Habitat, Legally Protected and Internationally Recognized Areas, Invasive Alien Species • Management of Ecosystem Services • Sustainable Management of Living Natural Resources	1. Nature Conservation Ordinance, 1975 (No. 4 of 1975) 2. Forest Act, 2001 (No. 12 of 2001), as amended, and Regulations (Government Gazette No. 5801) 3. Marine Resources Act, 2000 (No. 27 of 2000) 4. Plant Quarantine Act, 2008 (No. 7 of 2008) 5. Namibia's Biodiversity Strategy and Action Plan	• Various acts govern the protection and conservation of natural resources and legally protected area and control of invasive alien species. • While the EIA Regulations do allow for issues regarding impacts on biodiversity to be identified and assessed, the mechanism of defining habitat as modified, natural or critical does not exist and was specified as part of the Terms of Reference for the ESIA. • Implementing biodiversity off-sets in Namibia is not common and would need to be considered as part of this project where natural and/ or critical habitat is impacted. • While the biodiversity strategy and action plan make reference to the importance of ecosystem services, the EIA Regulations do not specifically require that ecosystem services be identified and the impact on these services assessed. The above requirements were included in the Terms of Reference for the ESIA.

No.	Guideline	Requirements	Equivalent Namibian Legislation	Gap
7	WB ESS 7: Indigenous Peoples/Sub-Saharan African Historically Underserved Traditional Local Communities	• Circumstances Requiring Free, Prior, and Informed Consent • Impacts on Lands and Natural Resources Subject to Traditional Ownership or Under Customary Use, Relocation of Indigenous Peoples from Lands and Natural Resources Subject to Traditional Ownership or Under Customary Use, Critical Cultural Heritage • Mitigation and Development Benefits • Private Sector Responsibilities Where Government is Responsible for Managing Indigenous Peoples Issues	1. United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP) 2007 2. Namibia ratified the International Convention on the Elimination of All Forms of Racial Discrimination (ICERD) in 1992 (Office of the Ombudsman 2012b: 9).	• Although the African Commission on Human and Peoples' Rights recommended that Namibia sign the International Labour Organization's Indigenous and Tribal Peoples Convention (ILO Convention 169 and 111), Namibia has not done so. • No risks to indigenous people have been identified. .
8	WB ESS 8: Cultural Heritage	1. Protection of Cultural Heritage in Project Design and Execution 2. Chance Find Procedures 3. Project's Use of Cultural Heritage	1. National Heritage Act, 2004 (No. 27 of 2004)	• The Act provides for the protection and conservation of places and objects of heritage significance and the registration of such places and objects; to establish a National Heritage Council; to establish a National Heritage Register. • The need for a Chance Find Procedure as part of an ESIA is not a requirement. • However, a procedure for chance finds and contacting the National Heritage Council of Namibia is included in the ESMP based on the findings of the Heritage Specialist Report (Refer to Appendix G).
9	WB ESS 9: Financial Intermediaries	Not applicable to this project	N/A	N/A
10	WB ESS 10: Stakeholder Engagement and Information Disclosure	• Stakeholder identification and analysis • Stakeholder Engagement Plan • Information disclosure • Meaningful consultation	1. Environmental Management Act, 2007 (No. 27 of 2007) 2. EIA Regulations GN 30, 18 January 2012.	• The EIA Regulations, 2012 call for detailed public participation (stakeholder engagement) throughout the ESIA process. This includes compiling a stakeholder database, informing interested and affects parties about the project and ESIA via the press, engaging with key stakeholders and disclosing the Scoping/ Terms of Reference (ToR) Report, EIA Report and ESMP for public comment before submitting it to the environmental authorities. All records of public meetings are included as Annexures to the Scoping Report and EIA Report. The current ESIA complied with these requirements (Refer to Section 4 for the Public Consultation Process). • There is no direct requirement for a Stakeholder Engagement Plan, however one was developed for this ESIA (Appendix C).

2.4 PLANNING CONTEXT

2.4.1 National level

Namibia faces significant constraints imposed by an arid climate, a huge country with low population numbers, and legacies of apartheid and colonialism. Namibia's comprehensive, guiding strategy "Vision 2030" (refer to section 2.2.7) which was finalised in 2004 aims to achieve "a prosperous and industrialised Namibia" to be realised through economic transformation and industrialization; it is being implemented through a series of five-year National Development Plans. The Fifth National Development Plan 2017/18 – 2021/22 (NDP5) aims to achieve rapid industrialisation while adhering to the four integrated pillars of sustainable development:

- Economic Progression
- Social Transformation
- Environmental Sustainability
- Good Governance

NDP5 plans to achieve economic progression by developing value added industrialisation, substituting imports for locally produced goods, creating value-chains of production, and to accelerate Small and Medium Enterprise (SME) development (NPC, 2017). NDP5 recognises that the availability and affordability of water is crucial for Namibia's transformation into an industrialized economy. NDP5 states:

> *"Water scarcity continues to be a serious constraint in achieving the economic, environmental and social development objectives. With highly variable and unpredictable rainy seasons, the first priority is given to water for domestic purposes including livestock; and the second priority given to water for economic activities such as mining, industries and irrigation."*

This project, which aims to be established in order to provide power to the proposed NamWater Desalination plant, is in line with a key strategy in NDP5 to construct new water supply infrastructure to supply water to the central coast of Namibia.

In 2015, the third President of Namibia spearheaded the Harambee Prosperity Plan (HPP) 2016/17 to 2019/20, before NDP5 was finalised, to complement NDP5 and Vision 2030. The five-year Harambee Plan aims to achieve social advancement through economic and infrastructure development and effective governance (RoN, 2016). The proposed project should contribute to the fifth pillar - infrastructure development, although it falls outside the timeline of achieving the HPP (RoN, 2016).

2.4.2 Regional and Local level

At a regional level, The Regional Councils Act 22 of 1992 sets out the conditions under which Regional Councils must be elected and administer each delineated region. Their powers, duties and function include: to undertake the planning of the development of the region with a view to physical, social and economic characteristics, urbanisation patterns, natural resources, economic development potential, infrastructure, land utilisation pattern and sensitivity of the natural environment. Regional councils work together with the National Planning Commission (NPC) to make a development plan which will guide growth and development in each region. Regional councils also help local

governments in the region, and they have the power to establish, manage and control settlement areas, such as Otjimbingwe and Okombahe.

Under the Local Authorities Act of 1992, there are three kinds of local authorities: villages, towns and municipalities. The classification of a local authority affects its duties and powers – municipalities have responsibility for more services than towns, and towns have responsibility for more services than villages. A local authority can be re-classified as it changes and develops. All local authorities must supply water, sewerage and refuse disposal services to communities which have been formally established as residential areas – which includes neighbourhoods where the local authority has laid out streets and divided the land up into plots available for purchase. When a local authority is unable to carry out its responsibilities, central government (the Ministry of Urban and Rural Development (MURD)) may take steps to deal with the problem.

Traditional Authorities must live in the communal area of the traditional community which they lead. They must administer customary law and preserve their community's culture, language, traditions and traditional values – but they must not apply any custom or tradition that violates anyone's constitutional rights. Traditional Authorities tend to play more of an important role in rural areas compared to urban area. The project is proposed to be developed in an area that falls under the jurisdiction of the Oë ≠Gân Traditional Authority.

2.4.3 Community organisations

Communal conservancies are self-governing, democratic entities, run by their members, with fixed boundaries that are agreed with adjacent conservancies, communities or landowners. Conservancies are recognised by the MEFT, but not governed by the Ministry. The Ministry does, however, have powers to de-register a conservancy if it fails to comply with conservation regulation. Communal conservancies are obliged to have game management plans, to conduct annual general meetings, and to prepare financial reports. They are managed under committees elected by their members. The #Gaingu Community Conservancy, in which the PV plant is proposed to be developed, was registered in 2004 and has approximately 3 000 members and is 7 731 km^2 in size.

3. ESIA APPROACH AND METHODOLOGY

This chapter provides the details of the ESIA Project Team, outlines the ESIA assumptions, limitations, and outlines the approach and methodology to the ESIA process, which covers both Environment and Social aspects.

3.1 ESIA PROJECT TEAM

The project team and specialists appointed to undertake the ESIA process are presented in Table 3-1. The curriculum vitae documentation for the SLR project team is attached in Appendix A. SLR and specialist consultants have no vested interest in the proposed project other than fair payment for consulting services rendered as part of the ESIA process.

Table 3-1: Details of the ESIA Project Team and specialists

Company	Name	Qualifications	Experience (years)	Roles
ESIA Project Team				
SLR Namibia / Africa	Edward Perry	MSc (Environmental Assessment and Management), Cardiff University	29	Technical director and QA/QC
	Sharon Meyer	MSc (Zoology and Environmental Science), University of the Witwatersrand	20	Project director
	Marline Medallie	MSc (Botany), University of Johannesburg	16	Report review
	Stephanie Strauss	MPhil (Environmental Management), University of Stellenbosch	9	Project manager and report compilation
	Robyn Christians	BSc Murdoch University, Perth LLB, University of Cape Town	6	Project assistance, liaison with authorities, public consultation
	Bronwyn Gernet	Certificates in ArcView, Advanced ArcView, Projections and Rasters	21	GIS data management and mapping
Specialist Team				
Ashby Associates CC	Auriol Ashby	BSc (Hons) (Environmental Sciences), UEA, UK	30	Socio-Economic Impact Assessment
Independent Consultant	Henriette Potgieter	MSc Environmental Science	7	Terrestrial Ecology Impact Assessment
Beyond Heritage	Jaco van der Walt	MA. Archaeology, University of the Witwatersrand	21	Heritage Impact Assessment
Green Tree Environmental	Yonanda Martin	MSc Ecological Remediation and Utilisation, North- West University	15	Visual Impact Assessment
African Conservation Services	Ann Scott	Doctor Technologiae Nature Conservation, Nelson Mandela University	40	Avifauna Impact Assessment

Company	Name	Qualifications	Experience (years)	Roles
	Mike Scott	National Higher Diploma in Forestry: Conservation	40	
SLR	Warren Meyer	BSc Eng Mechanical Engineering	12	Noise Impact Assessment
	Andrew Simpson	MSc Climatology & Atmospheric Science, University of Natal (now UKZN)	25	
	Marc Ngama	Master's in Petroleum Geoscience (Course work complete, pending thesis)	8	
SLR	Michael van Niekerk	MSc, Geography and Environmental Science, University of KwaZulu-Natal	14	Climate Change Risk and GHG Assessment
SLR	Mercy Nyirenda	BSc (Hons) Civil Engineering	7	Hydrological Impact Assessment
	Nompumelelo Dube	PGD in Business Administration BSc Hons Degree in Hydrology	16	

Profiles of the key SLR team members are provided below:

Edward Perry is the Operations Manager for the SLR Environmental Management Planning and Approvals (EMPA) team in Africa. He has worked in environmental consultancy for over twenty-five years for a wide range of public and private sector clients. Ed is a registered Environmental Auditor with the Institute for Environmental Management and Assessment, a Lead Auditor with the International Cyanide Management Institute, and a registered Environmental Assessment Practitioner with the Environmental Assessment Practitioner Association of South Africa. He has been involved with environmental authorisations throughout Africa. Ed has been Project Director of ESIAs for a wide range of facilities including: Renewable Energy Facilities; Metal Extractive Industries; Large Water Storage Schemes; New Mines, Extensions to Current Mines; and Oil and Gas Projects.

Sharon Meyer is an Associate Environmental Consultant with SLR and has over 20 years of experience in environmental authorisation processes within Africa. She has managed multidisciplinary and multi-national specialists and engineers on complex projects. Sharon has experience in environmental authorisations for the tourism sector, as well as for the infrastructure sector. Sharon is registered in the category of Environmental Management (Pr. Sci. Nat.) with the South African Council for Natural Science Practitioners.

Stephanie Strauss is an Associate Environmental Consultant with SLR and has nine years of experience as an Environmental Assessment Practitioner within the environmental consulting field in Namibia. Stephanie has been involved in several EIAs for projects in various sectors. Stephanie has worked on a variety of authorisation and auditing processes within various sectors. Key projects experience includes Environmental Assessments for urban development projects, road rehabilitation, telecommunication, waste management, and infrastructure development, mining and exploration

projects. She has conducted numerous public participation and stakeholder engagement activities relevant to the projects. Stephanie also has experience in environmental compliance monitoring and auditing for projects.

CVs of the SLR team for the ESIA are included in Appendix A:

3.1 ESIA ASSUMPTIONS AND LIMITATIONS

While every effort has been made to compile a robust assessment of the environmental and social risks associated with the proposed development, there remain certain assumptions, uncertainties and limitations which are applicable to the assessment in general as well as those applicable to each of the individual specialist assessment.

3.1.1 General

- SLR assumes that all relevant project information has been provided by NamWater and that it was correct and valid at the time it was provided;
- No significant changes to the project description or surrounding environment will occur between the submission of the final ESIA Report and implementation of the proposed project that could substantially influence findings and recommendations with respect to mitigation and management; and
- These assumptions and limitations, however, are not considered to have any negative implications in terms of the credibility of the results of the ESIA process.

3.1.2 Discipline Specific

3.1.2.1 Avifauna Assessment

- Combined data used in this report (including Southern African Bird Atlas Project (SABAP) 1 and SABAP2, site visit observations and other) provide a representative indication of the bird species likely to occur in the study area throughout the seasonal and inter-annual cycles.
- Recent findings at solar facilities in North America suggest that collision mortality impacts at solar PV plants may be underestimated, particularly in terms of collision trauma with PV panels; there is growing evidence that this may be associated with polarised light pollution and/or with waterbirds mistaking large arrays of PV panels as wetlands (the so-called "lake effect") (Jenkins *et al.* 2017; P Werstein Vargos de Matas [KfW Development Bank] pers. comm. 2021). It is assumed that this factor could potentially impact on the avifauna in the present solar PV development too, particularly in terms of nocturnally over-flying waterbirds.
- Renewable energy development is still relatively new to Namibia, including solar PV developments. Experiences in other parts of the world suggest that, like many other energy sources, solar power may have impacts on birds; however, the nature and implications of these effects are still poorly understood (DeVault *et al.* 2014; Jenkins *et al.* 2017; Visser *et al.* 2019; Bennun *et al.* 2021).
- A major limitation to the assessment and mitigation of potential impacts of such developments is the lack of representative long-term monitoring data, including recorded

incidents associated with solar PV structures. Ongoing monitoring with good record-keeping and periodic evaluation is therefore essential, with adaptive management if required.

- In terms of the required protocol for the assessment of solar PV developments (Jenkins *et al.* 2017), six one-day monitoring sessions were conducted over six months (i.e., from the beginning of April to the end August 2023); however, this period could not cover the full rainy season (January-March), nor interannual variations, relevant especially in terms of (rarer) episodic rainfall events. To address this shortfall, the monitoring data were supplemented by longer term SABAP1 & 2 data.
- The difficulty in obtaining confirmed records of bird flight paths is a further limitation to the assessment of the potential impacts of any new structure, including the proposed solar PV facility and associated power lines. However, existing satellite tracking data for both Lappet-faced Vultures and flamingos in the greater study area do provide some indication of the local flight path areas/ corridors of these birds, and were incorporated; furthermore, records of power line collisions (see below) provide an indication of bird species active in the area that have the potential to become involved in impacts on overhead structures, and of their flight paths.
- A further limitation to the assessment and mitigation of potential impacts of power line structures is the lack of representative long-term data on power line incidents throughout Namibia. Available data (2009-2020) from the NamPower/ Namibia Nature Foundation Strategic Partnership (EIS 2023) were consulted in this respect; the data for the Erongo Region are relatively comprehensive and include the results of annual (or more frequent), dedicated surveys on several power lines in the greater study area, including the 220 kV and 66 kV lines south of the proposed site.
- Information on bird and power line incidents (and of live birds) is limited in the section of the proposed servitude from the B2 road eastwards to the New Khan Substation. For this reason, an adaptive approach to marking mitigation is followed, based on the results of monitoring, which would be essential.
- In all cases where there is uncertainty, the precautionary principle should therefore apply, until such time as further data become available.

3.1.2.2 Climate Risk and Greenhouse Gas Assessment

- This report has been prepared in a manner that is consistent with the level of care and skill ordinarily exercised by members of the engineering and science professions currently practising under similar conditions. Also considering the jurisdiction in which the services are provided, subject to the time limits and physical constraints applicable to this report.
- The nature of the work undertaken is stochastic[2] with substantial inherent uncertainly around any given data points.
- The uncertainty associated with any projections or forecasts is increased by the duration of the projected period (25 years) and is subject to future developments or intervening acts which may manifest in the interim period.

[2] Having a random probability distribution or pattern that may be analysed statistically but may not be predicted precisely.

3.1.2.3 Heritage Assessment

- Due to the often-ephemeral nature of cultural remains and the limitations to a pedestrian (visual) survey, there is a possibility that some heritage sites or features may not have been discovered during the site survey undertaken for this ESIA. Thus, the possibility of the occurrence of heritage sites or features and unmarked graves cannot be excluded.
- Although the area was surveyed, as thoroughly as possible, it is incumbent upon the developer to inform the relevant heritage authority should further cultural remains be unearthed or laid open during the process of development, as this study does not claim to have recorded every site on the landscape.
- The desktop survey identified some known sites recorded by Kinahan (2006), specific to the Project area. These sites were not reassessed in this study, but rather their significance ratings, as provided by Kinahan (2006), were retained.
- Limited published information is available on intangible heritage and sacred sites for the study area. Information on such sites is sometimes considered confidential and is difficult to obtain. Furthermore, the foreseen impacts are based on the current conceptual layout for the Project and areas outside of this footprint were not assessed.
- This study did not separately assess the approximate 10km access road to the Gaingu Power Plant but assessed it as part of the proposed 33kv powerline as it will run under the proposed powerline to the Gaingu Power Plant.

3.1.2.4 Noise Assessment

Inevitable uncertainties in acoustical measurements and prediction can occur in practice. The following uncertainties, assumptions and gaps in knowledge are noted:

- Seasonal changes have the potential to influence sound levels directly (e.g., rain) or indirectly (faunal communication, see point below). Rainfall is very low in the study area, but some seasonality based on temperature and wind field variation may be observed.
- Faunal communication measurement fluctuations due to seasonal, time-of-day or night, etc. Certain fauna communicate during certain hours e.g., cicada may only be audible during night-hours, crepuscular birds are only audible during evening or night hours, crickets may be more active during summer, etc.
- Meteorological conditions can influence ambient noise and predicted noise. Causes include mainly temperature inversions and wind velocity gradient turbulence, which can affect propagation rates. Up to 6 dBA (increase) and 12 dBA (reduction) variation in noise levels may apply under extreme conditions for downwind and upwind scenarios respectively.
- Impact on biodiversity surrounding the project sites was not addressed in this report, as these were assessed by the biodiversity and avifaunal specialists in their assessments. Initial measurements, model outputs and summary of general findings are used to inform such specialists.
- The uncertainty associated with any projections or forecasts is increased with the duration of the projected period (long-term operations of several decades) and is also subject to future developments or intervening acts which may manifest in that period.

3.1.2.5 Terrestrial Biodiversity and Ecology Assessment

- Fauna and flora in a hyper-arid environment exhibit extremely variable temporal and spatial patterns. The occurrence of species fluctuates in response to environmental circumstances such as rare rainfall events, resulting in highly variable communities and populations of all taxa. Invertebrates may have activity cycles of up to 12 years, necessitating long-term, in-depth and systematic field surveys to present a more complete baseline description.
- Information on the taxa at the site is based largely on existing literature (desktop) and the specialist's knowledge. It is possible that some factors that could affect the persistence of species and/or composition of populations may have been overlooked during the short site visit.
- Invertebrates in the Central Namib have high conservation value in terms of rare, endemic, endangered and range-restricted species, and they provide essential ecosystem services such as pollination, soil formation, food source, and nutrient distribution. It is recommended that an invertebrate specialist be engaged during the detailed design phase for implementation before construction to ensure that the project does not increase the risk of extinction of a population.

3.1.2.6 Visual Assessment

- The extent of the study area is determined by the Zone of Potential Influence (ZoPI), which in this study relates to a radius of 10 km around the project sites. At 10 km and beyond the Project would recede into background views and/or be screened by ridges/ koppies, mountains, buildings and infrastructure.
- It was assumed that the dwelling units surrounding the proposed project site were still in use.
- The line of sight/ viewshed analysis is based on worst-case scenario and therefore doesn't take vegetation cover or other structures such as buildings into consideration.

3.2 ESIA PROCESS

The objectives of the ESIA process are to:

- Provide opportunity for I&APs to be involved in the ESIA process, through:
  - Ensuring effective public participation;
  - Adhering to an open and transparent consultation procedure at all times;
  - Ensuring that accurate and regular information is communicated to I&APs; and
  - Ensure that information is communicated in a manner which is understandable and accessible to I&APs;
- Ensure potential environmental and socio-economic impacts that would result from the proposed project are identified and assessed;
- Identify and assess feasible alternatives related to the project proposal;
- Provide information to facilitate informed, transparent and accountable decision-making by the relevant authorities;
- Implement measures to avoid, prevent, reduce, and if possible, offset significant adverse effects on the physical, biological and social environments;
- Determine the biodiversity footprint and baseline of the project and establish whether there are any no go areas;

- Avoid deterioration in the quality of the environment in order to achieve no net loss or a net gain of biodiversity and ecosystems and to promote social benefits; and
- Ensure that human health risks are quantified and mitigated where necessary.

To address these objectives, the ESIA process consists of three phases (1. Project Initiation and Screening Phase, 2. Scoping Phase and 3. Impact Assessment Phase) and a series of steps to ensure compliance with the EIA Regulations 2012 as set out in GN No. 30. The process involves an open, participatory approach to ensure that all impacts are identified and that relevant information on environmental and social impacts is provided into the decision-making process.

A flowchart indicating the generic ESIA process is presented in Figure 3-1.

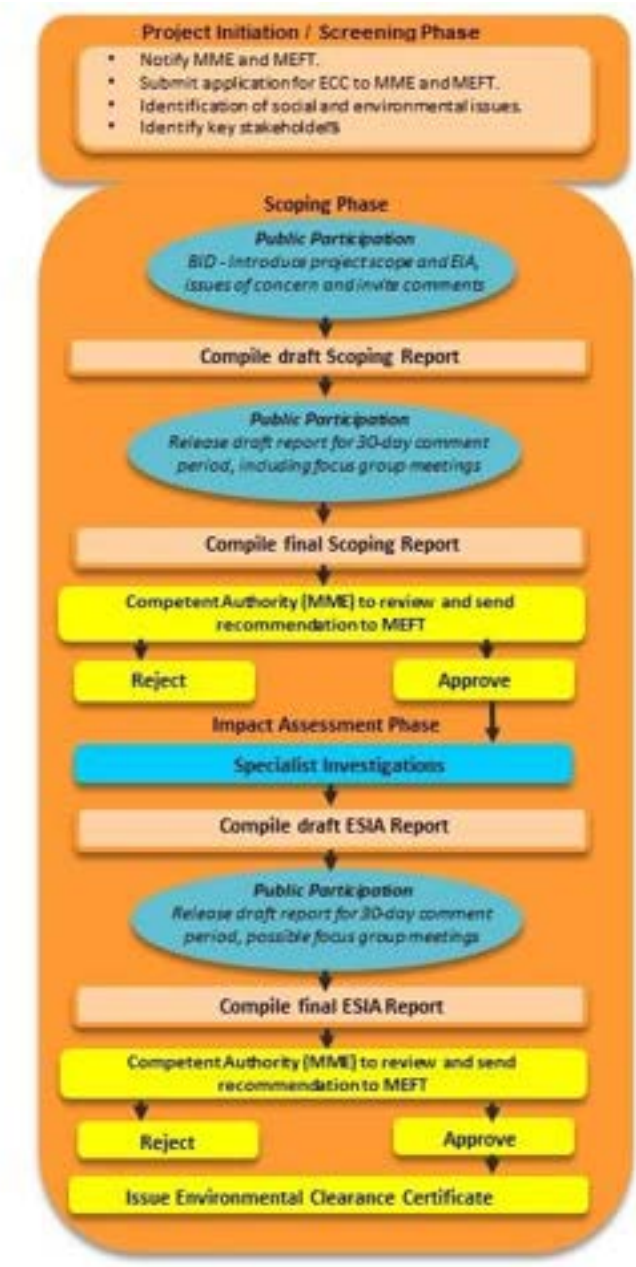


Figure 3-1: Flow Diagram of the Namibian EIA Process

3.2.1 Project Initiation / Screening Phase

The Project Initiation and Screening Phase has been completed and included the following tasks:

- Project inception and initiation meetings held between the EAP Team (SLR), the Project Team (ILF Consulting Engineers (ILF)) and applicant (NamWater) to discuss the project and ESIA process requirements;
- Early identification of environmental and social aspects and potential impacts associated with the proposed project activities;
- Identification of key stakeholders to be involved in the ESIA Scoping process; and
- Confirmation of the following:
    - The list of activities, according to the EMA, that may not be undertaken without an ECC (refer to Table 2-1)
    - The need for a "full ESIA[3]" process to be conducted according to the EMA, EIA Regulations as well as the lender requirements; and
    - The Scoping phase requirements.

3.2.2 Scoping Phase

The Scoping phase of the ESIA has been completed.

3.2.2.1 Scoping objectives

The objectives of the Scoping phase were to:

- Register the project and ESIA process with the relevant authorities, i.e. MAWLR and MEFT, through the submission of the Application for ECC Form and the online registration on MEFT's website;
- Provide a reasonable opportunity for I&APs to be involved in the process (refer to Section 4.1 for the public participation conducted as part of the Scoping phase);
- Identify relevant policies and legislation relevant to the proposed project and determine key gaps in relevant environmental and social legalisation;
- Provide environmental and social input into the Feasibility Study to inform decision-making for the preferred project alternative(s) to be considered in the Impact Assessment phase, through 'high level' consideration/ assessment of key environmental and social issues;
- Provide baseline environmental and social information;
- Identify all key environmental and social impacts to be addressed in the Impact Assessment phase; and
- Agree on the level of assessment to be undertaken (i.e. terms of reference for specialist studies), including the methodology to be applied, the expertise required, as well as the extent of further consultation during the Impact Assessment phase.
- Collate and respond to all written comments received during the Scoping phase in a Comments and Responses Report attached as Appendix C.
- Submit a Final Scoping Report (FSR) to the MEFT for review and acceptance.

[3] The "Full ESIA" process entails separate Scoping and Impact Assessment phases, with a Scoping Report being completed after the Scoping Phase and an ESIA Report and ESMP being prepared after the Impact Assessment phase. Public participation needs to be conducted during both phases of the ESIA process.

The FSR was approved by MEFT on 21 July 2021. This gave permission to SLR to proceed with the Impact Assessment phase in terms of Section 35(1)(b) of the EMA.

3.2.3 Impact Assessment Phase

The terms of reference for specialist investigations were developed through the Scoping Phase and approved as part of the Scoping Report acceptance. Specialist assessments, taking the above-mentioned terms of reference and the baseline work conducted during the Scoping Phase into consideration, were required to further inform the assessment of potential impacts that the proposed project may have on the physical, social and economic environment. Nine specialist assessments were conducted as part of the ESIA. The specialist assessments are attached to this report as Appendices D to L. A visit to the site was undertaken with the Manager of the #Gaingu Conservancy on 21 April 2023.

The ESIA Report (including an ESMP) has been prepared in compliance with Section 15(2) of the EIA Regulations 2012. The specialist findings, recommended mitigation and enhancement measures, as well as other relevant information, have been integrated into this report and provides further opportunity for I&APs to comment on the proposed project and findings of the Impact Assessment.

The Draft ESIA Report and ESMP was released for review and comment period from 22 September 2023 to 23 October 2023 (30 days) which was further extended from 20 November to 6 December 2023. The objective of the review and comment period was to ensure that I&APs were notified about the proposed project and given a reasonable opportunity to provide comments on the findings of the ESIA process. Steps included as part of this review and comment process are summarised in Chapter 4.

3.2.3.1 Completion of the Impact Assessment phase

As noted in Section 1.1, this Final ESIA Report is submitted to MME for consideration and review. After its review, MME will forward a recommendation to MEFT for a decision on the application. The decision taken by MEFT will be distributed to all I&APs registered on the project database.

3.3 MANAGEMENT OF CHANGE

As with most large, complex projects, refinement of the Project design is an ongoing and sometimes lengthy process. This ESIA considers the current “worst case scenario” when assessing impacts and developing mitigation measures. However, should the Project design change after submission of the ESIA Report, a Management of Change (MOC) Procedure will be implemented. The MOC Procedure applies to any changes to the project description (i.e., approved activities), impact assessment and/or mitigation and monitoring measures described in the ESIA Report and ESMP.

The level of change will determine the action to be taken to ensure the changes do not affect the Project’s ability to meet environmental and social performance requirements outlined in the ESIA Report and ESMP, Environmental Clearance Certificate and other relevant Namibian legislation (see Table 2-2). All future design changes will undergo an “internal screening” exercise in order to determine whether the change triggers a ‘Level 1’ or a ‘Level 2’ change.

Level of change	Description of Change Procedure
Level 1: Minor Change	Where the change is largely deemed to be immaterial to the ESIA findings, the listed activities that were applied for are still relevant and it does not affect the Project's ability to meet environmental and social performance requirements outlined in the ESIA Report and ESMP. Assuming the project is approved by MEFT, the ECC will need to be renewed every three years. As part of the ECC renewal application, the relevance of the ESMP should be reviewed and amendments proposed where necessary. These changes and their evaluation should be communicated to MAWLR and MEFT for information purposes and the ESMP revised where necessary.
Level 2: Significant Change	Where a future change or upgrade would lead to a significant departure from the base-case or a key aspect of it, such that the existing ESIA Report or ESMP does not adequately address potential impacts or require additional mitigation. This would imply that a new listed activity(s) is triggered or an approved activity would change. Update the ESIA Report and ESMP through an amendment application in terms of the Environmental Management Act, 2007 and Regulations 19 and 21 of the EIA Regulations 2012, and submit to MEFT for review and decision

4. PUBLIC CONSULTATION PROCESS

This chapter presents the principles of public consultation and the process undertaken during the Scoping Phase and that undertaken for the Impact Assessment Phase.

4.1 SCOPING PHASE

One of the key objectives of the Scoping phase Public Participation Process (PPP) was to ensure that I&APs were notified about the proposed project and alternatives being considered and given a reasonable opportunity to register on the project database and to register their views and concerns.

By consulting with relevant authorities and I&APs, the range of environmental and social issues to be considered in the Scoping Report has been given specific context and focus. Outputs from the initial stakeholder engagements were used to inform the Scoping Report and associated terms of reference for specialist studies.

Steps undertaken during the Stakeholder Engagement Process are summarised in Table 4-1. Detailed information on the stakeholder database, public notification, meeting notes, issues raised, and responses provided are provided in Appendix C.

Table 4-1: Tasks undertaken during the scoping phase public participation

Task	Description
Identify key stakeholders	SLR identified key stakeholders (e.g., Relevant Ministries; Regional and local Authorities and relevant Non-Governmental Organisations (NGOs) to be informed at the onset of the process, about the need for the proposed project, various alternatives being considered and the ESIA Scoping process commencement. SLR obtained representative contact persons/ details of the key stakeholders identified through telephone engagements and e-mail correspondence for future engagement.
Initial key stakeholder meetings and Background Information Document (BID)	An “initial” BID was drafted based on the concept project information. Key Stakeholder meetings were held during April to May 2019. These included meetings with: • Erongo Regional Council • Coastal Tourism Association of Namibia (CTAN) • Walvis Bay Municipality • Karibib Town Council • Ministry of Health and Social Services (MHS) - Okahandja • Arandis Town Council • City of Windhoek • Usakos Town Council • MEFT, Swakopmund • Swakopmund Municipality Copies of the “Initial” BID were distributed to the key stakeholders before and during the meetings. The purpose of these meetings and initial BID was to inform key stakeholders about the proposed project and feasibility study being undertaken, the environmental and social study; and how key stakeholders could

Task	Description
	participate in the process. Also, to discuss potential environmental and social impacts identified during the Scoping phase and to obtain input from key stakeholders' issues and concerns and environmental sensitivities and potential impacts. The minutes of the meetings (i.e. one-on-one meetings, public meetings and Concept Design Workshop) and the presentations were provided in the FSR.
Notification to MAWLR and MEFT	SLR compiled an "Application for ECC" (Form 1) in line with the EIA Regulations, 2012. The application form was submitted by NamWater to the MAWLR, as the competent authority, in September 2019. The MAWLR forwarded the application to the MEFT as the regulating authority. The project and application were also registered on the MEFT online system.
Further I&AP identification and database compilation	SLR coordinated a social scan to identify potential stakeholders (i.e., I&APs) in the project area. An I&AP database was developed, based on the initial stakeholder database, taking the various project components and project alternatives into consideration. Furthermore, throughout the public participation process I&APs that requested to be registered were added to the project I&AP database. The I&AP database included authorities (including State Departments with jurisdiction in the relevant areas and municipal offices), Organs of State, Non-Governmental Organisations, Community-based Organisations, Mining and Industrial stakeholders, Media, Residents and Farmers, Educational Institutions, Banking industry, and other stakeholders with a potential interest in the proposed project. The broad list of I&APs that were identified and consulted during the ESIA Scoping process was appended to the FSR (see Table 4-2).
Updated BID and distribution to I&APs	The "initial" BID was updated with additional project information that became available from the Project Team and when the details of the ESIA process to be undertaken had been better conceptualised. Copies of the updated BID were distributed via email to all parties registered on the I&APs database. The BID was made available online on the SLR website. Hardcopies of the BID was also distributed during the public meetings that were held at various locations as presented below. The purpose of the BID was to inform stakeholders about the proposed project, the ESIA Scoping process being undertaken, possible environmental and social impacts and means of providing input into the ESIA process. Attached to the BID was a registration and response form, which provided stakeholders with a mechanism to register on the I&AP database. The registration period was open until 15 November 2019.
Site notices	Site notices were placed at various locations, including Henties Bay, Swakopmund, Walvis Bay, Arandis, Usakos, Karibib, Okahandja and Windhoek. A copy of the site notice was provided in the FSR.
Newspaper Advertisements	Newspaper advertisements were placed in the following papers: • Die Republikein (21 & 28 October 2019); • Allgemeine Zeitung (21 & 28 October 2019); and • Namibian Sun newspaper (21 & 28 October 2019).

<table>
<tr><th>Task</th><th>Description</th></tr>
<tr><td></td><td>The newspaper advertisements provided information of the proposed project, the availability of the updated BID and the time and venues of the planned public meetings. Copies of the advertisements were provided in the FSR.</td></tr>
<tr><td>Scoping Public Meetings</td><td>Public meetings were held at various locations as presented below.
<table>
<tr><th>Location</th><th>Venue</th><th>Date and Time</th></tr>
<tr><td>Henties Bay</td><td>Henties Bay Community Hall</td><td>4 November 2019, 3:00PM- 4:30PM.</td></tr>
<tr><td>Swakopmund</td><td>Swakopmund Plaza Hotel</td><td>5 November 2019, 11:00AM-12:30PM.</td></tr>
<tr><td>Walvis Bay</td><td>Protea Hotel, Pelican Bay</td><td>5 November 2019, 3:00PM- 4:30PM.</td></tr>
<tr><td>Arandis*</td><td>Arandis Community Hall</td><td>Originally planned for 6 November 2019, 10:00–M - 11:30AM. Meeting was rescheduled and held on 14 November 2019. (5:00PM-7:00PM)</td></tr>
<tr><td>Usakos*</td><td>Usakos Community Hall</td><td>Originally planned for 6 November 2019, 13:00–M - 14:30PM. Meeting was rescheduled to 4 December 2019. (5:00PM-7:00PM)</td></tr>
<tr><td>Karibib*</td><td>Usab Community Hall</td><td>Originally planned for 11 November 2019, 11:00–M - 1:00PM. Meeting was rescheduled and held on January 2020.</td></tr>
<tr><td>Okahandja*</td><td>Okahandja Town Hall</td><td>8 November 2019, 10:00–M - 12:00PM.</td></tr>
<tr><td>Windhoek</td><td>Namibia Scientific Society</td><td>8 November 2019, 15:00AM-17:00PM.</td></tr>
</table>
*Note: Meetings in Arandis, Usakos, Karibib and Okahandja had to be postponed to a later date due to a poor turn out in attendance. The postponement of these meetings was supported and requested by the various Town Councils (Arandis, Usakos and Karibib) to coincide with their annual public events. Minutes of the meetings are included in the FSR.</td></tr>
<tr><td>Concept Workshop</td><td>A Concept Workshop was facilitated by NamWater and ILF at Daan Viljoen Lodge in Windhoek, between the 29 and 30 January 2020. The ESIA process was presented at this workshop and various questions on the process responded to by the ESIA team.</td></tr>
<tr><td>Comments and Responses</td><td>The registration and initial comments period (after the project and ESIA process were advertised) ended on 15 November 2019.

All issues raised by I&APs were summarised and responded to in the DSR.</td></tr>
<tr><td>I&APs review Draft Scoping Report (DSR)</td><td>The DSR was distributed for a 30-day comment period ending on 21 May 2021 in order to provide I&APs with an opportunity to comment on any aspect of the proposed project and the findings of the Scoping phase. The Executive Summary</td></tr>
</table>

<table>
<tr><th>Task</th><th>Description</th></tr>
<tr><td></td><td>of the Scoping Report was sent to registered I&APs with a notification letter. Copies of the full report was made available on the SLR Website and at the following locations:
<table>
<tr><th>Location</th><th>Name of Venue</th><th>Physical address</th></tr>
<tr><td>Henties Bay</td><td>Ministry of Education, Arts and Culture Community Library</td><td>Jakkalsputz Rd</td></tr>
<tr><td>Swakopmund</td><td>Swakopmund Public Library</td><td>Bismarck Street</td></tr>
<tr><td>Walvis Bay</td><td>Walvis Bay Public library</td><td>163, Nangolo Mbumba Drive, Civic Centre</td></tr>
<tr><td>Arandis</td><td>Arandis Town Council</td><td>Milkwood Street</td></tr>
<tr><td>Usakos</td><td>Usakos Town Council</td><td>Kaiser Wilhelm Street</td></tr>
<tr><td>Karibib</td><td>Karibib Town Council</td><td>Kalk Street</td></tr>
<tr><td>Okahandja</td><td>Okahandja Municipality</td><td>65 Martin Neib Avenue</td></tr>
<tr><td>Windhoek</td><td>Namibia Scientific Society</td><td>110 Robert Mugabe Ave</td></tr>
</table></td></tr>
<tr><td>Comments and Responses</td><td>All written comments were collated and responded to in an updated Comments and Responses Report. The Scoping Report was updated to address the I&AP comments.</td></tr>
<tr><td>FSR and MEFT decision.</td><td>The FSR was submitted to the MAWLR and MEFT for review. The FSR was accepted by the authorities on 21 July 2021. This gave permission to SLR to proceed with the Impact Assessment Phase in terms of Section 35(1)(b) of the EMA.</td></tr>
</table>

Table 4-2: Summary of I&APs on the project ESIA database during scoping phase

IAP Grouping	Organisation

Government Ministries	• MEFT;
	  ○ DEA;
	  ○ Directorate of Wildlife and National Parks (DWNP);
	• MAWLR;
	• Ministry of Fisheries and Marine Resources (MFMR);
	• MME;
	• Ministry of Lands and Resettlement (MLR);
	• Ministry of Health and Social Services (MHSS);
	• Ministry of Finance; and
	• National Heritage Council of Namibia (NHC).

Local and regional government – councillors and key officers	Erongo Regional Council; Swakopmund Municipality; Walvis Bay Municipality; Henties Bay Town Council; Arandis Town Council; Usakos Town Council; Karibib Town Council; Okahandja Municipality; Erongo Water Forum; City of Windhoek (CoW).
Government Parastatals	NamPower; TransNamib; Roads Authority; ErongoRed, Electricity Control Board (ECB)
Environmental Foundations and NGOs	Scientific Society Swakopmund, Namib Botanical Gardens, National Chamber of Environment, Namibian Uranium Association Namibian Coast Conservation and Management Project (NACOMA); Southern Africa Institute for Environmental Assessment (SAIEA); Earthlife Namibia; Desert Research Foundation of Namibia (DRFN); Wildlife Society of Namibia; Namibian Nature Foundation (NNF); World Wildlife Fund in Namibia (WWF); Namibia Environment and Wildlife Society (NEWS); National Botanical Research Institute (NBRI); Namibia Scientific Society.
National Chambers	Chamber of Mines of Namibia; National Chamber of Commerce and Industry; and National Chamber of Environment.
Media	Newspaper adverts: The Namibian Sun and Die Republikein. Live Radio Read on NBC Radio Stations.
General public	Other I&APs interested or potentially affected.

4.1.1.1 Summary of issues raised

The table below provides a summary of the key issues raised by I&APS on the project during the Scoping Phase. Copies of all comments and inputs received from I&APs were included in the FSR. As the Scoping Phase considered all the supply scenarios and their related power supply options (SS1, SS2 and SS3) some of the comments received were not related to SS1 and the corresponding power supply option and are thus not addressed in this ESIA Report.

Table 4-3: Summary of key issues raised by I&APs during the scoping phase

Topic	Summary of comment	Related to Power Supply for SS1 (Y/N)
Proposed project activities and alternatives being considered.	There is a need for clarity on how the proposed water supply capacity and the allocation along the en-route users was determined.	N
	The project scope should take into consideration additional en-route users including Oompahed Omatjete and Omihana in the Uis area apart from the currently proposed Arandis, Usakos, Karibib and Okahandja.	N
	The project should take into consideration the existing pipeline infrastructure at Trekkopje mine and Wlotzkasbaken.	N
	The current state of existing water infrastructure in Windhoek and its challenges should be taken into consideration when supplying to the city's water infrastructure.	N
	The project should involve and consider the power supply sector including NamPower and Independent Power Producers for the power supply alternatives.	Y
	Consideration of Nuclear Energy, as clean energy in the power supply option, should be taken into account.	Y
	NamWater should indicate the project custodian during the operational phase.	Y
	Consideration of alternatives including the storage of desalinated water in an aquifer should be taken into account.	N
	Information regarding the current state of the Erongo (Orano) Desalination Plant should be considered.	N
	NamWater should consider other similar international projects related to alternative water sources i.e. towing of iceberg from Atlantica Iceland.	N
	Issues related to the breakdown and routine maintenance services of the desalination plant should be considered as these may impact the water supply.	N
	Will there be a need to upgrade the existing en-route users' infrastructure?	N
	The location of the proposed desalination plant northwards of the current Orano desalination plant presents a risk to the lichen field and should be moved southwards on an already disturbed area.	N
	An inflated water demand could be used to motivate the construction of an additional desalination plant.	N
	The inclusion of the Botswana option should be decided before taking the design any further, because it will mean that a much larger pipeline must be built from the start (and partly financed by Botswana).	N

Topic	Summary of comment	Related to Power Supply for SS1 (Y/N)
	It will be difficult for NamWater to attract a Botswana contractor for a large new desalination plant if there is no assured offtake volume to pay back the investment.	N
	In the demand projections take into account the additional volume of Windhoek's effluent that will be treated in the upgraded WINGOC as per City of Windhoek's KfW-funded projects mentioned at the Concept workshop.	N
	Build the proposed new water carriage system in further stages when it can be foreseen that the demand will exceed the capacity.	N
Affordability of water	Affordability of the desalinated water was raised by many stakeholders, asking that it should form part of ESIA's Terms of Reference where the impact of the cost of water must be considered for all end users including poorer and more vulnerable communities.	N
Terms of reference for ESIA	Consideration of alternative water sources and other related previous studies to identify the feasible alternative.	N
	NamWater should take into consideration the central Namibian towns as an alternative water supply source i.e., from the aquifers.	N
	Thermal desalination as the cheapest desalination alternative should be considered.	N
	Costs related to the desalinated water could be a challenge.	N
	Detailed maps representing exact pipeline routing and location in each town should be presented in all public meetings.	N
	The Green Purchasing agreement of Solar PV panels between the supplier, Engineering, Procurement and Construction (EPC) contractor and Operator should include the returning of Solar PV Panels to the supplier for re-using and recycling after the solar panels have reached their life span or in an event of broken panels.	Y
	A waste disposal / recycling system should be implemented and include the green purchasing agreement to avoid storing of used reverse osmosis (RO) membranes at the desalination plant and the disposal to the landfill.	N
ESIA timing	The duration of the EIA Scoping Phase might extend further than the anticipated timelines.	Y

Public consultation process	• The Terms of Reference for future public meeting presentation should already include:
	  ○ Risk mapping of the pipeline route findings;
	  ○ Overview of Management and Mitigation measures.
	• A second public consultation meeting should provide EIA findings.
	• The presence of the client in public consultation meetings is necessary.
		Y

Topic	Summary of comment	Related to Power Supply for SS1 (Y/N)
	• The public consultation meetings should be scheduled after working hours to cater for the masses. • Public Meetings should be better organised and assisted by the Regional Authorities to ensure the masses is reached. • The public meetings should be held at various venues and various times. • There is a need for a consultation process dedicated to the affected farmers.	
Need and desirability	• Clarity is required in terms of the project benefits to en-route users and their communities. • The project scope should include the socio-economic benefits related to brine use for salt refiners.	N
Identification of potential key environmental and social impacts	• Impact of the pipeline routing on the wildlife corridor. • Shall the option to construct a new desalination plant be considered? • There is a need for a dissertation on the Impact of brine discharge cumulatively with all other desalination plants in the coastal area. • There is a risk of new power lines in the coastal region crossing flamingo flight paths.	N

4.2 IMPACT ASSESSMENT PHASE

The public participation steps undertaken during the Impact Assessment Phase are summarised below.

4.2.1 Consultation and Disclosure Methods

4.2.1.1 Initial Notification to I&APs

All I&APs on the project database were notified of the ESIA process commencement via email and SMS dated 28 July 2023. A Background Information Document was made available on the SLR website and I&APs were provided with an opportunity to register as an I&AP and/or submit any comments until 11 August 2023.

Twenty-four (24) written submissions were received during the comment period. These were either requests to be registered on the project database or comments regarding the project which should be considered in the ESIA. All these submissions were collated, and responded to, in the Comments and Responses Report in Appendix C.5.

4.2.1.2 Availability of the Draft ESIA Report and ESMP

The Draft ESIA Report and ESMP was released for a 30-day review and comment period from **22 September to 23 October 2023** in line with legislative requirements for public consultation. The objective of this review and comment period was to ensure that I&APs are notified about the proposed project and given a reasonable opportunity to provide comments on the impact assessment findings, proposed mitigation and ESMP. Copies of the Draft ESIA Report and ESMP were available on the SLR website for download and hard copies were available at the following locations for the duration of the comment period:

- Henties Bay – Ministry of Education, Arts and Culture Community Library.
- Swakopmund – Swakopmund Public Library.
- Walvis Bay – Walvis Bay Public library.
- Windhoek – Namibia Scientific Society.

A hard copy of the draft ESIA report was also provided to the #Gaingu Communal Conservancy for their review and comment. No written comments were received from the #Gaingu Communal Conservancy.

4.2.2 Notification Letters and Advertisements

All I&APs registered on the project database (see Appendix C) were notified of the Draft ESIA Report and ESMP comment and review period by means of a notification letter (sent via e-mail). To facilitate the commenting process, a copy of the Non-Technical Summary (in English) was attached to the letter.
The availability of the Draft ESIA Report and ESMP was also advertised in regional newspapers (Republikein, Sun and Allgemeine Zeitung) on 19 and 25 September 2023. As well as in the Namib Times on 22 September 2023.

During a meeting with MEFT the Environmental Commissioner stated that a public meeting should be held in Windhoek. As such I&APs were notified of the public meeting via email and SMS dated 20 November 2023. A newspaper advertisement (Republikein, Sun and Allgemeine Zeitung) appeared on 20 November 2023 notifying the public of the public meeting and the extension of the comment period until 6 December 2023. Proof of notification letters and advertising are provided in Appendix C.2 and C.3.

4.2.2.1 Public and Focus Group Meetings

During the public review period of the ESIA report, public and focus group meetings were held. The purpose of these meetings was to provide an overview of the project proposal and ESIA findings, and to provide stakeholders with the opportunity to raise any grievances, issues, concerns or comments.
Details of the meetings are provided in Table 4-4 and Table 4-5 and minutes of the meetings in Appendix C4. The meeting Power Point presentation slides were also shared with stakeholders upon request.

Table 4-4: Details of Public Meetings during the Impact Assessment Phase

No	Location	Venue	Date	Time
1	Swakopmund	Atlantic Villa Boutique Guesthouse and Conferencing	26 September 2023	17h30
2	Walvis bay	Lagoon Chalets and Caravan Park	27 September 2023	17h30
3	Henties Bay	De Duine Hotel	28 September 2023	17h30
4	Windhoek	The Scientific Society	29 November 2023	17h30

Table 4-5: Details of Focus Group Meetings During the Impact Assessment Phase

No	Organisation	Venue	Date	Time
1	Ministry of Fisheries and Marine Resources (MFMR)	MFMR office, Swakopmund	26 September 2023	09h00

No	Organisation	Venue	Date	Time
2	Orano Mining	Orano offices, Swakopmund	27 September 2023	09h00
3	Walvis Bay Municipality	Walvis Bay Municipality offices, Walvis Bay	27 September 2023	14h00
3	Swakopmund Municipality	Swakopmund Municipality offices, Swakopmund	28 September 2023	08h30
4	Henties Bay Municipality	Henties Bay Municipality offices, Henties Bay	28 November 2023	11h30
5	UNAM Henties Bay Campus	UNAM Henties Bay Campus	28 September 2023	14h00
6	Ministry of Environment, Forestry and Tourism	MEFT offices, Windhoek	5 October 2023	10h00
7	Oe-#Gan Traditional Authority - Chief G.I ǂNu-axa /Gaseb	Traditional Leaders Building, Harold Pupkewitz Street, Windhoek	13 October 2023	10h00

4.2.3 Written Comments Received during the Draft ESIA Report Review and Comment Period

All written submissions received during the Draft ESIA Report review and comment period (six in total received via completed comment forms and e-mail) are presented in Table 4-6. All these submissions were collated, and responded to, in the Comments and Responses Report in Appendix C5.

Table 4-6: List of I&APs that submitted written correspondence during the Draft ESIA Report review and comment period

Name/ Organisation	Summary of Comment
Bertram Geiger	I&AP registration
Hans Joachim and Tania Steinkopf	Public meeting attendance registration
Nangula Amutenya Amatsi – Walvis Bay Municipality	Public meeting attendance registration
Theo Schoeman – Wlotzkasbaken resident	Public meeting attendance registration
Bruce Stewart – Stewart Town and Regional Planning	I&AP registration
Alex Delle Donne - InnoSun	I&AP registration

4.2.4 Stakeholder Database Consolidation

The I&AP database was updated during the impact assessment phase, based on comments/ registrations received and attendance of public meetings. There are currently 195 stakeholders on the database (see Appendix C1).

4.2.4.1Stakeholder Notification of MEFT's Decision

MEFT: DEA's decision will be uploaded onto the SLR website for information purposes. All I&APs registered on the Project database will be notified of the decision via e-mail.

5. PROJECT DESCRIPTION

This chapter provides an overview of the proposed #Gaingu PV Power Plant project, outlines the need for the project, presents a description of the various components and describes possible project activities. The chapter is based largely on the Feasibility Report (ILF, 2021) completed as part of the Feasibility Study for the Desalination Plant and Water Carriage System to secure Water Supply to the Central Coast, Windhoek and en-route Users (inclusive of power supply).

5.1 PROJECT OVERVIEW

NamWater is the national water utility of Namibia. NamWater has undertaken a Feasibility Study for the development of a desalination plant and a water carriage system to supply water to the Central Coast, Windhoek and en-route users (Arandis, Usakos, Karibib and Okahandja). The primary objectives of the Feasibility Study were to investigate feasible and affordable water supply options and concepts that would diversify and secure supply alternatives to the target areas, as well as investigate different solutions for providing a RE power supply in combination with the national utility supply.

Three water supply scenarios were considered as part of the feasibility study for the proposed Desalination Plant and Water Carriage System as indicated below:

- Supply Scenario 1 (SS1): Supply additional potable water for the CCA only;
- Supply Scenario 2 (SS2): Supply additional potable water for the CCA, the area around Windhoek (Central Areas Network (CAN)) and for en-route Users along the transmission pipeline;
- Supply Scenario 3 (SS3): Supply additional potable water for the CCA, CAN and for en-route Users along the transmission pipeline, as well as additional 20 Mm^3/a to Gaborone from 2029. This scenario was not considered during the Scoping Phase and was not included in the Scoping Report, which was accepted by MEFT in July 2021.

The main inputs to the desalination plant are:

- Supply of up to 260 Mm^3/d of seawater for SS1, resulting in the production of up to 36.2 Mm^3/yr of treated water to the CCA, while the remaining approximate 154 656 m^3/d is returned to the sea as brine; and
- Power supply totalling approx. 35.10 MWp for SS1 by 2037.

The development and implementation of the desalination plant to meet the water demands of the CCA (Supply Scenario 1 (SS1)) was found to be imperative and considered to be the most viable project. Based on the findings of the Feasibility Study, NamWater has thus decided to proceed with SS1 only and thus will develop the corresponding power supply option which is the development of the #Gaingu PV Power Plant and associated infrastructure.

5.1.1 Background and Need for the Project

As part of the Feasibility Study, potential RE power supply systems were investigated to provide a part of the total demand of the desalination plant and water transmission system (WTS). In combination with the supply from the national utility, NamPower, the overall power supply of the desalination plant and the WTS throughout the project lifetime will be secured.

Various case scenarios for the RE Power Supply were investigated which correspond to the various water supply scenarios (SS1, SS2 and SS3) and implementation phases (steps) that were determined for the desalination plant and WTS.

The proposed #Gaingu PV Power Plant project was considered the most viable option, NamWater has thus decided to proceed with its development to supply power to SS1 of the desalination plant.

In terms of RE sources, Namibia is well-placed to make use of solar energy as the country receives high levels of direct sunlight throughout the year. Solar energy has domestic, commercial and industrial applications, but thus far there has been limited efforts to consolidate widespread and national benefits from it. Benefits that will arise from the NamWater project includes:

- **Security of electrical supply for the proposed desalination plant**. Currently Namibia is largely reliant on the importation of power from other regions (South Africa, Zambia) which exposes the country to tariff volatility and supply risks. The proposed desalination plant aims to secure water supply to the CCA of Namibia which is an area of strategic importance due to the region's contribution to the national economy. The proposed PV plant will thus ensure a secure and reliable source of electricity to power the desalination plant to ensure water security for the CCA.
- **Energy diversification**. Namibia's current electricity market consists of hydro, coal power plants, solar, wind and battery energy storage technologies. The project will add to the country's energy mix by lessening the reliance on carbon dioxide (CO_2) generating sources (heavy fuel/ diesel) and those impacted by seasonal environmental variations such as hydropower.
- **Economic stimulus for Arandis Town**. The project will be located in the #Gaingu Conservancy (closest town to the project is Arandis). The following are reasons which make this the ideal location for a project of this nature:
    - Local social economic development: The project will enlist unskilled, semi- skilled and skilled individuals during construction and operations.
    - SME's will equally be prioritized through a vetting process where eligible candidates will form part of a list of potential subcontractors which the appointed EPC company will be contractually bound to.
    - Foreign direct investments: This is a foreign direct investment whose infrastructural development will directly increase economic growth and reduce imports.

5.2 TECHNICAL COMPONENTS OF THE PROPOSED PROJECT

The #Gaingu PV Plant will be constructed in stepped increments as described in Table 5-1. In each step, it will be expanded to accommodate the increase in demand. The proposed #Gaingu Power Plant and grid connection infrastructure will consist of the following key components (Figure 5-1):

- The #Gaingu PV Power Plant
- Overhead power line (33 kV) connecting the Power Plant to the new Khan 33kV substation.
- New indoor 33 kV substation at New Khan Substation
- Access road (approximately 10km) connecting the Power Plant to the existing service road running parallel to the existing 220 kV powerlines.
- Associated ancillary infrastructure and services.

5.2.1 Power Generation and Operation Concept

The following power supply concept is proposed for SS1 of the desalination plant:

- The desalination plant and Pump Station 1 (PSS-1) shall be supplied by a combination of solar PV, Li-Ion Battery Energy Storage System (BESS and utility supplied power.
- Power will be wheeled using the national utilities´ (NamPower´s) network infrastructure to provide the supply at the lowest cost of energy.
- A solar PV and Li-ion BESS power plant will be constructed in the #Gaingu Conservancy (#Gaingu PV Power Plant) to wheel power to the desalination plant and PSS-1. The plant connects to the new 33 kV overhead line between New Khan 33 kV sub-station for power evacuation.
- The #Gaingu PV Power Plant will be installed in incremental steps to increase the RE power supply in-line with the step increases of the expansion of the desalination plant.
- The solar PV component of the facility must be oversized and installed with active power limitation as supply shall not exceed demand. Active power limitation limits the power export of the PV plant at a set value. For the Project, the limit set point would be the combined instantaneous demand of the desalination plant and pump stations. By doing so the PV plant supply can reach demand, the power export limit, in the early hours of generation and maintain a near constant supply until the end of day light hours. This increases the volume of purchasable energy from the Independent Power Producer (IPP).

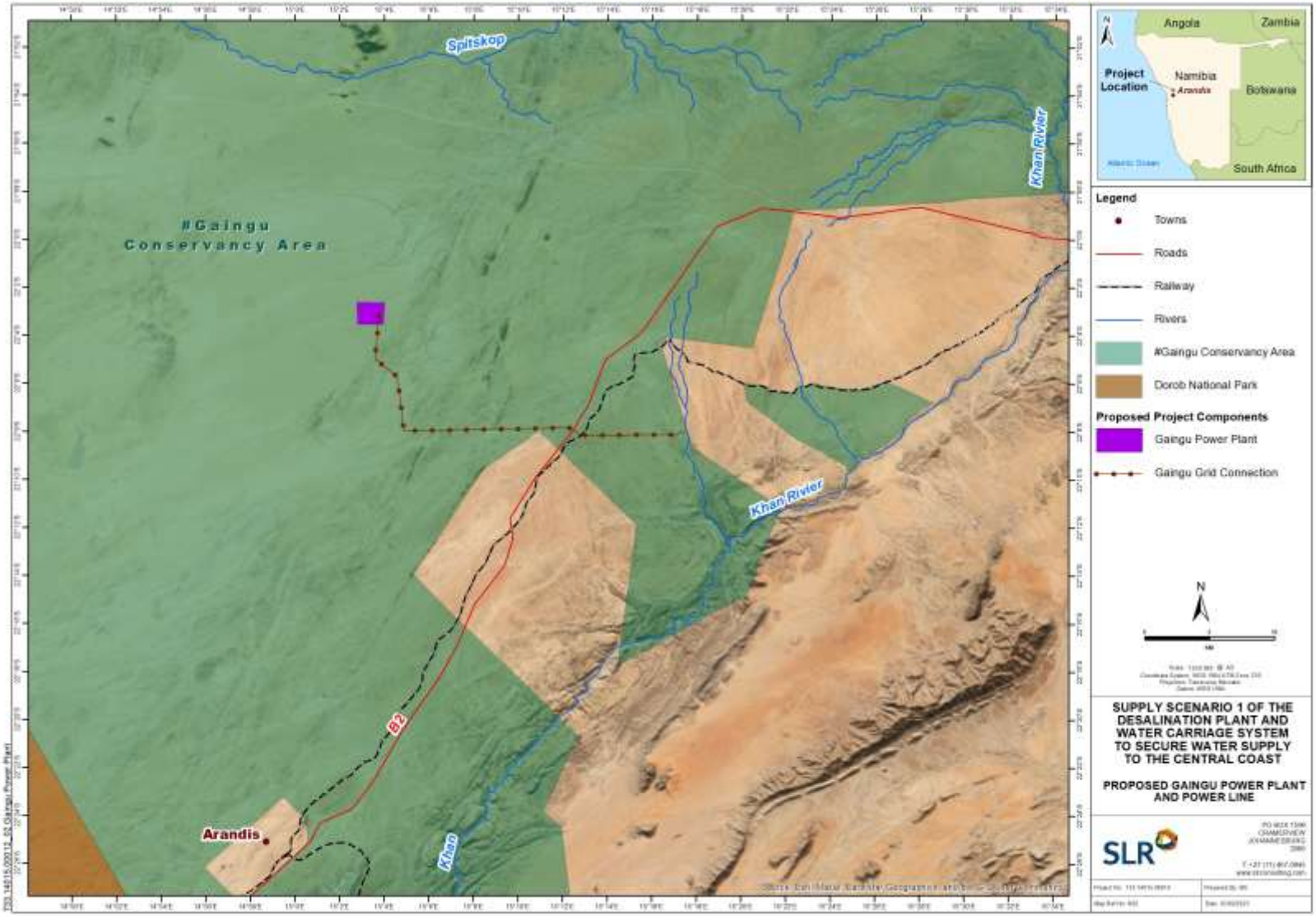


Figure 5-1: Locality of proposed #Gaingu PV Power Plant and Associated Infrastructure

5.2.2 #Gaingu PV Power Plant

Power generated to supply the desalination plant and Pump Station 1 (PSS-1) will be from a new PV and Li-ion BESS power plant located within the #Gaingu Conservancy to be known as the #Gaingu PV Power Plant. From the initial commercial operation of the desalination plant in 2024 and the subsequent phases of expansion in capacity in 2026 and 2037, the #Gaingu PV Power Plant will be expanded in capacity.

The main components of the #Gaingu PV Power Plant are;

- Mono-crystalline bi-facial half-cell Passivated Emitter Rear Contact (PERC) with a nominal rate capacity of 530 Wp.
- String inverters with a nominal output power of 195 kW @45°C.
- Single-axis tracker module mounting structure.
- Containerised Nickel Manganese Cobalt (NMC) Lithium-Ion Battery Energy Storage solution.

The #Gaingu PV Power Plant will be installed in incremental steps to increase the RE power supply in line with the step increases of the expansion of the desalination plant. Each plant will be brought into commercial operation in the years as described in Table 5-1 below. Up until 2026, the optimal energy supply option is from a combination of power purchased from the national utility and power provided by an IPP that is sold to the utility and supplied via the utility's network. From 2026 onwards the optimal power supply is a combination of power from the national utility, solar PV and BESS.

Table 5-1: SS1 - Capacity expansion of #Gaingu PV Power Plant

Description	Step 1 (2024)	Step 2 (2026)	Step 3 (2037)
PV Power Plant Additional Capacity (MWp)	16.00	6.13	12.37
PV Power Plant Cumulative Capacity (MWp)	16.00	22.13	35.10
Li-ion BESS Additional Capacity (kW/kWh)	-	125/500	4 375/17 500
Li-ion BESS Cumulative Capacity (kW/kWh)	-	125/500	4 500/18 000

The proposed #Gaingu PV Power plant is to be constructed on a large area of flat desert land in the #Gaingu Conservancy, located along the New Khan – Trekkopje 220 kV between the TIN and New Khan substations. This location was selected as optimal based on a number of factors:

- The site is close to existing infrastructure (the TIN and New Khan Substations and nearby transmission lines and corridor) thus limiting the costs of connection;
- The location is outside the coastal fog belt, thereby negating any loss of power production due to fog/ cloud (high Global Horizontal Irradiation (GHI) values); and
- is away from the highly saline and corrosive coastal area, thus reducing installation (corrosion protection) and maintenance costs, as well as the operational costs associated with higher cleaning frequencies.

The footprint size for the entire plant area is 344 ha. The footprint for the solar PV array itself for SS1 is approximately 65 ha, and approximately 176 ha for SS1 and SS2 combined.

The power plant will consist of mono-crystalline bi-facial half-cell PERC PV modules mounted on a single axis tracker module mounting structure. Direct Current (DC) power, generated by the PV modules, will be connected to utility scale string inverters for conversion to alternating current (AC) power. The AC power of the inverters will be marshalled at a low-voltage (LV) switchgear, to be stepped up to 33 kV for internal

distribution within the facility and exported via the main medium-voltage (MV) switchgear located in the control room.

It is proposed to connect the #Gaingu PV Power Plant at the New Khan substation by establishing a new 33 kV substation at the New Khan substation. This solution would require one of the spare 220 kV bays at New Khan to be equipped as a 220/ 33 kV transformer bay, connecting to a new 33 kV switchboard. It is envisaged to have a single 33 kV connection in SS1. The proposed routing for the grid connection would run south to join and run in parallel to the existing transmission line corridor of the New Khan – Trekkopje and Khan – Hentiesbay lines (approximately 35 km). All other power for SS1 will be purchased from NamPower.

Any excess energy generated by the PV system will be first stored in the Li-ion NMC BESS. Once full, the excess energy will be capped by active power limitation. Batteries will discharge either during periods of low irradiation or at nighttime, controlled by an export management system to optimise the time of export to achieve the lowest cost of electricity.

Real time monitoring between the power plant´s Supervisory Control and Data Acquisition (SCADA) and desalination plant's and pump station's SCADA system will provide the set points for the limits of the power plant´s export capacity. The RE facility will be able to supply on average 44% of the overall demand of the desalination plant and water transmission system through the project lifetime.

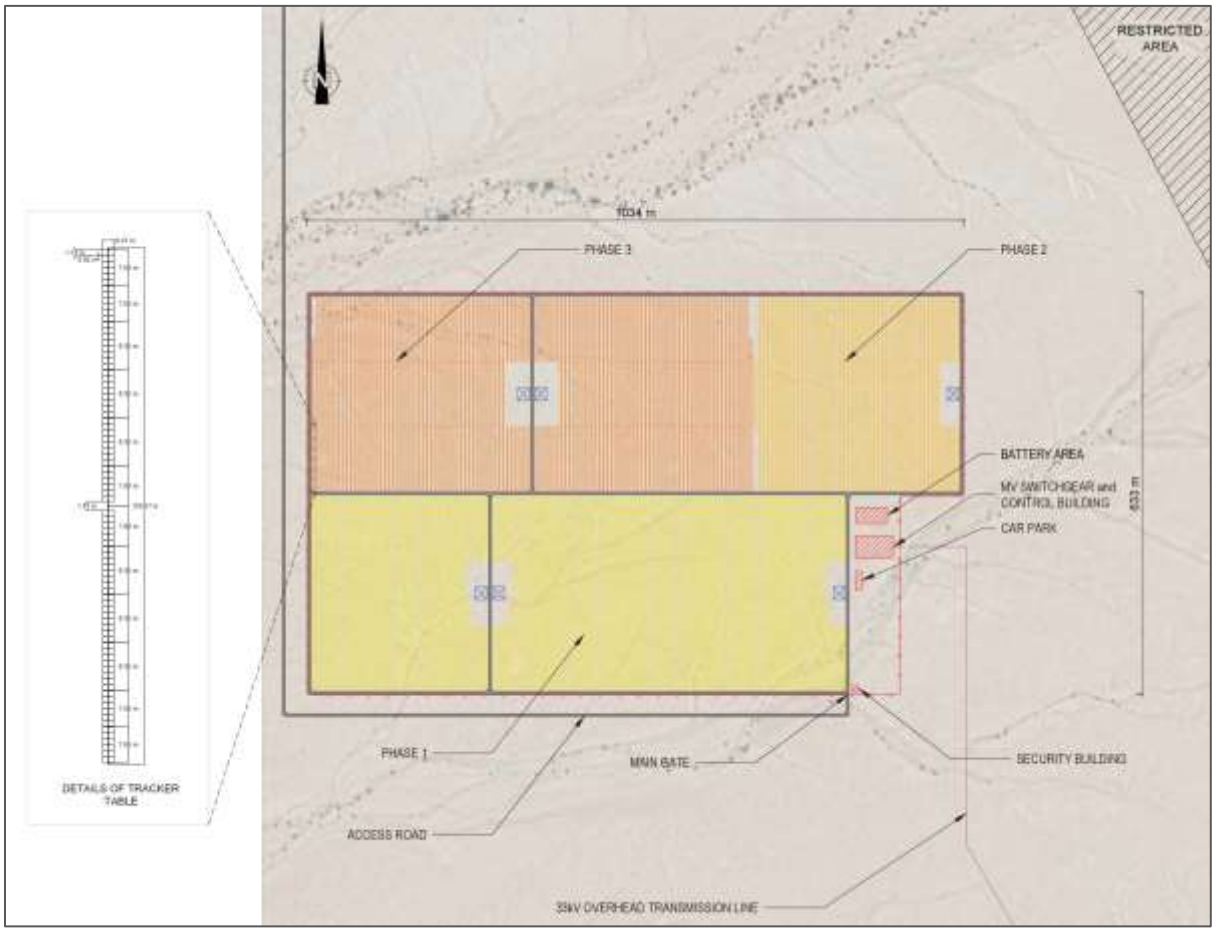


Figure 5-2: General Layout of proposed Gaingu PV Power Plant

5.2.3 Main Buildings and Structures

The facility contains the following main buildings and structures;

- Main Control Building (MCB)
- Single-axis tracking Module Mounting Structures (MMS)
- MV string inverter stations
- Li-Ion containerised battery power stations
- Roads and car park
- Fence and gate

5.2.4 Electrical Works and Equipment

The facility contains the following main equipment;

- PV Modules
- String inverters
- PV string cables
- LV switchgear
- Distribution transformer
- Ring Main Unit (RMU)
- Main MV switchgear
- Containerised BESS

5.2.4.1 PV Modules

The PV modules will be mounted on the MMS and convert solar irradiation into electrical energy. The main data and features of the PV modules are as follows:

- Mono-crystalline
- Bi-facial
- Half-cell
- PERC type
- Nominal rated capacity of 530 Wp.

5.2.4.2 String Invertors

String inverters will convert DC power from the PV modules to AC power. The main data and features of the string inverters are as follows:

- Input: 1,500 VDC, 18 strings in inputs, 2 MPPTs per input
- Output: 195 kVA @ 45°C, 800 V, 50 Hz, 3 phase, pf 0.8 LG – 0.8 LD
- Auto synchronizing

5.2.4.3 Photovoltaic String Cables

PV string cables will be installed between the PV array and string inverters. The main data and features of the PV string cables are as follows:

- H1Z2Z2-K (1500 VDC) type certified according to EN 50618
- Single core, fine wire, tinned copper conductor
- Cross linked insulator with halogen free cross-linked sheath
- Nominal DC Voltage (U0/U): 1.5/1.5 kV
- Durable, resistant to ozone, weather, UV, acid, base, hydrolysis, flame and cold resistant suitable for installation in PV systems.

5.2.4.4 Low Voltage Switchgear

The LV Switchgear will be connected to the MV transformer, used for combination of solar energy from the string inverters. Power feeds to the MV transformer to auxiliary loads and uninterruptible power supply (UPS) system.

Each inverter station will be fitted with two sets of LV switchgear, referred to as type A and B. Primary difference between the switchgears is, that one will connect to the auxiliary trans-former supply and have one (1) spare feed, the other will have two (2) spare feeds.

The main data and features of the type A and B LV switchgear are as follows;

- 800 V nominal system voltage
- 1 000 V rated insulation voltage
- 2 500 A/ 1 600 A/ 1 250 A bus bar, 3 phase, 50 Hz
- 250 A Molded Case Circuit Breakers (MCCB) inverse time and instantaneous trip type as provided by thermal magnetic or electronic trip elements for string inverter feeds.
- 2 500 A/ 1 600 A/ 1 250 A Air Circuit Breaker (ACB) operated via a reserved energy mechanism for immediate closing and tripping for RMU feeds.
- Type I + II metal zinc oxide (ZnO) varistor and/or spark-gap based protection accord-ing to IEC 61643-11.
- Installed measuring instruments in the LV switchgear shall include amp meters, volt-meters, watt-meter, watt-hour meter, power factor (PF) meter and accessories.
- Type tested, factory assembled, air insulated, metal enclosed switchgear.

5.2.4.5 Distribution Transformer

The distribution transformer will be connected to the LV switchgear and MV switchgear and shall step up the voltage from 800 V to 33 kV.

5.2.4.6 Ring Main Unit

At every inverter station the RMU shall be located next to the step-up transformer and include all necessary protection and communication devices as well as the required energy meters. The RMU shall connect each inverter station together and finally connect to the main MV switchgear.

5.2.4.7 Main MV Switchgear

The main MV switchgear shall be located indoors in the MV switchgear room of the MCB and include all necessary protection and communication devices as well as energy meters.

The insulated MV switchgear shall be type-tested, factory assembled, in a standardized metal-clad design and for freestanding indoor installation. Each switchgear cubicle shall be completely wired with all instruments, relays and equipment pre-installed and tested in the factory. The cubicles shall be aligned side by side and be individually separable.

5.2.4.8 Containerized Battery Energy Storage System

BESS shall be supplied to provide energy storage and to dis-charge power during the night.

5.2.4.9 Battery Energy Storage System Units

The battery technology will be NMC Lithium-Ion Batteries with a nominal discharge rate of 0.25 C. The batteries shall be composed of modular racks, which consist of several battery trays which are put together from modules which consist of Lithium-ion cells. The modules, trays and racks shall easily be exchangeable on site to improve reliability in case of fault and to facilitate the maintenance works.

The battery must be able to provide a minimum of 4 000 cycles at 80 % of depth of discharge (DoD) and 25°C. End of Life shall be 80 % of initial capacity. The guaranteed cycle life shall be depending on the energy throughput.

Inverter / Rectifier

The battery inverters shall be bidirectional and act as inverter and charger to batteries. The inverters shall be sized to deliver the maximum power provided by the Batteries at the AC connection terminal with the electrical conditions of the prevailing system. Reactive power shall be provided on top of the active power provided by the batteries, to fit the system needs. The inverters shall be equipped with suitable DC-breakers and fuses for the battery strings, they shall both be easily accessible and exchangeable.
Minimum protection shall be provided for battery inverters as follows including, but not limited to: Ground fault monitoring, grid monitoring, anti-islanding, DC reverse polarity, AC/ DC short circuit and overcurrent, AC/ DC overvoltage and temperature, frequency failure, surge protection, etc.

Heating, Ventilation and Air Conditioning (HVAC) Requirements (Li-ion BESS)

The containerised solution shall be equipped and sized with a 100 % redundant air conditioning system, where a failure of one system will not lead to a complete failure of the battery system. The ambient battery temperature and surrounding air humidity shall be monitored and always be kept within the manufacturer's specifications. For a maximum cooling efficiency, the container of the BESS must have a thermal insulation on walls, ceiling and floor. The insulation must be fire retardant.

Fire Protection

Containerised BESS are pre-fitted with HVAC and fire protection systems. BESS will be fitted with fire detection and fire suppression systems based on the manufacturers supplied integrated system. A fire & smoke detection system shall be installed in all rooms/ containers of the system. In case of fire, a visual and audible alarm has to be activated as well as a fire alarm signal shall be sent to the centralized SCADA system. The fire detection system shall be supplied from UPS system to ensure functionality even in case of grid failures.

Around the BESS compound (or part of it) a fire barrier wall shall be built to prevent fire to spread out of the BESS area. The fire barrier wall shall be in accordance with the NFPA 221 standard for fire barrier walls and according to the fire protection study to be performed by the EPC contractor.

5.2.5 Grid Extension Infrastructure

The IPP will be responsible for providing the grid extension infrastructure required on the NamPower network to enable the connection of the facility. The IPP will be responsible for providing this infrastructure in line with the requirements of the grid operator, who will pro-vide the design and technical specifications. The IPP will conduct a hand over of this infrastructure with NamPower in line with the operator's requirements.

It is proposed to connect the #Gaingu PV Power Plant to the existing NamPower New Khan 220 kV substation at 33 kV. A 33 kV busbar is currently not available at the substation; hence this voltage level would have to be established. The following works would be required to extend the existing NamPower network:

- Extension of the existing 220 kV substation with a new 220/ 33 kV transformer bay;
- Establishment of new indoor 33 kV substation at New Khan;
- All 33 kV cabling required to establish the connection to 33 kV line isolator;
- Protection, control and metering infrastructure to allow for grid integration incl. SCADA tie-in and associated telecommunication.

5.2.6 Powerline

The overhead line towers and materials will conform to all latest applicable IEC standards (ILF 2020). The main characteristics of the line are as follows:

- Concrete poles or monopole steel structures shall be utilised.
- Stranded aluminium steel reinforced conductor (ACSR), in accordance with BS EN 13601 shall be used.
- The average span distance is expected to be 100 m – 150 m but is to be confirmed during the design stage.

5.2.6.1 Powerline Structure

The intermediate pole structure, that will be used on the straight sections of the power line, will be a horizontal line post compact delta (HLPCD) with a single wooden pole (monopole) (Figure 5-3). The intermediate poles do not have stay wires.

The structure for strain or angle structures (bend points) will differ, with added strength including stay wires. If the angle exceeds 30˚, a steel A-frame with cross-arm, mounted on a wooden pole, may be used. The latter structure may also have stay wires.

A wooden H-pole strain structure may also be used, either as a terminal or angle structure, to give the power line additional height on a road crossing (such as on the above B2 road crossing). The structure will have stay wires, and an earth wire running vertically from the ground to the top of each pole.

A 22 m wide servitude will be registered/ cleared beneath the power line (the NamPower standard for 33kV).

5.2.6.2 Cables

On the intermediate structure, three conductors are suspended, 800 mm one above the other but in "delta" (offset) configuration, each resting on an insulator.

5.2.6.3 Pole height and span distance

The poles of the wooden monopole structure are 11 m high above ground level. The average span distance (between poles) is a maximum of 120 m.

5.2.6.4 Earthing

There is no optical ground wire (OPGW), often combined with an earth wire, running above the conductors on this structure.

Each intermediate pole is earthed by means of a galvanised wire running vertically from the ground to the top of the pole. It is standard practice to provide an "air space safety gap", whereby the earth wire on each pole stops 300 mm below the lowest conductor phase, in order to reduce electrocution risk; this procedure is known as "gapping". The gap should be wide enough to avoid being permanently active, but close enough to allow it to be bridged by a lightning strike.

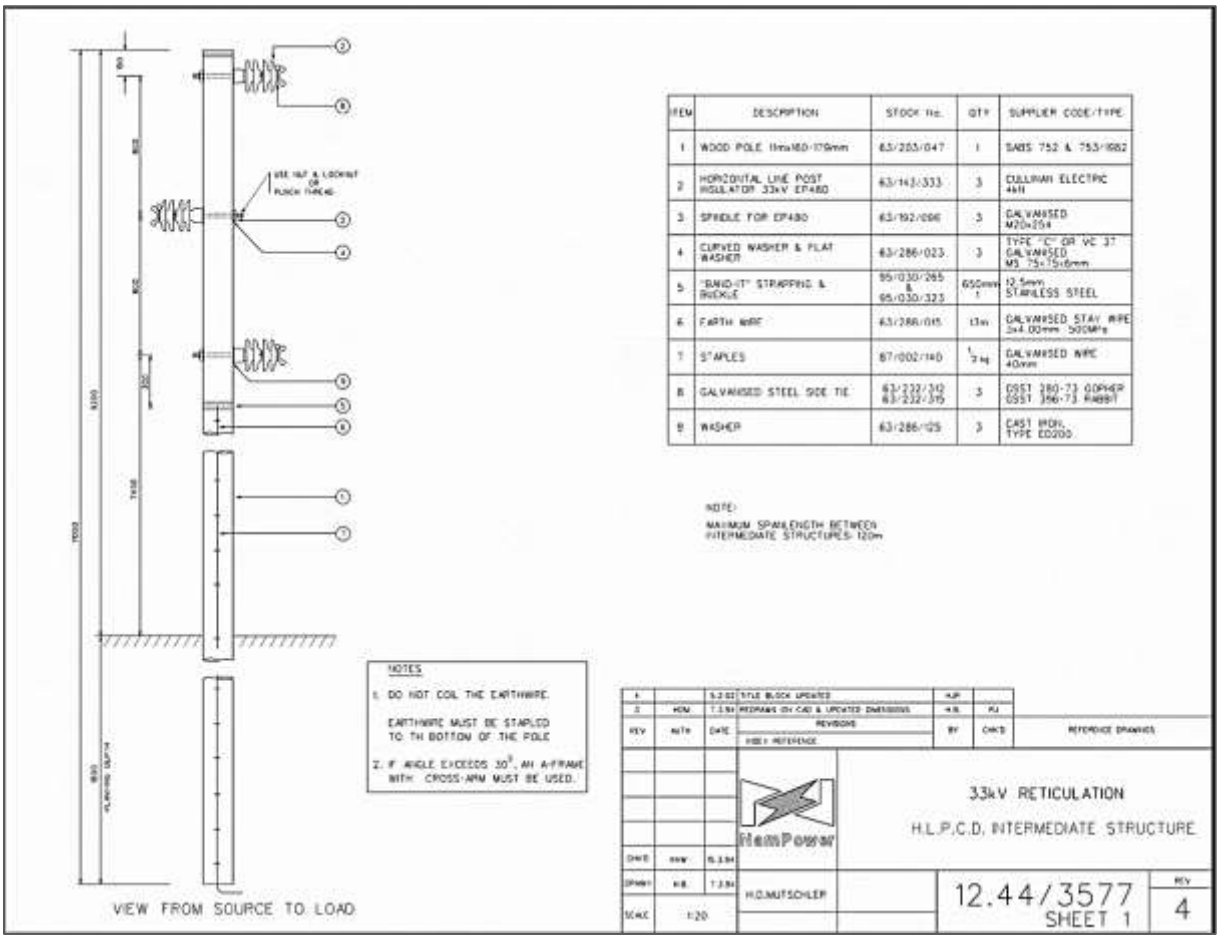


Figure 5-3: Diagram showing details of the structure of a wooden 33 kV horizontal line post compact delta pole (Source: (NamPower 2023))

5.2.7 Mechanical works

5.2.7.1 Water Supply and sanitation

The power plant will require limited water supply, only required for operating personnel during operations and wet cleaning at the #Gaingu PV Power Plant, estimated to be required once per year. This water will be brought in via water truck and stored in Intermediate Bulk Containers (IBC), for truck mounted washing of the PV modules.

Sufficient IBC storage containers shall be supplied for wet cleaning of the PV modules. The volume of water required shall be assumed on a maximum water supply of 0.4 litre per PV module per cleaning cycle. The IBC storage containers shall be sufficient in capacity to insure a full cleaning cycle within less than 7 days. The PV module wet cleaning shall be performed by using a vehicle to transport the IBC tanks to the PV module area.

Piping systems shall be laid out, supported, guided and anchored in such a way as to preclude excessive thrust or stress due to the combination of loading from internal pressure, thermal expansion and weight. All underground pipework shall be designed in order to withstand the loading from covering soil as well as from road traffic. Pumps shall be designed for maximum continuous operation conditions and required to install dry-run protection in form of a flow switch or equivalent with shut-down and alarm function.

5.2.7.2 Heating, Ventilation and Air Conditioning and Fire Protection

The following HVAC and fire protection systems apply to both the inverter station building and main control building.

HVAC Requirements (PV power plant)

The inverter station building and main control building shall be provided with all necessary HVAC equipment including duct works, pipe works, controls, instrumentation, interlocking and cabling systems designed to maintain appropriate environmental conditions for equipment and personnel.

The ventilation system for switchgear room shall comply with NEC standards and other applicable local standards. Attention shall be paid to the battery room ventilation requirements, to evacuate any potentially explosive gases from accumulating within the room.

Humidity control shall be provided in areas containing electronic or other equipment with specific humidity limitations imposed by the equipment manufacturer.

All ventilation equipment shall be fitted with filters and control/ electronic equipment rooms shall be particularly installed with filtered air at a rate which exceeds any applicable extract rate, in order to suppress ingress of dust.

Fire Protection

Portable fire extinguishers shall be supplied and the type and number of extinguishers shall be suitable to the nature of the building. Fire extinguishers shall be marked with geometric symbols for extinguisher classes based on type of fire fuels and mandatory cautions.

An automatic self-exploding powder type extinguishers unit shall be selected and installed in cable conduits, inverter stations rooms, control building rooms including to electrical equipment rooms. Each unit shall be made from steel material, suitable for fixed installation, and fitted with a heat activated glass bulb sprinkler head. The automatic self-exploding powder type extinguisher should be mounted centrally over the area to be protected, with the discharge nozzle pointing vertically downwards away from the ceiling.

The automatic self-exploding power type shall be safe to use on live electrical equipment. Powder fire extinguishers shall be certified for class A, B, C fires for protection against ordinary combustibles like wood, cloth, plastic, paper, rubber, flammable liquids, combustible liquids, petroleum greases, tars, oils, oil-based paints, solvents, lacquers, alcohols, flammable gases and fires that involve energized electrical equipment in accordance with NFPA standard.

5.2.8 Roads

For the Gaingu Power Plant an access road between the service road (running parallel to the existing 220 kV powerline) and the entrance to the facility will be required to be constructed. The road will be approximately 10 km in length.

5.3 PROJECT ALTERNATIVES

During 2019, as part of the inception and design phase of the Feasibility Study, several meetings and site visits were conducted in order to determine the project scope.

5.3.1 Power Supply/ Type of Activity Alternatives

Based on these investigations, four options have been identified to supply RE to the proposed desalination plant.

The following power supply options were investigated:

- 100% utility supplied power (NamPower);
- Solar PV from an IPP in combination with utility power;
- Solar PV from an IPP with BESS in combination with utility power; and
- Concentrated Solar Power (CSP) in combination with utility power.

The CSP option was found to not be commercially viable for this level of power demand and was dismissed.

5.3.2 Locality Alternatives

5.3.2.1 Solar PV facility, Power line and battery storage

Two alternative locations for the solar PV facility, powerline and BESS were considered during the scoping phase that will wheel power to the desalination facility via the electricity grid:

- Option A - at Khan/ New Khan site – connect at New Khan 220 kV Substation (Figure 5-4); or
- Option B - TIN site near Trekkopje mine – new tie-in substation required (Figure 5-5).

Option A is located close to the existing Khan/ New Khan 220 kV substation (Figure 5-4), whilst Option B is situated in proximity of the existing TIN 66 kV substation (Figure 5-5). The existing TIN substation is at full capacity, as such would require the construction of a new substation to wheel electricity into the grid, whilst Option A is expected to connect directly to the Khan/ New Khan substation.

Key sensitive environmental features of the coastal strip where the PV plant facilities are proposed includes Lappet-faced Vulture flight paths, as well as drainage lines and rocky outcrops as habitat features. Site Option B is more preferable from an environmental perspective due to less complex landscape structure. Site Option A is characterised by many drainage lines and rocky outcrops, which act as resource sinks and habitat for fauna and flora (Table 5-2).

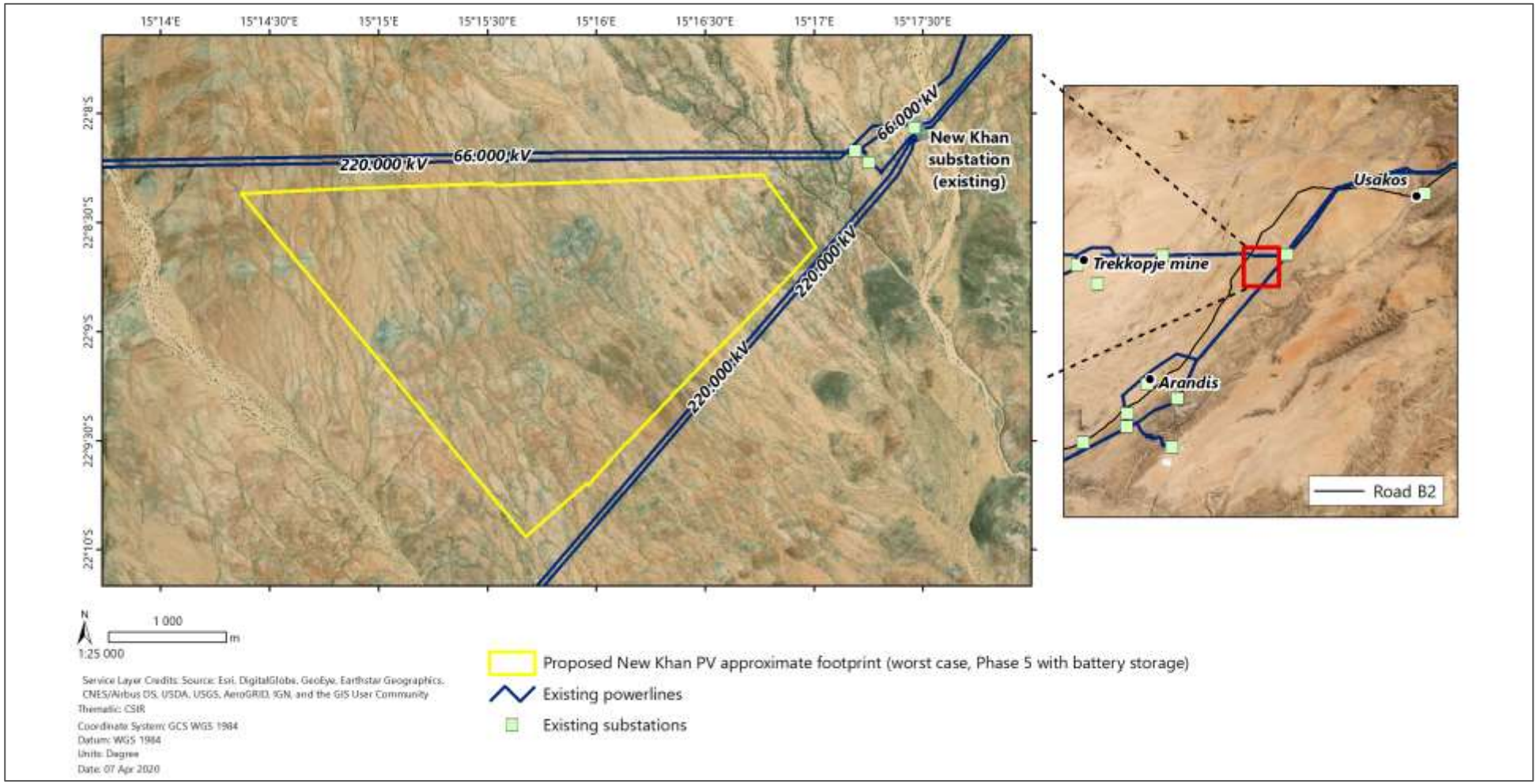


Figure 5-4: Solar PV facility Option A near the existing Khan/ New Khan substation.

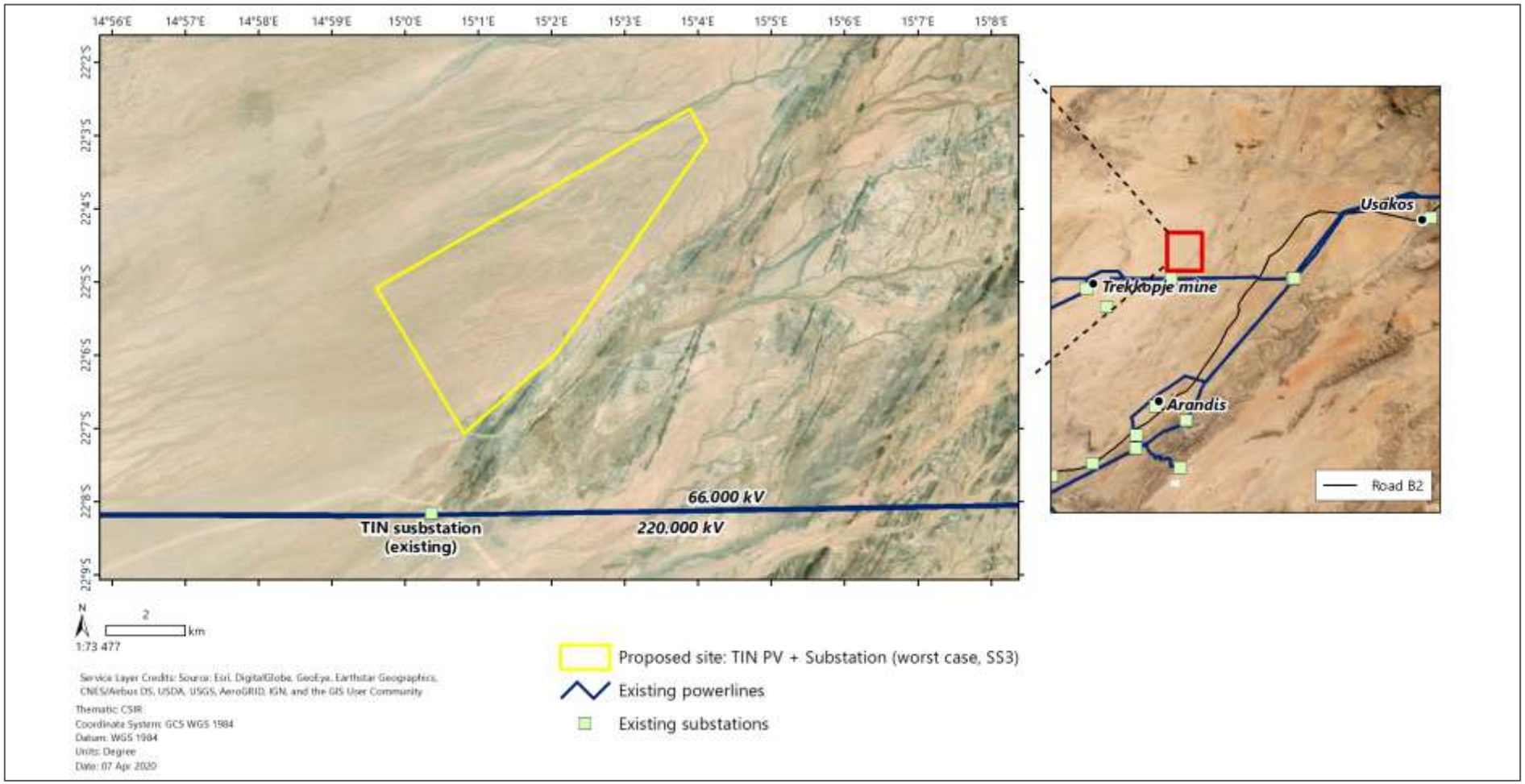


Figure 5-5: Solar PV facility Option B (including new-build substation) near the existing TIN substation.

Table 5-2: Alternatives comparison for Solar PV facility, Power line and battery storage

Key environmental theme	Key environmental features and rational for alternative preference	Solar PV, power line and battery storage	
		Option A (New Khan site)	Option B (TIN site) *
Freshwater	• Fewer drainage lines present at TIN PV site than at New Khan PV site.		✓
Flora	• Fewer drainage lines present at TIN PV site than at New Khan PV site. Drainage lines are key resources sinks and habitat for fauna and flora.		✓
Fauna	• Fewer drainage lines present at TIN PV site than at New Khan PV site. Drainage lines are key resources sinks and habitat for fauna and flora.		✓
Avifauna	• Potential impacts on bird species at risk - flight paths, habitat destruction, etc. • Similar features, impacts and mitigation expected.	✓	✓
Conservation Planning	• Situated in the Gaingu community conservancy. • Similar features, impacts and mitigation expected.	✓	✓
Heritage	• Similar features, impacts and mitigation expected.	✓	✓
Visual	• New Khan PV site is located adjacent to the B2 road which would be visible to tourists and other road users.		✓
✓ *Green block indicates preferred alternative from an environmental perspective.*			

In light of the above Option B: Solar PV facility, powerline, and battery storage at the TIN site is preferred from an environmental perspective and poses no known technical limitations. As this alternative was assessed during the scoping phase a final location was not confirmed and as such further alternative options within the vicinity of the TIN site and other potential areas was assessed during the ESIA phase as discussed in the section below.

5.3.3 Site Alternatives for Option B: Solar PV facility, on-site substation, and battery storage

During the ESIA process it was further proposed to assess alternative locations for the PV Plant facility. After a site visit was undertaken four options were considered and assessed as shown in Figure 5-6 and summarised in Table 5-3.

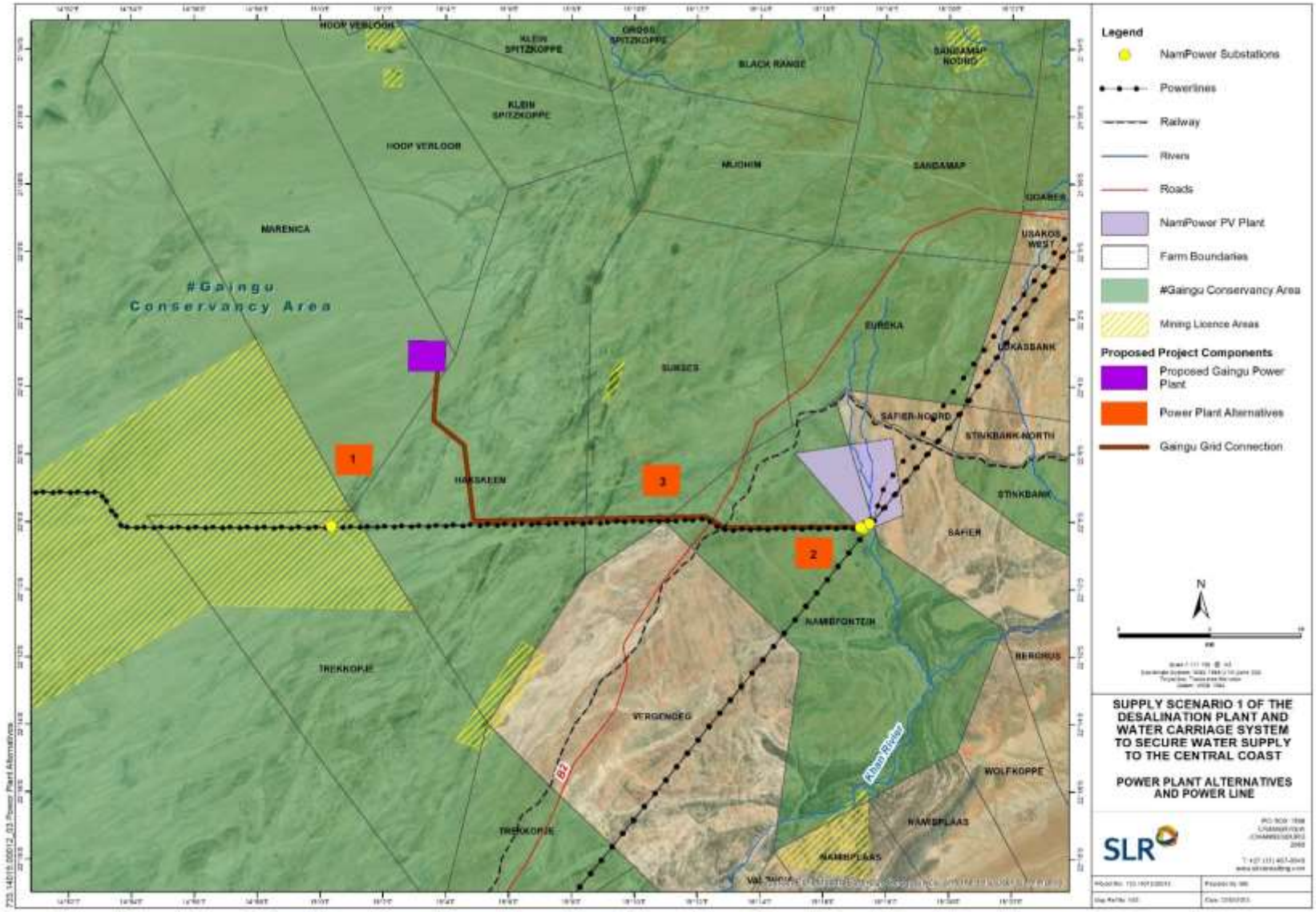


Figure 5-6: PV Plant location alternative options

Table 5-3: Summary of Solar PV, power line and battery storage alternative options

Key environmental feature	Key environmental feature and rational for alternative preference	Solar PV, power line and battery storage			
		Option 1 (Near TIN substation)	Option 2 (New Khan Site)	Option 3 (Near the B2)	Option 4 (Proposed)
Freshwater	Fewer drainage lines present at Options 1, 3 and 4 than at Option 2.	✓		✓	✓
Flora	Fewer drainage lines are present at Options 1, 3 and 4 than at Option 2. Drainage lines are key resources sinks and habitat for fauna and flora	✓		✓	✓
Fauna	Fewer drainage lines are present at Options 1, 3 and 4 than at Option 2. Drainage lines are key resources sinks and habitat for fauna and flora	✓		✓	✓
Avifauna	Potential impacts on bird species at risk - flight paths, habitat destruction, etc. Option 1,2 and 3 - Similar features, impacts and mitigation expected & outside of key biodiversity considerations. Option 4 - Korhaan and Martial Eagle identified on site, springbok breeding area.	✓	✓	✓	
Heritage	Similar features, impacts and mitigation expected	✓	✓	✓	✓
Visual	**Option 2 and 3** - located adjacent to the B2 road which would be visible to tourists and other road users.	✓			✓
Infrastructure	**Option 1** - existing access road in good condition. Shorter distance of powerline to tie into the TIN substation. TIN substation at capacity - construction of additional substation required. **Option 2** - access road existing, additional road to be constructed to access the site. Shorter distance of powerline to tie into the Khan substation. Transformer required to step up to 220kV. **Option 3** - shorter access road. Shorter distance of powerline to tie into the Khan substation. Transformer required to step up to 220kV. **Option 4** - access road construction/ upgrade required, existing NamPower track not sufficient to transport construction	✓	✓	✓	

Key environmental feature	Key environmental feature and rational for alternative preference	Solar PV, power line and battery storage			
		Option 1 (Near TIN substation)	Option 2 (New Khan Site)	Option 3 (Near the B2)	Option 4 (Proposed)
	materials to site. Emissions from construction of road and road traffic over the distance. Extent of powerline to be constructed to tie into the Khan substation.				
Land use	All - Within Gaingu community conservancy	✓	✓	✓	✓

From an environmental perspective Option 1 for the PV Plant location is preferred for the following reasons:

- Fewer drainage lines on the site.
- Reduced visual impact due to remote location.
- Existing access road available for use.
- Fewer avifauna impacts anticipated.

However, Option 1 is encroaching onto the adjacent mining licence area and it would not be feasible to acquire the land to develop the project. Ownership of the land for Options 2 and 3 is also considered as a constraint to developing it at those locations and Option 2 is located closer to the B2 road which will have an increased visual impact. In light of the above Option 4 is considered the preferred alternative which is assessed in the ESIA.

5.3.4 Tie-in Substation Alternatives

Table 5-4 below provides a summary of the alternatives considered for the tie-in substation.

Table 5-4: Summary of substation alternative options

Key environmental feature	Key environmental feature and rational for alternative preference	Substation	
		Option A (Khan)	Option B (TIN)
Flora	Similar features, impacts and mitigation expected	✓	✓
Fauna	Similar features, impacts and mitigation expected	✓	✓
Avifauna	**Option A -** High potential for bird impacts due to longer powerline. **Option B** - Less risk of bird impacts due to shorter length of powerline.		✓
Heritage	Similar features, impacts and mitigation expected	✓	✓
Land use	**Option A -** Within Gaingu community conservancy **Option B** - Potential overlap with mining license area	✓	
Infrastructure	**Option A** – further away, longer powerline, longer servitude for maintenance, transformer required to step up to 220 kV **Option B** - closer to alternative site, shorter powerline, substation at capacity - would require a new substation to be built.		✓

For the substation the Khan substation (Option A) is the preferred option due to the fact that the TIN substation is at capacity and should the project tie into that substation a new substation would need to be developed. Whereas at the Khan substation there is an empty bay available in which a transformer can be developed for the project to tie into.

5.4 CONSTRUCTION PHASE

During the construction phase the following ancillary infrastructure and services may be required:

- Setup of construction camps;
- Laydown areas for all materials including powerline and other raw materials;
- Water and electricity supply during construction;
- Sewage and wastewater treatment at construction sites;
- Waste management and disposal; and
- Hazardous materials storage such as temporary storage of diesel and other hazardous materials.

Where possible, materials, plant and equipment will be sourced from suppliers within the vicinity of the project site, locally in Namibia. The bulk of the specialist equipment, i.e., PV modules, inverters, BESS, substation components, etc, will be imported from China, Europe and/or South Africa and be shipped to Walvis Bay.

The construction phase of the proposed project will be for a period of up to 18 – 24 months.

5.5 OPERATIONAL PHASE

The most suitable commercial approach was selected to be an IPP model, where RE power is directly purchased from an IPP. This approach gives flexibility in the design of the RE power supply and increases competitivity when procured through a competitive bidding process. It will drive down tariff prices aiding to support the lowest cost of energy. Furthermore, it releases the energy purchaser of any obligation to operate and maintain the power plants.

The proposed project will be operated on a 24-hour, 7 days a week basis. The operational phase of the proposed project will comprise the following activities:

- Regular cleaning of the PV modules by trained personnel;
- Vegetation management under and around the PV modules to allow maintenance and operation at full capacity;
- Maintenance of all components including PV modules, mounting structures, trackers, inverters, substation transformers, BESS, and equipment;
- Office management and maintenance of operations and maintenance of buildings;
- Supervision of the solar PV facility operations; and
- Site security monitoring.

5.6 DECOMMISSIONING PHASE

The proposed project is expected to operate for at least 25-years. Once the solar PV facility reaches the end of its life, the facility will be decommissioned or continue to operate. If decommissioned, all components will be removed, and the site rehabilitated. Where possible all materials will be recycled, otherwise they will be disposed of in accordance with local regulations and international best practice.

6. RECEIVING ENVIRONMENT

This chapter is aimed at providing the reader with general information on relevant environmental (geographical, physical, biological, social, economic, heritage and cultural) aspects associated with the proposed project.

6.1 INTRODUCTION

Baseline information for this ESIA Report was sourced through a desktop study and draws extensively on information contained in studies that have been conducted by various government departments and non-government environmental organisations with interest in the area covered by the project. Several sources were used for this section, including:

- Atlas of Namibia (Mendelsohn et al., 2002) and Namibia's Coast (Robertson et al., 2012);
- Environmental Impact Assessment for the proposed desalination project at Mile 6 near Swakopmund, Namibia (CSIR, 2009);
- Report of the Environmental and Social Impact Assessment of the Trekkopje Desalination Project, Erongo Region, Namibia (Turgis Consulting, 2008);
- Social and Environmental Impact Assessment for the proposed Rössing Uranium Desalination Plant new Swakopmund (SLR & Aurecon, 2015);
- EIA for the proposed Encroacher Bush Biomass Power Project in Namibia (SLR, 2018);
- Available internet information on the baseline environment within the area;
- Topocadastral and geological maps covering the application area at scales ranging from 1:50 000 to 1:250 000; and
- Inputs from environmental and social specialists based on the specialists' reports conducting intense baseline studies and site visits during the ESIA phase (Refer to relevant Specialist reports in Appendices D to L for references per section).

6.2 CLIMATE

Climatically the study area may be classified as a Cold Arid Desert (Kottek, Grieser, Beck, Rudolf, & Rubel, 2006) with a rainfall that is not only very low (annual median is 50-100 mm) but also highly variable: 90-100%, the second highest ranking of variation coefficient (Mendelssohn, Jarvis, Roberts, & Robertson, 2002). The average annual temperature in the study area is 18 - 20°C.

The solar PV site falls within the Nama Karoo biome, with the Namib Desert biome adjacent to the west and the extensive tree and shrub savanna to the north-east (Mendelsohn et al. 2002; Atlas of Namibia Team 2022).

The site has a relatively lower incidence of fog than on the coast. The project site thus falls outside the range of the thick coastal fog that occurs along the Central Namib coast. It is located outside the Dorob National Park and inside the #Gaingu Conservancy.

The dominant wind direction is from the south, with wind speeds averaging 10-20 km per hour. East winds also occur.

6.2.1 Temperature, Rainfall and Fog

Rainfall is highly seasonal with more than 90% received between December and April (summer through autumn) with average annual rainfall around 135.8 mm. Figure 6-1 presents the average monthly temperature and rainfall for the Erongo Region in which the project site is located from 1991 to 2020[4]. On average, October to March are the hottest and wettest months, while April to September are the coolest and driest months.

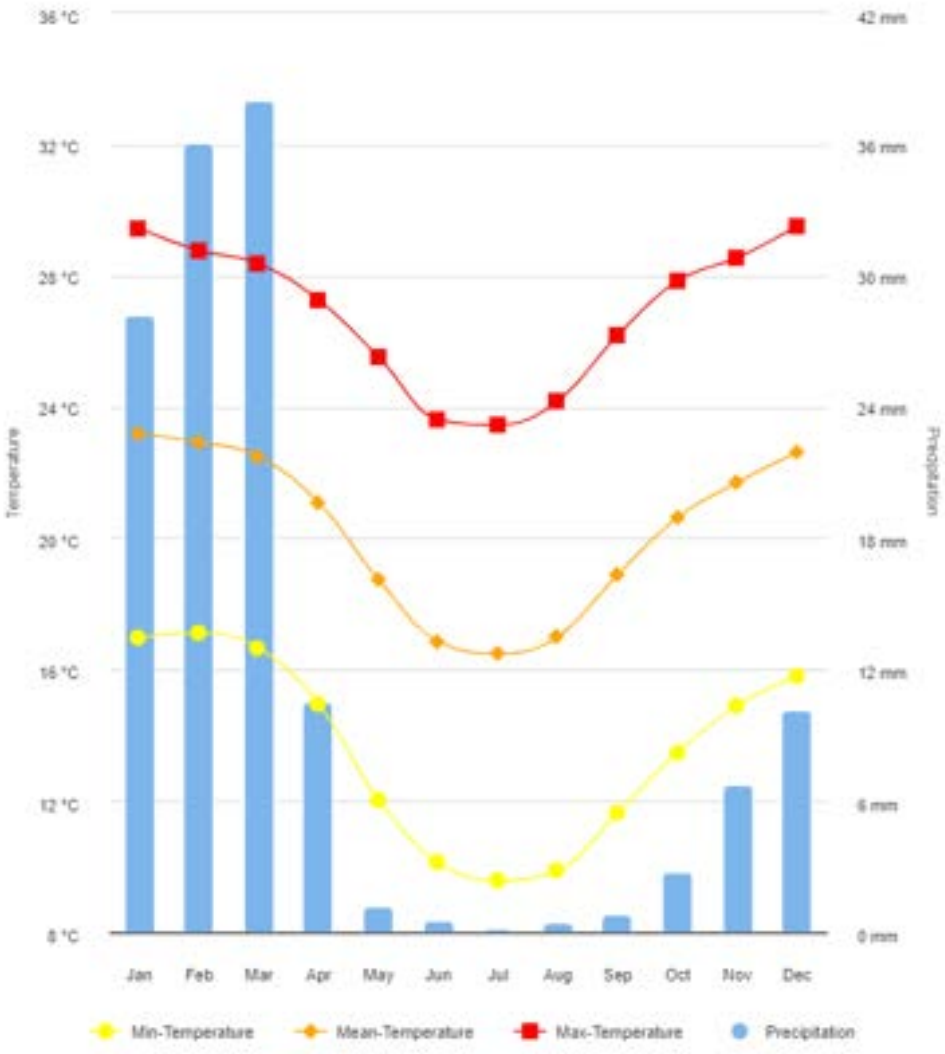


Figure 6-1: Monthly average temperature and rainfall (1991 to 2020) for the Erongo Region[5]

[4] World Bank Group (2021). *Limpopo*. URL: **https://climateknowledgeportal.worldbank.org** [accessed on 28 February 2023].

[5] *Ibid*.

6.2.2 Sunshine and cloudiness

Low stratus and stratocumulus clouds are often formed at the coast during the early morning hours when onshore breezes blow over the upwelling zone. These clouds may move inland, intersecting the rising land to produce fog. The amount of cloud cover is thus highest at night but decreases consistently throughout the day. Namibia is characterised by high Global Horizontal Irradiation[6] (GHI) which means it has good potential for generating solar power (Figure 6-2). This potential is, however, diminished along the coast due to fog.

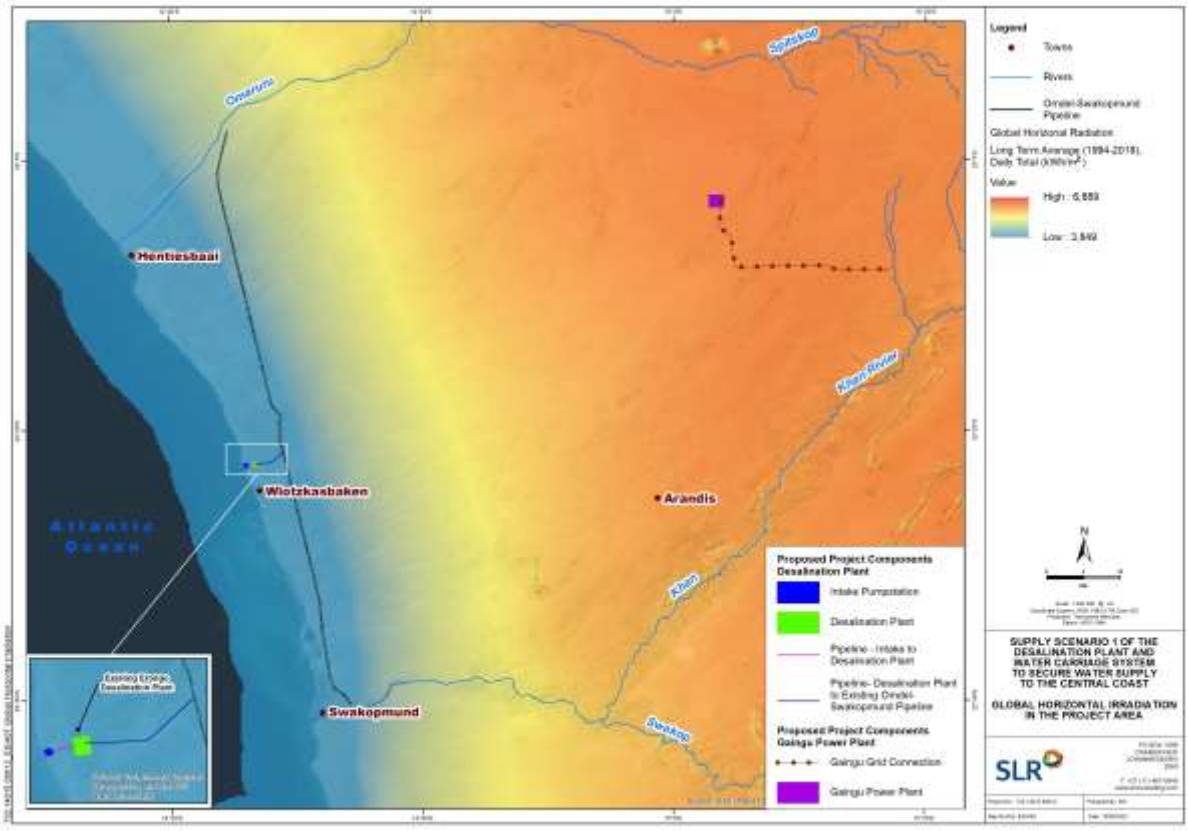


Figure 6-2: Long term average global horizontal Irradiation (Daily total) for the proposed project area

6.3 TOPOGRAPHY

The coastal plain of Namibia rises towards the east and forms a plateau of between 900 and 1 300 metres above sea level (m.a.s.l). The incisions of the ephemeral Khan- and Swakop rivers can be observed between Usakos and Swakopmund, and Otjimbingwe and Swakopmund respectively (Figure 6-3).

[6] "Global Horizontal Irradiance (GHI) is the total solar radiation incident on a horizontal surface. It is the sum of Direct Normal Irradiance (DNI), Diffuse Horizontal Irradiance, and ground-reflected radiation" (Homer Energy, n.d.)

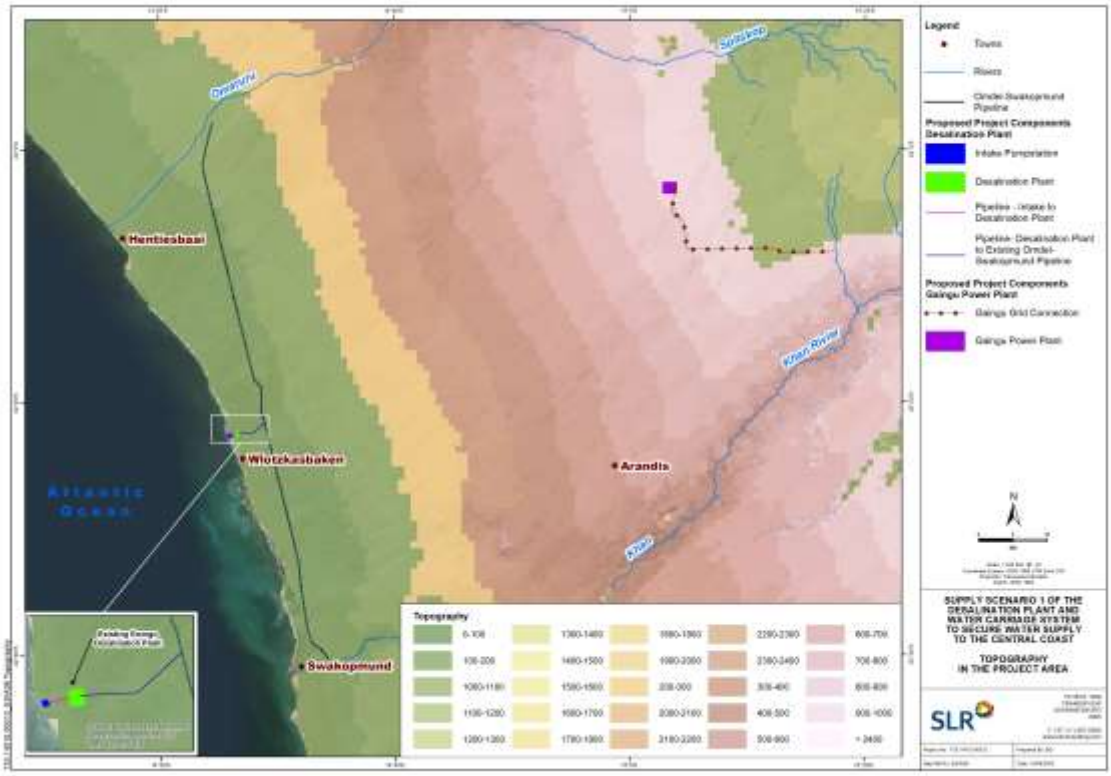


Figure 6-3: Topography of the proposed project area

6.4 GEOLOGY, SOILS AND LAND COVER

Schists and dolomites, with patches of granite and complex rock types, predominantly underlie the proposed project area (Figure 6-4).

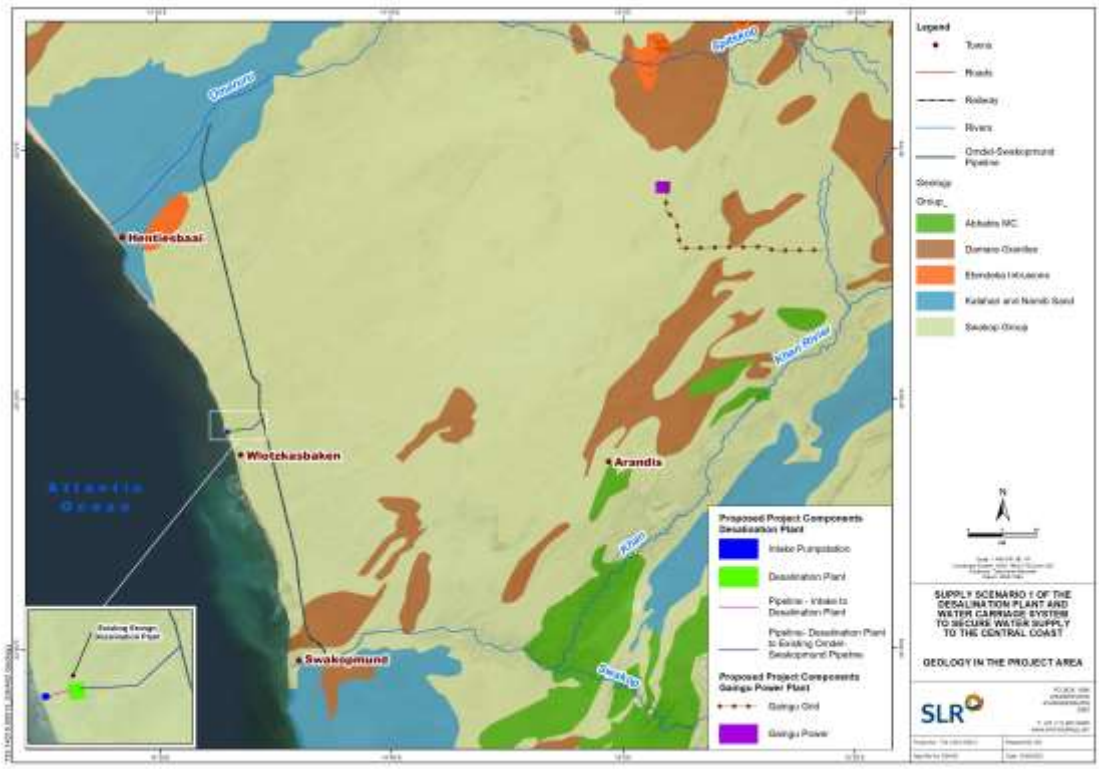


Figure 6-4: Underlying geology of the proposed project area

The dominant soil types of the proposed project area are petric Gypsisols, pertic Calsisols, eutric Regosols, and lithic and eutric Leptosols, with interspersed rocky outcrops (Figure 6-5).

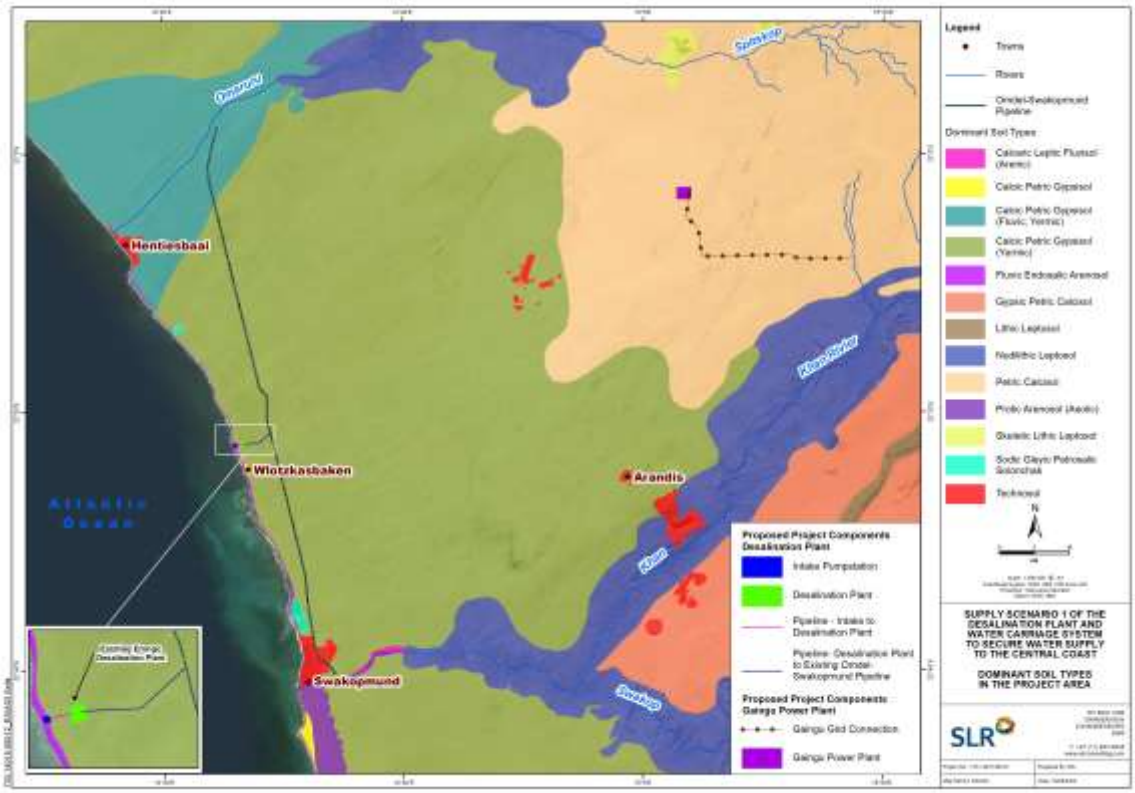


Figure 6-5: Soil types of the proposed project area

The desert areas of the proposed project area is sparsely covered with lichen and vegetation (Figure 6-6).

Figure 6-6: Land cover of the proposed project area

6.5 HYDROLOGY AND HYDROGEOLOGY

6.5.1 Regional Hydrology

The proposed project is located in the Omaruru Delta, which lies between the Omaruru and Swakop catchments. There are no perennial rivers within the project site but the site is characterised by minor ephemeral drainage lines that rarely flow. The natural topography of the drainage lines direct runoff westward towards the ocean. The drainage lines are generally dry, sandy watercourses that are lined by relatively thick vegetation sparsely spread and trees as shown in Figure 6-7. Figure 6-8 provides a map of the surface water resources.

Figure 6-7: Ephemeral drainage lines (photos taken from the upper reaches of the Omaruru delta)

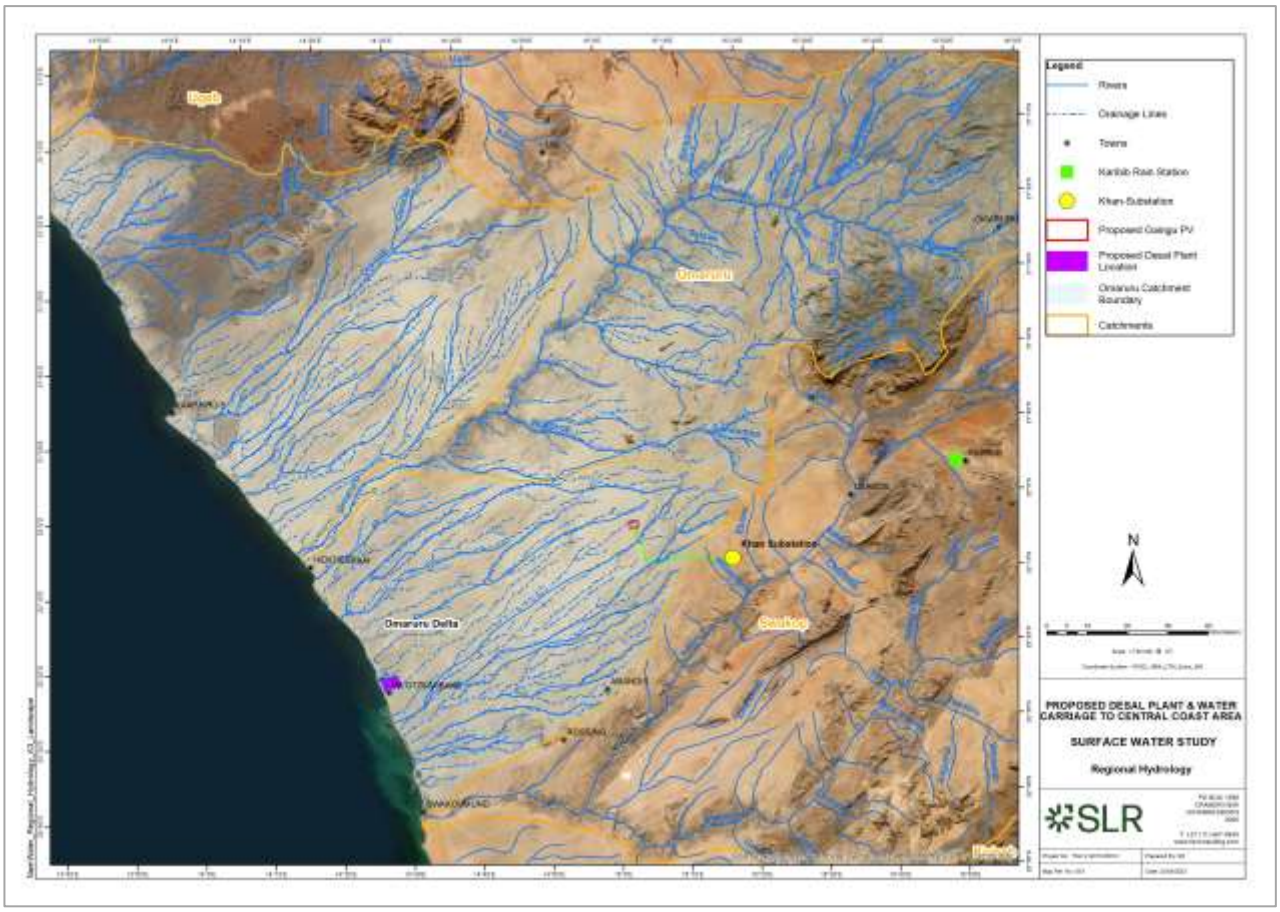


Figure 6-8: Regional map of surface water resources

6.5.1.1 Surface Water Sensitivity

The Omaruru catchment is not heavily industrialised and urbanised. The potential of the catchment to self-rehabilitate are high. The drainage lines are well defined even though there is no continuous flow through the year. The drainage lines may be categorised as ephemeral river systems that flow during extreme rain events.

The site for the solar PV will consist of solar cell modules, inverters, offices or control buildings as well as movement of vehicles to service various mechanical and electrical equipment. Currently approximately 342 hectares of land has been earmarked for the PV plant. This will potentially alter natural drainage line.

However, if the movement of vehicles to and from the PV site is kept within the same path and only limit the drainage line disturbance only to areas that need to be developed as well as providing detailed stormwater management plan the chances of the catchment and its water resources to self-rehabilitate are high.

6.5.2 Groundwater

In Namibia, where surface water is very sparse, groundwater is a critical resource. Little or no groundwater exists between the coast and ~ 15°15'E. Shallower groundwater areas are often associated with surface water features (ephemeral rivers and dry rivers).

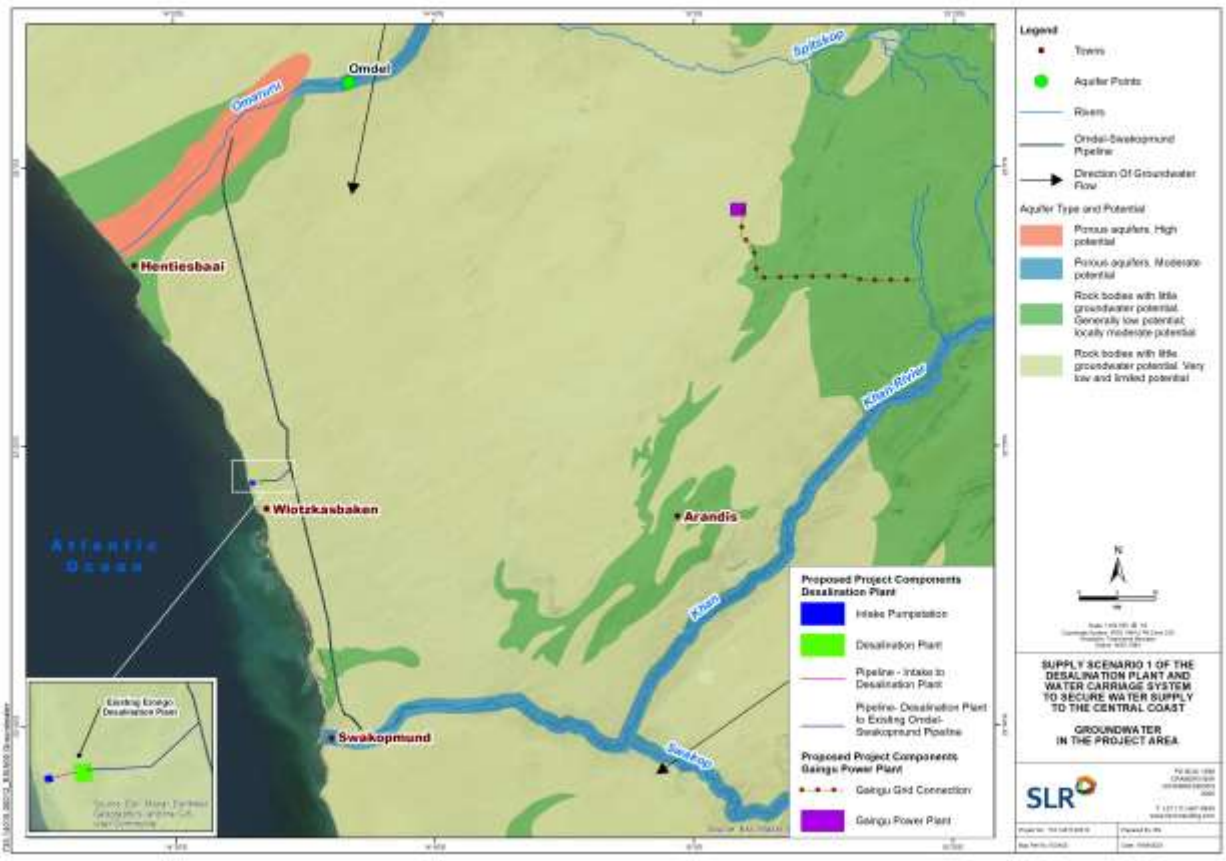


Figure 6-9: Surface and groundwater features of the proposed project area

6.6 AVIFAUNA

6.6.1 Major topographical feature and avifauna habitats

The dominant landscape comprises Central-Western Plains. The Namib land surface consists mostly of flat, slightly undulating gravel plains, with occasional ridges, sloping gradually down towards the coast and Atlantic Ocean to the west. The soils are mainly schists and dolomites, and granite.

Numerous shallow, ephemeral drainage lines are an important feature of the gravel plains, running mainly in a south-westerly direction down towards the ocean. In these habitats, the relatively higher moisture enables vegetation growth, and provides a more attractive habitat for desert-adapted bird species such as the near-endemic resident Rüppell's Korhaan and nomadic Gray's Lark, and (seasonally) Ludwig's Bustard, and for associated animal life.

As mentioned above, drainage lines also appear to be linked to potential flight path corridors/ flyways for birds moving between the coast and inland (e.g., for Lesser Flamingo and Greater Flamingo, moving between the coast and inland habitats such as Etosha National Park).

The existing 220 kV and 66 kV power line servitude (which overlaps with the proposed 33 kV line servitude) passes through rocky, hilly terrain from the New Khan Substation eastwards to the TIN Substation. Thereafter, the habitat changes to flat, sandy-gravel plains with very little vegetation. The servitude includes numerous drainage lines, some deeply incised in the eastern section, and including one deep/wide line

further westwards (22.134355S; 15.109938E). Several other relatively deep lines occur to the west of the Khan Substation/east of the B2 road and closer to the Khan River.

The solar PV site lies in a broad, flat, sandy area that includes several drainage lines, with a more deeply incised line in the northern part. South-east of the site, numerous dolerite ridges run from north-east to south-west. The altitude for the solar PV plant site is ~920 m.

Falling within the Nama Karoo biome, the vegetation type in this area is classed as Central-Western Escarpment and Inselbergs, with the dominant structure comprising varied shrubland and grasslands (Atlas of Namibia Team 2022).

A major terrestrial topographical feature in the greater area is the deeply incised, ephemeral Khan and Swakop rivers and their tributaries, running south-east of the study site. The Khan River is 32 km from the site. The river is largely dry, but there are a few small perennial pools that attract birds. Rainfall events (and flooding) are rare and episodic. The surrounding habitats are rocky and mountainous. The above rocky habitats are attractive to raptors. South of the study site, near Arandis, the Rössing Mountain range reaches ~670 m in height.

Although the study site and surrounding area are not regarded as a critical habitat/habitat of significant importance for species such as Rüppell's Korhaan, Gray's Lark and Ludwig's Bustard, these areas are nevertheless sensitive in terms of providing limited habitats for such species, including breeding habitats for the korhaans, also suspected for Gray's Lark, and possibly for the bustards.

6.6.2 Bird species richness and abundance

A total of 80 bird species has been recorded in the one Quarter Degree Square (QDS)/two pentads for the solar PV plant and power line study site (SABAP1 and SABAP2 data, supplemented by power line incident data; see Figure 2; Appendix 1 of African Conservation Services cc, 2023). This number represents 12% of the 676 species currently recorded in Namibia (Brown *et al*. 2017). The above species richness is regarded as typically low for the relatively arid environmental conditions. The bird species are restricted mainly to terrestrial inland habitats, although there is evidence of movements by aquatic birds through the area (e.g. according to power line incident data, e.g. for flamingos, and pelicans). Such movements typically take place at night. Some of the main species discussed in terms of this study area are illustrated in Figure 6-10 and Figure 6-11 below.

6.6.2.1 Threatened status

The checklist for the solar PV plant study site (80 species) includes seven Namibian Red-listed species (9%; Simmons *et al.* 2015; Brown *et al.* 2017; Kolberg 2022; Appendix 1 of African Conservation Services cc, 2023), representing 9% of the 78 species currently on the Namibian Red List. Four species (57%) are also Globally Threatened (International Union for Conservation of Nature (IUCN) 2023). Four of the above species are terrestrial and three are aquatic (the latter representing birds in passage, rather than sedentary/resident).

As mentioned above, around 75% of Namibia's Red Data birds fall into one or more of the following groups (Simmons *et al.* 2015):

- Wetland birds (20 spp.)
- Coastal/marine birds (19 spp.)
- Birds impacted by power lines (10 spp.)
- Scavenging birds (10 spp.)

Of the above seven Red-listed species, six occur in sufficient numbers to have the potential to be impacted in some way by the project. These comprise three species that are Endangered in Namibia and three that are Vulnerable.

The seven Red Data species are as follows (six species with a higher probability of being present in the solar PV and power line study site area are indicated in bold; *species confirmed during recent site visits [2023] are indicted by an asterisk):

- Terrestrial species, including three raptors (4)
    - ***Ludwig's Bustard** (Endangered, also Globally Endangered) Note: 13 bustards were counted on the ≠Gaingu Conservancy Game Count on 14-16 May 2023 (N Hendriks, ≠Gaingu Conservancy pers. comm. 2023); 713 km were covered (for an area of 7,731 km^2), providing a baseline estimate of 0.02 bustards/ km for the conservancy (presumed Ludwig's Bustard, based on recorded power line incidents, but to be confirmed).
    - ***Martial Eagle** (Endangered, also Globally Endangered).
    - ***Lappet-faced Vulture** (Endangered, also Globally Endangered).
    - Verreauxs' Eagle (Near Threatened).
- Aquatic species (3)
    - **Lesser Flamingo** (Vulnerable; also, Globally Near Threatened).
    - **Greater Flamingo** (Vulnerable).
    - **Great White Pelican** (Vulnerable).

Ludwig's Bustard, Lesser Flamingo and Greater Flamingo

The recorded high incidence of collisions of the above species on power lines to the south of the study area is a cause for concern. It is possible that Kori Bustards may also be involved. This aspect is discussed further in Section 6.6.2.2 below.

Lappet-faced Vulture

This raptor has been flagged as a species of concern in the Scoping Report (SLR & CSIR 2021), based on fairly recent satellite tracking data that indicate movements in the eastern parts of the study area. These wide-ranging movements are discussed further in Section 6.6.2.2 below. Although SABAP records for the species are relatively sparse in the study area, the area is under-atlased. The species is also power line sensitive.

Figure 6-10: a-f. Raptor species recorded in the vicinity of the solar PV plant site and proposed power line servitude: Large, inactive, suspected Lappet-faced Vulture nest that has fallen down from its original position on the top of the tree (top left); Lappet-faced Vulture chick being ringed in area (2013; top right; photo S Muller, Orano); suspected Martial Eagle nest on pylon (centre left); Martial Eagle juvenile on nest on 132 kV power line (2015; centre right); Greater Kestrel on 66 kV power line pole (bottom left); Black-chested Snake Eagle perched on 220 kV steel lattice pylon (bottom right).

Figure 6-11: Other terrestrial bird species recorded in the greater study area: Rüppell's Korhaan (top); Namaqua Sandgrouse (centre left); typical nest probably shared by crows/kestrels (centre right); Stark's Lark (bottom left); and small, cryptic nest of (unidentified) ground-nesting bird species in the solar PV plant area (bottom right).

6.6.2.2 Endemism

Endemism or having a limited distribution due to restricted habitat requirements renders populations more vulnerable to threats.

The checklist of 79 species for the solar PV study site includes three species (3%) that are near-endemic to Namibia (Appendix 1 of African Conservation Services cc, 2023). Of these, at least two (indicated in bold) are potentially at risk to impacts from the project:

- ***Rüppell's Korhaan** (a medium-sized, sedentary terrestrial species; also recorded in collisions on power lines in the area)
    - Note: 20 korhaans (assumed to be Rüppell's Korhaan) were counted on the ≠Gaingu Conservancy Game Count on 14-16 May 2023 (N Hendriks, ≠Gaingu Conservancy pers. comm. 2023); 713 km were covered (for an area of 7,731 km^2), providing a baseline estimate of 0.03 korhaans/km for the conservancy
    - Also reported as power line collision incidents in the area
- ***Gray's Lark** (a small, nomadic terrestrial species that breeds on the Namib gravel plains); commonly recorded in the proposed solar PV area
- Herero Chat (a small species found very locally in a specific microhabitat: the bands of somewhat lusher woodland around the base of rocky escarpments at the edge of the Namib Desert)

6.6.2.3 Residency, nomadism and migrant status (priority species)

Although many species on the bird checklist are resident, nomadic movements are common during at least some stages of life, due to changing conditions in an arid environment. Nomadic/migrant habits result in high mobility and consequently increase the risk of impacts such as collisions on overhead structures.

As mentioned above, Namibia has a responsibility to conserve its migrant bird species. The priority bird checklist includes at least four species (5%) with some form of migrant status (Appendix 1 of African Conservation Services cc, 2023). These include:

- 3 intra-African (including breeding) migrants
- 1 partial migrant

Among the seven Red Data species (see Section 6.6.2.1 above), two species have some form of migrant status.

Focusing on potential priority species, the four migrant species are as follows (four species with a higher probability of being present in the solar PV plant study site area are indicated in bold; *1 species confirmed during recent site visits [2023] indicted by an asterisk):

- **Lesser Flamingo** (partial intra-African migrant)
- **Greater Flamingo** (partial intra-African migrant)
- ***Namaqua Sandgrouse** (partial migrant)
- **Yellow-billed Kite** (intra-African migrant)

Two of the above migrant species are terrestrial, and two are aquatic.

Species such as Greater Flamingo and Lesser Flamingo are known to move between the coast and inland habitats, including Etosha National Park. Such movements, including over the present solar PV study area, are supported by power line incident data in the area.

6.6.2.4 Recorded breeding

A suspected Martial Eagle nest was observed on a 220 kV steel lattice power line pole 10 km south-east of the site on 14 March 2023, together with a (live) adult (22.134677S; 15.120101E). A juvenile of the above species on a nest was recorded on a 132 kV wooden (Kamerad) power line structure 47 km south-west of the site on 30 March 2015 (22.249834S; 14.655290E).

A large, inactive, suspected Lappet-faced Vulture nest that has apparently fallen down from its original position on the top of the tree to a fork half-way down the structure was found on 29 May 2023 (22.13441S 15.08644E). A Lappet-faced Vulture chick at a nest on the Orano Mine property about 10 km south-west of the solar PV site was ringed by Vultures Namibia on 25 October 2013 (S Mueller pers. comm. 2023).

Breeding of the sedentary Rüppell's Korhaan in the solar PV plant/power line area is suspected, based on observations of family groups of four in the area.

Breeding of the near-endemic Gray's Lark is suspected in the solar PV plant area, based on observations of several likely old nests, used as roosting sites.

Species such as Cape Crow and Greater Kestrel have been observed to nest on the power line structures in the area, apparently sharing the same nest but at different times. Species including Speckled Pigeon are also likely to nest on structures such as those at the Khan Substation.

6.6.3 Potential sensitivities of bird groups in the study area

6.6.3.1 Large terrestrial birds

Larger terrestrial birds are well represented in the above habitats. These include Ludwig's Bustard, Rüppell's Korhaan, Namaqua Sandgrouse; and, less frequently, Southern Black Korhaan, Red Crested Korhaan, Double-banded Sandgrouse, Red-billed Spurfowl.

This group of birds is prone to power line interactions, including collision and disturbance/habitat modification. Collisions of Ludwig's Bustard, and Rüppell's Korhaan, are an ongoing concern on the power lines to the south of the solar PV site, as well as elsewhere.

6.6.3.2 Raptors

Raptors play a key ecological role in ecosystems, being predators at the top of food webs; they help regulate populations of rodents and other small animals, including insects. Scavenging raptors such as vultures play a pivotal role in keeping the environment clean and healthy. They thus also serve as indicator species for ecological health.

Apart from the three above Red Data raptor species (Martial Eagle, Lappet-faced Vulture, Verreauxs' Eagle) and the migrant Yellow-billed Kite, at least seven other raptor species occur in the study area (Pale Chanting Goshawk, Rock Kestrel, Greater Kestrel, Black-chested Snake Eagle; and, less frequently, Lanner Falcon, Augur Buzzard, Gabar Goshawk).

Raptors as a group are prone to power line interactions, including collision, electrocution and disturbance/habitat modification. Raptors are also in decline due to poisoning on farms that targets mammalian predators; and to deliberate poisoning of vultures by commercial poachers (Simmons *et al.* 2015).

6.6.3.3 Aquatic species

Aquatic species tend to be nomadic, often flying at night, in groups, to avoid predation. Although aquatic habitats are lacking in the study area, movements of both Greater Flamingo and Lesser Flamingo have been confirmed by collisions on the power lines south of the study site (see below). Great White Pelican is nomadic at times and has also been recorded in the greater study area, including at the Husab Mine to the south-east.

6.6.4 Known sensitivity to power line interactions

6.6.4.1 Power line-sensitive bird species in the greater study area

Bird species may be sensitive, in varying degrees, to power line impacts such as collision, electrocution and/or disturbance and habitat destruction. The incidence of Red Data power line-sensitive bird species per QDS in the greater study area is indicated in Figure 6-13. This sensitivity in the study area itself (QDS 2215AA; 6-8 species potentially at risk) is regarded as relatively average in relation to surrounding QDSs, apart from the Swakopmund area on the coast where it is higher; however, only SABAP1 data are used for the maps, and in general the area is under-atlased.

Examples of the distribution of power line-sensitive species in the solar PV study area (based on SABAP1 data) are shown below (Figure 6-14), namely for Ludwig's Bustard, Lesser Flamingo and Greater Flamingo (combined), Rüppell's Korhaan, Great White Pelican and Lappet-faced Vulture.

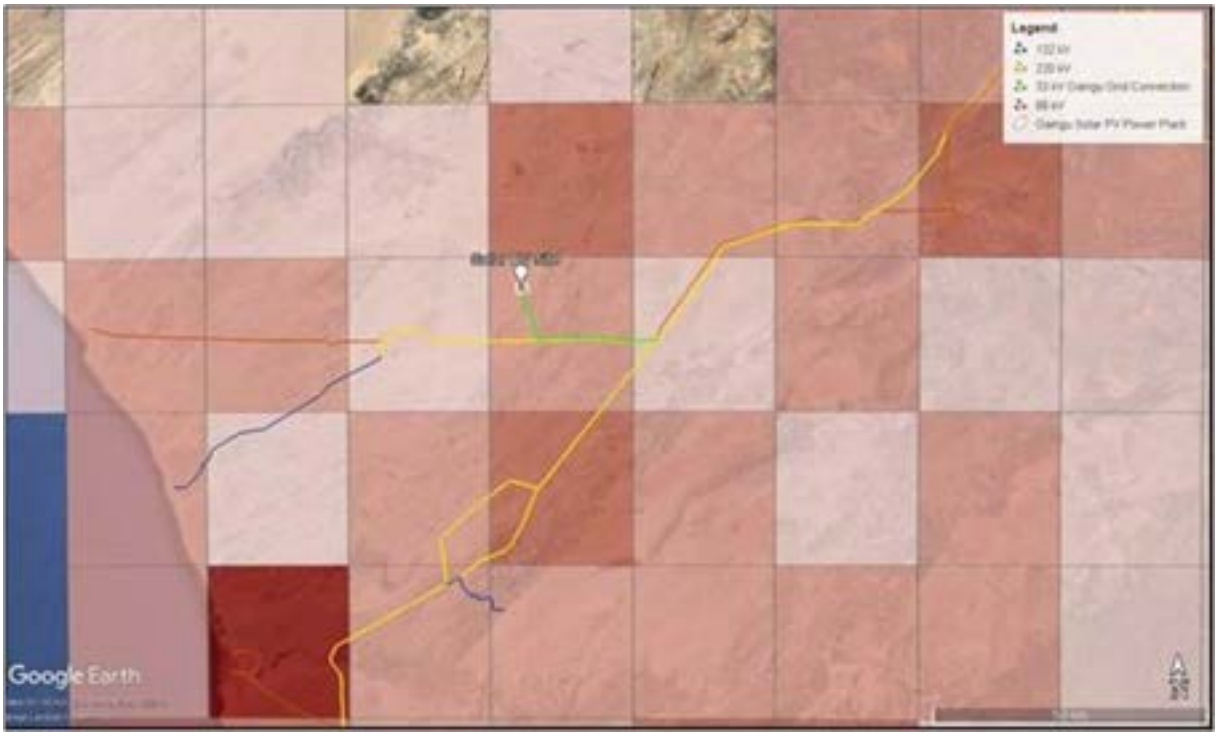
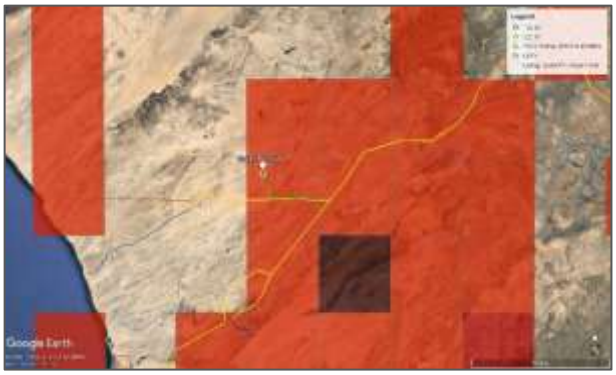
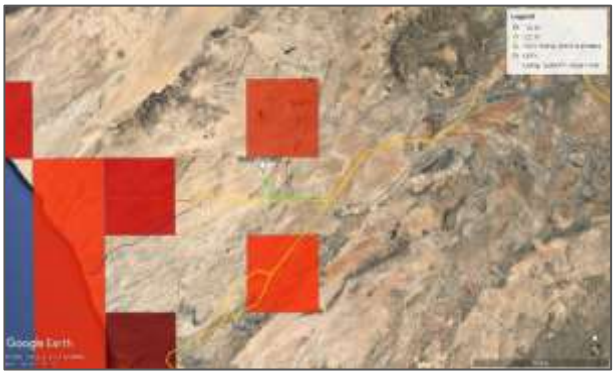


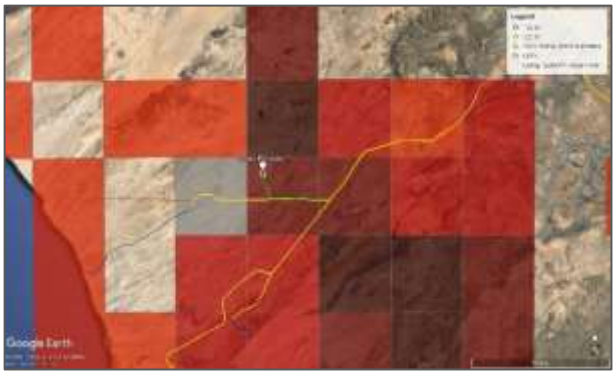
Figure 6-13:Relative occurrence of power line-sensitive Red Data species (6-8 species) and power lines in the greater study area (based on SABAP1 data; range of sensitivity from low [light] to high [dark]; EIS 2023).



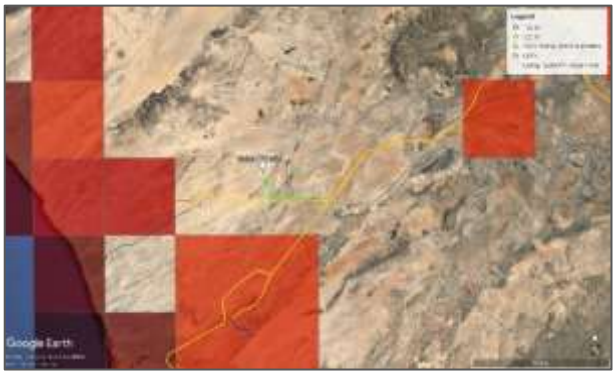
a. Ludwig's Bustard.



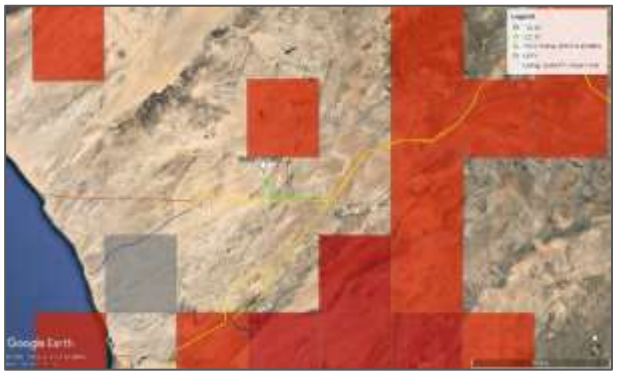
b. Lesser Flamingo and Greater Flamingo (combined).



c. Rüppell's Korhaan.



d. Great White Pelican.



e. Lappet-faced Vulture.

Figure 6-14: SABAP1 reporting rates in the greater study area for selected bird species, as indicated, also showing power lines (EIS 2023).

6.6.4.2 Bird and power line incidents on record for Namibia

The NamPower/Namibia Nature Foundation (NNF) Strategic Partnership (http://www.nnf.org.na/project/nampowernnf-partnership/13/5/5.html) has documented wildlife and power line incidents from 2009 to the end of 2020, involving around 850 individuals (EIS 2023). Due to the difficulty of obtaining records in bush-encroached areas (especially in the northern and north-eastern parts of the country), low reporting rates and the high scavenging rates in general, it is likely that the incidents observed are an underestimate. Most of the incidents recorded throughout the country have involved flamingos (39%) and bustards/ korhaans (27%; Figure 6-15). A further 11% have involved other waterbirds, while 10% have involved raptors, mainly vultures as well as eagles, snake-eagles and owls. Most of the incidents (90%) have taken the form of collisions (761 individuals); however, electrocution (10%) is also an ongoing concern.

Localities of recorded power line incidents in the Erongo Region, including the greater study area, are shown in Figure 6-17. Examples of power line collision incidents recorded in this area to date (involving Ludwig's Bustard, Rüppell's Korhaan, Greater Flamingo and Lesser Flamingo, and Great White Pelican) are shown in Figure 6-18 (NamPower/NNF Strategic Partnership database, EIS 2023).

For a section of power line in the present greater study area that has been monitored from 2009-2020, namely on the combined 220 kV Khan-Trekkopje and 66 kV Khan-Hentiesbaai lines (in the area known as the Trekkopje Bypass), a total of 137 km surveyed yielded 11 bustard/korhaan collision fatalities, and 23 flamingos (i.e., a mean of *0.26 fatalities per km* surveyed; NamPower/ Namibia Nature Foundation Strategic Partnership database). With the inclusion of the 132 kV Trekkopje-Wlotzka power line, the overall total of 1,345 km surveyed further yielded 46 bustards/ korhaans and 16 flamingos (a mean of 0.05 fatalities per km); however, the latter section could be surveyed only from the adjacent road. Apart from a section of the 132 kV Kuiseb-Walvis Bay line (mean 2.16-2.70 collisions/km surveyed), the above collision rates are amongst the highest on record for Namibia. The above data have not been corrected for bias (observer bias or scavenger bias), which would render higher percentages.

High mobility of bird species, e.g., among ephemeral food sources, may render them more prone to power line interactions. Ludwig's Bustards are nomadic and move in search of feeding opportunities. Together with Rüppell's Korhaan, they appear to use ephemeral water course habitats for feeding and shelter.

Flamingos are particularly prone to collisions due to their habit of flying at night or under conditions of poor light, in groups and at speed. Apart from movements up and down the coast, collision records on power lines indicate that flamingos appear to use rivers and drainage lines as flightpaths at times, e.g., on routes inland to the north-east, to Etosha National Park. It is possible that waterbirds such as flamingos may mistake large solar arrays for waterbodies in poor light and try to land on such surfaces (see discussion on impacts below). Several multiple (group) collisions of at least 5-6 flamingos are on record for the coastal area, as well as one larger incident involving 29 Lesser Flamingos.

Note that sections of some of the existing transmission lines in the area have already been fitted with markers in order to increase visibility to birds, as a mitigation for avoiding collisions. This includes a section of the 66 kV line at the Trekkopje Bypass has recently been marked with "Raptor Clamp Diverters" (see Section Mitigation below) in 2020 (C Klein pers. comm. 2020).

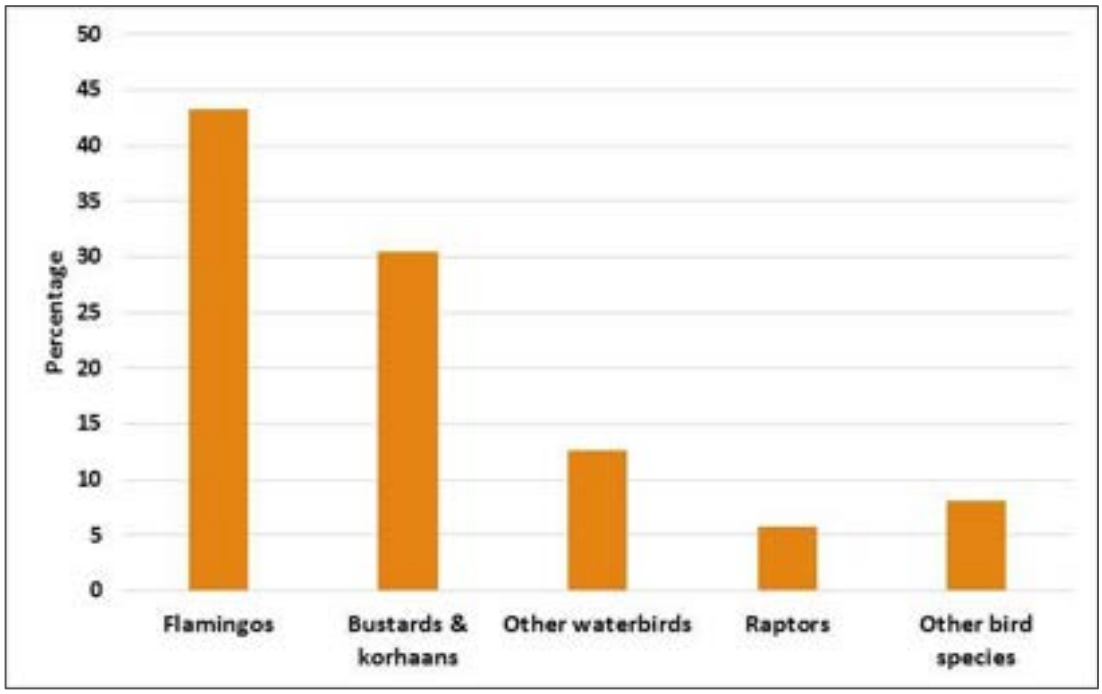


Figure 6-15: Percentages of groups of birds involved in power line collision incidents in Namibia, 2009 - 2020 (n = 761 individuals; NamPower/NNF Strategic Partnership data 2020; EIS 2023).

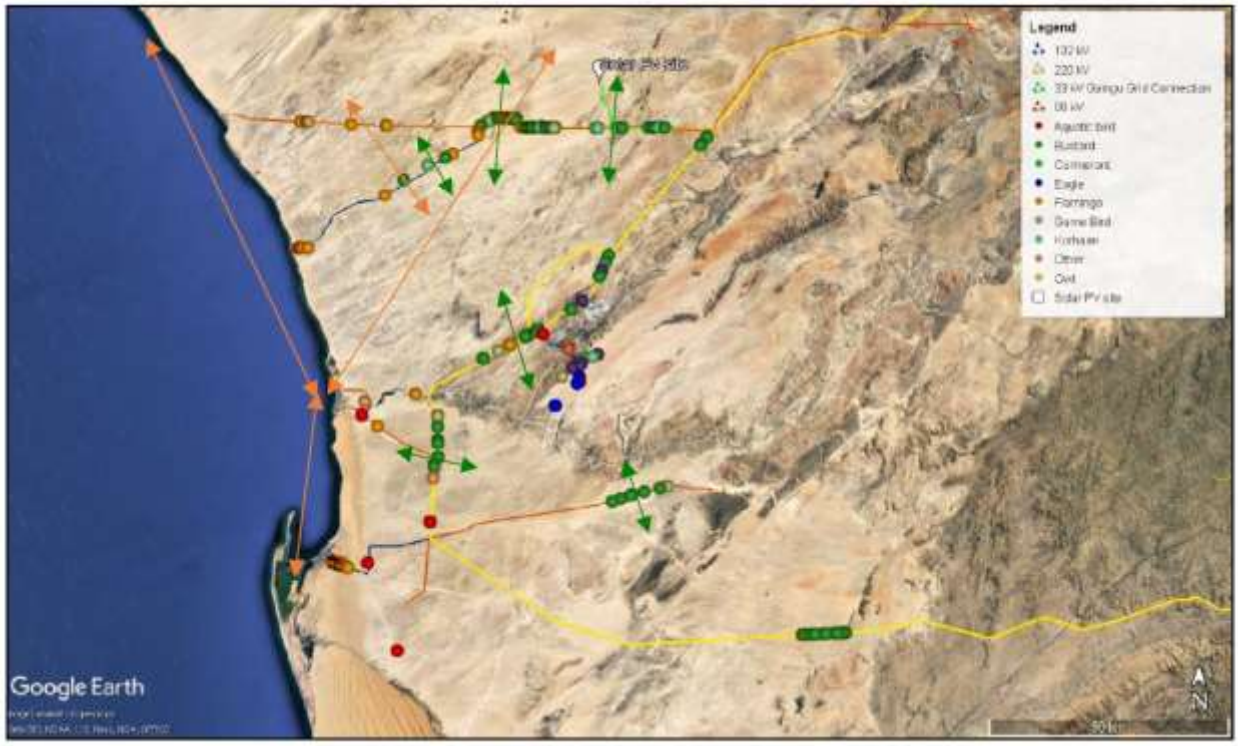


Figure 6-16: Power line incidents recorded within the Erongo Region, 2009-2020 (NamPower/NNF Strategic Partnership data; EIS 2023). Examples of bustard (and korhaan) flightpath areas (confirmed by power line collisions) are indicated by green arrows (note the variable directions of these paths); similarly, flamingo flightpaths are indicated by orange arrows (those along the coast have been confirmed by satellite tracking).

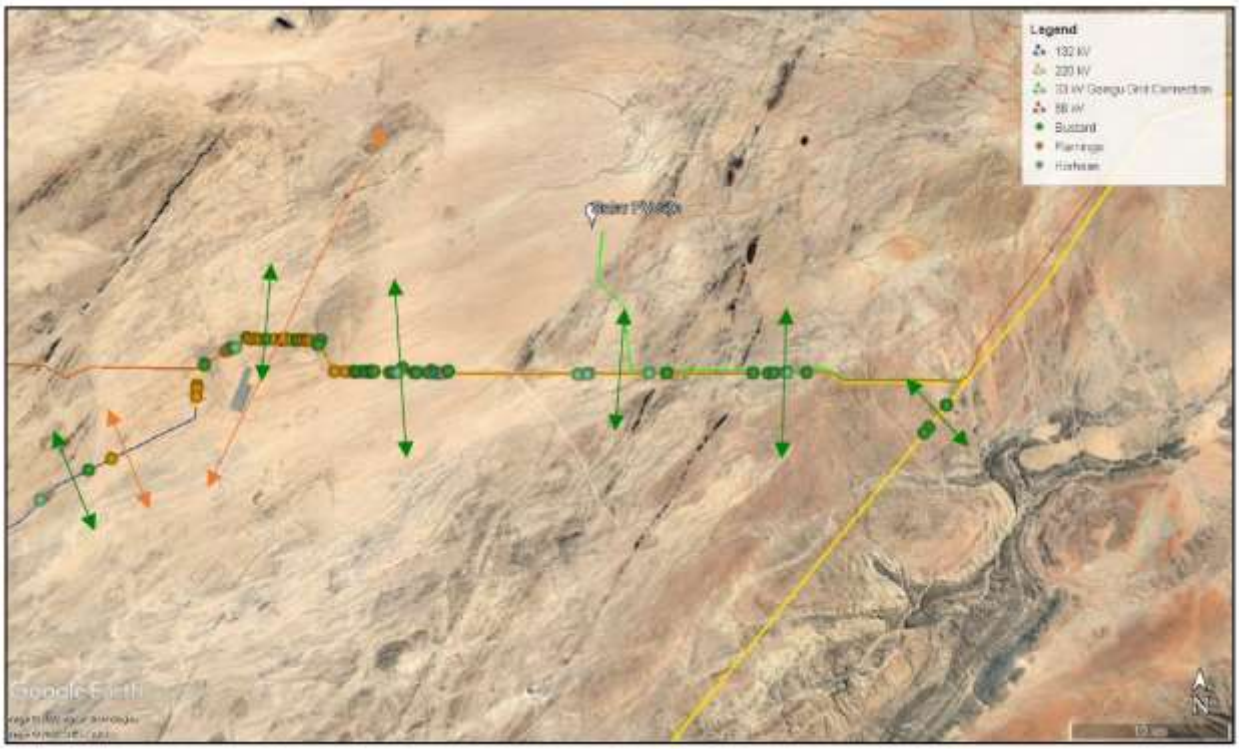


Figure 6-17: Detail of power line collision incidents recorded in the vicinity of the solar PV plant site area, 2009-2020 (NamPower/NNF confirmed by power line collisions) are indicated by green arrows; similarly, flamingo flightpaths are indicated by orange arrows. Strategic Partnership data; EIS 2023). Examples of bustard (and korhaan) flightpath areas

Figure 6-18: Examples of power line collision incidents recorded in the study area: Ludwig's Bustard (top left) and Ruppell's Korhaan (top right) on the 220 kV/66 kV lines south of the solar PV plant site; Greater Flamingo on a wooden five-pole structure (centre left) and on a distribution line on the Swakop River (centre right); flamingo bones from a multiple collision on a wooden five-pole structure in parallel with a steel lattice tower structure south-west of the solar PV plant site (bottom left); and Great White Pelican on a steel monopole structure (below right; NamPower/NNF Strategic Partnership data; EIS 2023).

6.6.5 Potential flight paths/flyways

Bird flight paths and flyways are likely to vary, depending on current environmental conditions, and are not always easily predicted. Aquatic habitats may become important at different times, especially if and when these systems hold water. However, existing data for recorded power line incidents (see above; Figure 6-16 to Figure 6-18) do provide some indication of bird flight paths that intersect power line servitudes in the area, including for Ludwig's Bustard and Greater Flamingo and Lesser Flamingo; however, it is likely that these are not the only routes used.

6.6.5.1 Vultures

Lappet-faced Vultures have been tracked in Namibia by Vultures Namibia and the MEFT over the past four years (since 2018; see Kolberg 2022, and preceding issues of Lanioturdus). The results for 33 tracked individuals indicate some movement over the study area, although this area falls closer to the periphery of a main core area of regular vulture activity, e.g., to the south/central part of the country (Figure 6-19; www.movebank.org). It is likely that such recorded flights over the study area are made infrequently, dependent on changing environmental conditions and food supply.

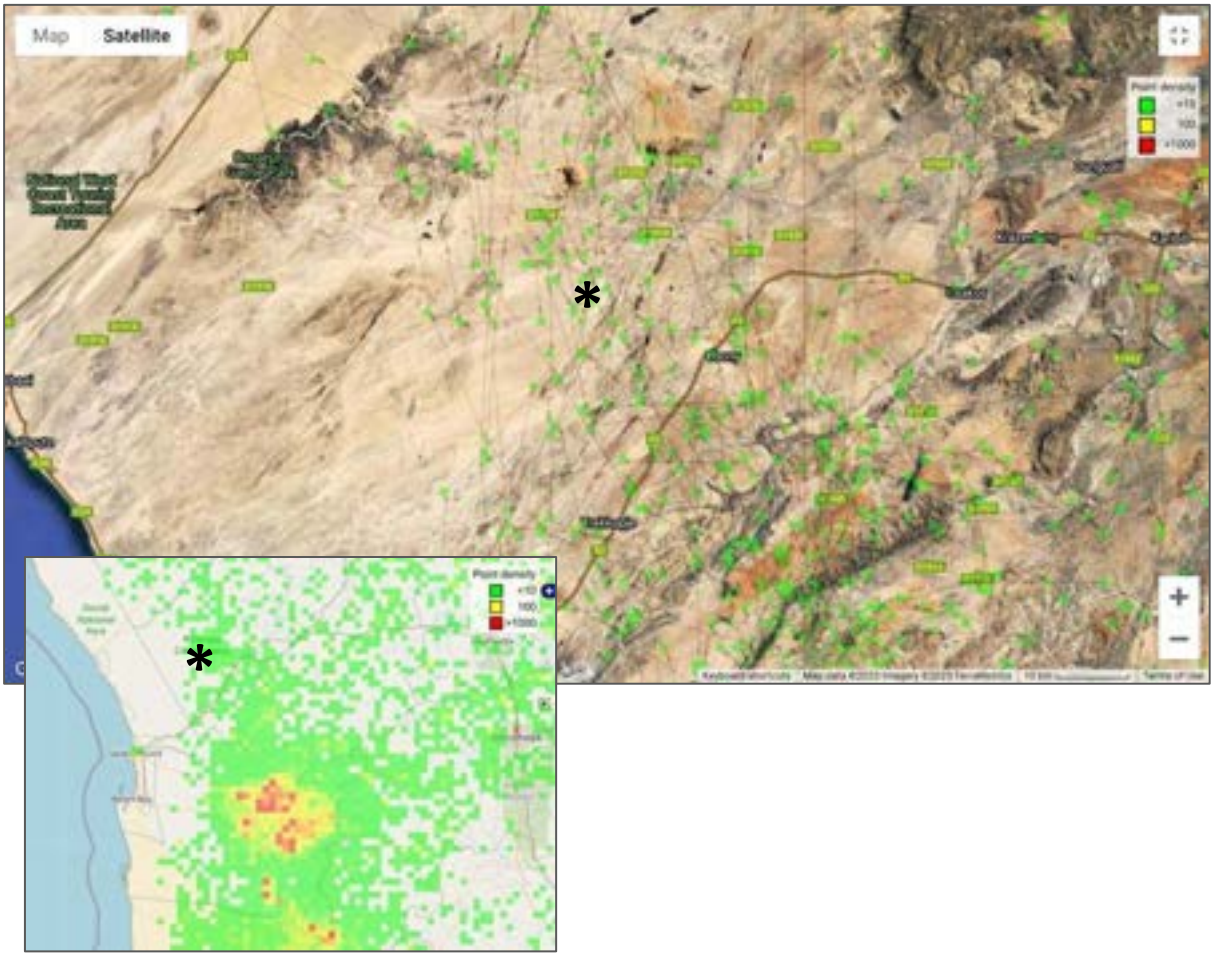


Figure 6-19: Results of satellite tracking of 33 Lappet-faced Vultures show some movement over the solar PV study area* (green dots = satellite fixes; grey lines = direct routes between fixes); inset shows a core breeding area within the Namib-Naukluft Park (yellow/red dots; data: Vultures Namibia and the Ministry of Environment, Forestry and Tourism; www.movebank.org; Kolberg 2022; 28 February 2023).

6.6.5.2 Flamingos

Species such as Greater Flamingo and Lesser Flamingo are known to move up and down the coast regularly, among the coastal habitats. They also move inland periodically, after good rains, in order to breed in Botswana and, occasionally, in Etosha National Park. The details of their flight paths on such migratory routes within Namibia have not yet been confirmed. However, the flyways of Greater and Lesser Flamingo on longer migratory routes between Botswana and elsewhere in southern Africa have been confirmed by satellite tracking, with some movements to Namibia, including for one Greater Flamingo from Etosha National Park to the Namibian coast (G McCullogh *et al.* 2003). For Lesser Flamingo, regular movements have similarly been recorded between South Africa and Botswana, as well as more limited movements to Etosha National Park in the west (but not yet to the Namibian coast) and to Mozambique and Madagascar in the east (Pretorius *et al.* 2020).

The results of (limited) GPS satellite tracking of one Lesser Flamingo and four Greater Flamingo from Mile 4 Saltworks in 2013-2015 indicate regular movements between these saltworks and Cape Cross to the north (100 km), and to the Walvis Bay wetlands in the south (45 km; Figure 6-20; NamPower/ NNF Strategic Partnership database).

The clustering of recorded power line collision incidents of flamingos on the power lines south of the solar PV plant area furthermore believed to indicate bird movement corridors that may be of both local and regional importance.

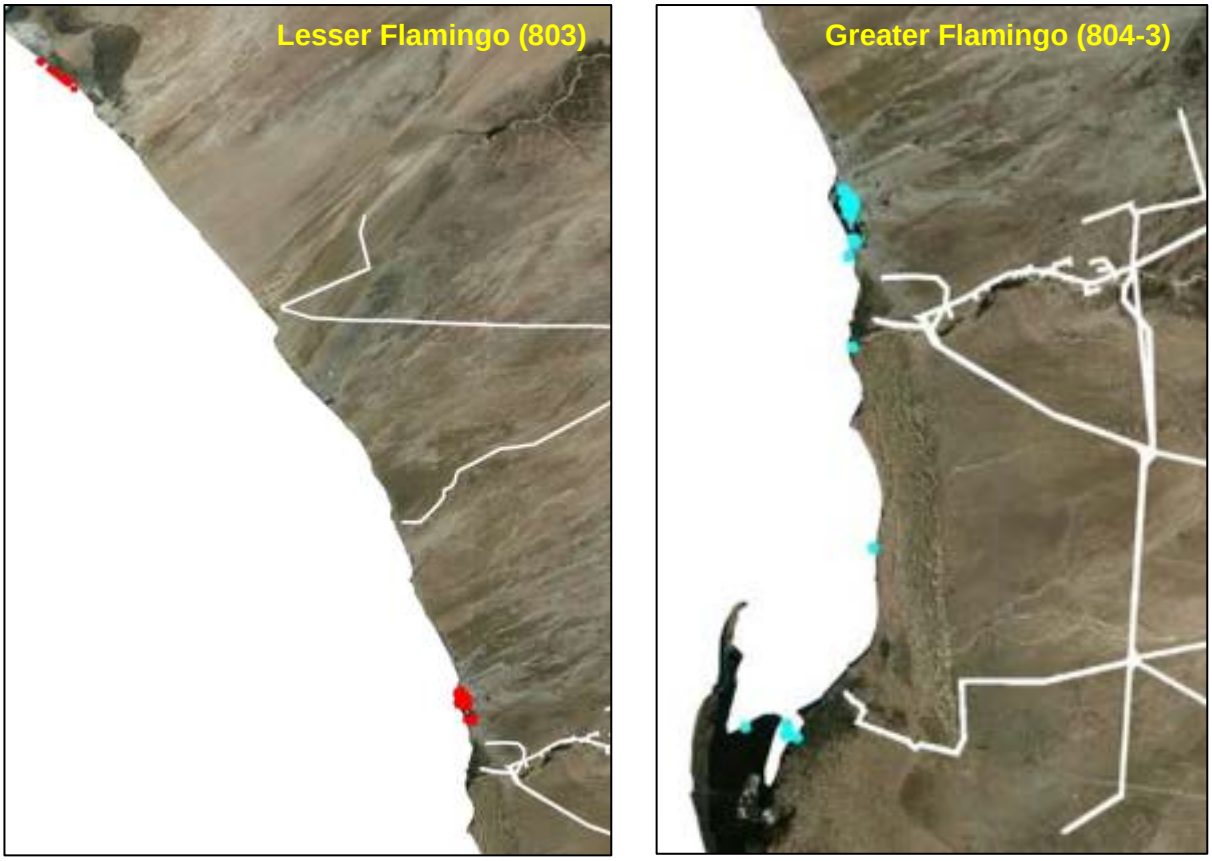


Figure 6-20: GPS satellite tracking data of one Lesser Flamingo (left) and one Greater Flamingo (right) from Mile 4 Saltworks in 2013-2015.

6.6.6 Priority Bird Species

Risk assessment and mitigation efforts are directed towards priority bird species, defined as species that have a high biological significance, i.e., primarily Red Data species (including those with migrant status) and/or species endemic or near endemic to Namibia. However, non-priority species may also be affected by impacts.

Twenty-three (23) potential priority species were initially identified, narrowed down to 14 species on the basis of observed abundance in the study area (Table 6-1). Six examples of non-priority species with the potential to cause impacts on infrastructure are also indicated in Table 6-1.

The 14 priority species for the inland section may be divided into the following groups (species confirmed in 2023 indicated with an asterisk*):

- Six Red Data species (four of which are also Globally Threatened)
  - Three terrestrial species
    - *Ludwig's Bustard (Endangered, Globally Endangered; partial migrant);
    - *Martial Eagle (Endangered, Globally Endangered); and
    - *Lappet-faced Vulture (Endangered, Globally Endangered).
  - Three aquatic species (non-resident)
    - Lesser Flamingo (Vulnerable; Globally Near Threatened; nomadic, [partial] intra-African migrant);
    - Greater Flamingo (Vulnerable; nomadic, [partial] intra-African migrant); and
    - Great White Pelican (Vulnerable; sedentary, nomadic).
- Two species near endemic to Namibia (90% of population)
  - *Rüppell's Korhaan (sedentary); and
  - *Gray's Lark (sedentary/nomadic).
- Two other (non-Red Data) migrant species
  - *Namaqua Sandgrouse (nomadic, partial migrant); and
  - Yellow-billed Kite (intra-African migrant, raptor).
- Four other (raptor) species with the potential to be impacted by the project
  - *Black-chested Snake Eagle;
  - *Pale Chanting Goshawk; and
  - *Rock Kestrel / *Greater Kestrel.

Several other (non-priority) bird species have the potential to impact on infrastructure, including on solar PV and power line structures, through their perching, nesting and other activities. These species are indicated in Table 6-1. Examples are:

- Tractrac Chat;
- Pied Crow; and
- Speckled (Rock) Pigeon.

Sighting localities for priority larger terrestrial bird species in the solar PV plant and power line area, based on site visits and pre-construction monitoring results (and including power line incidents 2009-2020; but excluding #Gaingu Conservancy Game Count data, May 2023) are shown below (Figure 6-21), and similarly for raptor species (Figure 6-22).

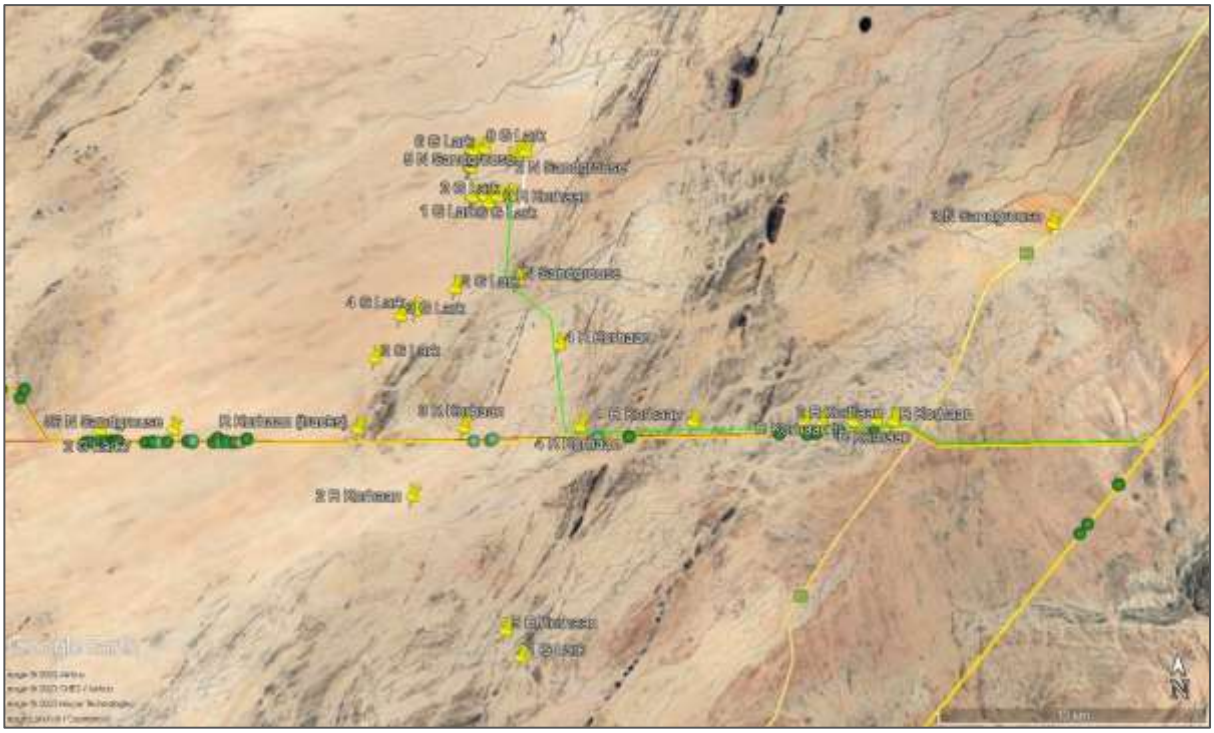


Figure 6-21: Sighting localities for priority larger terrestrial bird species in the solar PV plant and power line area; including power line incidents 2009-2020 (dark green dots = bustard collisions; light green dots = korhaan collisions) but excluding ≠Gaingu Conservancy Game Count data, May 2023 (based on a Google Earth image).

Figure 6-22: Sighting localities for priority raptor species in the solar PV plant and power line area; including power line incidents recorded in the area 2009-2020 (based on a Google Earth image).

Table 6-1: Checklist of priority bird species for the proposed Gaingu PV Plant and associated infrastructure

Common group	Common species	Cons status	Residency/ other sensitivities	Hab	SABAP1		SABAP2 (2205_1510)		Additional records	Impact	Prob
					2215 AA	2215 AB	Ad hoc (RR%)	Latest record (Ad hoc)			
A. Red Data/Namibian near-endemic/other migrant species with the potential to be impacted by the project (10)											
Red Data species (6)											
Bustard	Ludwig's	EN, G EN	Nom	T					2020; 13 on Gaingu Conservancy Game Count May 2023 PL – C 2020	PL – C	M-H
Eagle	Martial	EN, G EN	Res, raptor	T	√		0.9	2015	Pers obs 2023 Nest 2015 old nest 2023 PL – C, E 2020	D PL – C, E	M
Vulture	Lappet-faced	EN, G EN	Res, juv movements, raptor	T			0.9	2013	Pers obs 2023 Nest 2013 PL – C, E Satellite tracking (recent)	PL C, E	M
Flamingo	Lesser	VU, G NT	Nom, intra-Afr mig	A					PL – C 2020	PL – C SP – C	L-M
Flamingo	Greater	VU	Nom, (par) intra-Afr mig	A					PL – C 2020	PL – C SP – C	L-M
Pelican	Great White	VU	Sed, nom	A					PL – C 2020	PL – C SP – C?	L-M
Namibian near-endemic species (2)											

Common group	Common species	Cons status	Residency/ other sensitivities	Hab	SABAP1		SABAP2 (2205_1510)		Additional records	Impact	Prob
					2215 AA	2215 AB	Ad hoc (RR%)	Latest record (Ad hoc)			
Korhaan	Rüppell's	NamNE 90%	Sed	T	√	√	7.1	2020	Pers obs 2023 20 on Gaingu Conservancy Game Count May 2023 PL – C 2020	D, N PL – C	H
Lark	Gray's	NamNE 90%	Sed, nom	T	√				Pers obs 2023 – locally common	D	M
Other migrant species (2)											
Sandgrouse	Namaqua		Nom, partial mig	T	√		0.9	2022	Pers obs 2023 PL – C 2020	PL – C	H
Kite	Yellow-billed		Intra-Afr mig, raptor	T			0.9	2020		PL – C	L-M
B. Other species with the potential to be impacted by the project (4)											
Goshawk	Pale Chanting		Raptor	T	√	√	21.4	2016	Pers obs 2023 PL – E 2020	PL – E	M-H
Kestrel	Rock		Raptor	T	√	√	11.6	2017	Pers obs 2023	PL – E	M
Kestrel	Greater		Raptor	T					Pers obs 2023	PL – E	?
Eagle	Black-chested Snake		Raptor	T		√			Pers obs 2023 PL – C 2020	PL – C, E	L-M
C. Other (non-priority) species with the potential to cause impacts on infrastructure (examples [3])											
Chat	Tractrac			T	√	√	4.5	2022	Pers obs 2023	N	M-H
Crow	Pied		Res	T	√		6.3	2022	Pers obs 2023 PL – N 2016	N	M-H

Common group	Common species	Cons status	Residency/ other sensitivities	Hab	SABAP1		SABAP2 (2205_1510)		Additional records	Impact	Prob
					2215 AA	2215 AB	Ad hoc (RR%)	Latest record (Ad hoc)			
Pigeon	Speckled (Rock)			T	√	√	2.7	2018		N	M-H

KEY:

*Common and scientific names according to SABAP2 website (http://sabap2.adu.org.za); also see Roberts Bird Guide 2016 (Chittenden *et al.* 2016)

PRIORITY STATUS (provisional first-screened priority species indicated in red; see Appendix 1 of specialists' report for scientific names)

- **Conservation status**
  - **Red Data status** (Simmons *et al.* 2015, Brown *et al.* 2017; red): CR = Critically Endangered, EN = Endangered, VU = Vulnerable, NT = Near Threatened, LC = Least Concern/Secure; G = global status; rare = now rare in Namibia
  - **End = Endemism** (Simmons *et al.* 2015, Brown *et al.* 2017; green): NE = near endemic; Nam = Namibia (≥90% of population in Namibia); s Afr = southern Africa; B = breeding
- **Residency**: R = resident, N = nomadic, M = migrant (blue), V = vagrant, Ra = rare, par = partial; migrant species: pal = Palearctic, intra-Afr = intra-African

Hab. = Habitat: M = purely/predominantly marine; A = aquatic (freshwater/marine/coastal waterbodies); T = terrestrial

BIRD ATLAS DATA (see Figure 2 of specialists' report)

- **SABAP1:** Southern African Bird Atlas Project 1 data that was published as Harrison *et al.* (1997), available on EIS 2021 (QDS 2214AD)
- **SABAP2:** Southern African Bird Atlas Project 2 data, available on http://sabap2.adu.org.za; (see Figure 9 of specialists' report) (presence or absence; pentad 2220-1425; 2225_1425; 2215_1425)
- **Latest record:** SABAP2 (RR[%] = reporting rate as %; full protocol or *ad hoc*)
- **Additional records:** power line incidents in greater area (2009-2020); personal observation 2023

PROB

- Probability of (priority) species occurring in study area (based on observed local abundance): H = high, M = moderate, L = low, I = improbable

IMPACT

- Provisional screening of potential impacts: D = disturbance (including road mortalities); H = habitat impacts; N = attraction to novel habitats; E = electrocutions on power line infrastructure; C = collisions on infrastructure (power lines, solar panels)

6.7 TERRESTRIAL ECOLOGY

6.7.1 Landscape description

On a global scale, the project site falls in the Afrotropical Region for all vertebrate taxa (Proches & Ramdhani, 2012) and on the regional scale, on the western edge of the Nama Karoo biome where it starts to transition into the Namib Desert biome. The landscape can be described as Central-western Plains with vegetation type Western-central Escarpment and Inselbergs, dominated by Varied Shrubland and Grassland (Mendelssohn, Jarvis, Roberts, & Robertson, 2002) (ACACIA, 2011).

6.7.2 Habitat description

The #Gaingu PV Power plant will be located on wide, very gently undulating plains that drain from northeast to southwest via many small washes and one larger drainage (dark blue in Figure 6-23). The washes and drainage, characteristic of hyper-arid and marginal zones, support a much higher biodiversity than the surrounding plains, supporting woody species such as shrubs and forbs, as well as the odd small tree. Many endemic and protected species grow in the large drainage, and the larger woody species are an important source of food and shelter for animals. Drainages and washes are also a source of recolonisation for surrounding disturbed areas.

The substrate of the plains consists of a gravel surface and very fine soil beneath, rendering the landscape prone to scarring by vehicle tracks. There is a thin cover of grass and sparsely distributed shrubs and bushes. It is expected that the plains would be covered in grass after rare rainfall events, alternating with successive years without plant cover.

A margin of at least 50 m from the drainage should be kept free of infrastructure, and water flow in all washes should be unimpeded. Water flow underneath the PV array should be managed to avoid erosion and the dumping of soil into the washes and drainage.

A 33 kV circuit (grey line in Figure 6-23) will connect the PV plant with the New Khan substation, approximately 35 km away. The power line corridor is dominated by two main habitat types: plains, and a swarm of dolerite ridges across which the corridor runs transversely. The dolerite ridges are visible as black lines and smudges in Figure 5-1.

The dolerite ridges are characterised by diverse assemblages of protected plants such as *Hoodia currori, Aloe namibensis, Adenia pechuelii*, *Lithops rushciorum* and several *Commiphora species*, all of them endemic or near endemic and at risk from poaching and habitat destruction. Another endemic species, Hoesch's Pygmy Toad, is highly likely to occur in the ridges and rocky outcrops where they breed in ephemeral rock pools.

Similar to vegetated drainages, the ridges represent a habitat of rich biodiversity providing crucial ecological services in an arid area, especially to vertebrate taxa. Pockets of plant diversity occur in the cracks between rocks where water, nutrients and wind-blown sand get trapped. These pockets of plant material provide sustenance for detritivores and invertebrates, and for the vertebrates that feed on them. The rocks and boulders provide habitat for rock-specialist reptiles, bats and rodents.

There is light lichen cover on top of the ridges, and a sparse biological soil crust. The substrate of the ridges is susceptible to wind erosion, and driving and tracks can form erosion trenches and excessive dust. Dust that covers plants may interfere with photosynthesis. New tracks should be kept to a minimum, and all vehicle and human movements should be strictly confined to existing tracks. Some construction impacts may be mitigated by putting access roads around instead of across the ridges.

The plains are considered Least Sensitive, the drainage and large wash are Sensitive, and the ridges are classified as Highly Sensitive.

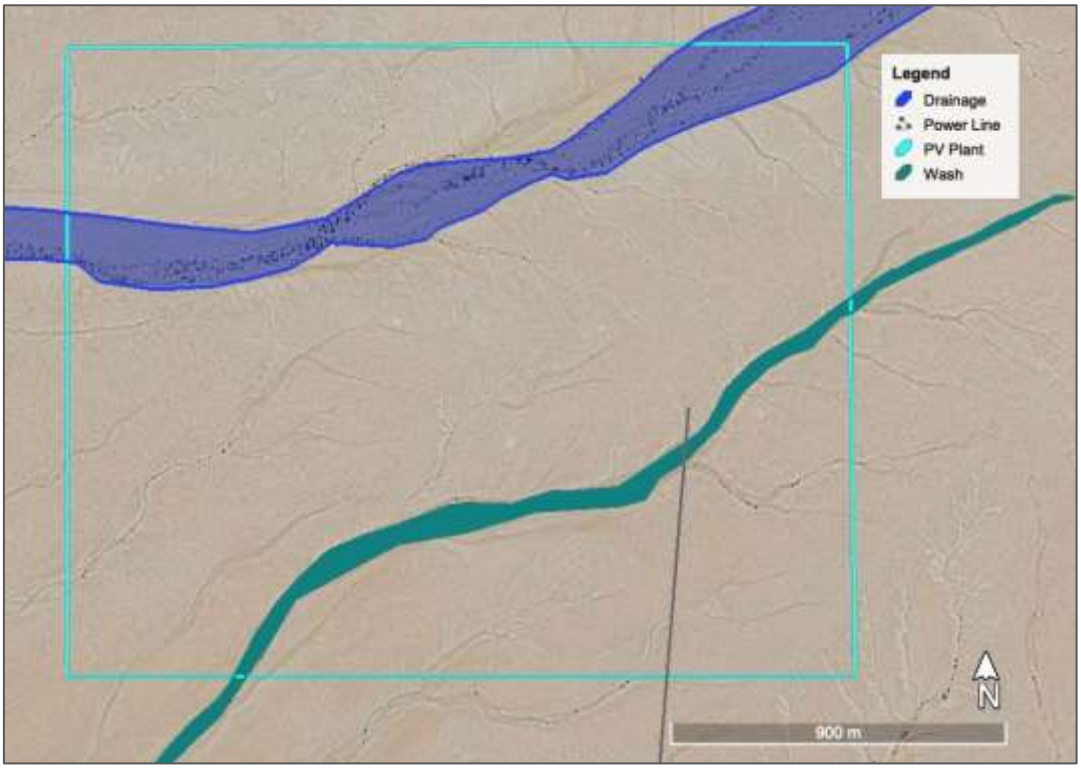


Figure 6-23: Drainage on the project site

6.7.3 Species

6.7.3.1 Mammals

The northwest escarpment area, which includes the project site, has a high mammal diversity according to Cunningham, 2006, who lists 52 species. For this report, 41 species are considered likely to utilise the habitats that occur in the study area (Appendix E). Of these, 7 are endemic but not one of them is legally protected in Namibia: Angola hairy Bat, Namib Long-eared Bat, Namib round-eared Elephant Shrew, Setzer's hairy-footed Gerbil, Brush-tailed hairy-footed Gerbil, Pygmy Rock Mouse and Dassie Rat.

Bats and rodents represent more than 50% of the mammals expected to occur in the area (22 species), and both are under studied taxa. Important habitats for these two taxa include the drainage and washes with their associated vegetation, and the ridges along the proposed power line.

The Brown Hyaena is considered Near Threatened by the IUCN and in Namibia. The Leopard is considered Vulnerable in Namibia, Near Threatened by the IUCN and is listed on Convention on International Trade in Endangered Species (CITES) 1. The Cape Fox and Aardwolf are Protected Game according to the Nature Conservation Ordinance, 1975 (No. 4 of 1975) (NCO), and the Hartmann's Zebra is Protected Game and also listed on CITES 2. The Caracal is listed on CITES 2, bringing the total of protected mammal species occurring within the study area to 6.

The large footprint of the PV plant is of particular concern for the Brown Hyaena since it may disrupt their foraging behaviour by presenting a barrier to their movement across the landscape.

Members of the #Gaingu Conservancy say that Black-backed Jackal, Springbok, Porcupine and Caracal are regularly seen in the study area. Steenbok and Oryx are seen very seldom, and Mountain Zebra has not been seen there in the past three years, which they ascribe to a few bad rainfall seasons.

6.7.3.2 Reptiles

Becker (2021) lists 285 species of reptile occurring in Namibia, 68 of which are endemic. In the Namibian context the study area falls in an area with the second highest ranking of endemicity (21 – 24 species) and in a medium ranking for reptile diversity with 41-60 species (Mendelssohn, Jarvis, Roberts, & Robertson, 2002). This study deems 39 species likely to be found in the study area and 20 of these are endemic, a very high rate of 50% endemism.

Important habitat niches for reptiles include the sandy substrate and vegetation of the washes and drainage, as well as the rocky ridges where there is shade at some times of the day, ample shelter in crevices and vegetation, and more food resources than on the surrounding plains.

The national and international assessment of this taxon in Namibia has not been updated comprehensively in almost 20 years and it is likely that the situation, specifically regarding threatened species, has changed significantly.

6.7.3.3 Amphibians

Approximately 64 species of frog are expected to occur in Namibia (Becker, 2021). This relatively low number (118 have been recorded in South Africa) is due to the marginal habitat in much of the country and also to this taxon being under-collected. There is no permanent surface water in the study area, restricting species richness since most amphibians require water bodies for breeding.

Ephemeral rock pools may occur in the ridges and koppies after rainfall events, possibly supporting 6 species of frog whose distribution ranges overlap with the study area. Hoesch's Pygmy Toad is endemic to Namibia and highly likely to occur in the rock outcrops along the proposed power line, where it breeds in sandy-bottomed temporary pools for only a few nights after heavy rains.

6.7.3.4 Terrestrial vegetation

A total of 281 plant species have been recorded in the study area (Appendix V of Potgieter, 2023), with 57 endemics, 26 listed as Least Concern by the IUCN and one as Near Threatened (*Gossypium anomalum),* and 16 protected by the Forestry Act or NCO.

Of particular conservation concern are all Lithops species, *Commiphora* species and *Adenia pechuelii*, all of them threatened in Namibia by habitat destruction and poaching. Relocation may be a viable measure for some plants, e.g. successful relocation of *Adenia pechuelii* has been reported (Kolberg, 2014).

The plains where the PV plant will be constructed are dominated by grasses (*Eragrostis nindensis* and *Stipagrostis spp*) and herbs, including *Monechma genistifolium, Zygophyllum cylindrifolium*, *Cleome angustifolia diandra, Limeum argute-carinatum, Blepharis grossa* and *Hermannia solaniflora*, all endemic or near-endemic, although none of high conservation concern. The endemic *Hermannia complicata* and *Forsskaeolea hereroenseis* were observed near the washes. Succulents include the endemic *Lithops ruschiorum*, a protected species.

Along the drainage can be found *Boscia foetida, Vachellia reficiens,*the protected *Euclea Pseudebenus* and *Vachellia erioloba*, as well as endemic *Arthraerua leubnitziae Zygophyllum stapfii*, *Commiphora saxicola*, *Commiphora dinteri* and *Blepharis gigantea*.

The rocky ridges are characterised by the endemic *Aloe namibensis, Commiphora saxicola, Commiphora virgata, Psilocaulon salicornioides* and *Hermannia complicata*. The near-endemic *Adenolobus pechuelii* may also be found here. During construction of the power line, these species are at high risk. Commiphoras are slow-growing, and it is unlikely that damage to them can be restored in any meaningful way, necessitating careful planning and demarcation of access to the proposed route of the power line.

6.8 HERITAGE (INCLUDING ARCHAEOLOGY, LANDSCAPE SETTING & PALAENTOLOGY)

6.8.1 Archaeological heritage

6.8.1.1 Stone Age

The broad sequence of the Stone Age includes the Later Stone Age (LSA), the Middle Stone Age (MSA) and the Earlier Stone Age (ESA). Each of these phases contains sub-phases or industrial complexes, and within these we can expect regional variation regarding characteristics and time ranges. For Cultural Resource Management (CRM) purposes it is often only expected/ possible to identify the presence of the three main phases. Yet sometimes the recognition of cultural groups, affinities, or trends in technology and/or subsistence practices, as represented by the sub-phases or industrial complexes, is achievable. The three main phases can be divided as follows.

- LSA: associated with Khoi and San societies and their immediate predecessors. - Recently to ~30 thousand years ago.
- MSA: associated with Homo sapiens and archaic modern human - 30-300 thousand years ago.
- ESA: associated with early Homo groups such as Homo habilis and Homo erectus. - 400 thousand -> 2 million years ago.

The earliest dated evidence of early human occupation was dated to 800 000 years Before Present within the Namib Desert with periods of occupation based on climatic conditions with occupation hiatuses being common (Kinahan, 2021). Human occupation shows favouring of water sources and

the amount of occupation sites are lower nearer to the coastline. Scattered stone tools of Oldowan and Acheulean technologies have been found in small quantities signifying movement of early humans.

In Namibia, blades and points of the MSA have been found but retouching of tools is rare within the MSA assemblages of Namibia (Kinahan, 2011). Fine grained quartzite and silcrete and chert were common materials used to create these MSA tools with evidence of tools being transported far distances as an indication of human movement. Multiple MSA sites have been excavated by the Erongo Mountains and have yielded an abundance of MSA material including quartz cores, pointed flakes, and scarce amounts of blades (Schmidt, 2011).

ESA and MSA finds within the Erongo region are marked mainly by surface scatters on the Namib gravel plains, granite outcrops and dolerite ridges (Kinahan, 2009). Many of these sites and artefacts have been disturbed through off-road traffic, as well as movement of drill-rigs (Kinahan, 2009). LSA communities of hunter-gatherers on the landscape are of those of San and Khoekhoe groups with the first emergence of pottery and specialised strategies for hunting and food gathering.

The Brandberg Mountain area is a declared archaeological monument within the Erongo Region (Govt. Notice 286, 1/8/1951; Gazette No. 1603, 1/8/1951). The famous Maack rock art, also often referred to as White Lady is also found in the Tsisab Ravine within the Brandberg. Pager (1980) spent extensive time documenting over 500 rock painting sites and nearly 30 000 rock painting figures. His research led him to estimate that the Brandberg Mountain is home to closer to 1 000 rock art sites. Rock art sites are generally separate in that rock paintings and rock engravings do not occur together in many sites within the region (Sandelowsky, 1983).

Namibia is home to an expansive record of rock art sites with new sites constantly being identified. Many rock art sites date back to around 30 000 years Before Present. 80% of rock paintings within Namibia are of human figures or human–like figures, with the other 20% accounting for animals such as giraffes, springbuck, eland, kudu, and oryx as well as mythical animals (Kinahan, 2011: 28, Sandelowsky, 1983). These figures chosen for rock paintings held ritual meaning for the San whereby ritual healers would take on a supernatural power of said animal for a period of time. In comparison, rock engravings differ in that human figures are rare, and birds and shapes are more commonly engraved than painted. Exceptions to this have been found in other regions more south in Namibia. These birds are also often depicted to be in stride and are adorned with decorations bearing similarities to body decorations used during trace dance.

A common practice amongst hunter-gatherers of Namibia is that of seed collection through caches from harvester ant nests. Seeds are collected and cleaned then stored in bag shaped jars which are known for this purpose. Seeds are then processed by grinding them down using granite outcrops which were used as grinding surfaces (Kinahan, 2021). These outcrops were also generally found along with cavities which would naturally collect rainwater. Signs of seed collecting and processing are often found in conjunction as a site with multiple seed caches and grinding surfaces. Ethnographic studies have found that seed collecting and processing has been ascribed as a female role within the community (Kinahan, 2011).

The Hunter-gatherers of Namibia largely employed the use of hunting blinds as a method of animal hunting. The blinds consist of stones packed in small circles which would be strategically placed in order to capture animals in search of water sources or grazing lands (Kinahan, 2006). These hunting blinds are often well preserved and have been found scattered all across the landscape. One side of the packed stones would be higher than another side and often no other artefacts are found in association with these hunting blinds, which differentiates remains of hunting blinds to that of hut remains.

There are three other archaeological heritage sites in the Erongo Region that are proclaimed National Monuments dating to this period: Philipp Cave, Ameib (Govt. Notice 119, 6/2/1951; Gazette No. 1575, 1/2/1951); Paula Cave, Omandumba West (Govt. Notice 165, 1/3/1951; Gazette No. 1581, 1/3/1951); Bushman Paradise, Spitzkoppe (Govt.Notice 159, 1/7/1954; Gazette No. 1844, 1/7/1954).

6.8.1.2 Iron Age/ Farming Communities

Bantu-speaking people moved into Eastern and Southern Africa about 2 000 years ago (Mitchell, 2002). These people cultivated sorghum and millets, herded cattle and small stock and manufactured iron tools and copper ornaments. Because metalworking represents a new technology, archaeologists call this period the Iron Age. Characteristic ceramic styles help archaeologists to separate the sites into different groups and time periods. The Iron Age as a whole represents the spread of Bantu speaking people and includes both the Pre-Historic and Historic periods. It can be divided into three distinct periods:

- The Early Iron Age (EIA): Most of the first millennium AD.
- The Middle Iron Age (MIA): 10th to 13th centuries AD.
- The Late Iron Age (LIA): 14th century to colonial period.

Existing LSA communities largely continued to occupy much of the Erongo region and Namibia right through the Iron Age and Historical period. The Damara people are thought to be the first Bantu group to have migrated into Namibia during the Holocene (Sandelowsky, 1983, Wadley 1977). The Damara are a unique group as they are of Bantu origin, yet they speak the Khoekhoe language (Wadley, 1977: 21). Archaeological features found that have been associated with earlier Damara communities include stone cairns, old stock enclosures, and small graveyards, especially those of abandoned settlements on the Kuiseb Riverbank (Sandelowsky, 1983). They are known to have inhabited the Erongo Mountains, Brandberg Mountains, and present day Okombahe within the Erongo region. Much of the Damara communities were killed or forced out of the region with the arrival of the Herero people.

During the Bantu migration, the Herero people migrated southwards in a series of waves, eventually reaching present-day Namibia. They are believed to have originated from the region of present-day Central Africa. The Herero people first settled in Kaokoland before migrating southwards more into the Erongo region. They established communities and developed a pastoral lifestyle centred on cattle herding. The availability of water sources, grazing lands, and favourable environmental conditions in the Erongo region would have attracted the Herero people to settle in the area. By the late 18th century, the Herero had formed a centralized political structure known as the Herero Kingdom

(Wallace, 2011). Under the leadership of paramount chiefs, the Herero Kingdom became a significant power in the region, encompassing various Herero communities.

Within the Namibian Iron Age, archaeological research has shown the favouring of stone for creating tuyères and furnaces which were used for metal smelting. This is a unique occurrence of stone usage over clay compared to other smelting sites within Southern Africa (Mitchell 2002: 247). Ceramics are commonly found within these metal working sites, indicating the processing and use of clay ware but that clay was an unfavourable material for metalwork associated artefacts (Sandelowsky, 1983). The size and shapes of these stone tuyères and furnaces also vary largely from those made of clay.

6.8.1.3 Historical/ Colonial Period

Near the end of the 18th century, Walvis Bay was established by the Dutch as a stopover port on route to Cape Town. Once the British had taken the Cape colony, Walvis Bay was annexed by the British (Wallace, 2011: 117). Walvis Bay became the centre of trade and an important port for whaling and seal hunting trade. They also traded with locals but were unable to infiltrate territory further inland. The earliest accounts for trading with locals prior to colonial power, are with the ≠Aonin people who would largely trade cattle which is seen through the cattle paths present near Walvis Bay (Kinahan, 2014).

In 1883, Adolf Lüderitz arrived in Namibia and began purchasing land in what would be the beginning of Germany's occupation of the land (Wallace, 2011: 115). The period of 1884-1915 marks the German colonisation of Namibia. Then known as German South-West Africa, the German colonisation aimed to exploit the region's natural resources, establish commercial interests, and assert control over the indigenous populations (Gewald, 2003). German authorities implemented policies that resulted in land dispossession and forced labour. Indigenous communities saw their lands confiscated, leading to displacement and loss of traditional territories. Indigenous people were also subjected to forced labour on German farms and in mining operations, further exacerbating their suffering.

Resistance to the harsh ruling led to rising frictions and notably amongst the Herero and Nama communities who challenged the German ruling which led to the breakout of a war in 1904 (Gewald, 2003). Led by their paramount chief Samuel Maharero, the Herero people and the Nama people led by Hendrik Witbooi and Jakubus Morenga, launched an uprising against the German forces (Wallace, 2011: 161). The German response was brutal, resulting in what is now known as the Herero and Nama genocide. German forces, led by General Lothar von Trotha employed military action along with reinforcements sent from Germany to win the war resulting in the killing of Herero and Nama people. The German forces drove the surviving rebellion into the Namib Desert and many concentration camps were setup in which conditions were so harsh, survival rates were low. The exact death toll is debated but it is estimated that tens of thousands were killed during the Namibian War of 1904-1908 (Wallace, 2011). In 2004, the German government issued an apology for the atrocities committed during the colonial period and negotiations have been underway in relations to reparations.

After World War I, South Africa received a mandate from the League of Nations to administer Namibia (Gewald 2003). South African rule, which lasted for several decades, was characterized by racial segregation and discriminatory policies akin to apartheid. Indigenous Namibians faced restrictions on

their movement, limited political rights, and segregated social and economic structures. Apartheid policies implemented in Namibia mirrored those enforced within South Africa itself.

During this period, the Namibian people, led by political organizations such as the South West Africa People's Organization (SWAPO), began a struggle against South African rule. The liberation struggle involved both armed resistance within Namibia and diplomatic efforts on the international stage. Namibians sought to regain their independence and end the discriminatory policies imposed by South Africa. The armed struggle, diplomatic initiatives, and international pressure eventually led to Namibia's independence in 1990. Thereafter, in 1994, Walvis Bay was formally integrated into Namibia (Wallace, 2011: 307).

6.8.2 Cultural Heritage Baseline conditions at #Gaingu PV Power Plant and Grid Connection

The terrain at the project area is dominated by weathered granite outcrops with drainage towards the Khan River. Soils are coarse clay content. These conditions are favourable for the existence of harvester ants *Messor* spp., whose underground stores of grass seed were an important food resource for people in the Central Namib, especially during the second millennium AD (Kinahan 2006).

A survey conducted by Kinahan (2006) that covered much of the current grid corridor found numerous traces of seed diggings, as well as the remains of temporary encampments in granite rock shelters, none of which will be affected by the current project. During his survey he did however record seven features in close proximity to the power line from the proposed Gaingu PV Power Plant. These consist of lithic scatters, hunting blinds and a German Fortification. The current assessment recorded similar occurrence of sites.

The hunting blinds are ~ 1.4m in diameter, and well preserved. As Kinahan (2006 & 2008) noted no artefacts were observed in association with the blinds although lithics are observed in the wider area (e.g., waypoint 3612). He concludes that these features provide a valuable indication of the local distribution of hunting blind sites, as well as confirmation of their association with the dolerite dykes characteristic of the area. These features are however indirectly affected by the existing powerline that impacted on the sense of place.

Another important site on the proposed power line route concerns the well-preserved German fortifications recorded as Site 1. The site occupies a strategic ridge which overlooks the railway line to the east. The fortifications consist of a circular parapet, with an external curtain wall protecting the doorway that faces towards the railway line. The fortification occupies the crest of the ridge, and there are a number of lightly protected positions elsewhere on the same ridge with a possible cartwheel track leading down towards the railway line. This site will not be directly impacted on by the power line, but the added element on the landscape could have a visual impact on the site and alter the sense of place. General site conditions and selected observations are illustrated in Figure 6-24 to Figure 6-27. The observations are spatially illustrated in relation to the Project in Figure 6-28 and co-ordinates are listed in
Table 6-2.

Figure 6-24: General site conditions along the powerline route, following an existing route.

Figure 6-25: Dolerite outcrops occur along the powerline route.

Figure 6-26: Hunting blind recorded at 3621.

Figure 6-27: Hunting blinds (63) in relation to the existing powerline.

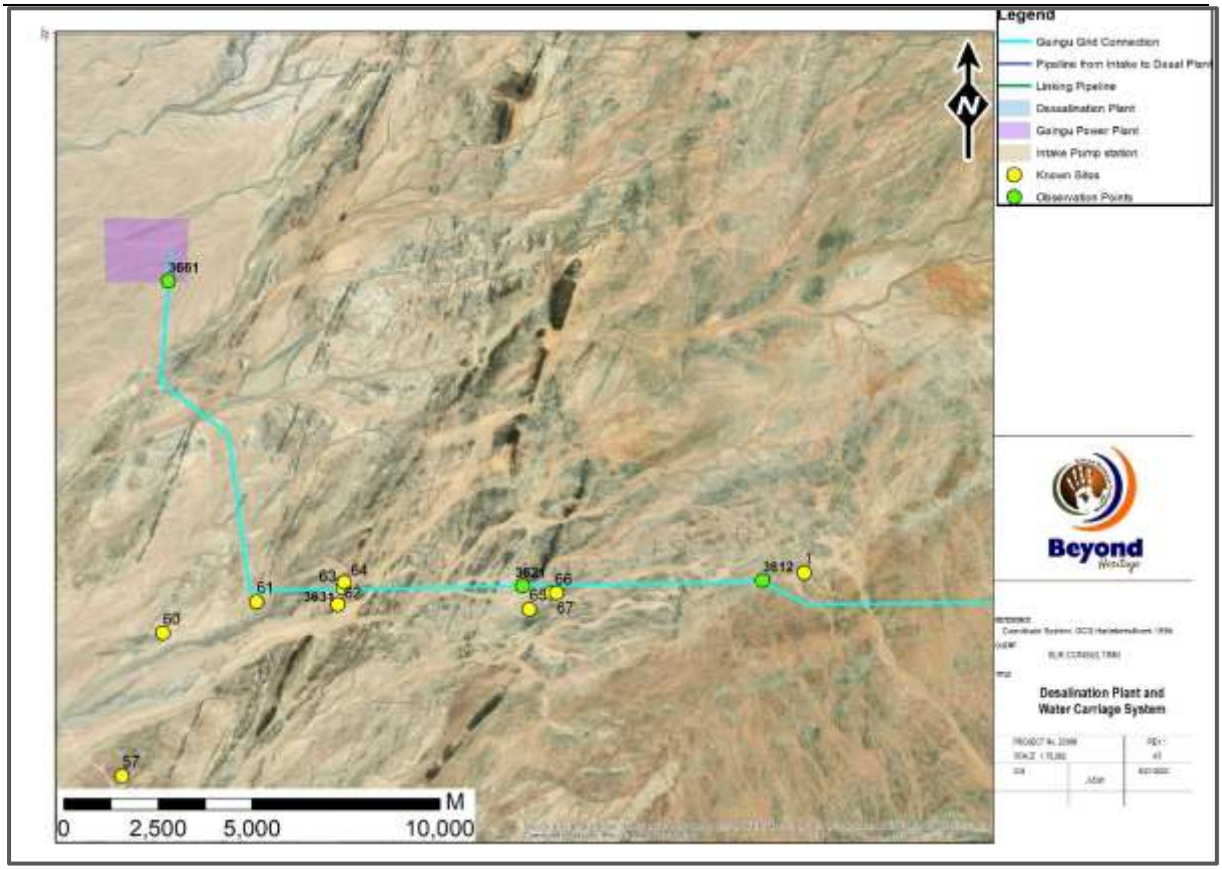


Figure 6-28: Aerial image showing Power Plant power line corridor and recorded observations

Table 6-2: Recorded heritage features

Label	Longitude	Latitude	Description	Impact	Source
1	15° 12' 50.5080" E	22° 07' 43.9700" S	The fortification occupies the crest of the ridge, and there are several lightly protected positions elsewhere on the same ridge. Some scars on the outcrop suggest that the fortification may have been subjected to artillery fire before it was captured or abandoned during the 1915 campaign. The site is of some historical interest	711 m northeast of the line	Kinahan 2006
11	15° 04' 43.9680" E	22° 13' 56.6800" S	No description provided	No impact expected - more than 2 km from the line.	Kinahan 2006
12	15° 05' 07.1880" E	22° 14' 18.7800" S	No description provided	No impact expected - more than 2 km from the line.	Kinahan 2006

Label	Longitude	Latitude	Description	Impact	Source
13	15° 04' 55.0200" E	22° 15' 53.2400" S	No description provided	No impact expected - more than 2 km from the line.	Kinahan 2006
14	15° 06' 08.0640" E	22° 17' 20.0000" S	South African and German cemetery comprising eleven graves of servicemen lost in a skirmish at Trekkopje on 26th April 1915. The site is fenced and receives periodic attention from the authorities.	No impact expected - more than 2 km from the line.	Kinahan 2006
15	15° 06' 14.4360" E	22° 17' 39.3700" S	A dump of military ration tins dating to the 1915 campaign. The material comprises typical German ration tins of the era, such as herring, as well as typical South African tins such as condensed milk.	No impact expected - more than 2 km from the line.	Kinahan 2006
46	15° 06' 17.0640" E	22° 17' 24.6100" S	Cemetery comprising ten graves in two rows, and including at least three children.	No impact expected - more than 2 km from the line.	Kinahan 2006
47	15° 06' 16.2360" E	22° 17' 23.5300" S	No description provided	No impact expected - more than 2 km from the line.	Kinahan 2006
48	15° 05' 46.8240" E	22° 17' 08.0500" S	Adjacent to site 46 was a dispersed midden of charcoal, bone, tin, and glass (Site 48). The graves and the midden appeared to be contemporaneous, and the presence of concrete bricks and screw-top glass jars on one of the children's graves suggests that the sites are no more than thirty years old. The sites do not therefore fall under the provisions of the National Heritage Act (27 of 2004), Part 1, Sections 1 (a).	No impact expected - more than 2 km from the line.	Kinahan 2006
49	15° 05' 18.9960" E	22° 15' 19.2200" S	No description provided	No impact expected - more than 2 km from the line.	Kinahan 2006

Label	Longitude	Latitude	Description	Impact	Source
50	15° 04' 55.6320" E	22° 14' 46.4300" S	No description provided	No impact expected - more than 2 km from the line.	Kinahan 2006
51	15° 04' 47.1720" E	22° 14' 44.8800" S	No description provided	No impact expected - more than 2 km from the line.	Kinahan 2006
52	15° 03' 34.1280" E	22° 12' 38.2300" S	Hunting Blinds/ Rock Shelter	No impact expected - more than 2 km from the line.	Kinahan 2006
53	15° 03' 28.8720" E	22° 12' 43.7800" S	Hunting Blinds/ Rock Shelter	No impact expected - more than 2 km from the line.	Kinahan 2006
54	15° 03' 21.8880" E	22° 12' 52.0200" S	Granite core-stone outcrop, with numerous large boulders lying on an extensive exposure of granite. The latter has several large ponds which would have provided temporary rainwater supplies when the area was occupied. Among the boulders are several localized scatters of stone artefact debris, mainly hydrothermal vein quartz, associated with ostrich eggshell fragments and pottery. The occupation area also has stone pestles and mortars which would have been used for grinding grass seed from harvester ant caches. Short stone barriers have been laid out between some of the boulders	No impact expected - more than 2 km from the line.	Kinahan 2006
55	15° 03' 31.5360" E	22° 12' 55.3000" S	Site 55 is a group of eight circular stone hunting blinds arranged across the saddle mentioned above. The blinds are positioned to intercept game attempting to cross the saddle, either in search of grazing or en route to water.	No impact expected - more than 2 km from the line.	Kinahan 2006

Label	Longitude	Latitude	Description	Impact	Source
			The blinds are about 2.4m in external diameter, and well preserved		
56	15° 03' 34.9560" E	22° 12' 53.6000" S	Hunting Blind/ Rock Shelter.	No impact expected - more than 2 km from the line.	Kinahan 2006
57	15° 03' 03.0960" E	22° 10' 38.9600" S	No description provided.	No impact expected - more than 2 km from the line.	Kinahan 2006
60	15° 03' 38.0880" E	22° 08' 35.8440" S	No description provided.	No impact expected - more than 2 km from the line.	Kinahan 2006
61	15° 04' 58.8360" E	22° 08' 08.9900" S	No description provided.	Approximately 289 m South of the powerline	Kinahan 2006
62	15° 06' 08.9640" E	22° 08' 11.2600" S	Site 62 is a light scatter of stone artefact debris on the crest of a dolerite ridge.	Approximately 393 m South of the powerline	Kinahan 2006
64	15° 06' 14.5440" E	22° 07' 52.1000" S	Site 64 is a single hunting blind positioned in a narrow gap on the same dolerite ridge as the previous site.	180 m north of the line	Kinahan 2006
65	15° 08' 53.7000" E	22° 08' 15.2900" S	Site 65 is a granite core-stone outcrop with an extent of approximately 1ha and a low-density surface scatter of stone artefact debris, mainly hydrothermal vein quartz.	621 m south of the line	Kinahan 2006
66	15° 09' 13.1040" E	22° 08' 01.1000" S	Isolated hunting blinds on granite pediment gravel.	196 m south of the line	Kinahan 2006
67	15° 09' 17.3880" E	22° 08' 01.2800" S	Isolated hunting blinds on granite pediment gravel.	204 m south of the line	Kinahan 2006
3612	15° 12' 14.9831" E	22° 07' 50.5884" S	Broken flake with retouch	24 m north of the line	Current Study
3621	15° 08' 48.3648" E	22° 07' 55.2685" S	Hunting Blind with a 1-meter diameter	3 m south of the line	Current Study
3631 and 63	15° 06' 13.2805" E	22° 07' 56.9532" S	Site 63 is a group of three stone hunting blinds positioned in the saddle of a	32 m north of the line	Kinahan (2006)

Label	Longitude	Latitude	Description	Impact	Source
			dolerite ridge. The blinds are completely circular in construction, with an internal diameter of approximately 2.0m.		and Current Study
3661	15° 03' 42.7753" E	22° 03' 32.8393" S	Broken flake LSA	Inside Gaingu power plant	Current Study

6.9 AIR QUALITY

Air quality in Namibia is generally good and air pollution is broadly not considered a key issue in Namibia. There are few industrial sources mainly associated with mining and smelting activities, which are generally remote from populated areas (FAO, 2001). Vehicle density and use in the urban areas is not currently sufficient to lead to major problems. Particulate Matter (PM) concentrations in Windhoek have been found to be relatively high due to vehicle exhaust emissions and re-suspension of road dust caused by moving vehicles (Hamtui & Beynon, 2017). Socio-economic activities such as minerals exploration and industrial development in Namibia have the potential to promote fugitive dust production (Von Holdt & Eckardt, 2017), whilst dust particles smaller than 10 µm can pose adverse effects to human respiratory and cardiovascular (Chen et al., 2010; Griffin & Kellogg, 2004; Kanatani et al., 2010). Namibia does not currently have air quality policies, regulations or standards in place (Ehsani, 2017).

6.10 LAND USE

The primary land-uses within the study area are described in the table below.

Table 6-3: Land uses within the study area

Land Use	Description
Residential	There are no farmsteads/ dwellings located within the ZoPI of the #Gaingu PV Power Plant. There are however a few farmsteads/ dwellings located within the surrounding area, along the B2 road, and villages located to the north of the project site along the D1918.
Mining/ Industrial	There are no mining or industrial activities located within the ZoPI but the Trekkopje Mine is located to the south-west of the #Gaingu PV Power Plant site and the mining rights area expands into the ZoPI.
Infrastructure	The infrastructure in this study area is limited, especially around the power plant. There are a few gravel roads, the existing powerline (transmission line) between Trekkopje Mine and the Khan Substation, the B2 road that connects Swakopmund with Usakos and the D1918 to the north of the project site.
Tourism	The #Gaingu PV Power Plant and powerline is in the #Gaingu Community Conservancy. The only noted tourist destination located within the ZoPI was

Land Use	Description
	the Trekkopjes Ruins and the Historical German Fortification, no accommodation facilities were noted within the ZoPI. The area is however visited by tourists to explore the wonders of the Namib Desert. The Trekkopjes Cemetery is located just off the B2 Road and Spitzkoppe is located to the north along the D3716 Road.

6.11 VISUAL

Landscape quality, aesthetic value and “sense of place” are key determinants of the quality of a visual resource, which is ultimately a subjective matter that is highly dependent on the receptor(s). Tourism is a popular activity and an economically valuable industry in Namibia, much of which is based on the scenic beauty and landscape character of the country. There is thus strong argument that visual resources must be given strong consideration during development planning and permitting processes. Visual receptors to this project would include local landowners, occupiers and users, domestic travellers and tourists.

6.11.1 Landscape Character

The study area is characterised by a slightly rolling topography that is created by the rocky outcrops and the dry minor rivers or drainage lines. The Spitzkoppe and other mountainous areas are visible in the background. The vegetation cover is typical of the Namib Desert and consist of grasses, small shrubs, and a few scattered trees, mostly along the minor rivers or drainage lines. There are a few dwellings scattered to the north-east of the #Gaingu PV Power Plant project site. The #Gaingu PV Power Plant, powerline and access road is located within the #Gaingu Community Conservancy. Refer to Figure 6-29, which indicates the location of the viewing points and potential sensitive receptors.

Figure 6-29: Viewpoints and potential sensitive receptors

6.11.2 Visual Resource/Scenic Quality

The scenic quality of the study area is primarily derived from the combination of land-uses in the area as well as the landscape character (topography, vegetation cover, mountains, and rivers). The area is characterised by the natural component of the Namib Desert, rocky outcrops, rivers/ drainage lines, and vegetation. Although the natural landscape has been compromised by human interventions such as the roads, infrastructure, mining and settlements, the natural landscape is still dominant and contributes the highest score to the visual resource value of the study area.

When considering the criteria as listed in Table 6-4 below, an overall rating of *high* is allocated to the study area. Although the natural landscape has been compromised by the intrusion of human related activities it is still considered to be an area that exhibits a positive character which is valued. A summary of the study area's visual resource values is tabulated in Table 6-4 below.

Table 6-4: Value of the visual resource

High	Moderate	Low
This landscape type is considered to have a *high* value because it is a: **Distinct landscape that exhibits a very positive character with valued features that combine to give the experience of unity, richness and harmony. It is a landscape that may be of particular importance to conserve and which has a strong sense of place.**	This landscape type is considered to have a *moderate* value because it is a: Common landscape that exhibits some positive character, but which has evidence of alteration / degradation/ erosion of features resulting in areas of more mixed character.	This landscape type is considered to have a *low* value because it is a: Minimal landscape generally negative in character with few, if any, valued features.
Sensitivity: **It is sensitive to change in general and will be detrimentally affected if change is inappropriately dealt with.**	Sensitivity: It is potentially sensitive to change in general and change may be detrimental if inappropriately dealt with.	Sensitivity: It is not sensitive to change in general and change.

6.11.3 Sense of place

The sense of place associated with the study area of the #Gaingu PV Power Plant, powerline and access road can be described as natural and tranquil. This is mainly due to the vast open area that positively contributes to the high visual resource value. The sense of place changes slightly when travelling along the B2 road and towards the Khan substation since the natural landscape is replaced by manmade structures such as the powerlines, roads and the substation.

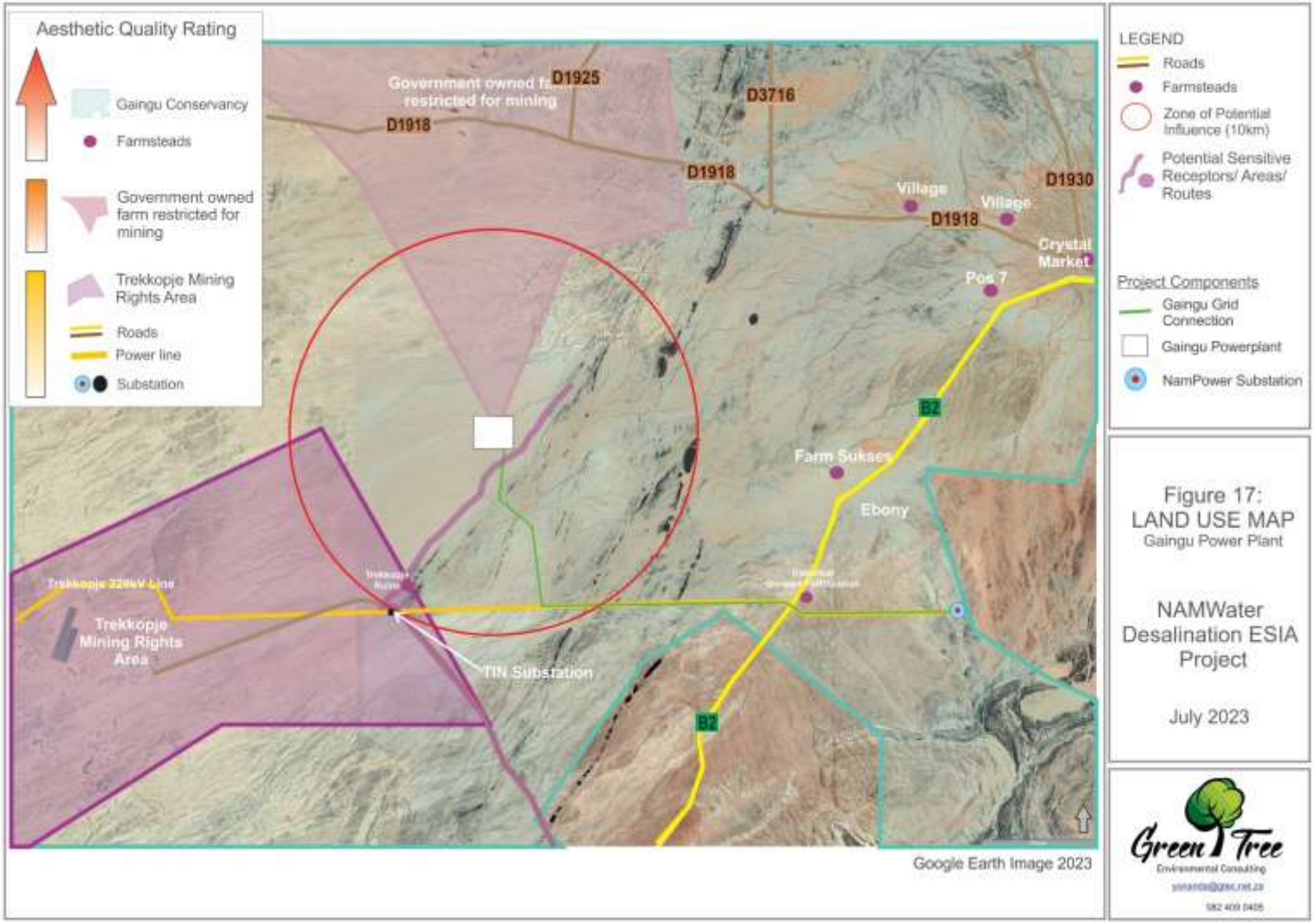


Figure 6-30: Land use map

6.11.4 Sensitivity of visual receptors/viewers

The sensitivity of the visual receptors/ viewers is determined by looking at the susceptibility of the visual receptors to the change that the proposed Project will bring to their views. The susceptibility of the visual receptor is a function of:

- Occupation or activity of people experiencing the view at particular locations; and
- The extent to which their attention or interest may therefore be focused on the views and the visual amenity they experience at particular locations.

The Landscape Institute with the Institute of Environmental Management and Assessment (2002) therefore suggest that the visual receptors most susceptible to change are generally likely to include:

- Residents at home;
- People who are engaged in outdoor recreation, including use of public rights of way, whose attention or interest is likely to be focused on the landscape and or particular views;
- Visitors to heritage assets or other attractions, where views of the surroundings are an important contributor to the experience;
- Communities where views contribute to the landscape setting and is enjoyed by residents in the area.

Visual receptors with a moderate susceptibility to change will include:

- Travellers on road, rail or other transport routes.

Visual receptors that are likely less sensitive to change would include:

- People engaged in outdoor sport or recreation which does not involve or depend on appreciation of views of the landscape;
- People at their place of work whose attention may be on their work and not on their surroundings.

When considering the proposed project, the visual receptors identified during the site visit will include:

- Receptors located on farms/ dwellings and settlements surrounding the Gaingu Power Plant, powerline and access road;
- Tourists visiting the different tourist attractions and accommodation;
- People travelling along the D1918, C34, B2 and other local roads (D1925, D1930 and D3716) located within the study area; and
- People travelling to and from work, between towns or to the project facilities.

6.11.4.1 Sensitive Viewers

Within the context of the study area and the region, the following receptors (Table 6-5) were identified as potential sensitive viewers during the site visit.

Table 6-5: Potential sensitivity of visual receptors

High	Moderate	Low
Residents staying on the farmsteads/ dwellings located near the proposed Gaingu Power Plant. Tourists visiting the various tourist attractions such as the Gaingu Community Conservancy, Trekkopjes Ruins, Historical German Fortification, Lichen Fields.	Locals travelling through the study area on the local roads (D1918, gravel roads).	People working within the study area and travelling along local roads (B2, D1918) whose attention may be focused on their work or activity and who therefore may be potentially less susceptible to changes in the view.

6.12 NOISE BASELINE

Noise sensitive receptors were identified by means of desktop study and during the survey conducted as part of the noise specialist study for the ESIA (up to approximately 6 km surrounding the project sites). It was confirmed by desktop study and during the site visit that no human sensitive receptors exist within several kilometres of the proposed solar PV power plant. From the outset, it is expected that no negative noise impacts (human related) will occur during the PV plant phases. Notional values for construction impacts are provided for linked studies such as biodiversity.

6.13 ROAD NETWORK AND TRAFFIC

The main roads in the proposed project area are road C34 and B2. Road B2 is the main road between Swakopmund and the central region of Namibia, joining the B1 road at Okahandja, the main north-to-south route in Namibia, which links to Windhoek. Traffic volumes on the B2 are relatively low, but fluctuates seasonally, with higher traffic flows during long weekends and school holidays, and the festive season (December/January).

Trunk / expressway roads in the study area are surfaced with bitumen / asphalt, whilst the majority of other main roads are gravel surfaced (Table 6-6). In terms of road accidents, approximately 4 000 crashes are recorded annually, with approximately 260 casualties per 100 000 persons. The majority of traffic accidents occur in the Khomas region (MVA, 2018).

Table 6-6: Summary of road types and surfacing in the Erongo, Otjozondjupa and Khomas regions (Roads Authority, 2017).

Road type	Surface	Region		
		Erongo	Otjozondjupa	Khomas
Trunk Roads	Bitumen	100.0 %	100.0 %	100.0 %
	Gravel	0.0 %	0.0 %	0.0 %
Main Roads	Bitumen	7.5 %	11.6 %	9.7 %
	Gravel	80.0 %	85.3 %	86.2 %
	Salt	12.5 %	0.0 %	0.0 %
	Earth	0.0 %	3.1 %	4.1 %
District Roads	Bitumen	0.3 %	0.3 %	1.2 %
	Gravel	44.6 %	65.9 %	57.1 %
	Salt	6.8 %	0.0 %	0.0 %

	Earth	48.3 %	33.8 %	41.7 %
All Roads	Bitumen	13.3 %	15.6 %	13.1 %
	Gravel	49.8 %	61.1 %	62.7 %
	Salt	7.7 %	0.0 %	0.0 %
	Earth	29.2 %	23.3 %	24.2 %

6.14 SOCIO-ECONOMIC BASELINE

6.14.1 The #Gaingu Conservancy

The proposed solar PV and Lithium-ion BESS power plant (the #Gaingu PV Power Plant) will be constructed in the #Gaingu Conservancy to provide power to the desalination plant.

The #Ganigu Conservancy covers an area of 7 721km^2 east of Wlotzkasbaken, bordering with the Dorob National Park, the Omaruru River to the north, the Erongo Mountains and Usakos to the east, and south. It additionally covers the land surrounding Trekkopje, Arandis and the old Khan Mine with the B2 trunk road cutting through its south-eastern border. It was registered as a conservancy in 2004 and has an entirely rural population of approximately 3 000 people who make a living from farming with goats and livestock, relying considerably on cash remittances from family members who have jobs elsewhere and from social welfare grants for children and pensioners.

The #Gaingu Conservancy is a legally recognised community conservation organization, gazetted in 2004, that enables the people living in the communal area to have rights to actively manage natural resources in that area and to generate returns from them. Conservancies are typically defined by social ties uniting groups of people with the common goal of conservation.

The 2021 Namibian Association of Community Based Natural Resource Management (CBNRM) Support Organisations (NACSO) institutional report on the conservancy noted that it maintains excellent communication with stakeholders and conservancy members hold its management committee accountable. Its main enterprise is the Spitzkoppe Community Campsite which employed 21 staff of whom 17 were women in 2021. Some conservancy members are small scale miners for semi-precious stones which can be found in some of the mountains in the region[7].

6.14.2 Arandis

Arandis is located about 60 km east of Swakopmund and was established in 1970 to house employees of Rössing Uranium Limited (RUL); it was proclaimed a municipality in 1994. It has good transport links and infrastructure, and the town is well-laid out. Key areas such as the business centre and municipal offices are easily accessible to the whole population which was 5 100 people in 2011 (NSA, 2014). No data is available on household sizes and composition.

Although the town has always been economically dependent on RUL, it has made great effort to attract other industries. Since the construction and opening of the Husab mine, Arandis has experienced considerable population growth and has built housing in Extension 5 and 7, mainly for workers at the Husab mine. The number of ratepayers has grown to 3 700 (domestic and business), a

[7] https://www.nacso.org.na/conservancies/gaingu

61% increase since 2017. The town has no informal settlement, but many houses have backyard shacks[8].

The Arandis Town Council (ATC) has faced numerous constraints as its revenue base is narrow, depending primarily on rates and sewerage charges for its revenue. Currently 95% of domestic users are in arrears with their rates bill and occasionally the council will cut-off the water supply to force households to pay some arrears and reschedule payments. Even some of the big institutions and industries are also in debt with ATC. Nevertheless, the new housing and increased property prices have increased the revenue base. Higher income earners tend to live in Swakopmund, thereby causing the local buying power to be insufficient to expand the retail base.

In Arandis, the biggest water consumers are the 49 registered industries, Namibian Institute of Mining and Technology (NIMT), schools and lodges. Approximately, 95% of water users are post-paid and 5% are on a pre-paid pilot scheme which was introduced just before the COVID lockdowns. The government announcement that water would not be billed during COVID, lead to the interpretation of free water and many households accumulated large water debts. The pilot phase of the pre-paid water meters has not been a success as some meters become faulty and do not record use, resulting in major losses to the municipality.

6.14.3 Broader Socio-Economic Factors

6.14.3.1 National Economic Overview

Namibia's rich mineral base and small population of 2.5 million gives it a World Bank classification of an upper-middle-income country, yet Namibia's level of income inequality is among the highest in the world, with a Gini coefficient of 0.59[9] (NSA, 2019). In 2022, the Gross Domestic Product (GDP) per capita at market prices was N$79 431 (NSA, 2023).

Namibia has abundant sun, potential for desalinated water from its coastal waters, some remaining fish stocks, widespread livestock production, an increasing urban population and high school attendance of both girls and boys up to Grade 11. However, there is widespread rural and urban poverty, low educational attainment, few technical skills, and worst of all major housing back-logs in all urban areas and deepening unemployment. Thirty-three years after Independence from South African rule, the governing political party, SWAPO, is under more pressure than ever before to improve the lives of Namibians. The economy shows signs of a slow economic recovery from the recession of 2016-2020 and the 2020/21 COVID-19 pandemic, mainly due to positive improvements in the mining and financial services sectors.

Tertiary industries (including the public sector, retail and wholesale, transport and services sectors) have always been the most significant contributor to Namibia's GDP in recent years, contributing 55.5%, in 2022. Secondary industries contributed 15.8% to GDP and include manufacturing such as

[8] Pers Com. Geraldine Tjiramba, Accountant, ATC on 15/3/2023

[9] The Gini coefficient can take any values between 0 to 1 (or 0% to 100%). A coefficient of zero indicates a perfectly equal distribution of income or wealth within a population. Data show that the coefficient generally ranges from 0.24 to 0.63.

meat and other food processing, beverages, mineral processing, electricity generation and construction. The primary industries contributed 20.8% to GDP (NSA, 2023).

The Institute for Public Policy Research (IPPR), a Namibian NGO think-tank, summed up the economic situation in July 2020 and all the points remain valid in 2023:

> *"Levels of private investment and Foreign Direct Investment, upon which future growth depends, had sunk back to levels not seen since before the Global Financial Crisis. Levels of public investment had also started to decline as the splurge in public spending since 2009 aimed at countering the global downturn petered out while levels of public borrowing reached their limits. Long-standing characteristics, such as poor or non-existent formal employment growth, limited export diversification, the bloated size of the public sector, the generally poor performance of Public Enterprises, and wasteful public spending were all visible. Corruption and mismanagement were widespread as demonstrated most starkly by the Fishrot scandal which had arisen from the secretive way in which one of Namibia's key economic sectors had been managed over many years"* (IPPR, 2020).

An analysis of the state of the Namibian economy (Sherbourne, 2022) points the way forward to include:

- A clampdown on corruption and adoption of a more technocratic approach to economic management;
- Oil and Green Hydrogen projects should start to take shape in coming years allowing government to borrow and bridge fiscal gap;
- Oil and gas revenues are effectively managed, and benefits are distributed across population leading to poverty reduction and resources for climate adaptation;
- Government uses oil and Green Hydrogen as a means of diversifying the economy.

6.14.3.2 Poverty and Vulnerabilities

Poverty is defined as "the number of people who are unable to command sufficient resources to satisfy basic needs" (NSA, 2017). They are counted as "the total number of people living below a specified minimum level of income or below a national poverty line" (NSA, 2017). The projected upper middle-income poverty rate of 62.4% means the number of poor people in Namibia, living on the upper middle-income poverty line of USD 5.5 (N$84)/person/day, has reached 1.56 million (World Bank, Oct 2022). The national rate of multi-dimensional poverty (based 11 indicators on living standards, health and education) averages at 43.3% of the population, with almost 60% living in rural areas compared to 25% of urban dwellers – such as in the CCA. Female headed households, larger households and households with many children are more likely to suffer multidimensional poverty. Based on the 2011 census figures, the Erongo Region has the *lowest* incidence of multidimensional poverty in Namibia at 16.6% (NSA, 2021) although this is likely to be higher in 2023.

Due to the history of Namibia, poverty has evolved along racial and ethnic lines; white Namibians hold more wealth and power and are seldom found in the low-income and vulnerable groups. The most vulnerable groups at the coast are women and men living in poverty, with low incomes. Many but by no means all, are recent migrants who have come to seek work and a better life from rural areas in Northern Namibia, whose home languages are Oshiwambo or Rukwangali. Language is a door opener,

but as they often have poor English and no Afrikaans, they struggle to find work or training opportunities.

In 2011, Swakopmund ranked the 7th *least* deprived constituency out of the 107 in the country because of its residents' easy access to health, education and employment (NPC, 2015).

6.14.3.3 Indigenous Peoples

Namibia signed the United Nations Declaration on the Rights of Indigenous Peoples in 2007. The Constitution of Namibia emphasises equality and freedom from discrimination on the grounds of sex, race, colour, ethnic origin, religion, creed or social or economic status (Article 10).

"While most people in Namibia can be characterized in a strict sense as indigenous to the area, the San, Himba, Ovatua, Ovatjimba, and Ovazemba are recognized by the Government as particularly marginalized groups. The conditions of these groups, especially relative to other segments of the population of Namibia, can be identified as similar to those of groups identified as indigenous worldwide" (Anaya, 2013).

The 2011 census identified 37 San-speaking households living in urban areas in the whole of the Erongo Region but did not differentiate within Otjiherero-speaking peoples, which includes the Himba. Should any indigenous peoples be living in the coastal towns, it is expected that their households are known to local level political structures, such as councillors, as they are entitled to food aid distributed by government.

6.14.3.4 Gender

Patriarchal practices and rigid gendered social structures are common in Namibian households and in public life. This is often reinforced by Christian values (98% of the population identifies as Christian) under which the man is considered the head of the household. Gender and cultural norms that uphold men as the decision makers and women as dependents leave many women and their children among the most vulnerable. In most cases these norms result in men having control over household resources and income from all sources. They also empower mostly men with the means to dominate the lucrative economic activities and decision-making processes. Gender norms include the expectation within households that women should be primarily responsible for care and domestic labour, while men take on the responsibility for "heavy work" and the role of primary income earners[10].

Many migrant workers are single women who have to care for and feed their children with little or no support from the children's father or from extended families. This pushes many women deeper into poverty, vulnerability and risk. Although there are progressive laws and policies in place to protect women, knowledge of these is not widespread; women are left to navigate the systems on their own. As a result, many of the most vulnerable are not benefiting from the legal protections which are in place to fight discrimination and Gender Based Violence (GBV).

[10] This section is largely based on work done by Brigit Rudd, Namibian Gender and Development Specialist

In Walvis Bay, it is mostly women working the fish processing lines while men are offered jobs on boats and vessels where there are no gender-separate sleeping and bathroom arrangements. In 2018, in the well-paid mining sector males dominated the workforce by over 82%. Conversely in the generally low-paid accommodation and food service sector, 77% of those employed were women (NSA, 2019b).

GBV is widespread in Namibian society and is rooted in the structural inequality in power relations between women and men. GBV is defined as the physical, mental or social abuse (including sexual violence) that is attempted or threatened, with some type of force (such as violence, threats, coercion, manipulation, deception, cultural expectations, weapons or economic circumstances) and is directed against a person because of his or her gender roles and expectations in a society or culture. Forms of GBV include sexual violence, sexual abuse, sexual harassment, sexual exploitation, early marriage or forced marriage, gender discrimination, and denial (such as education, food and freedom). The Namibian GBV statistics are probably under representative but 33% of women have experienced physical or sexual violence; 28% of girls and 29.5% of adolescent boys believe beating is acceptable. Violence against women and girls has devastating short and long-term consequences on their health and wellbeing. All sectors of society need to intensify prevention efforts to address social norms, attitudes and behaviours that perpetuate inequalities and GBV (UNFPA, 2020).

6.14.3.5 Employment and Unemployment

In the Erongo Region, the labour force stood at 112 800 in 2018, with a labour force participation rate[11] of 81% (86% among males and 75% among females) which is the highest of all the regions, compared to the national average of 71% (NSA, 2019b). However, 41% of those employed were in informal employment – such as working in private households or in agriculture and fishing – and had no social protections such as a pension scheme, medical aid, or social security (NSA, 2019b).

Conversely, the Erongo Region recorded the second lowest regional unemployment rate at 30%, with women only slightly more likely to be unemployed than men: 31% of women were unemployed, compared to 29% of men in the region (NSA, 2019b). Youth unemployment however, amongst people aged 15-34 years, was 37% in the region, and fairly equally affecting young men and women (NSA, 2019b).

6.14.3.6 Availability of Project-related Skills of Training Institutions

The Engineering Council of Namibia (ECN) has a comprehensive list of engineers and technicians operating in Namibia, by discipline, by professional level and by nationality, as indicated in the figures below. Figure 6-31 shows there are only 40 chemical engineers and 22 industrial engineers registered with the ECN in 2023, although there are 320 mechanical engineers.

[11] The labour force participation rate (LFPR) is the proportion of the economically active population in the age group 15 to 65 years

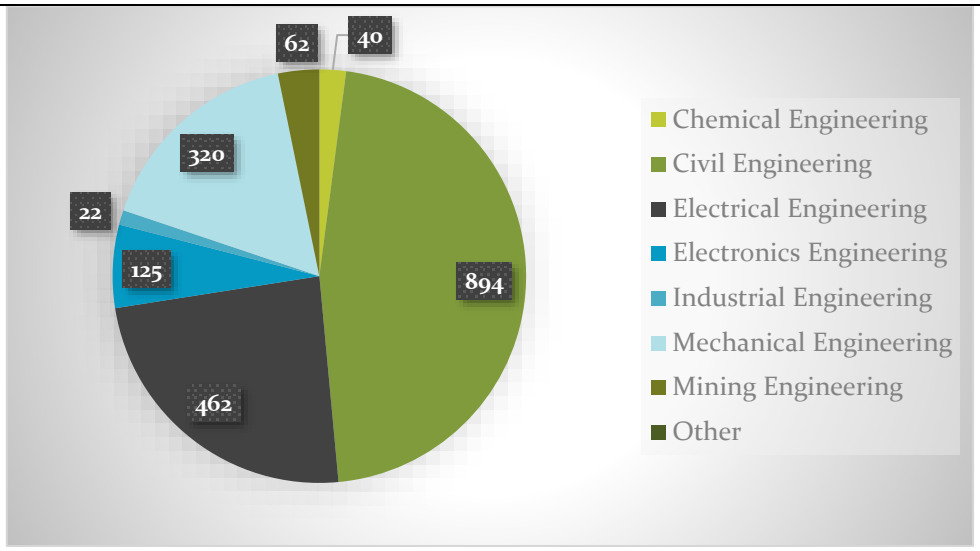


Figure 6-31 Engineers and Technicians by discipline registered with ECN

Source: Engineering Council of Namibia (ECN) main page: ecn.org.na/ecn/

A graduate with a degree can register with the ECN as an engineer- or technician-in-training and after at least four years, she/he can apply to become a professional engineer. Some people may not register after training but will apply for membership only when they are ready to become a professional engineer; some may never apply to become professionals. Of the 1997 people registered, just over half (51%) are still in training or have not applied for professional membership (Figure 6-32). Approximately 18% of those registered are women.

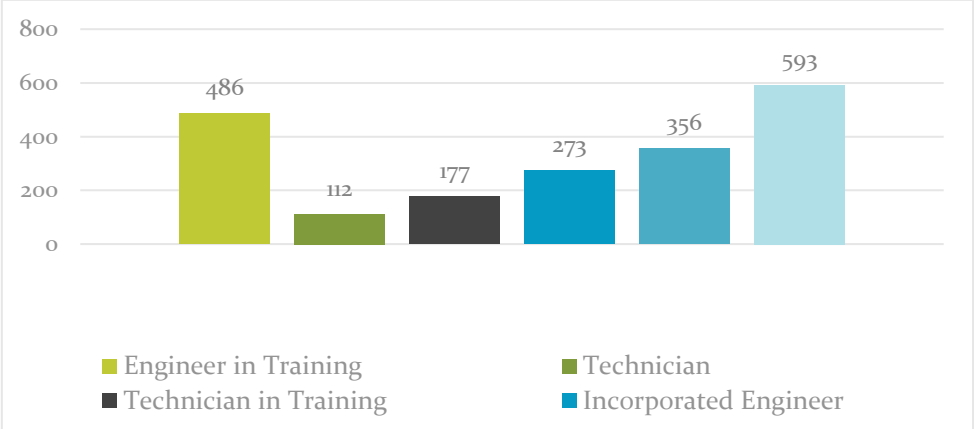


Figure 6-32 Number of Engineers and Technicians registered with the ECN 2023

Source: Engineering Council of Namibia (ECN) main page: ecn.org.na/ecn/

Figure 6-33 below shows that the vast majority (80%) of people registered with the Engineering Council are Namibian.

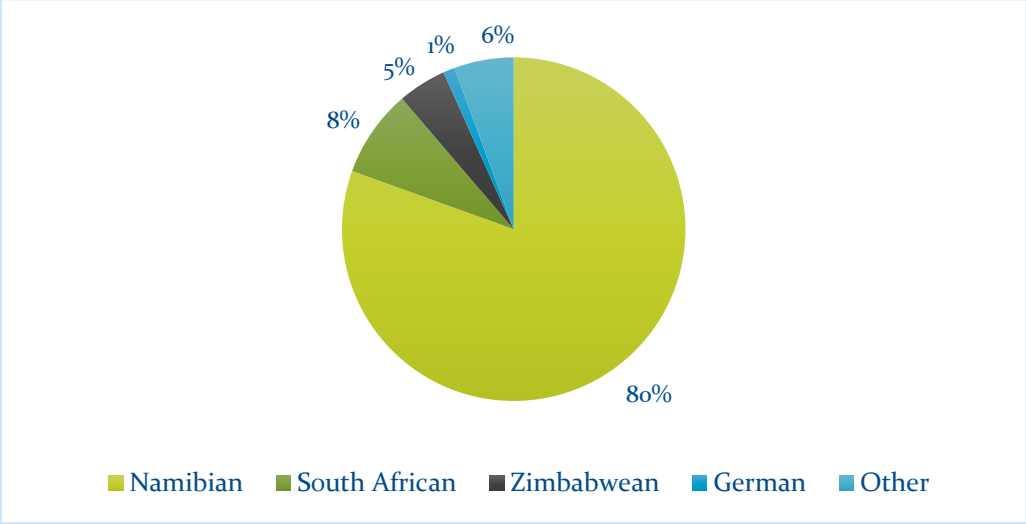


Figure 6-33 ECN Registered Engineers and Technicians, by Nationality
Source: Engineering Council of Namibia (ECN) main page: ecn.org.na/ecn/

The University of Namibia (UNAM) runs a School of Engineering and the Built Environment at the Jose Eduardo dos Santos Campus, Ongwediva. It offers BSc Honours and Masters' courses in civil engineering, electrical engineering, mechanical engineering and electronics and computer engineering; it does not offer chemical engineering.

The **https://www.rocapply.com/Namibia University of Science and Technology (NUST)** offers a 3 year Bachelors of Engineering In Chemical Engineering course and also runs a fulltime, one year course leading to a (B.Tech. Water Engineering) for which admission requirements are a National Diploma in Civil Engineering and Project Management. Its B.TECH in Electronic Engineering course provides training for instrumentation technicians.
Namibian Institute of Mining and Technology (NIMT) campus in Arandis offers up to Level 3 in Instrumentation.

Namibians can also study chemical engineering and other relevant courses in South Africa at the University of Cape Town, the University of the Witwatersrand, Stellenbosch University, the University of Western Cape, University of Pretoria, Cape Peninsula University of Technology and the University of Johannesburg.

According to the National Training Authority (NTA), Namibia has 85 approved training providers, with the majority located in Khomas (36) and Erongo (14) Regions. The only training provider registered with the NTA in Swakopmund is the Namibia Institute of Welding (NTA, 2022). However, for admission to these courses, applicants often require Grade 11 completion certificates or an equivalent qualification – excluding a large portion of potential vocational seekers.

Swakopmund also has a Community Skills Development Centre (COSDEC) which offers Level 1 and 2 in the following trades: Bricklaying & Plastering, Clothing Design & Production, Hospitality and Tourism (to Level 3), Joinery & Cabinet Making, Business Services (Office Administration &

Computing), Plumbing & Pipefitting and Welding & Fabrication. It also offers short 1 week to 3 months courses in Information Communication and Technology, and Office Administration[12].

With over 42,000 school leavers who completed Grade 10 – 12 nationally in 2018 (MoEAC, 2020), demand for vocational training placements far outstrips supply. In addition, Namibia's vocational education and training system is not adequately geared towards the needs of the labour market (GIZ, 2021). It does not constitute a comprehensive and consistent network of providers/trainers but it remains fragmented and has poor linkages with basic education, higher education and between its own components (UNESCO, 2016).

[12] https://www.cosdef.org.na/cosdec-swakopmund/

7. ENVIRONMENTAL IMPACT ASSESSMENT

This chapter describes and assesses the significance of potential impacts associated with the proposed #Gaingu PV Power Plant and associated infrastructure project. This assessment was preceded by the Scoping Phase in which screening was conducted of the potential interactions of the proposed project with biophysical and socio-economic resources/receptors.

As part of the previous scoping process, SLR in consultation with I&APs, regulatory authorities and specialist consultants identified several environmental and social risks associated with the proposed project. For reference, the identified risks are summarised below:

- Surface water;
  - Physical disturbance and destruction of dry and ephemeral watercourses and drainage lines.
- Soils;
  - Physical damage/ destruction of soil crusts and soil horizons.
  - Contamination/ pollution of soils.
- Fauna and flora;
  - Physical terrestrial habitat disturbance, alteration and loss;
  - Establishment and spread of Alien Invasive Plants; and
  - Restriction of animal movement and entrapment of animals.
- Avifauna;
  - Bird electrocution and collision.
- Conservation planning;
  - Conflict with conservation initiatives.
- Heritage (including archaeology, landscape setting and palaeontology);
  - Damage to and destruction of heritage features and sites; and
  - Removal of heritage features.
- Visual;
  - Change to the visual landscape and impact on sense of place related to all proposed new surface infrastructure.
- Noise;
  - Potential noise impacts and disturbance to third parties and animals.
- Socio-economic;
  - Job creation and disruption of livelihoods;
  - Potential impacts on Community Health and Safety; and
  - Affected people are not consulted in the development process.
- Climate change;
  - Greenhouse gas emissions; and
  - Climate change adaptation.
- Waste management.

The discussion and assessment of impacts below covers the construction, operational, decommissioning and closure phases where relevant. This is indicated in the table at the beginning of

each sub-section. Included in the table is a list of project activities/ infrastructure that could cause the potential impact per project phase. The activities/ infrastructure that are summarised in this chapter, link to the description of the proposed project (see Section 5.2).

Key management and mitigation measures to address the identified impacts are discussed in this section and included in more detail in the ESMP that is attached in Appendix M.

Both the criteria used to assess the impacts and the method of determining the significance of the impacts is outlined in Table 7-1 which complies with the Environmental Impact Assessment Regulations: Environmental Management Act, 2007 (Government Gazette No. 4878) EIA regulations.

Part A provides the approach for determining impact consequence (combining severity, spatial scale and duration) and impact significance (the overall rating of the impact). Impact consequence and significance are determined from Part B and C. The interpretation of the impact significance is given in Part D. Both mitigated and unmitigated scenarios are considered for each impact. In addition, a comment on SLR's confidence in the significance rating is provided for each impact. The confidence options range from high, to moderate to low and must be read in the context of the assumptions, uncertainties, and limitations set out in section 3.1.

Table 7-1: Criteria for assessing impacts

PART A: DEFINITIONS AND CRITERIA		
Definition of SIGNIFICANCE		**Significance = consequence x probability**
Definition of CONSEQUENCE		**Consequence is a function of intensity, extent, and duration**
Criteria for ranking of the INTENSITY of environmental impacts	**VH**	Severe change, disturbance, or degradation. Associated with severe consequences. May result in severe illness, injury, or death. Targets, limits, and thresholds of concern continually exceeded. Habitats or ecosystems of high importance for maintaining the persistence of species or habitats that meet critical habitat thresholds. Substantial intervention will be required. Vigorous/widespread community mobilization against project can be expected. May result in legal action if impact occurs.
	H	Prominent change, disturbance, or degradation. Associated with real and substantial consequences. May result in illness or injury. Targets, limits, and thresholds of concern regularly exceeded. Habitats or ecosystems which are important for meeting national/provincial conservation targets. Will definitely require intervention. Threats of community action. Regular complaints can be expected when the impact takes place.
	M	Moderate change, disturbance, or discomfort. Associated with real but not substantial consequences. Targets, limits, and thresholds of concern may occasionally be exceeded. Habitats or ecosystems with important functional value in maintaining biotic integrity. Occasional complaints can be expected.
	L	Minor (Slight) change, disturbance, or nuisance. Associated with minor consequences or deterioration. Targets, limits, and thresholds of concern rarely exceeded. Habitats and ecosystems which are degraded and modified. Require only minor interventions or clean-up actions. Sporadic complaints could be expected.

	VL	Negligible change, disturbance, or nuisance. Associated with very minor consequences or deterioration. Targets, limits, and thresholds of concern never exceeded. Species or habitats with negligible importance. No interventions or clean-up actions required. No complaints anticipated.
	VL+	Negligible change or improvement. Almost no benefits. Change not measurable/will remain in the current range.
	L+	Minor change or improvement. Minor benefits. Change not measurable/will remain in the current range. Few people will experience benefits.
	M+	Moderate change or improvement. Real but not substantial benefits. Will be within or marginally better than the current conditions. Small number of people will experience benefits.
	H+	Prominent change or improvement. Real and substantial benefits. Will be better than current conditions. Many people will experience benefits. General community support.
	VH+	Substantial, large-scale change or improvement. Considerable and widespread benefit. Will be much better than the current conditions. Favourable publicity and/or widespread support expected.
Criteria for ranking the DURATION of impacts	**Very Short term**	Very short, always less than a year or may be intermittent (less than 1 year). Quickly reversible.
	Short term	Short-term, occurs for more than 1 but less than 5 years. Reversible over time.
	Medium term	Medium-term, 5 to 10 years.
	Long term	Long term, between 10 and 20 years. Likely to cease at the end of the operational life of the activity or because of natural processes or by human intervention.
	Very long term/ permanent	Very long, permanent, +20 years. Irreversible. Beyond closure or where recovery is not possible either by natural processes or by human intervention.
Criteria for ranking the EXTENT of impacts	**Site**	A part of the site/property. Impact is limited to the immediate footprint of the activity and within a confined area.
	Whole site	Whole site. Impact is confined to within the project area and its nearby surroundings.
	Beyond site	Beyond the site boundary, affecting immediate neighbours.
	Local	Local area, extending far beyond site boundary.
	Regional/ national	Regional/National. Impact may extend beyond district or regional boundaries with national implications.

PART B: DETERMINING CONSEQUENCE – APPLIES TO POSITIVE OR ADVERSE IMPACTS					
	EXTENT				
	Site	**Whole site**	**Beyond the site, affecting neighbours**	**Local area, extending far beyond site**	**Regional/ National**
INTENSITY = VL					

DURATION	Very long term /permanent	Low	Low	Medium	Medium	Medium
	Long term	Very Low	Low	Low	Medium	Medium
	Medium term	Very Low	Low	Low	Low	Medium
	Short term	Very low	Very Low	Low	Low	Low
	Very short term	Very low	Very Low	Very Low	Very Low	Low
INTENSITY = L						
DURATION	Very long term /permanent	Low	Medium	Medium	High	High
	Long term	Low	Medium	Medium	Medium	High
	Medium term	Low	Low	Medium	Medium	Medium
	Short term	Very low	Low	Low	Medium	Medium
	Very short term	Very low	Very low	Low	Low	Low
INTENSITY = M						
DURATION	Very long term /permanent	Medium	Medium	High	High	Very High
	Long term	Low	Medium	Medium	High	High
	Medium term	Low	Medium	Medium	Medium	High
	Short term	Low	Low	Medium	Medium	Medium
	Very short term	Very low	Low	Low	Low	Medium
INTENSITY = H						
DURATION	Very long term /permanent	Medium	High	High	Very High	Very High
	Long term	Medium	Medium	High	High	Very High
	Medium term	Low	Medium	Medium	High	High
	Short term	Low	Medium	Medium	Medium	High
	Very short term	Very low	Low	Low	Medium	Medium
INTENSITY = VH						
DURATION	Very long term /permanent	Medium	High	Very High	Very High	Very High
	Long term	Medium	High	High	Very High	Very High
	Medium term	Medium	Medium	High	High	Very High
	Short term	Low	Medium	Medium	High	High
	Very short term	Low	Low	Medium	Medium	Medium

PART C: DETERMINING SIGNIFICANCE - APPLIES TO POSITIVE OR ADVERSE IMPACTS							
PROBABILITY (of exposure to impacts)	Definite/ Continuous	VH	Very Low	Low	Medium	High	Very High
	Probable	H	Very Low	Low	Medium	High	Very High
	Possible/ frequent	M	Very Low	Very Low	Low	Medium	High
	Conceivable	L	Insignificant	Very Low	Low	Medium	High
	Unlikely/ improbable	VL	Insignificant	Insignificant	Very Low	Low	Medium
			VL	L	M	H	VH
			CONSEQUENCE				

PART D: INTERPRETATION OF SIGNIFICANCE		
Significance		**Decision guideline**
Very High	**Very High +**	Represents a key factor in decision-making. Adverse impact would be considered a potential fatal flaw unless mitigated to lower significance.
High	**High +**	These beneficial or adverse impacts are considered to be very important considerations and must have an influence on the decision. In the case of adverse impacts, substantial mitigation will be required.
Medium	**Medium +**	These beneficial or adverse impacts may be important but are not likely to be key decision-making factors. In the case of adverse impacts, mitigation will be required.
Low	**Low +**	These beneficial or adverse impacts are unlikely to have a real influence on the decision. In the case of adverse impacts, limited mitigation is likely to be required.
Very Low	**Very Low +**	These beneficial or adverse impacts will not have an influence on the decision. In the case of adverse impacts, mitigation is not required.
Insignificant		Inconsequential, not requiring any consideration.

7.1 SURFACE HYDROLOGY IMPACT ASSESSMENT

Potential impacts to surface water resources were assessed by (SLR, 2023) and included in Appendix D.

7.1.1 Contamination of Surface Water Resources

There are various sources of pollutants from each project phase, which have the potential to pollute surface water, especially in the unmitigated scenario. However, the potential pollution sources are generally temporary and diffuse in the construction, decommissioning and closure phases. Although these sources of pollution are considered temporary, they have pollution potential that can be long-term during the operational phase.

7.1.1.1 Construction Phase

Water Quality Impacts

- Construction activities that include the use of vehicles and machinery, storage of chemicals, fuels and materials, as well as the storage of domestic and industrial waste, have the potential to result in contamination of watercourses.
- Soluble construction materials also have the potential to dissolve in runoff from the area. This can result in an increase of dissolved solids in surface water receptors during periods of heavy rainfall.
- Deterioration of water quality during the construction phase can be attributed to the following:
    - Construction activities loosen topsoil, which makes it susceptible to erosive forces either by wind or rainfall which get deposited into the nearby watercourses.
    - Water contamination could result from poor management of waste during the construction phase if not adequately managed. Typically, the following pollution sources exist: building materials, lubricants, and sewage or wastewater at the construction site etc.

- Discharge of dirty water into the catchment around the project site when unplanned events occur, some of the structures may overtop and overflow, causing dirty material to wash into nearby ephemeral drainage lines.

The impact on surface water quality during the construction phase has been assessed to have a moderate intensity that would occur over the short-term (1-5 years). It is expected to impact the immediate neighbouring watercourses, however the significance prior to mitigation is assessed to be **Medium**, while after implementation of mitigation measures, the impact can be reduced to **Low** as shown in Table 7-2 below.

Table 7-2: Contamination of surface water resources in construction phase

Description of Impact		
Type of Impact	Direct	
Nature of Impact	Negative	
Phases	Construction	
Criteria	**Without Mitigation**	**With Mitigation**
Intensity	Moderate change (Medium)	Minor change (Low)
Duration	Short-term (1 and 5 years)	Short-term (1 and 5 years)
Extent	Beyond site	Beyond site
Consequence	Medium	Low
Probability	Probable	Probable
Significance	**Medium -**	**Low -**
Additional Assessment Criteria		
Degree to which impact can be reversed	*The impact can be **partially reversible** with the implementation of mitigations measures.* *Although drainage lines in the PV plant site rarely flows, measures outlined in the Stormwater Management Plan (SWMP) and summarised in the Hydrological Management Plan must be implemented to minimise potential contamination of water in the drainage lines, should there be flows (refer to the ESMP).*	
Degree to which impact may cause irreplaceable loss of resources	***Medium** as construction phase last for short period of time, therefore, will result in less water pollution.*	
Degree to which impact can be avoided	***Medium** as the impact cannot be avoided, however the significance can be reduced through the application of mitigation measures.*	
Degree to which impact can be mitigated	***Medium** as the recommended mitigations can reduce the significance from medium to low.*	
Cumulative impact		
Nature of cumulative impacts	*The cumulative impact is assessed to be medium because there are no other development activities taking place close to the proposed #Gaingu PV Plant.*	
Rating of cumulative impacts	**Without Mitigation**	**With Mitigation**
	Medium -	**Low -**

Description of Impact	
Residual impact	
Residual impact discussion	*The residual impact is Low.*

Mitigation

- Minimise the disturbance of soils as much as possible by restricting construction activities within demarcated areas.
- Phasing / scheduling of earthworks should be implemented to minimise the footprint that is at risk of erosion at any given time, or schedule works according to the season. Construction is recommended for months or seasons where there is less rainfall.
- Progressive rehabilitation of disturbed land should be carried out to minimize the amount of time that bare soils are exposed to the erosive effects of rain and subsequent runoff.
- Traffic and movement over stabilised areas should be controlled (minimised and kept to certain paths), and damage to stabilised areas should be repaired timeously and maintained.
- In case of an occurrence of a discharge incident that could result in the pollution of surface water resources, an emergency response procedure should be implemented.
- Water quality monitoring should be undertaken as per the monitoring programme (as outlined in the relevant section of the ESMP included in Appendix M).
- Maintenance of vehicles to be undertaken in a bunded lined area or off-site the project area.
- A spill kit must be kept on-site and be easily accessible.
- Good housekeeping practices should be implemented and maintained by timeous cleaning-up of accidental spillages. Waste should be disposed to a licensed waste site. In addition, spill cleaning kits and material safety data sheets for chemical and hazardous substances should be accessible and available.

7.1.1.2 Operational Phase

Water Quality Impacts

- Any stormwater runoff from operational areas may carry or wash potential pollutants such as oils, solvents, paints, fuels and waste materials into the nearby ephemeral drainage lines.

The impact on surface water during the operational phase has been assessed to have a moderate intensity and would occur over the long-term (10 to 20 years) during the operational phase. It is expected to impact immediate neighbours and as such the significance prior to mitigation is assessed to be **Medium**. With the implementation of mitigation measures the impact can be reduced to **Low**, as shown below in in Table 7-3.

Table 7-3: Contamination of surface water resources in operational phase

Description of Impact		
Type of Impact	Direct	
Nature of Impact	Negative	
Phases	Operational	
Criteria	**Without Mitigation**	**With Mitigation**

Description of Impact		
Intensity	Moderate change (Medium)	Minor change (Low)
Duration	Long-term (10 and 20 years	Long-term (10 and 20 years
Extent	Beyond site	Beyond site
Consequence	Medium	Medium
Probability	Probable	Possible / frequent
Significance	**Medium -**	**Low -**
Degree to which impact can be reversed	*The impact is **partially reversible** as it is temporary during the operational phase and can be reversed when the operations ends. Also, the stormwater management are recommended to reduce the impact.*	
Degree to which impact may cause irreplaceable loss of resources	***Medium** as the operational phase last for long this implies that there is a high chance of surface water quality degradation should the recommended mitigation measures are not implemented.* *However, with the implementation of mitigation measures irreplaceable loss of resources is expected to be low.*	
Degree to which impact can be avoided	***Medium,** as the impact cannot be avoided, however, the significance can be reduced through the application of mitigation measures, rehabilitation, and restoration measures.*	
Degree to which impact can be mitigated	***Medium** with the implementation of mitigation measures presented as well as using the proposed monitoring plan presented in the ESMP to ensure measures work as intended to mitigate the impact during operational phase.*	
Cumulative impact		
Nature of cumulative impacts	*The cumulative impact is assessed to be medium because there are no other development activities taking place close to the proposed Gaingu PV Plant that might impact on water quality*	
Rating of cumulative impacts	**Without Mitigation**	**With Mitigation**
	Medium -	**Low -**
Residual impact		
Residual impact discussion	*The residual impact is considered to be Low after the implementation of mitigation.*	

Mitigation

- Adhere to the mitigation measures as per the SWMP (refer to the relevant section in the ESMP included in Appendix M).
- Stormwater management measures have been recommended whereby:
    - Dirty water catchments will be separated from clean water catchments.
    - Clean water diversion berms will be designed to divert any clean surface water generated upstream of the proposed infrastructure, away from the development and dirty water areas.

- Dirty water will be collected in lined channels and contained. Containment facilities will be lined and sized to contain at least the 1:100-year storm event in accordance with EHS requirements.
- Dirty water that cannot be contained or re-used will be treated before being discharged into the environment.
- Dirty water dams/ponds must be designed, constructed, maintained, and operated to have a minimum of a 0.8 m freeboard above full supply level.

- Water quality monitoring should be undertaken as per the monitoring programme (as outlined in the relevant section in the ESMP included in Appendix M).
- An emergency response plan procedure should be formulated and adhered to during any occurrence of incident discharge or spillage of chemicals.
- Good housekeeping practices should be implemented and maintained by timeous cleaning-up of accidental spillages. Waste should be disposed to a licensed waste site. In addition, spill cleaning kits and material safety data sheets for chemical and hazardous substances should be accessible and available.

7.1.1.3 Decommissioning Phase

Water Quality Impacts

Surface water resources are receptors of fine materials and contaminants arising from the demolition of infrastructure. The contaminants might include oil and fuel from storage areas, domestic and other industrial chemicals.

The impact on surface water quality during the closure phase has been assessed to have a moderate intensity and would occur over the short-term (1-5 years). It is expected that immediate neighbours and close watercourses will be impacted, however the significance prior to mitigation is assessed to be **Medium**, while after implementation of mitigation measures, the impact can be reduced to **Low** as shown in Table 7-4 below.

Table 7-4: Contamination of surface water resources in decommissioning phase

Description of Impact		
Type of Impact	Direct	
Nature of Impact	Negative	
Phases	Decommissioning	
Criteria	**Without Mitigation**	**With Mitigation**
Intensity	Moderate change (Medium)	Minor change (Low)
Duration	Short-term (1 and 5 years)	Short-term (1 and 5 years)
Extent	Beyond site	Beyond site
Consequence	Medium	Low
Probability	Probable	Probable
Significance	**Medium -**	**Low -**

Description of Impact		
Degree to which impact can be reversed	*The impact can be **partially reversible** with the implementation of rehabilitation and restoration measures.*	
Degree to which impact may cause irreplaceable loss of resources	***Medium** as closure phase last for short period of time, therefore, will result in less pollution.*	
Degree to which impact can be avoided	***Medium** as the impact cannot be avoided, however the significance can be reduced through the application of mitigation measures.*	
Degree to which impact can be mitigated	***Medium** as the recommended mitigations can reduce the significance from medium to low.*	
Cumulative impact		
Nature of cumulative impacts	*The cumulative impact is assessed to be medium because there are no other development activities taking place close to the proposed Gaingu PV Plant that might impact on water quality during decommissioning phase.*	
Rating of cumulative impacts	**Without Mitigation**	**With Mitigation**
	Medium -	**Low -**
Residual impact		
Residual impact discussion	*The residual impact is considered to be low.*	

Mitigation

- The decommissioning phase should be done in seasons of low rainfall to limit the washing of sediments and other chemicals from the demolished infrastructure into the surface water resources.
- Water quality monitoring should be undertaken as per the monitoring programme.
- A post rehabilitation audit should be undertaken to ascertain whether the remediation has been successful and if not, further measures should be recommended and implemented.
- Good housekeeping practices should be implemented and maintained by timeous cleaning-up of accidental spillages. Waste should be disposed to a licensed waste site. In addition, spill cleaning kits and material safety data sheets for chemical and hazardous substances should be accessible and available.

7.1.2 Flooding

Stormwater currently generally flows via natural drainage flow paths on site. However, the proposed development would change the land use, which may impact the hydrological response of the area (infiltration and runoff). The paving and compaction of surfaces during construction of associated infrastructure will very likely result in increased runoff and runoff volume. Therefore, the increased flood volumes and peak flows will result in erosion of the natural drainage lines and flooding of any infrastructure located close to the drainage lines.

7.1.2.1 Construction, Operational & Decommissioning Phase

The #Gaingu PV Plant infrastructure might be susceptible to flooding by non-perennial rivers/drainage lines during extreme rainfall events which are very rare given to the dry conditions in project site. The flooding impact will continue throughout the construction, operational and decommissioning phases.

The significance is **Medium** in all phases without mitigation, and it reduces to **Low** with mitigation measures as shown in Table 7-5.

Table 7-5: Flooding in construction, operation and decommissioning phases

Description of Impact		
Type of Impact	Direct	
Nature of Impact	Negative	
Phases	All	
Criteria	**Without Mitigation**	**With Mitigation**
Intensity	Moderate change (Medium)	Negligible change (Very low)
Duration	Long-term (10 and 20 years	Long-term (10 and 20 years
Extent	Beyond site	Beyond site
Consequence	Medium	Low
Probability	Probable	Probable
Significance	**Medium**	**Low**
Additional Assessment Criteria		
Degree to which impact can be reversed	*The impact is **partially reversable** with the implementation of stormwater management measures.*	
Degree to which impact may cause irreplaceable loss of resources	***Low** as the rivers are non-perennial and does not flow most of the times.*	
Degree to which impact can be avoided	***High** with the implementation of all recommended stormwater management measures.* *The recommended stormwater containment measures will be designed, managed, and operated with a 0.8m freeboard above full supply level to minimise frequent spillages that might cause localised flooding.* *A recommended maintenance plan for all stormwater management infrastructure is aiming at ensuring that all measures are free of debris and silt to ensure flood water is conveyed as intended and avoid flooding.*	
Degree to which impact can be mitigated	***High** with the implementation of mitigation measures presented as well using the Monitoring Plan presented in the ESMP to check the effectiveness of mitigation measures recommended.*	
Cumulative impact		
Nature of cumulative impacts	*The cumulative impacts are assessed to be low as the rivers are always dry and there is no other development close by that can increase flooding incident.*	
Rating of cumulative impacts	**Without Mitigation**	**With Mitigation**
	Medium	**Low**

Description of Impact	
Residual impact	
Residual impact discussion	*The residual impact is Low after application of mitigation measures.*

Mitigation

- The PV plant and associated infrastructure, according to IFC requirements, must be sited and operated such that the facilities do not impede the flow of water.
- Detailed SWMP (as outlined in the ESMP included in Appendix M) should be prepared for built-up infrastructure.
- Stormwater management infrastructure should be designed in a manner that prevents frequent spills and minimize flooding.
- Rainwater harvesting is also recommended to manage water emanating from impervious areas.
- Monitoring and inspection of channels, containment berms, silt traps, culverts for signs of erosion, cracking, silting and blockages of inflows, to ensure the efficient performance of the storm water infrastructure during storm events is recommended.
- Monitoring should be undertaken monthly during the wet season and after storm events or as per the site management schedule, where available.
- The monitoring plan should be reviewed regularly to ensure effectiveness of measures recommended.

7.1.3 Alteration of Natural Drainage Patterns and Flow

The site infrastructure and associated SWMP measures may alter the hydrologic response of the project site (infiltration and runoff), and this has a potential to spread across the whole site if not mitigated.

The development is associated with the removal of vegetation, compaction of soils, and introduction of impervious land cover. This results in high peak flows, high runoff volumes that report to downstream rivers changing the natural flow regime of receiving watercourses. Due to increased peak flows and high volume of water, riverbanks may also become unstable, and erode.

7.1.3.1 Construction, Operation and Decommissioning Phase

During the construction, operational and decommissioning phases, the surface water run-off will be affected by the proposed infrastructure, which will be designed and constructed as required by legislation. The stormwater management infrastructure will be used to attenuate and contain any runoff from the dirty water catchments and divert clean water away from dirty water areas.

The alteration of the drainage patterns may occur in all the phases. The impacts of the activities in all the phases were rated as **Medium** without mitigation and it reduces to **Low** with mitigation measures as shown in Table 7-6 below.

Table 7-6: Alteration of natural drainage patterns and flow during construction, operational and decommissioning phases

Description of Impact		
Type of Impact	Direct	
Nature of Impact	Negative	
Phases	All	
Criteria	**Without Mitigation**	**With Mitigation**
Intensity	Moderate change (Medium)	Moderate change (Medium)
Duration	Long-term (10 and 20 years	Long-term (10 and 20 years
Extent	Beyond site	Site
Consequence	Medium	Low
Probability	Probable	Probable
Significance	**Medium -**	**Low -**
Additional Assessment Criteria		
Degree to which impact can be reversed	***Partially reversable*** *at the Gaingu PV site there will be buildings and paved areas which introduce impervious surfaces. These will be present throughout the life of the PV plant or even beyond.*	
Degree to which impact may cause irreplaceable loss of resources	***Medium*** *the photovoltaic plant can take up large areas of land, approximately 342 hectares of land has been earmarked for the plant. Some drainage lines might be permanently disturbed but only limited to the areas being developed and covered by the solar PV infrastructure.*	
Degree to which impact can be avoided	***Medium*** *disturbance of drainage lines may not entirely be avoided; however, it will be limited to areas that need to be developed.* *Stormwater measures are proposed to manage runoff from the site and runoff emanating from impervious areas with the site to minimise rapid change in natural flow regimes of drainage lines.*	
Degree to which impact can be mitigated	***Medium*** *with the implementation of the recommended stormwater infrastructure will help to reduce the impact from medium to low.*	
Cumulative impact		
Nature of cumulative impacts	*The cumulative impact is low as no other developments are known to be taking place or planned near the project site.*	
Rating of cumulative impacts	**Without Mitigation**	**With Mitigation**
	Medium -	**Low -**
Residual impact		
Residual impact discussion	*The residual impact is considered Low.*	

Mitigation

The increased flow resulting from the development must be managed by the SWMP measures (as outlined in the ESMP included as Appendix P) to avoid frequent stormwater discharges into the downstream watercourses and provide some flow attenuation.

7.2 AVIFAUNA IMPACT ASSESSMENT

This section is based on the Avifauna Impact Assessment undertaken for the proposed project by African Conservation Services cc (African Conservation Services cc, 2023) and is included in Appendix F.

Fourteen priority bird species have been identified in the project area (refer to Section 6.6.6, Table 6-1) that could be impacted by the proposed PV plant and associated powerline. The priority species are potentially at risk to the following impacts:

- Physical/human disturbance of birds;
- Direct and indirect modification/loss/destruction of bird habitat;
- Attraction of birds to novel habitats through the artificial provision of scarce resources;
- Bird electrocutions on power line structures; and
- Bird collisions with infrastructure such as solar panel arrays, fences, guyed masts and power lines.

7.2.1 Physical/human disturbance of birds, including noise and light disturbance

Physical/human disturbance can potentially impact birds during both the construction, operational and decommissioning phases, thereby affecting the presence and/or foraging and breeding success of key species (Jenkins et al. 2017). During the construction phase, vehicle and human activity on the site is at a peak, with high levels of disturbance. There is a potential for road mortalities, and for poaching of birds (including chicks) and eggs. Once operational, the amount of disturbance should decrease.

Disturbance in the form of artificial lighting may impact on night-flying or migrant birds, especially in terms of causing disorientation and/or collisions on structures. Research indicates that lights can attract and confuse migrating birds (Gehring et al. 2009; Manville 2005, 2009, 2013). Some insectivorous birds may also be attracted to lights. New forms of lighting in areas that were previously unlit may exacerbate the problem of collisions, and also affect movement patterns and corridors. It has been found that nocturnally migrating birds (small passerines, in this case) may become attracted to an isolated pool of diffused light (G Martin pers. comm.). When there is no moon, plus low fog, the birds could also become attracted to an illuminated, reflective array of solar panels; perhaps becoming disorientated because they are used to following visual clues such as the moon.

The existing disturbance levels at the proposed inland solar PV plant site are minimal. During construction disturbance levels, including human, machine and vehicle activity, at the site are also likely to be high in view of the relatively large size of the proposed development (176 ha for the solar PV array for SS1 and SS2 combined), even if this takes place in two stages. During operations there will be ongoing activities but it will be at a lower level, and noise and other disturbance levels at the solar site are thus likely to decrease. Security lighting will be in effect during operation.
The results of disturbance may be indirect or direct, and likely to be cumulative. These could include:

- Potential impacts of noise caused by construction activities on foraging or breeding birds;
- Displacement of birds from areas suitable for them before development, either temporarily or permanently; possible barrier effects to normal movements;
- A reduction in bird breeding success due to displacement (including of any territorial bird species);

- Unnatural mortalities or injuries of birds (adults and chicks), caused by road collisions or poaching;
- Disorientation of night-flying birds by artificial lighting, including migrants; lighting could enhance opportunities for predation of adults, chicks and eggs; and/or
- Indirectly, mortalities of adults could also lead to the mortalities of dependent chicks.

Priority bird species in the study area may potentially be impacted by disturbance as a result of the construction of the new solar PV development and power line, resulting in displacement; such sensitivity is particularly high during breeding activities; impacts are likely to be cumulative. These species include:

- ***Ludwig's Bustard** (Endangered, Globally Endangered; partial migrant); nomadic; readily displaced by disturbance.
- ***Rüppell's Korhaan** (near endemic to Namibia); breeding suspected in the area; disturbance and lighting could enhance opportunities for predation of adults, chicks and eggs; sedentary and may return to the site once disturbance levels decrease.
- ***Gray's Lark** (near endemic to Namibia; sedentary/nomadic); breeding suspected in the area; disturbance could cause displacement; may return to the site once disturbance levels decrease, if suitable habitats remain.
- ***Martial Eagle** (Endangered, Globally Endangered); sedentary, with breeding recorded in greater area; disturbance could cause displacement.
- ***Lappet-faced Vulture** (Endangered, Globally Endangered); breeding recorded in greater area; disturbance could cause displacement.
- Other raptors, e.g., *Black-chested Snake Eagle; *Rock Kestrel and *Greater Kestrel; *Pale Chanting Goshawk; Peregrine Falcon; disturbance could create stress/displacement for this territorial group.
- Aquatic species such as Lesser Flamingo and Greater Flamingo (and possibly Great White Pelican) are non-resident and move through the area, mainly at night, and are thus at lower risk to disturbance.

The significance of the impact for the PV plant is **Medium** without mitigation, reduced to **Low** with mitigation as shown in Table 7-7.

Table 7-7: Impact of physical/human disturbance of birds, including noise and light disturbance for PV plant

Physical/human disturbance of birds, including noise and light disturbance		
Type of Impact	Direct	
Nature of Impact	Negative	
Phases	All Phases	
Criteria	**Without Mitigation**	**With Mitigation**
Intensity	Prominent change (High)	Moderate change (Medium)
Duration	Short-term (1 to 5 years)	Short-term (1 to 5 years)

Physical/human disturbance of birds, including noise and light disturbance		
Extent	Whole site and nearby surroundings	Whole site and nearby surroundings
Consequence	Medium	Low
Probability	Definite / Continuous (Very high)	Probable (High)
Significance	**Medium -**	**Low -**
Additional Assessment Criteria		
Degree to which impact can be reversed	***Partially reversible*** *(Rüppell's Korhaan, Gray's Lark may return to the site)*	
Degree to which impact may cause irreplaceable loss of resources	***Low***	
Degree to which impact can be avoided	***Medium***	
Degree to which impact can be mitigated	***Medium***	
Cumulative impact		
Extent to which the cumulative impact may arise	*Likely*	
Rating of cumulative impacts	**Without Mitigation**	**With Mitigation**
	Medium -	**Low -**
Residual impact		
Residual impact discussion	*The potential impacts of physical/human disturbance on the receiving environment (in this case, on birds) cannot be eliminated as disturbance (including noise and light disturbance) is an unavoidable part of the construction, and operation, process. With the effective implementation of mitigation measures, the residual impact will be reduced to LOW significance.*	

The significance of the impact for the powerline is **Low** without mitigation, reduced to **Insignificant** with mitigation as shown in Table 7-8.

Table 7-8: Impact of physical/human disturbance of birds, including noise and light disturbance for powerline

Physical/human disturbance of birds, including noise and light disturbance		
Type of Impact	Direct	
Nature of Impact	Negative	
Phases	All Phases	
Criteria	**Without Mitigation**	**With Mitigation**
Intensity	Moderate change (Medium)	Negligible change (Very low)
Duration	Short-term (1 to 5 years)	Very Short-term (< 1 year)

Physical/human disturbance of birds, including noise and light disturbance		
Extent	Whole site and nearby surroundings	Whole site and nearby surroundings
Consequence	Low	Very low
Probability	Probable (High)	Possible / frequent (Medium)
Significance	**Low -**	**Insignificant -**
Additional Assessment Criteria		
Degree to which impact can be reversed	***Partially reversible***	
Degree to which impact may cause irreplaceable loss of resources	***Very low***	
Degree to which impact can be avoided	***Medium***	
Degree to which impact can be mitigated	***Medium***	
Cumulative impact		
Extent to which the cumulative impact may arise	*Unlikely*	
Rating of cumulative impacts	**Without Mitigation**	**With Mitigation**
	Low -	**Very low -**
Residual impact		
Residual impact discussion	*The potential impacts of physical/human disturbance on the receiving environment (in this case, on birds) cannot be eliminated as disturbance (including noise and light disturbance) is an unavoidable part of the construction, and operation, process. With the effective implementation of mitigation measures, the residual impact will be reduced to LOW significance.*	

7.2.1.1 Mitigation

Construction

- Before construction starts, the proposed solar PV site and the proposed power line route should be inspected for any signs of bird nesting activity. Disturbance of nesting/chick-rearing birds should be avoided (breeding season for Rüppell's Korhaan is mainly February-May; for Gray's Lark May-July).
- Implement abatement controls (as outlined in the ESMP) to reduce noise disturbance created during construction.
- Implement operational controls to manage and regulate contractor activity, such as:
  - A speed limit should be strictly enforced.
  - The construction activity should be restricted to the actual construction site and no unnecessary movement of vehicles or people should be allowed outside the construction zone. All vehicles should be fitted with silencers.
  - Exclusion fencing should be erected around identified sensitive areas, if required (e.g., pre-identified active nesting sites).

- Anti-poaching measures should be strictly enforced, with zero tolerance, and this should be emphasised during induction to contractors; offenders should be prosecuted.

- Ongoing awareness should be promoted amongst construction workers and staff about the value of biodiversity and the negative impacts of disturbance, especially to breeding birds, and of poaching and road mortality.

Operation

- As far as possible, the use of outdoor lighting should be minimised (Jenkins et al. 2017). Security lighting should be kept to the minimum and directed downward and away from any reflective surfaces.
- Lighting on any high structures (e.g., weather/communication masts) should preferably be flashing rather than static (G Martin pers. comm.); and red, intermittent lighting is recommended in general (Bennun et al. 2021), if permitted by the Namibian Civil Aviation Authority (NCAA).
- Noise levels should be kept to a minimum during operation.

7.2.2 Direct and indirect modification/loss/destruction of bird habitat

Any removal or disturbance/modification of natural vegetation will in turn impact avifaunal habitat, potentially impacting on their ability to breed, forage and roost in the vicinity. The sparsely vegetated drainage lines on the gravel plains in the study area are sensitive, and particularly vulnerable to habitat destruction resulting from development.

Solar developments can potentially affect birds by destroying or degrading large areas of habitat, displacing sensitive species (Jenkins et al. 2017), particularly in the case of the present solar PV development that entails a total footprint size of 176 ha (for the PV array for SS1 and SS2 combined). In many cases, solar PV facilities have involved the complete removal of vegetation from the inclusive footprint of the installed plant (Lovich & Ennen 2011; DeVault et al. 2014).

It is this tendency to destroy, degrade, fragment or otherwise displace birds from large areas of natural habitat that has stimulated most concern to date about the implications for avifauna of large-scale solar PV developments (Lovich & Ennen 2011; RSPB 2011; UNEP/CMS 2015), particularly in relation to (near-endemic) species with restricted ranges and very specific habitat requirements, for example Rüppell's Korhaan and Gray's Lark.

A large concentration of solar plants in one area may also lead to increased levels of fragmentation and barrier effects to terrestrial species, particularly if the sites are fenced (Bennun et al. 2021).

The results of habitat destruction/modification may be indirect or direct, and could include:

- Displacement of birds from areas suitable for them before development, either temporarily or permanently; barrier effects to normal movements/activities;
- A reduction in bird breeding success due to displacement (including of territorial bird species); and/or
- Permanent modification/destruction of sensitive habitats, already subject to cumulative impacts.

Habitat modification/loss/destruction is known to impact on bird species in different ways, resulting in displacement that may be either temporary or permanent.

Priority bird species in the study area that may potentially be impacted by habitat modification/ loss/destruction as a result of the construction of the new solar PV plant and power line include the terrestrial species below; although this area is not regarded as Critical Habitat, these species are subject to increasing cumulative impacts of habitat losses due to development.

- **Ludwig's Bustard** (Endangered, Globally Endangered; partial migrant); nomadic; dependent on (limited) ephemeral grassy habitats, resulting from good rainfall, and drainage lines.
- ***Rüppell's Korhaan** (near endemic to Namibia); subject to cumulative impacts including habitat loss; sedentary, with suspected breeding in the area; may possibly return to the site (once disturbance levels decrease) if suitable habitats are created, e.g., due to shade and increased water run-off from solar panels, and resultant vegetation flush; individuals affected but not populations.
- ***Gray's Lark** (Namibian near-endemic; sedentary/nomadic); suspected breeding in solar PV plant area; potentially displaced by habitat loss; may possibly return to the site (once disturbance levels decrease) if suitable habitats are created, e.g., due to shade and increased water run-off from solar panels, and resultant vegetation flush; individuals affected but not populations.
- **Raptors**, e.g., ***Lappet-Faced Vulture**, ***Martial Eagle**; and *Black-chested Snake Eagle; *Rock Kestrel and *Greater Kestrel; *Pale Chanting Goshawk; Peregrine Falcon; loss of habitat could reduce breeding and feeding opportunities and result in stress/displacement for this territorial group.

The significance of the impact for the PV plant is Medium with and without mitigation, on as shown in Table 7-9. The significance of the impact for the powerline is Medium without and Low with mitigation, on as shown in
Table 7-10.

Table 7-9: Impact of direct and indirect modification/loss/destruction of bird habitat at the PV plant

Direct and indirect modification/loss/destruction of bird habitat		
Type of Impact	Direct	
Nature of Impact	Negative	
Phases	Construction and Operation	
Criteria	**Without Mitigation**	**With Mitigation**
Intensity	Prominent change (High)	Moderate change (Medium)
Duration	Long-term (10 to 20 years)	Long-term (10 to 20 years)
Extent	Whole site and nearby surroundings	Whole site and nearby surroundings
Consequence	Medium	Medium
Probability	Definite / Continuous (Very high)	Probable (High)

Direct and indirect modification/loss/destruction of bird habitat		
Significance	**Medium -**	**Medium -**
Additional Assessment Criteria		
Degree to which impact can be reversed	***Partially reversible***	
Degree to which impact may cause irreplaceable loss of resources	***Low*** *(habitat of Ruppell's Korhaan, Gray's Lark impacted but both species could return; not Critical Habitat)*	
Degree to which impact can be avoided	***None***	
Degree to which impact can be mitigated	***Medium***	
Cumulative impact		
Extent to which the cumulative impact may arise	*Likely*	
Rating of cumulative impacts	**Without Mitigation**	**With Mitigation**
	Medium -	**Low -**
Residual impact		
Residual impact discussion	*The potential impacts of direct and indirect modification/loss/destruction of habitat on the receiving environment (in this case, on birds) cannot be eliminated as such habitat changes are an unavoidable part of the construction process. With the effective implementation of mitigation measures, the residual impact will be reduced to LOW significance.*	

Table 7-10: Impact of direct and indirect modification/loss/destruction of bird habitat for the powerline

Direct and indirect modification/loss/destruction of bird habitat		
Type of Impact	Direct	
Nature of Impact	Negative	
Phases	Construction and Operation	
Criteria	**Without Mitigation**	**With Mitigation**
Intensity	Minor change (Low)	Minor change (Low)
Duration	Short-term (1 to 5 years)	Short-term (1 to 5 years)
Extent	Whole site and nearby surroundings	Whole site and nearby surroundings
Consequence	Low	Low
Probability	Probable (High)	Possible / frequent (Medium)
Significance	**Medium -**	**Low -**
Additional Assessment Criteria		
Degree to which impact can be reversed	***Partially reversible***	
Degree to which impact may cause irreplaceable loss of resources	***Low*** *(habitat of Ruppell's Korhaan, Gray's Lark impacted but both species could return; not Critical Habitat)*	
Degree to which impact can be avoided	***None***	
Degree to which impact can be mitigated	***Medium***	

Direct and indirect modification/loss/destruction of bird habitat		
Cumulative impact		
Extent to which the cumulative impact may arise	*Likely*	
Rating of cumulative impacts	**Without Mitigation**	**With Mitigation**
	Medium -	**Low -**
Residual impact		
Residual impact discussion	*The potential impacts of direct and indirect modification/loss/destruction of habitat on the receiving environment (in this case, on birds) cannot be eliminated as such habitat changes are an unavoidable part of the construction process. With the effective implementation of mitigation measures, the residual impact will be reduced to LOW significance.*	

7.2.2.1 Mitigation

- Micro-siting: where possible avoid the unnecessary destruction of habitat or degradation of the environment; water courses and drainage lines are particularly sensitive. The larger watercourses (e.g., 22.064439S 15.064439E to 22.048994S 15.046793E) should be regarded as no-go areas in terms of development.
- Rehabilitate degraded or damaged biodiversity features and ecosystem services that cannot be completely avoided and/or minimised, e.g., by restoration of temporary-use and lay-down areas as soon as reasonably practicable after construction activities are complete.
- Implement abatement control measures to reduce emissions and pollutants (erosion, dust, waste) created during construction; wastewater management and water conservation measures.
- Implement operational controls to manage and regulate contractor activity, such as exclusion fencing around sensitive areas (e.g., pre-identified active nest sites), designated machinery and lay-down areas, minimisation of vegetation loss and disturbance to soil; managing the timing of vegetation control activities at suitable intervals.
- Ongoing awareness should be promoted about the value of biodiversity and the negative impacts of habitat destruction.

7.2.3 Attraction of birds to novel habitats through the artificial provision of scarce resources

The construction of buildings and other infrastructure has the potential to attract species such as gulls, by providing perch sites on roofs, walls and other structures.

Solar PV developments may attract novel species to an area by the artificial provision of otherwise scarce resources – for example perches, nest sites and shade (DeVault *et al.* 2014; Jenkins *et al.* 2017). Potentially positive impacts of solar energy projects on birds include the use of the various raised structural components of these developments as artificial nesting and roosting sites by a suite of otherwise tree-nesting species (Lovich and Ennen 2011; Hernandez *et al.* 2014). The effects of this impact would be more marked in a relatively treeless environment such as the present study area. It is considered that the ultimate impact of this phenomenon – in terms of the effect of inflated numbers

of some species on the overall species composition in the vicinity of the development area, and the possible need for management or removal of these nests by the developer – is difficult to predict (Jenkins *et al.* 2017).

In terms of the present study, increased shade, water run-off and the resultant vegetation flush at the solar PV site could potentially attract ground-breeding species such as the near-endemic Rüppell's Korhaan and Gray's Lark, once disturbance levels become lower after construction. Although this impact is potentially positive, it could also have negative indirect impacts, e.g., entrapment in fences if the bird is startled; and predation, including of eggs/chicks.

The provision of artificial habitats/resources such as power line poles, transformers and other structures could also result in negative impacts on the power supply (i.e., flash-overs) caused by bird nesting, perching and other activities. Distribution lines (such as the proposed 33 kV line) are more at risk to such impacts, given the smaller clearances. Crow nests on power line structures may contain pieces of wire, which could cause outages. Pied Crow has been recorded in the greater study area, but in low numbers at present; Cape Crow could also occur.

Crows and gulls are attracted to food sources in areas with human activity and may similarly be attracted to new food sources, e.g., food waste associated with construction workers.

Nesting and perching on solar PV structures by (non-priority) groups such as crows, gulls, doves/ pigeons and sparrows may cause pollution and/or technical problems. Tractrac Chat (a ground-nesting species) occurs in the main study area and perches readily on the highest object within reach.

Priority bird species in the study area that may potentially be impacted by the attraction to novel (artificial) habitats and resources include:

- ***Rüppell's Korhaan** and ***Gray's Lark** (both near-endemic to Namibia) may return to the solar PV area after construction if suitable habitats are formed due to increased shade and water run-off from solar panels, with resultant vegetation flush; although potentially positive, this behaviour could place them at risk to other impacts, such as predation or collisions on infrastructure; and
- **Raptors** may perch/hunt from or attempt to nest on solar PV plant infrastructure (but not necessarily cause negative impacts); however, such activities on power line infrastructure could result in electrocution.
- Non-priority species may impact on solar PV or infrastructure, e.g.:
    - *Pied Crow.
    - Rock Dove (Feral Pigeon), Speckled (Rock) Pigeon.
    - *Tractrac Chat.

The significance of the impact is **Medium** without mitigation; no mitigation is proposed (Table 7-11), but adaptive management is recommended based on monitoring results.

Table 7-11: Impact of attraction of birds to novel habitats through the artificial provision of scarce resources

Attraction of birds to novel habitats through the artificial provision of scarce resources		
Type of Impact	Direct and Indirect	
Nature of Impact	Negative	
Phases	Construction and Operation	
Criteria	**Without Mitigation**	**With Mitigation**
Intensity	Minor change (Low)	No major mitigation measures are proposed; adaptive management is recommended, based on monitoring results, which would reduce the impact to low/very low.
Duration	Long-term (10 to 20 years)	
Extent	Whole site and nearby surroundings	
Consequence	Medium	
Probability	Probable (High)	
Significance	**Medium -**	
Additional Assessment Criteria		
Degree to which impact can be reversed	*Impact can be reversed at end of project by the removal of such structures*	
Degree to which impact may cause irreplaceable loss of resources	***Low**; some negative impacts on infrastructure (negative for developer)*	
Degree to which impact can be avoided	***Medium***	
Degree to which impact can be mitigated	***Medium**: impact can be mitigated through adaptive management*	
Cumulative impact		
Extent to which the cumulative impact may arise	*Possible*	
Rating of cumulative impacts	**Without Mitigation**	**With Mitigation**
	Medium -	**Low -**
Residual impact		
Residual impact discussion	*The potential impacts caused by the attraction of birds to novel habitats through the provision of artificial habitats and resources on the receiving environment (in this case, on birds) cannot be eliminated as the creation of artificial habitats and resources is an unavoidable part of the construction, and operation, process. With the effective implementation of mitigation measures (based on an adaptive management approach), the residual impact will be reduced to LOW significance.*	

7.2.3.1 Mitigation

- Construction phase
  - Ensure strict and effective waste management (including of food) during construction activities, to discourage an unnatural increase in scavenging species such as Pied Crow.
  - Avoid creating new habitats with open water, e.g., accumulations of stormwater or pipe leakages/open water/run-off, that may attract birds.

- Operational phase
  - Monitoring is essential to identify (potential) problem areas (refer to the ESMP); any movement of hitherto unrecorded species onto or beneath the solar panel structures should be monitored; and any resulting negative impacts (e.g., entrapment of korhaans or other species including spurfowl/ francolins in fences; predation), should be addressed accordingly.
  - Bird perching or nesting activities on solar infrastructure may become a problem (e.g., by causing fouling of the solar panels), and adaptive management measures may be required (such as anti-perch measures, e.g., spanning a low wire across the perching area). Nesting activities should be discouraged early in the cycle, before any eggs are laid; the Ministry of Environment, Forestry and Tourism (MEFT) should be contacted for specific guidelines for dealing with such problems.
  - Numerous actions/devices have been developed to deter birds from an area (WEST 2014; Walston et al. 2015, UNEP/CMS 2015; Jenkins et al. 2017). In terms of solar PV arrays, these deterrents could include habitat management, control of prey populations, anti-perching devices, nest-proofing, netting or other enclosures, scaring or chasing (e.g., with trained dogs), bio-acoustic or visual deterrence. The desirability and effectiveness and such deterrents would need to be considered on a case-by-case basis, using an adaptive management approach.
  - Should any nesting or other activity by crows on power supply structures cause disruptions of the power supply, consult with the MEFT for appropriate measures to discourage and manage such activities, e.g., by removing nests at a stage when this is acceptable.

7.2.4 Bird electrocutions on power line infrastructure

An electrocution occurs when a large bird is perched or attempts to perch on an electrical structure and causes an electrical short circuit by physically bridging the air gap between live components and/or live and earthed components. An electrocution could also be caused should a large bird perch on top of a tower and send down a "streamer" of excrement that could hit a conductor, thereby bridging the gap between an earthed and a live component. Electrocution impacts may potentially take place on the main/suspension pole structures, as well as other associated structures (including strain poles, and transformer structures).

The use of power line pole structures as perches by raptors and other larger birds is possible, given the lack of large trees in the area. This could attract birds to potentially unsafe sections of the structure.

The risk on the proposed monopole structure is considered relatively high, given the small clearances (0.4 m/400 mm between conductors). Should a bird perch or attempt to perch on the poles, the risk is increased if the bird is large (e.g., raptors, pelicans), in view of the relative size of the wingspan, for instance 2.8 m in the case of a Lappet-faced Vulture and 2.2 m in the case of White-backed Vulture. In the case of present structure, to which an earth wire is fitted vertically along the pole, the risk of electrocution is increased unless an air space safety gap is provided at the top of the pole (see mitigation measures below). The risk is also greater if the structure or bird is wet or damp (e.g., from

precipitation, or bathing), or when groups of birds interact. Electrocutions can also take place through excrement streamers touching a live component.

An electrocution is a direct impact that could potentially result in:

- Bird injuries and/or mortalities.
- Outages/disruptions to the power supply.

Priority species in the study area that are prone to electrocution on power line infrastructure (i.e., by direct contact, or by streamers) include (mainly) perching raptors, and possibly one waterbird, e.g.:

- *Martial Eagle (Endangered, Globally Endangered; resident);
- *Lappet-faced Vulture (Endangered, Globally Endangered; resident/nomadic);
- Yellow-billed Kite (Intra-African migrant);
- Other raptors: *Rock Kestrel, *Greater Kestrel, *Pale Chanting Goshawk, *Black-chested Snake-eagle (Least Concern/Secure; resident); and
- Great White Pelican (Vulnerable; sedentary, nomadic).

Non-priority species:

- *Pied Crow.

The significance of the impact is rated as **Medium** without mitigation and is reduced to **Very Low** with mitigation as shown in Table 7-12.

Table 7-12: Impact of bird electrocutions on power line infrastructure

Attraction of bird electrocutions on power line infrastructure		
Type of Impact	Direct	
Nature of Impact	Negative	
Phases	Operation	
Criteria	**Without Mitigation**	**With Mitigation**
Intensity	Minor change (Low)	Negligible change (Very low)
Duration	Long-term (10 to 20 years)	Long-term (10 to 20 years)
Extent	Whole site and nearby surroundings	Whole site and nearby surroundings
Consequence	Medium	Low
Probability	Probable (High)	Conceivable (Low)
Significance	**Medium -**	**Very low -**
Additional Assessment Criteria		
Degree to which impact can be reversed	*Fully reversible: impact can be reversed at end of project by the removal of such structures. Death of a bird is irreversible.*	
Degree to which impact may cause irreplaceable loss of resources	***Low***	
Degree to which impact can be avoided	***Medium***	
Degree to which impact can be mitigated	***Medium**: mitigation is feasible and may reduce the impact significance rating*	
Cumulative impact		
Extent to which the cumulative impact may arise	*Possible*	

Attraction of bird electrocutions on power line infrastructure		
Rating of cumulative impacts	**Without Mitigation**	**With Mitigation**
	Medium -	**Low -**
Residual impact		
Residual impact discussion	*The potential impacts of electrocutions of birds on power line infrastructure cannot be eliminated as the potential for this occurrence exists on any energised structure. With the effective implementation of mitigation measures, the residual impact will be reduced to LOW significance.*	

7.2.4.1 Mitigation

Construction phase

- A standard mitigation for electrocutions on wooden power line poles is to "gap" the earth wire near the top of the pole, i.e., the earth wire on each power line pole should stop at least 300 mm below the lowest phase to provide an air space safety gap, in order to reduce the electrocution risk Figure 7-2).
- Transformer/switchgear structures should be designed in such a way that they are not attractive as bird perches/nesting sites; selected live components should be insulated (e.g., using Polyvinyl chloride (PVC) piping or Low density polyethylene (LDPE) pipe; Figure 7-1:). Additional (high) perches could be fitted above transformer structures on poles that prove to be problematic.
- On strain structures where "jumper" wires are used, at least the centre jumper should be insulated, using PVC piping or LPDE pipe. Jumpers should be offset where possible.
- The stay wires should also be "gapped" by the use of an insulator.

Operational phase

- The need for reporting power line incidents should be stressed, and reporting procedures clarified.
- Any sections that subsequently still prove to be problematic in terms of electrocutions should be retro-mitigated, by way of adaptive management.
- Should electrocutions prove to be problematic on a specific structure, a steel perching bar for birds is proposed as a mitigation for electrocutions. This horizontal bar should be >500 mm long, and fitted onto the top of each pole, 220 mm above the pole top.

Figure 7-2: Example of "gapping" of a pole earth wire to provide an air space safety gap, in order to reduce the electrocution risk, The arrow indicates the upper limit of the earth wire.

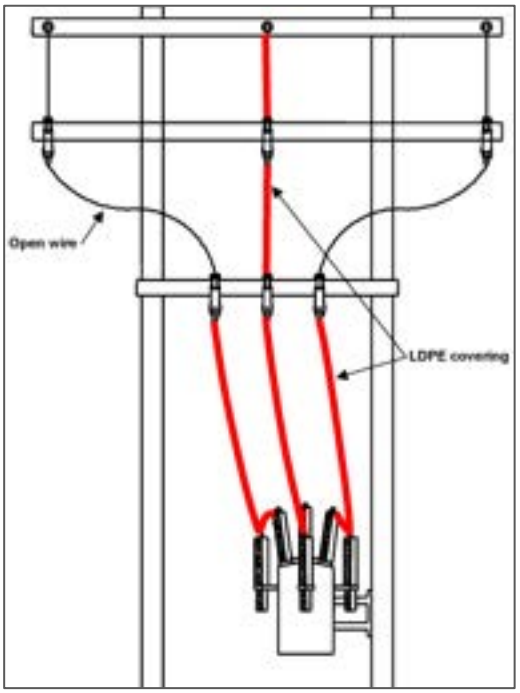


Figure 7-1: Example of use of Low-Density Polyethylene (LDPE) pipe on jumpers to insulate selected live components of transformers and switch gears.

7.2.5 Bird collisions on infrastructure such as solar PV panel arrays and fencing

Birds may be injured or killed by colliding with solar PV panels and other infrastructure, including fences.

According to Jenkins et al. (2017), recent findings at solar PV facilities in North America suggest that collision mortality impacts at solar PV plants may be underestimated, particularly in terms of collision trauma with solar PV panels; this could possibly be associated with polarised light pollution and/or with waterbirds mistaking large arrays of solar PV panels for wetlands (the so-called "lake effect"; Horvath et al. 2009; Lovich and Ennen 2011; Chock et al. 2020). Due to this misperception, such birds may land on the hard panel surfaces and die on impact, become injured, or are unable to take off from terrestrial surfaces and ultimately die of exposure, or become preyed upon. This effect has emerged as a significant impact factor at one solar site where mortality monitoring is on-going (H.T. Harvey and Associates 2014; Kagan et al. 2014; Walston et al. 2016). Collisions are also possible on associated fencing, especially if a bird is startled.

Although there are few studies of the impacts of utility-scale photovoltaic (PV) facilities on birds (Jenkins et al. 2017; McAlister 2019), especially in the region, a recent study that assessed the impacts of such a facility on birds in the Northern Cape, South Africa (Visser et al. 2019) reported a count of eight fatalities during three months of surveys of the solar field for bird carcasses and other signs of collisions, which the above authors rate as relatively low. However, the extrapolated mortality for the facility was 435 (95% CI 133–805) birds per year (4.5 bird fatalities·MW−1·yr−1; 95% CI, 1.5–8.5). No threatened species were impacted by the PV facility, but it was concluded that further data are

required to better understand the risk of PV solar energy developments on birds. This finding is supported by McAlister (2019), who also cited that DeVault et al. (2014) observed no obvious evidence for bird casualty in terms of collision risk caused by solar panels, despite conducting 515 bird surveys at solar PV sites in the United States.

Artificial lighting may impact on night-flying or migrant birds, especially in terms of causing disorientation and/or collisions on structures. Flamingos and other waterbirds (including migrants) usually fly at night and fall into this group. Research indicates that lights can attract and confuse migrating birds (Gehring et al. 2009; Manville 2005, 2009, 2013). Some insectivorous birds may also be attracted to lights. New forms of lighting in areas that were previously unlit may exacerbate the problem of collisions, and also affect movement patterns and corridors. It has been found that nocturnally migrating birds (such as small passerines, in this case) may become attracted to an isolated pool of diffused light (G Martin pers. comm.). When there is no moon, plus low fog, the birds could also become attracted to an illuminated, reflective array of solar panels; perhaps becoming disorientated because they are used to following visual clues such as the moon. It is possible that night-flying birds, such as flamingos, may mistake a solar PV array for a water body if it is illuminated, or if the moon is reflected on the surface, thereby colliding with the structure.

Bird collisions are a direct and negative impact, usually resulting in injury or mortality. Indirect impacts resulting from such collisions, and/or entrapment in surrounding fences, could include predation if the bird is unable to fly or take off.

The high incidence of flamingo mortalities recorded on the existing 220 kV and 66 kV power lines south of the solar PV site raises a cause for concern about the potential for such collisions on the solar PV surfaces. There is also a risk of cumulative collision impacts, given the relative proximity to the coastal wetlands (75 km), and the increasing number of solar PV developments, some very large, in the greater area (the closest being some 30 km to the south-west).

The priority list includes at least three aquatic species that could potentially be impacted by collisions with solar PV panels in the above way. Of these, flamingos are the main concern. These species are:

- Lesser Flamingo (Vulnerable; Globally Near Threatened; nomadic, [partial] intra-African migrant); nocturnal flying, suspected flight path areas between coast/saltpans (Mile 4 Saltworks) and inland (e.g., Etosha)
- Greater Flamingo (Vulnerable; nomadic, [partial] intra-African migrant); as for Lesser Flamingo
- Great White Pelican (Vulnerable; resident, nomadic); sedentary/nomadic; flight paths not known but has been recorded at tailings dams of nearby uranium mines (e.g., 60 km to the south).

The significance of the impact is rated as **Low** without mitigation and is reduced to **Very Low** with mitigation as shown in Table 7-13.

Table 7-13: Impact of bird collisions on infrastructure such as solar PV panel arrays and fencing

Bird collisions on infrastructure such as solar PV panel arrays, fencing and power lines		
Type of Impact	Direct	
Nature of Impact	Negative	
Phases	Operation	
Criteria	**Without Mitigation**	**With Mitigation**
Intensity	Minor change (Low)	Negligible change (Very low)
Duration	Long-term (10 to 20 years)	Long-term (10 to 20 years)
Extent	Whole site and nearby surroundings	Whole site and nearby surroundings
Consequence	Medium	Low
Probability	Possible / frequent (Medium)	Conceivable (Low)
Significance	**Low -**	**Very low -**
Additional Assessment Criteria		
Degree to which impact can be reversed	*Fully reversible: impact can be reversed at end of project by the removal of such structures. Death of a bird is irreversible.*	
Degree to which impact may cause irreplaceable loss of resources	***Low***	
Degree to which impact can be avoided	***Medium***	
Degree to which impact can be mitigated	***Medium**: mitigation is feasible and may reduce the impact significance rating*	
Cumulative impact		
Extent to which the cumulative impact may arise	*Possible*	
Rating of cumulative impacts	**Without Mitigation**	**With Mitigation**
	Medium -	**Low -**
Residual impact		
Residual impact discussion	*The potential impacts of electrocutions of birds on power line infrastructure cannot be eliminated as the potential for this occurrence exists on any energised structure. With the effective implementation of mitigation measures, the residual impact will be reduced to LOW significance.*	

7.2.5.1 Mitigation

Project design phase

- In order to reduce the chances of the panels being mistaken for sheets of water, minor modifications could be made to the panel design (e.g., by means of applying visual cues: see Operational phase: minimisation, below), but at this stage this should rather be considered as an adaptive mitigation, to be retro-applied once there is a recorded need.
- The solar PV panels should be arranged in rows with gaps as large as possible in between the rows, to help reduce the effect of a solid mass of water.
- The solar PV area should be fenced with predator-proof fencing, to reduce indirect predation of any nesting birds/chicks, or bird collision species (if injured and still alive), and also to prevent the removal of any carcass material by mammalian scavengers before it is recorded.

- As far as possible, the use of outdoor lighting at the solar facility should be minimised (Jenkins et al. 2017). Security lighting should be kept to the minimum and directed downward and away from the solar PV panels if possible.
- The solar PV panels themselves should not be directly illuminated. Non-reflective surfaces (e.g., anti-reflective coating) should be used if possible.

Operational phase

- If monitoring results indicate that bird collisions are taking place on the solar panels, adaptive mitigations could include the retrofitting of visual cues to existing panels (Kagan *et al*. 2014). Such minor modifications to the panel design could reduce the chances of the panels being mistaken for sheets of water. These visual cues may include UV-reflective or solid (white) contrasting bands spaced no further than 28 cm from each other. This arrangement has been shown to significantly reduce the number of small passerine birds hitting expanses of windows on commercial buildings. Non-polarising white tape used around and/or across panels (grid partitioning) can also minimise reflection, which can attract aquatic insects (and thus avian predators), as it mimics reflective surfaces of waterbodies (Horvath *et al*. 2010; Bennun *et al*. 2021).
- In extreme cases of repeated collisions by night-flying (aquatic) birds (e.g., ducks, grebes), the situation should be reassessed in terms of the possibility of tilting the solar panels to a non-horizontal position when in standby mode (at night) (Walston *et al*. 2015, UNEP/CMS 2015, Jenkins *et al*. 2017), taking into account technical constraints. This mitigation would be possible with the proposed panel design.
- During induction of contractors/staff, the need for slow, careful driving around the facility should be emphasised, to avoid unnecessary disturbance and the startling of birds that may have become entrapped.
- Monitoring of any potentially negative impacts is considered essential (refer to the ESMP). Should the results show that such impacts, including injuries and/or mortalities of birds are taking place, adaptive mitigation measures would need to be investigated, if necessary, on a species-specific basis.
- If monitoring results indicate that bird collisions are taking place on the perimeter fencing of the solar project, systematic fence marking may be utilised to reduce avian collisions with fences (Jenkins *et al*. 2017). Markings should be at an appropriate height to be visible to birds flying at or above the height of the solar panels.

7.2.6 Bird collisions with power line infrastructure

Bird collisions are also possible on associated power line infrastructure.

A collision occurs when a bird in mid-flight does not see the overhead cables or structures (including conductors and/or earth/optical ground wires [OPGWs]) until it is too late to take evasive action. These impacts could take place on any parts of the power line but are more likely in sections where the line crosses flight paths/corridors or flyways, such as water courses/drainage lines or ridges. Collisions may also take place on stay wires (which are usually also included on strain poles/bend points), for instance when a bird is flushed from its position on the ground, and on other associated structures. Collisions may take place even during the construction phase, once the conductors have

been strung although not yet energised but occur mainly during the operational phase. Environmental conditions, including topography, vegetation and climatic factors (e.g., strong [especially east, in the local situation] winds, dust, rain, fog), may strongly affect both exposure to collision risk, and susceptibility to collision (Jenkins et al. 2010).

Recent research has highlighted the fact that the most susceptible groups to collision mortality on power lines are large, long-lived and slow-reproducing birds, often habitat specialists with hazardous behavioural traits (especially flight height and flocking flight), with high spatial exposure to collision risk with power lines, and with unfavourable conservation status (Jenkins et al. 2010; Bernardino et al. 2018 and authors cited therein; D'Amico et al. 2019). The collision risk is believed to be increased by factors that include a large wingspan and low manoeuvrability, nomadic/migrant habits, flying in groups, flying in low light (e.g., flamingos and other waterbirds), territorial or courtship behaviour (e.g., raptors), juvenile inexperience and predation. Predominantly, the above collision-prone group comprises large terrestrial or wetland species (Jenkins et al. 2010). Gregarious species (such as vultures) are generally thought to be more vulnerable than species with solitary habits (Bernardino et al. 2018).

A further contributory factor to bird collisions is the occurrence of a visual "blind spot" when flying forwards, which has been demonstrated in some groups of birds, including bustards and korhaans, vultures, snake-eagles and storks (Martin & Shaw 2010; Martin 2011); while searching for food on the ground, or observing conspecifics, these birds thus fail to see overhead structures such as power lines in their path, especially cables.

Collisions may occur when birds cross power lines in their local, daily movements between breeding/ nesting or roosting sites, and foraging areas (or between foraging areas); often such regular flights may take place at dawn and/or dusk (Bernardino et al. 2018). High mobility and nomadism, especially in habitats with ephemeral resources, may render bird species prone to power line interactions. In the present study, groups such as flamingos are particularly susceptible to collisions due to their nomadic habits.

The bird collision impact on power line infrastructure is well documented in Namibia and elsewhere in the world; generally, individuals are affected, rather than entire populations.

A further collision risk that applies to the present study is the configuration and close proximity of adjacent power lines (of different structures and heights) in the same area, e.g., where the proposed 33 kV line will run in parallel with the existing 220 kV and 66 kV lines; the three lines are of different heights, with the poles at different span lengths. Although increasing visibility, in effect this would also increase the size of the physical barrier and hence the collision risk. The risk is increased by the presence of a thinner, less visible optical ground wire (OPGW) that runs above the conductors of the highest 220 kV structure.

The marking of wires is currently regarded as the most widespread and recommended measure for reducing bird collisions on power line infrastructure (Barrientos 2011, 2012; Bernardino et al. 2019; Shaw et al. 2021; Silva et al. 2022). However, there is still much uncertainty about the explanations for the effectiveness of this practice. Overall, wire-marking has been shown to reduce bird collisions

with power lines by half (Bernardino et al. 2019); and by 51% for all large birds, testing two types of markers in South Africa: bird flappers (Viper Live Bird Flapper) and static bird flight diverters (SWANFLIGHT Diverters – although in the latter case, this was 92% effective for Blue Cranes, but with no effect for bustards [Shaw et al. 2021]). Mitigation effectiveness has been shown to be as high as 94%, during the testing three types of markers (Fire-Fly Bird Diverter, RIBE Bird Flight Diverter and SWANFLIGHT Diverter) on 77 km of 22 kV and 110 kV power lines in Slovakia (Gális, Ševčík 2019). However, such mitigation does not work as well for all bird species, including bustards (Shaw et al. 2021).

The reactions of birds at greater distances and reduced number of bird fatalities under marked lines are considered to indicate that all the latter tested diverters have a positive effect on reducing the number of avian collisions with power lines.

A more recent development (known as a Rotamarka power line marker, made by Balmoral Engineering, https://balmoralengineering.com/product/bird-diverters-and-markers/) is designed to be conspicuous with respect to what is known about birds' vision, and is being tested in South Africa (GR Martin pers. comm. 2020; Martin 2022). The device has a unique combination of 3D shape and rotating design, creating high impact visualisation of the power line. It is thus conspicuous over a range of light levels, i.e. detectable well into dusk and dawn and also detectable at a sufficient distance for a flying bird to change its flight path.

Mitigation marking of power lines is carried out by power utilities in Namibia as standard practice under EIA regulations and recommendations, including by NamPower on the existing 66 kV Khan-Trekkopje power line.

A collision is a direct impact that could potentially result in bird injuries and/or mortalities.

Thirteen priority species in the present study that are prone to collisions on power line infrastructure include (mainly) raptors (7 spp.); large-medium terrestrial species (3 sp.); aquatic species (3 spp.), e.g.:

- *Ludwig's Bustard (Endangered, Globally Endangered; nomadic);
- *Martial Eagle (Endangered, Globally Endangered; resident);
- *Lappet-faced Vulture (Endangered, Globally Endangered; resident, juvenile movements);
- Lesser Flamingo (Vulnerable; Globally Near Threatened; nomadic, [partial] intra-African migrant);
- Greater Flamingo (Vulnerable; nomadic, [partial] intra-African migrant);
- Great White Pelican (Vulnerable; sedentary, nomadic);
- *Rüppell's Korhaan (Namibian near-endemic; sedentary);
- *Namaqua Sandgrouse (partial migrant; nomadic);
- Yellow-billed Kite (intra-African migrant);
- *Pale Chanting Goshawk;
- *Rock Kestrel;
- *Greater Kestrel; and
- *Black-chested Snake-eagle.

Bustards are likely to visit the area after good rains, and to move along drainage lines in search of food and shelter, while also using the open spaces. Korhaans are resident and use the same drainage lines including as nursery areas. Both the above groups are prone to power line collisions. There are no large waterbodies in the vicinity, which could be an attraction of waterbirds; however, collisions recorded in the area appear to result from over-flying aquatic species, such as flamingos, which fly nocturnally. Waterbirds may, however, be attracted to solar PV arrays, mistaking them to waterbodies at night. Other raptors may also occasionally be at risk to collision impacts on the power lines.

There are few monitoring data for east/west movements (although this aspect has not been monitored at the same frequencies, as the existing power lines run mostly from east to west). Limited avifaunal information is also available for the section of proposed line from the B2 road eastwards to the New Khan Substation, as the level of monitoring for this section has been relatively low, due to inaccessibility.

A precautionary approach, based on ongoing monitoring and adaptive management, is therefore recommended.

The significance of the impact is rated as **Medium** without mitigation and is reduced to **Low** with mitigation as shown in Table 7-14.

Table 7-14: Impact of bird collisions with power line infrastructure

Bird collisions with power line infrastructure		
Type of Impact	Direct	
Nature of Impact	Negative	
Phases	Operation	
Criteria	**Without Mitigation**	**With Mitigation**
Intensity	Prominent change (High)	Moderate change (Medium)
Duration	Long-term (10 to 20 years)	Long-term (10 to 20 years)
Extent	Whole site and nearby surroundings	Whole site and nearby surroundings
Consequence	Medium	Medium
Probability	Probable (High)	Possible / frequent (Medium)
Significance	**Medium -**	**Low -**
Additional Assessment Criteria		
Degree to which impact can be reversed	*Fully reversible: impact can be reversed at end of project by the removal of such structures. Death of a bird is irreversible.*	
Degree to which impact may cause irreplaceable loss of resources	***Medium***	
Degree to which impact can be avoided	***Medium***	
Degree to which impact can be mitigated	***Medium**: mitigation is feasible and may reduce the impact significance rating*	
Cumulative impact		
Extent to which the cumulative impact may arise	*Possible*	

Bird collisions with power line infrastructure		
Rating of cumulative impacts	**Without Mitigation**	**With Mitigation**
	Medium -	**Low -**
Residual impact		
Residual impact discussion	*The potential impacts of bird collisions with power line infrastructure cannot be eliminated as the infrastructure is essential for the provision of power; and birds make extensive movements in the same environments, often at the same height. With the effective implementation of mitigation measures and suitable engineering designs of the intake structure, the residual impact will be reduced to MEDIUM-LOW significance, but it will not be eliminated.*	

7.2.6.1 Mitigation

Project design phase

- No sections of the power line are identified as "no-go" areas, to be avoided at all costs; however, some sections are regarded as being more sensitive to collision impacts (see below).

Construction phase

- To address the collision risk on the proposed 33 kV distribution line, the marking of the more sensitive sections of the line to increase visibility is recommended, with the minimum for each section as follows (A-A, B-B, C-C, D-D; also see Table 7-15 below for marking sections). Ideally, Section D-D could be buried underground, if technically and economically feasible.
- Should monitoring results indicate a need, Section E-E should also be (retro-)marked, using an adaptive management approach.

Table 7-15: Recommended (minimum) sections of power line to be marked, for Route Options A, B and C

Marking section for each route option	Distance (km)	Start	End
A-A	12.7	22.132956S 15.081328E	22.130857S 15.204386E
B-B	1.3	22.136194S 15.223778E	22.136085S 15.235961E
C-C	1.1	22.135543S 15.274276E	22.135813S 15.285057E
D-D	9.8	22.133492 15.080612	22.052415 15 062188
TOTAL	**24.9**		
E-E	8.9	22.133339S 15.207268E	22.134261S 15.291242E

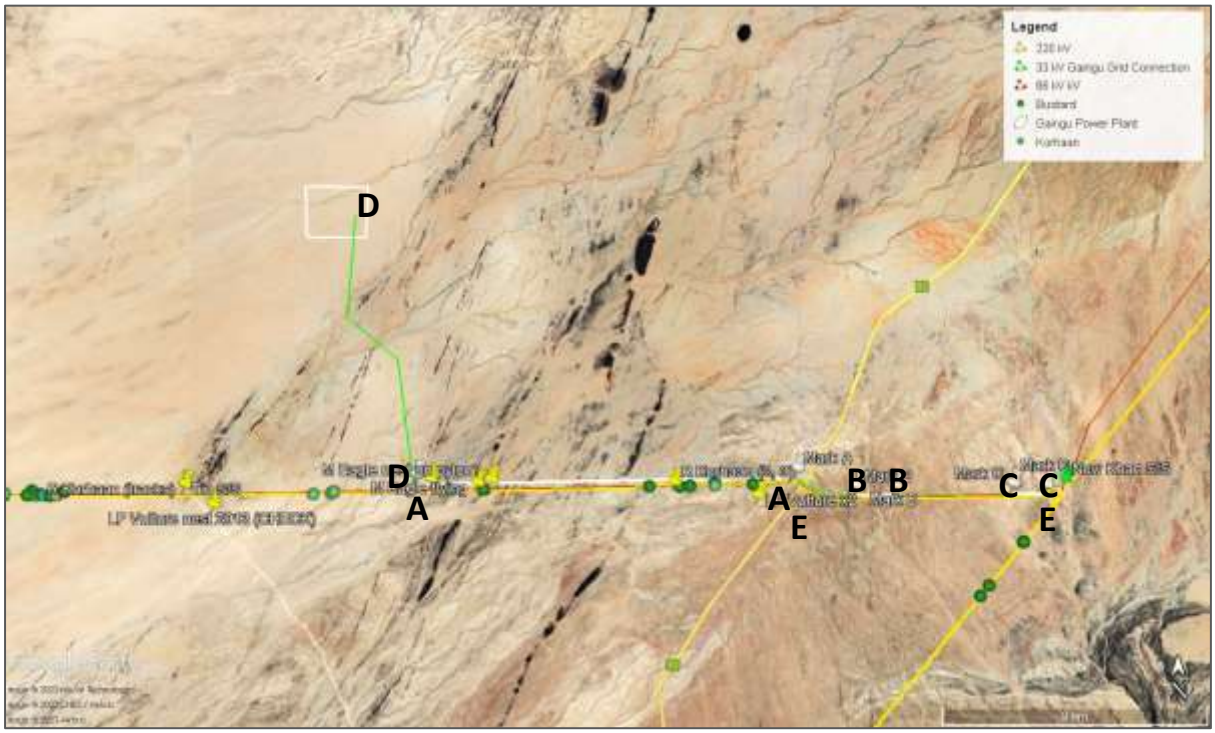


Figure 7-4: Sections of the proposed 33 kV power line recommended for fitting with marking devices, as a mitigation for bird collisions (based on a Google Earth image).

- The top horizontal conductor should be marked, for the full length of each span.
    - Examples of recommended marking devices (Figure 7-5) include the following, both made in South Africa: RAPTOR-CLAMP Diverter (also known as the Viper Live Bird Flapper ["Viper"]); and the BIRD-FLIGHT Diverter (BFD) could also be considered, with at least 4-5 of the latter devices on each span and alternating with the Vipers.
- The marking distance between devices on each line should be 10 m; the colours should be offset where possible (e.g., black and white/yellow).
- At this stage, no nocturnally visible marking is recommended, but it should become mandatory should monitoring results indicate the necessity (e.g., repeat collisions of any nocturnal fliers such as flamingos or owls on power lines), using an adaptive management approach.
- The need for retro-fitting any mitigation for collisions on stay wires (e.g., marking with vibration dampers) should also be based on monitoring results, using an adaptive management approach.

Operational phase

- The need for reporting power line incidents should be stressed. Set up a reporting channel and clarify monitoring and reporting procedures to all partners (see ESMP).
- As far as possible, the use of outdoor lighting at substations should be minimised. Security lighting should be kept to the minimum and directed downward.

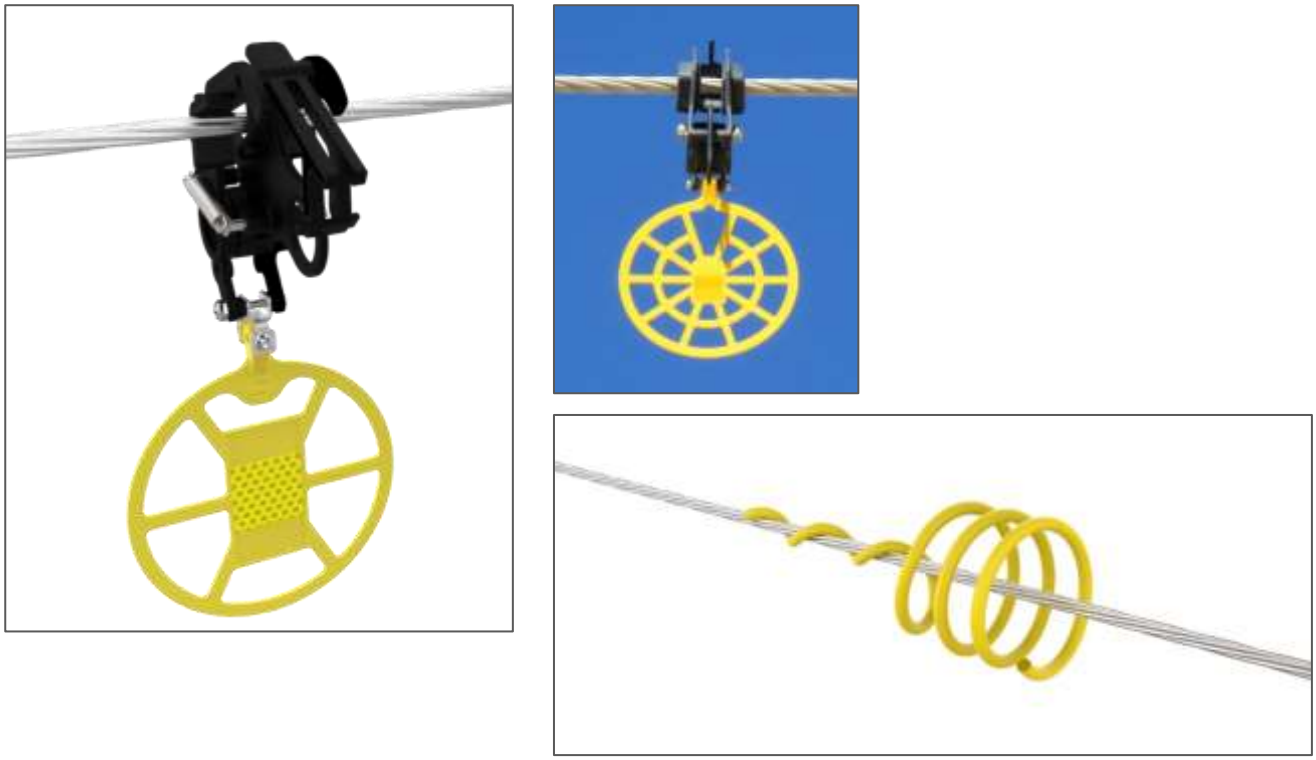


Figure 7-5: Examples of power line marking devices, used as a mitigation for bird collisions: a. RAPTOR-CLAMP Diverter (or Viper Live Bird Flapper ["Viper"] left and top right); and BIRD-FLIGHT Diverter (BFD; bottom right).

7.3 TERRESTRIAL BIODIVERSITY AND ECOLOGY IMPACTS ASSESSMENT

This section is based on the Terrestrial Biodiversity and Ecology Impact Assessment undertaken for the proposed project by Henriette Potgieter (Potgieter, 2023) included in Appendix E.

7.3.1 Destruction of habitat and organisms

The following describes the potential ways in which habitat and organisms' destruction could occur because of the project, the potential sources of the impact are outlined in Table 7-16:

- Death of animals due to ground clearing, vehicle movement and construction activities.
- Brown hyaena is particularly vulnerable to roadkill.
- Death of animals due to poaching.
- Destruction of plants due to firewood collection.
- Human movement, noise, lights and dust disturb animals, cause increase in stress, followed by increased potential mortality.
- Mammal and reptile burrows, burrow habitats and feeding habitats are destroyed, affecting the viability of the populations of these taxa.
- Parts of territories and home ranges are destroyed. Reptiles are particularly vulnerable because of their restricted ranges and high rate of endemism. Nocturnal reptiles are at risk from vehicles using roads and tracks.
- Increased dust levels (during construction) may have a negative effect on the health and growth rate of plants.

- Large footprint of the project results in destruction of plants, disturbance and compaction of soil, and alteration of drainage channels.
- Loss of plants and disturbance of soil cause a decline in habitat quality. As soil is washed from the denuded hills to the washes and drainage, habitat quality is affected downstream and beyond the borders of the site.
- Provision of shade and decrease in soil surface temperature underneath the PV arrays – plant species thrive at the cost of desert specialists.
- Boundary fencing – do not electrify lower 50 cm to allow thoroughfare for small and burrowing animals.
- Arrays provide "false" habitat for invertebrates, inducement to lay eggs, and other impacts which may change the ecosystem all the way up the food chain and extend beyond the boundaries of the site.
- Fragmentation of habitat, leading to the loss of migration corridors for various taxa, in turn resulting in the loss of individual organisms and potentially populations. This is a cumulative impact.

Table 7-16: Source of destruction of habitat and organisms

Project phase	Activity/infrastructure
Construction	• Construction and use of roads by vehicles and machinery. • Clearing of land; laydown areas; water tanks; building of infrastructure. • Power line construction activities, ground moving for access roads, transport of materials across sensitive ridges and rocky outcrops. • Accommodation for construction staff. • Human activities and vehicle movements.
Operations	• Use of roads by vehicles and machinery. • Footprint of the PV array, associated infrastructure, and power line. • Human activities and vehicle movements. • Barriers such as buildings, pylons, PV array and pipelines cause habitat fragmentation. • Traversing the dolerite ridges for power line maintenance.

The significance of the impact is **High** in both phases without mitigation, and it reduces to L**ow** with mitigation measures as shown in Table 7-17.

Table 7-17: Impact of disturbance and destruction of habitat and organisms

Description of Impact		
Type of Impact	Direct	
Nature of Impact	Negative	
Phases	Construction and Operations	
Criteria	**Without Mitigation**	**With Mitigation**
Intensity	Severe change (Very high)	Severe change (Very high)
Duration	Permanent (> 20 years)	Medium-term (5 to 10 years)
Extent	Whole site and nearby surroundings	Part of site/property

Consequence	High	Medium
Probability	Probable (High)	Possible / frequent (Medium)
Significance	**High -**	**Low -**
Additional Assessment Criteria		
Degree to which impact can be reversed	*PV array: Irreversible. Loss of plants and concomitant loss of soil is permanent.* *Power line: Irreversible but localised, provided mitigation measures are followed.*	
Degree to which impact may cause irreplaceable loss of resources	*PV array: medium. It is in a habitat type with few species of conservation concern and is a wide-spread habitat.* *Power line: medium. Losses can be limited by strict adherence to mitigation measures.*	
Degree to which impact can be avoided	*PV array: None.* *Power line: Medium. Follow mitigation measures to keep impact restricted to very small surface areas.*	
Degree to which impact can be mitigated	*PV array: Low.* *Power line: Medium, provided mitigation measures are followed.*	
Cumulative Impact		
Extent to which a cumulative impact may arise	*Unlikely*	

7.3.1.1 Mitigation

- A comprehensive restoration plan should be drawn up by an expert BEFORE construction commences, at least at conceptual level, and should make provision for monitoring and adaptive management as the project continues. Project engineers and managers should work closely with the restoration expert from the planning phase and through all construction and operations.
- Some rehabilitation actions should be implemented during operations in order to be effective, e.g. removal and storage of topsoil; location of waste dumps; road, power line and pipeline routes.
- Do not remove soil or clear-cut the PV site. This will ensure a well-stocked soil seed bank for re-colonisation.
- Plan activities to go around those plants that hamper construction activities – there are only a few individuals on the PV site.
- Start re-vegetation as soon as possible after construction.
- Keep the overall development footprint as small as possible.
- PV plant: the extent and location of the construction site should be demarcated, and all construction activities should take place within the demarcated area. Adherence should be strictly enforced.
- Power line: Keep construction activities confined to the sites where pylons will be located, and directly underneath the cables where unavoidable. Where the cables cross ridges, ensure that construction staff use one access route and not make multiple sets of tracks.
- Mitigation actions specifically for the power line include:
    - Use the same road during construction and for maintenance during operations.

  - The road should be close to the power line to ensure a narrow strip of disturbance or use the existing road where possible.
  - Excavated and laid-down soil should be levelled.
  - Strictly enforce a no-go policy outside the boundaries of the power line corridor.
  - New tracks should be kept to a minimum, and all vehicle and human movements should be strictly confined to existing tracks.
  - Some construction impacts may be mitigated by putting access roads around instead of across the ridges.
- All roads and tracks should be planned to minimise fragmentation or disturbance of habitats.
- Anti-erosion measures should be taken where roads and tracks cross a wash or drainage.
- A margin of at least 50 m from the drainage should be kept free of infrastructure, and water flow in all washes should be unimpeded.
- Water flow underneath the PV array should be managed to avoid erosion and the dumping of soil into the washes and drainage.
- Carefully plan the placement of stockpiling construction material to avoid sensitive areas.
- Limit construction activities to daytime hours to reduce noise and light.
- Position temporary construction infrastructure (e.g. accommodation) in areas that will definitely be disturbed during operations.
- Erect linear structures (power lines, water pipelines) as close as possible to existing roads and tracks.
- No sewerage overflow or French drain may be placed within 100 m of the drainage (dark blue in **Error! Reference source not found.**) or large wash (teal in **Error! Reference source not fo und.**).
- Identify nests, dens, burrows, and other breeding locations, demarcate them, and avoid these sites. If avoidance is not possible, commission specialists to relocate the animals.
- Reptiles that are exposed during ground clearing should be captured for translocation by a qualified expert.
- Educate construction and permanent staff as to their environmental obligations. All contractors should be held responsible for transgressions, and significant penalties should be levied to ensure compliance.
- No collection of plants should be allowed. No fires should be allowed. No indiscriminate defecating should be allowed.
- Avoid damage to soil crust by staying on designated roads and restricting foot and vehicle traffic to the project site.
- Limit driving to daylight hours because many reptiles are nocturnal and at risk from vehicle collisions.
- Invite the NBRI to assess threatened species and commission them to relocate plants where possible.

Monitoring

- The proponent and a terrestrial biodiversity specialist need to conduct a survey along the power line and at the PV plant directly after the construction phase. Duration: 3 days. Method: visual observation on foot. This needs to be repeated twice, at six-month intervals.

Information gathered during the monitoring should be used to inform management measures, following an adaptive approach.

7.3.2 Disturbance of animals and interference with their behaviour

The following describes the potential ways in which disturbance of animals and interference with their behaviour could occur as a result of the project. The potential sources of the impact are outlined in Table 7-18:

- The main impact is from permanent structures during the operational phase, although there will be some risk during the construction phase, but this can be mitigated to very low by following the measures proposed for the first impact.
- Fragmentation of habitat.
- Provision of shade and decrease in soil surface temperature – plant species thrive at the cost of desert specialists.
- The PV infrastructure provides "false" habitat for invertebrates, inducement to lay eggs, and other impacts which may change the ecosystem all the way up the food chain and extend beyond the boundaries of the site.
- Large mammals, burrowing mammals and reptiles, and birds are the taxa most likely to be affected.
- The loss of migration corridors causes stress and an increased risk of death to various taxa.
- The loss of daily movement corridors and interference with the feeding habits of the Brown Hyaena is of concern, although the low density of animals in the area.
- Animals are disturbed while going about their daily activities, such as feeding and breeding.
- Noise disturbs the normal behaviour of animals, specifically mammals.

Table 7-18: Source of disturbance of animals and interference with their behaviour

Project phase	Activity/infrastructure
Operations	• Infrastructure of the PV plant is a solid 300 ha barrier to the directional movement of animals. • Increase in human and vehicle presence, and movement resulting from operational activities. • Loud noise caused by vehicles and machinery.

The significance of the impact is **Medium** in the operational phase without mitigation, and it reduces to **Very low** with mitigation measures as shown in Table 7-19.

Table 7-19: Impact of Disturbance of animals and interference with their behaviour during construction and operational phases

Description of Impact		
Type of Impact	Direct	
Nature of Impact	Negative	
Phases	Construction and Operational	
Criteria	**Without Mitigation**	**With Mitigation**
Intensity	Moderate change (Medium)	Minor change (Low)

Duration	Long-term (10 to 20 years)	Medium-term (5 to 10 years)
Extent	Whole site and nearby surroundings	Part of site/property
Consequence	Medium	Low
Probability	Probable (High)	Conceivable (Low)
Significance	**Medium -**	**Very low -**
Additional Assessment Criteria		
Degree to which impact can be reversed	***Irreversible*** *during lifetime of project.*	
Degree to which impact may cause irreplaceable loss of resources	***Low*** *- Low densities of all taxa limit the extent of loss.*	
Degree to which impact can be avoided	***Low*** *- PV plants and power lines are solid barriers.*	
Degree to which impact can be mitigated	***Medium*** *- Movement corridors for mammals may be effective. Compliance with driving restrictions may mitigate the intensity of the impact.*	
Cumulative Impact		
Extent to which a cumulative impact may arise	*Likely*	
Rating of cumulative impacts	**Without Mitigation**	**With Mitigation**
	Very High -	**Low -**

7.3.2.1 Mitigation

- The extent of the operation should be clearly demarcated on site layout plans, and on the ground, it should be either fenced in or marked with clear signposts.
- Areas surrounding the PV plant that are not part of the demarcated development should be considered no-go zones. No employees, visitors, vehicles, or machinery should be allowed in such zones.
- If the PV plant is fenced, keep sections clear underneath to provide ingress and egress routes to reptiles.
- Boundary fencing – do not electrify lower 50 cm to allow thoroughfare for small and burrowing animals.
- No off-road driving or driving next to established roads/tracks should be allowed.
- Limit activities to day-time hours to reduce noise.
- No fires should be allowed.
- Train all staff and contractors how to interact with wildlife in a sensitive and situation-appropriate manner.
- A specialist on brown hyaenas should be consulted for input on the restoration plan. The plan should make provision for adequate corridors for hyaenas and other large animals to migrate.
- Adherence to the restoration plan (see impact 1) should be strictly enforced.

7.3.3 Light Pollution

Invertebrates that are attracted to the light provide an unnatural food source for taxa such as bats and geckos. These insectivores are attracted to the food and then face conditions where they are more likely to die from causes such as collisions and predation. Invertebrates die every night from exhaustion or predation, potentially disrupting their population numbers and causing disturbances in ecological processes. The sources of impacts related to light pollution are outlined in Table 7-20.

Table 7-20: Source of impact of light pollution

Project phase	Activity/infrastructure
Construction	Light sources that are visible outdoors.
Operational	• Light sources at the PV plant that are visible outdoors. • Since no nocturnal operational activities are envisaged, this impact is expected to be restricted in scale. • The extent and duration of the impact that light pollution has on populations and ecosystems have not been thoroughly studied and the precautionary principle is applied here.

The significance of the impact is **Low** in all phases without mitigation, and it reduces to **Very low** with mitigation measures as shown in Table 7-21.

Table 7-21: Impact of light pollution

Description of Impact		
Type of Impact	Direct	
Nature of Impact	Negative	
Phases	Construction and Operational	
Criteria	**Without Mitigation**	**With Mitigation**
Intensity	Moderate change (Medium)	Minor change (Low)
Duration	Long-term (10 to 20 years)	Medium-term (5 to 10 years)
Extent	Part of site/property	Part of site/property
Consequence	Low	Low
Probability	Probable (High)	Conceivable (Low)
Significance	**Low -**	**Very low -**
Additional Assessment Criteria		
Degree to which impact can be reversed	***Fully reversible*** *with adherence to mitigation measures.*	
Degree to which impact may cause irreplaceable loss of resources	***Low -*** *Small extent of impact.*	
Degree to which impact can be avoided	***High -*** *Small extent of impact, and adherence to mitigation measures may avoid this impact.*	
Degree to which impact can be mitigated	***High -*** *Follow mitigation measures.*	
Cumulative Impact		
Extent to which a cumulative impact may arise	***Unlikely***	

7.3.3.1 Mitigation

- Install motion detectors to limit light use to the minimum possible.
- Outdoor lights should be directed downwards and not up into the sky. Skyward pointing lights interfere with bats, birds and flying insects, temporarily blinding and disorienting them.
- Use yellow or amber outdoor lights because invertebrates don't detect yellow light as well as white.

- Install insect screens in doors and windows located in buildings that are used after sunset.

7.3.4 Vehicle Tracks

The scars of vehicle tracks remain visible in the desert for decades, and the damage caused by traversing a pristine area is wider and more significant than just two visible ruts. Off-road driving damages the structure of the soil surface and causes soil compaction, which results in less water infiltration and availability, limited root penetration and less vegetation cover – conditions that are already severe in a desert.

Where a soil crust is damaged, the fine underlying layer of soil becomes vulnerable to wind erosion and dust is created. Dust settles on plants, interferes with photosynthesis, and causes a decline in habitat quality.

Most compaction of soil occurs on the first pass, and therefore access routes for construction and operations should be planned and laid out before construction commences. The extent of this impact may be reduced by keeping to one set of tracks because driving in the same tracks again does not significantly affect the degree of compaction under the tracks, but it greatly reduces the compacted area (Nortjé, et al., 2012). The sources of impacts related to vehicle tracks are outlined in Table 7-22.

Table 7-22: Source of impact of light pollution

Project phase	Activity/infrastructure
Construction	• Transport of materials for construction of the power line and the PV plant. Cars, heavy vehicles, and machinery traverse the area carrying out construction activities.
Operational	• Maintenance of the power line. • Access to the PV plant.

The significance of the impact is **High** in both phases without mitigation, and it reduces to **Low** with mitigation measures as shown in Table 7-23.

Table 7-23: Impact from vehicle tracks

Description of Impact		
Type of Impact	Indirect	
Nature of Impact	Negative	
Phases	Construction and Operational	
Criteria	**Without Mitigation**	**With Mitigation**
Intensity	Prominent change (High)	Minor change (Low)
Duration	Permanent (> 20 years)	Permanent (> 20 years)
Extent	Whole site and nearby surroundings	Whole site and nearby surroundings
Consequence	High	Medium
Probability	Definite / Continuous (Very high)	Possible / frequent (Medium)
Significance	**High -**	**Low -**
Additional Assessment Criteria		

Degree to which impact can be reversed	***Irreversible*** *- Damage to the subsurface soil is permanent.*	
Degree to which impact may cause irreplaceable loss of resources	***High*** *- Ridges function as sources of biodiversity when conditions render the surrounding areas less productive, e.g. in times of drought.*	
Degree to which impact can be avoided	***Low*** *- Access to the site and power line is necessary, so the impact is unavoidable.*	
Degree to which impact can be mitigated	***Medium*** **-** *Impact is unavoidable, but the extent may be minimised by strict implementation of mitigation measures.*	
Cumulative Impact		
Extent to which a cumulative impact may arise	Possible. Unplanned and unrestricted development across the grasslands and ridges of the western escarpment means everyone makes their own new tracks.	
Rating of cumulative impacts	**Without Mitigation**	**With Mitigation**
	High -	**Low -**

7.3.4.1 Mitigation

- Plan and lay out all access routes before construction commences, and plan access tracks with construction, operations, maintenance and decommissioning in mind so that the same tracks will serve in all phases of the project.
- Driving next to an existing track and the formation of new tracks should be prohibited as far as possible.
- Drive around instead of across ridges where possible, and if not, then cross ridges at their lowest points and at points where the vegetation is least dense.
- Do not put pylons on the tops of ridges but rather between two lower ridges with the cables running over the summit – this avoids an access road to the summits of ridges.
- Train all staff, contractors and construction staff on the reasons and methods for track discipline, and make sure that unskilled labourers are also aware of the severity of the problem, not only top management.
- If signs are used next to roads, ensure that the wording is clear and written in an appropriate tone.
- Penalty clauses in contracts, fines and removal from site should be used as deterrents, and an environmental officer should be on site at all times to monitor compliance.

7.4 HERITAGE IMPACT ASSESSMENT

This section is based on the Heritage Impact Assessment undertaken by Beyond Heritage (Beyond Heritage, 2023) and is included in Appendix G.

Assessment of cultural significance is based on the values attributed to heritage resources and these are used as a basis for developing conservation and management strategies. Cultural significance is classified in terms of aesthetic, historic, scientific, or social value for past, present, or future generations (see e.g., Article 1.2 of the Burra Charter). Cultural heritage ranges from movable to immovable, from tangible to intangible, from single monuments to entire cultural landscapes. A values-based approach, therefore, gives more prominence to the cultural significance conveyed by cultural heritage properties, than to the properties themselves.

Site importance for this assessment is based on six interrelated criteria or values: (1) primary versus secondary context; (2) amount of deposit; (3) number and variety of features; (4) uniqueness; (5) potential to answer present research questions and (6) tourism potential.

Sites with no importance do not require management; low to medium significant sites may require limited management, while sites of high significance require extensive management.

A specialist desktop Palaeontological Impact Assessment was conducted for the Project by Prof Marion Bamford (2023). Bamford concluded that the proposed site lies on the Neoproterozoic to Cambrian rocks of the Damara Sequence that comprise non-fossiliferous granites while the Damara Group rocks are composed of schists, quartzites, shales, dolomites, marble, and volcanic rocks. No fossils have been reported from this region although trace fossils occur in younger rocks to the south (Nama Group) and the Otavi Group to the northeast. Given a Cambrian age of the rocks and potential of finding fossils, it is recommended that no further paleontological impact assessment is required unless fossils are found by the contractor, ECO, or other designated responsible person once excavations or drilling activities have commenced. Since the impact will be low, as far as the palaeontology is concerned, the project should be authorised.

Impacts to heritage resources in relation to the powerlines are assessed as **Medium** without mitigation and reduced to **Low** with mitigation as shown in Table 7-24.

Table 7-24: Impact to heritage resources – powerlines

Description of Impact		
Type of Impact	Direct	
Nature of Impact	Negative	
Phases	Construction	
Criteria	**Without Mitigation**	**With Mitigation**
Intensity	Moderate change (Medium)	Minor change (Low)
Duration	Long-term (High)	Long-term (High)
Extent	Beyond site (Medium)	Part of site (Very Low)
Consequence	Medium	Low
Probability	Probable	Probable
Significance	**Medium -**	**Low -**
Additional Assessment Criteria		
Degree to which impact can be reversed	*Impacts on heritage resources are permanent and irreversible, but the features can be mapped and recorded and so preserved in the archaeological record of the area.*	
Degree to which impact may cause irreplaceable loss of resources	*Heritage resources cannot be replaced and are irreplaceable.*	
Degree to which impact can be avoided	*Medium - Avoidance is possible by siting the line.*	

Description of Impact		
Degree to which impact can be mitigated	*High: any additional impacts can be mitigated by the implementation of a chance find procedure.*	
Cumulative impact		
Nature of cumulative impacts	*The greater area has been impacted on by numerous mining developments, and in the Namibian context cumulative impacts relate not only to the loss of heritage resources but also to the effect of the developments on the characteristic vast, open Namibian landscape. It can be argued that the large number of projects add to the archaeological record of the area and with the management of impacts cumulative impacts are reduced. Therefore, with the implementation of the mitigation measures in this report, the cumulative impact on heritage resources is expected to be low.*	
Rating of cumulative impacts	**Without Mitigation**	**With Mitigation**
	Low -	**Low -**
Residual impact		
Residual impact discussion	*No additional impact on heritage resources is expected. As such, it is not anticipated that the Project will have a high negative cumulative impact on the broader landscape which is already dominated by mining infrastructure.*	

Impacts to heritage resources in relation to the PV plant are assessed as **Low** without mitigation and reduced to **Very Low** with mitigation as shown in Table 7-25.

Table 7-25: Impact to heritage resources – PV plant

Description of Impact		
Type of Impact	Direct	
Nature of Impact	Negative	
Phases	Construction	
Criteria	**Without Mitigation**	**With Mitigation**
Intensity	Minor change (Low)	Minor change (Low)
Duration	Long-term (High)	Long-term (High)
Extent	Whole site (Low)	Part of site (Very Low)
Consequence	Medium	Low
Probability	Conceivable	Conceivable
Significance	**Low -**	**Very low -**
Additional Assessment Criteria		
Degree to which impact can be reversed	*Impacts on heritage resources are permanent and irreversible.*	
Degree to which impact may cause irreplaceable loss of resources	*Heritage resources cannot be replaced and are irreplaceable.*	

Description of Impact		
Degree to which impact can be avoided	*The project could impact on traditional lifeways of the #Gaingu Conservancy community as expressed by the representatives during the site visit, potentially reducing their hunting ground. The Project and its components are however not expected to have a high negative impact on the intangible cultural aspects of the surrounding communities as a result of the relatively small development footprint within the #Gaingu Conservancy*	
Degree to which impact can be mitigated	*Low*	
Cumulative impact		
Nature of cumulative impacts	*The greater area has been impacted on by numerous mining developments, and in the Namibian context cumulative impacts relate not only to the loss of heritage resources but also to the effect of the developments on the characteristic vast, open Namibian landscape. It can be argued that the large number of projects add to the archaeological record of the area and with the management of impacts cumulative impacts are reduced. Therefore, with the implementation of the mitigation measures in this report, the cumulative impact on heritage resources is expected to be low.*	
Rating of cumulative impacts	**Without Mitigation**	**With Mitigation**
	Low -	**Low -**
Residual impact		
Residual impact discussion	*No additional impact on heritage resources is expected. As such, it is not anticipated that the Project will have a high negative cumulative impact on the broader landscape which is already dominated by mining infrastructure.*	

Mitigation

- Avoidance of known features.
- Pre-Construction survey of new project development areas.
- Development of a heritage site development plan.
- In the event that previously unknown fossils, heritage resources or burial grounds and graves are exposed or found during the life of the project, the chance find procedure should be implemented.
- Management of Chance Finds
- Avoidance and in situ preservation of heritage sites.
- Monitoring of heritage features during construction and routine monitoring of land-clearing activities.
- Contractors, Subcontractors, and employees should be sensitized to the procedures that must be followed in case of a discovery and the potential presence of archaeological resources that may be discovered during land-clearance and mechanical excavation activities.
- Indication of known heritage features on development plans and demarcation of features.

7.5 VISUAL IMPACT ASSESSMENT

This section is based on the Visual Impact Assessment undertaken for the proposed project by Green Tree Environmental (Green Tree Environmental Consulting, 2023) and is included in Appendix H.

The visual impact of the project will mostly be as a result of the visibility of the #Gaingu Power Plant, powerline, and the new access road.

The visual impact during the construction phase will as a result of dust created, vehicle traffic (trucks) (more specifically along the gravel roads), the construction camp/ office and the visibility of the newly constructed structures.

7.5.1 Sensitive Viewers and Locations

There are currently no public views towards the #Gaingu Power Plant since the public roads (B2 and the D1918) are located far from the site, viewers travelling on these roads are considered to be less sensitive. These viewers will however be exposed to the powerline that will run parallel to the existing powerline. The gravel roads that are accessible are mainly used by tourists visiting the #Gaingu Community Conservancy, the Trekkopje Ruins, Historical German Fortification and by locals that stay in the area. These viewers and viewer locations are considered to be more sensitive. The sensitive viewers in relation to the project site are shown in Figure 7-6.

Viewers that were considered to be least sensitive are people working at the Trekkopje Mine as well as motorists that travels along the local roads (D1918 and B2) to get to their place of work.

Figure 7-6: Viewpoints and potential sensitive receptors

7.5.2 Visibility

The visibility of the proposed project is based on the distance from the proposed project to selected viewpoints. The 'zone of potential influence' was established at 10 km for the #Gaingu Power Plant and 2 km for the powerline. Beyond this distance the impact of the Project's activities would have diminished as the project will recede into the background and/or views to the site would be screened by the slightly rolling topography (including the ridges and existing structures).

In determining the visibility of the Project, the general heights associated with the Project components were used to generate the viewshed/ line of sight as illustrated in Figure 7-7. It is clear from the line of sight that the rolling topography of the landscape surrounding the #Gaingu Power Plant will play a significant role in the visibility of the power plant. The rocky outcrops located along the eastern section of the ZoPI and the rivers/ drainage lines towards the north, will decrease the visibility of the project when the viewer is located behind the outcrops or within the lower point. The #Gaingu Power Plant will be visible when standing on elevated areas such as the rocky outcrops. The powerline will be visible when travelling along the powerline or when the powerline cross over the roads (gravel roads and B2). The ZoPI for the powerline is approximately 2 km and beyond 2 km the powerline will become part of the background and the visibility of the powerline will diminish due to distance. The power line will be visible from the Historical German Fortification since this historical site is located on an elevated area. The access road will mainly be visible or noticed when motorists travel on the road and dust is created.

The visibility of the #Gaingu Power Plant might extend beyond the ZoPI in the evenings as the lights from the plant will be more visible in the dark.

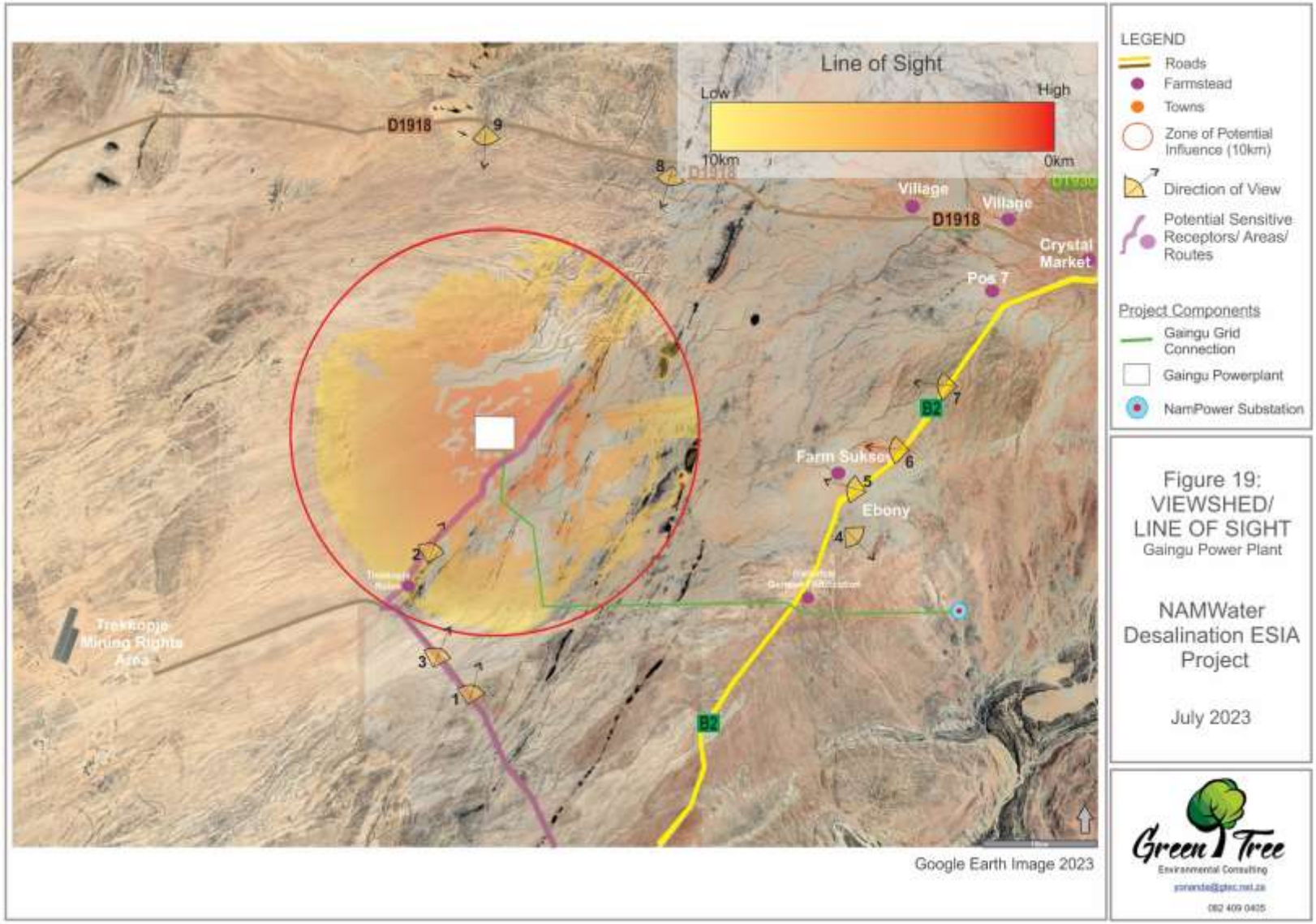


Figure 7-7: Viewshed/Line of Sight

7.5.3 Visual Exposure

Visual exposure is determined by qualifying the visibility with a distance rating to indicate the degree of intrusion and visual acuity. The following criteria was used to describe the visual exposure:

- Highly visible – dominant or clearly noticeable, foreground view (0 –1 km);
- Moderately visible – recognisable to the viewer, middle-ground view (1 km – 5 km); and
- Marginally visible – not particularly noticeable to the viewer, background view (5 km – 10 km).

Table 7-26 below indicates the exposure of the various sensitive viewing areas.

Table 7-26: Potential sensitive receptors - Visual Exposure for the #Gaingu Power Plant, powerline and access road

	Foreground view i.e. 0 – 1km from Project Site	Middle-ground view i.e.1km to – 5km from Project Site	Background view i.e. 5km - 10km from Project Site	Beyond 10km from Project Site
B2	**X clear to partially obstructed view of the powerline, no view of the power plant**	**X clear to partially obstructed view the powerline, no view of the power plant.**		
D1918				**X no view of the project. Lights might be visible if not mitigated.**
Local road	**X clear to partially obstructed view**	**X clear to partially obstructed view**	**X mostly obstructed view**	**X mostly obstructed view**
Trekkopje Ruins			**X mostly obstructed view**	
Historical German Fortification	**X clear view of the power line**			
Residential (farmsteads/ dwellings)				**X mostly obstructed to no view of the project. Lights might be visible if not mitigated.**

7.5.4 Visual Absorption Capacity (VAC)

The visual absorption capacity is the potential of the landscape to absorb or conceal the proposed project:

- High VAC – e.g., effective screening by topography and vegetation;
- Moderate VAC - e.g., partial screening by topography and vegetation; and
- Low VAC - e.g., little screening by topography or vegetation.

The topography of the study area surrounding the #Gaingu Power Plant is rolling with rocky outcrops. The vegetation is sparse and consists of grasses, shrubs, and a few scattered trees. The vegetation will not aid in screening the project from viewers, but the rolling topography will screen views. It can therefore be said that the visual absorption capacity of the landscape is **moderate**. The powerlines will not be absorbed by the landscape unless the viewer is behind the rocky outcrops.

7.5.5 Landscape Integrity

Landscape integrity refers to the compatibility or similarity of the project with the qualities of the existing landscape, or the 'sense of place':

- Low compatibility – visually intrudes, or is discordant with the surroundings;
- Medium compatibility – partially fits into the surroundings, but clearly noticeable; and
- High compatibility – blends in well with the surroundings.

The #Gaingu Power Plant will be the first photovoltaic plant within the study area and although there are mining related activities, these activities are further away and contributes to the visual resource of the general area. The powerline will cross a section of the landscape which has no other power lines before it joins the existing servitude and follows the line to the Khan substation. The integrity of the landscape was therefore considered to be **low** since the project will be visually intrusive to the landscape.

7.5.6 Intensity of Impact

According to the results tabulated below in Table 7-27, the severity/ magnitude of visual impact (based on the worst case scenario) of the proposed #Gaingu Power Plant, and powerline will be **high** as it will cause a total loss to the key elements/features/characteristics of the baseline environment.

Table 7-27: Severity/ Magnitude of Impact of the proposed #Gaingu Power Plant and powerline

High	Moderate	Low	Negligible
Total loss of or major alteration to key elements / features / characteristics of the baseline. i.e. Pre-development landscape or view and / or introduction of elements considered to be totally uncharacteristic when set within the attributes of the receiving landscape. High scenic quality impacts would result.	Partial loss of or alteration to key elements / features / characteristics of the baseline. i.e. Pre-development landscape or view and / or introduction of elements that may be prominent but may not necessarily be substantially uncharacteristic when set within the attributes of the receiving landscape. Moderate scenic quality impacts would result	Minor loss of or alteration to key elements / features / characteristics of the baseline. i.e. Pre-development landscape or view and / or introduction of elements that may not be uncharacteristic when set within the attributes of the receiving landscape. Low scenic quality impacts would result.	Very minor loss or alteration to key elements/features/ characteristics of the baseline. i.e. Pre-development landscape or view and / or introduction of elements that is not uncharacteristic with the surrounding landscape – approximating the 'no change' situation. Negligible scenic quality impacts would result.

The severity/magnitude/intensity of impact is predicted to be **high** on sensitive views for the following reasons:

- The proposed #Gaingu Power Plant, powerline and access road will have a high negative effect on the visual quality of the landscape since it is not compatible with the patterns that define the study area's landscape.
- The proposed #Gaingu Power Plant, powerline and access road will have a high effect on sensitive viewing areas such as the Historical German Fortification and the local roads, that is mainly used by people visiting the Gaingu Community Conservancy.
- The proposed #Gaingu Power Plant, powerline and access road will change the sense of place of the study area.

7.5.7 Significance of the impact

The following tables (Table 7-28 to Table 7-33) summarises the significance of the visual impact, these results are based on worst-case scenario when the impacts of all aspects of the Project are taken together.

7.5.7.1 Impact of dust

The significance of the impact during the construction phase is rated **Low** with and without mitigation as shown in Table 7-28.

Table 7-28: Impact of dust created during the construction phase

Dust		
Type of Impact	Direct	
Nature of Impact	Negative	
Phases	Construction	
Criteria	**Without Mitigation**	**With Mitigation**
Intensity	Moderate change (Medium)	Minor change (Low)
Duration	Short-term (1 to 5 years)	Short-term (1 to 5 years)
Extent	Whole site and nearby surroundings	Whole site and nearby surroundings
Consequence	Low	Low
Probability	Definite / Continuous (Very high)	Probable (High)
Significance	**Low -**	**Low -**
Additional Assessment Criteria		
Degree to which impact can be reversed	*Fully reversable. The impact will be easy reversable if the correct mitigation measures are implemented since dust is controllable.*	
Degree to which impact may cause irreplaceable loss of resources	*None. The dust created during construction will not result in the irreplaceable loss of the visual quality of the area.*	
Degree to which impact can be avoided	*High. Dust can be easily mitigated and controlled.*	
Degree to which impact can be mitigated	*High. Dust can be easily mitigated and controlled.*	
Cumulative Impact		
Extent to which a cumulative impact may arise	*Possible*	
Rating of cumulative impacts	**Without Mitigation**	**With Mitigation**
	Low -	**Very low -**

The significance of the impact during the operational phase is rated **Medium** with and without mitigation as shown in Table 7-29.

Table 7-29: Impact of dust created during the operational phase

Dust		
Type of Impact	Direct	
Nature of Impact	Negative	
Phases	Operational	
Criteria	**Without Mitigation**	**With Mitigation**
Intensity	Moderate change (Medium)	Minor change (Low)
Duration	Long-term (10 to 20 years)	Long-term (10 to 20 years)
Extent	Whole site and nearby surroundings	Whole site and nearby surroundings
Consequence	Medium	Medium
Probability	Definite / Continuous (Very high)	Probable (High)
Significance	**Medium -**	**Medium -**
Additional Assessment Criteria		
Degree to which impact can be reversed	*Fully reversable. The impact will be easily reversable if the correct mitigation measures are implemented since dust is controllable.*	
Degree to which impact may cause irreplaceable loss of resources	*None. The dust created during operations will not result in the irreplaceable loss of the visual quality of the area.*	
Degree to which impact can be avoided	*Low. Dust can be easily mitigated and controlled but might not be feasible over the long term.*	
Degree to which impact can be mitigated	*High. Dust can be easily mitigated and controlled but it will have to be a long-term solution that might not be feasible, specifically when considering the amount of trips that will take place.*	
Cumulative Impact		
Extent to which a cumulative impact may arise	*Possible*	
Rating of cumulative impacts	**Without Mitigation**	**With Mitigation**
	Low -	**Very low -**

7.5.7.2 Impact of alteration of the landscape character

The significance of the impact is rated **Medium** with or without mitigation as shown in Table 7-30.

Table 7-30: Alteration of the landscape character during the construction phase

Alteration of the Landscape Character		
Type of Impact	Direct	
Nature of Impact	Negative	
Phases	Construction and Operational	
Criteria	**Without Mitigation**	**With Mitigation**
Intensity	Prominent change (High)	Prominent change (High)
Duration	Short-term (1 to 5 years)	Short-term (1 to 5 years)
Extent	Beyond site	Beyond site

Alteration of the Landscape Character		
Consequence	Medium	Medium
Probability	Definite / Continuous (Very high)	Definite / Continuous (Very high)
Significance	**Medium -**	**Medium -**
Additional Assessment Criteria		
Degree to which impact can be reversed	*Partially reversable: The PV plant, buildings and infrastructure can be removed but the landscape will still show evidence of disturbance.*	
Degree to which impact may cause irreplaceable loss of resources	*Medium: The construction activities can be stopped and the PV plant, buildings and infrastructure can be removed but the site will not be the same and there will be a loss in landscape character or visual resource.*	
Degree to which impact can be avoided	*None*	
Degree to which impact can be mitigated	*Medium, but no mitigation for the power line.*	
Cumulative Impact		
Extent to which a cumulative impact may arise	*Likely specifically referring to the power line*	
Rating of cumulative impacts	**Without Mitigation**	**With Mitigation**
	Low -	**Low -**

7.5.7.3 Impact of change in the sense of place

The significance of the impact is rated **High** with and without mitigation as shown in Table 7-31.

Table 7-31: Change in sense of place during operational phase

Change in 'sense of place'		
Type of Impact	Direct	
Nature of Impact	Negative	
Phases	Construction and Operational	
Criteria	**Without Mitigation**	**With Mitigation**
Intensity	Prominent change (High)	Prominent change (High)
Duration	Long-term (10 to 20 years)	Long-term (10 to 20 years)
Extent	Local area, far beyond site	Local area, far beyond site
Consequence	High	High
Probability	Definite / Continuous (Very high)	Probable (High)
Significance	**High -**	**High -**
Additional Assessment Criteria		
Degree to which impact can be reversed	*Partially reversable: The PV plant, buildings and infrastructure can be removed but the landscape will still show evidence of disturbance.*	
Degree to which impact may cause irreplaceable loss of resources	*Medium: The PV plant, buildings and infrastructure can be removed but the site will not be the same and there will be a loss in landscape character or visual resource.*	

Change in 'sense of place'		
Degree to which impact can be avoided	*None*	
Degree to which impact can be mitigated	*Medium, but no mitigation for the power line.*	
Cumulative Impact		
Extent to which a cumulative impact may arise	*Possible*	
Rating of cumulative impacts	**Without Mitigation**	**With Mitigation**
	Medium -	**Low -**

7.5.7.4 Impact of visibility

The significance of the impact is rate **High** with and without mitigation as shown in Table 7-32.

Table 7-32: Visibility of the project

Visibility of the Project		
Type of Impact	Direct	
Nature of Impact	Negative	
Phases	Construction and Operational	
Criteria	**Without Mitigation**	**With Mitigation**
Intensity	Prominent change (High)	Prominent change (High)
Duration	Long-term (10 to 20 years)	Long-term (10 to 20 years)
Extent	Local area, far beyond site	Local area, far beyond site
Consequence	High	High
Probability	Definite / Continuous (Very high)	Probable (High)
Significance	**High -**	**High -**
Additional Assessment Criteria		
Degree to which impact can be reversed	*Partially reversable: The PV plant, buildings and infrastructure can be removed but the landscape will still show evidence of disturbance.*	
Degree to which impact may cause irreplaceable loss of resources	*Medium: The PV plant, buildings and infrastructure can be removed but the site will not be the same and there will be a loss in landscape character or visual resource.*	
Degree to which impact can be avoided	*None*	
Degree to which impact can be mitigated	*Medium, but no mitigation for the power line.*	
Cumulative Impact		
Extent to which a cumulative impact may arise	*Possible*	
Rating of cumulative impacts	**Without Mitigation**	**With Mitigation**
	Medium -	**Low -**

7.5.7.5 Impact of light

Light pollution is largely the result of bad lighting design, which allows artificial light to shine outward and upward into the sky, where it's not wanted, instead of focusing the light downward, where it is needed. Ill designed lighting washes out the darkness of the night sky and radically alters the light levels in rural areas where light sources shine as 'beacons' against the dark sky and are generally not wanted. The significance of the impact is rate **Medium** without mitigation and **Low** with mitigation as shown in Table 7-33.

Table 7-33: Light impact

Light Impact		
Type of Impact	Direct	
Nature of Impact	Negative	
Phases	Construction and Operational	
Criteria	**Without Mitigation**	**With Mitigation**
Intensity	Moderate change (Medium)	Minor change (Low)
Duration	Long-term (10 to 20 years)	Long-term (10 to 20 years)
Extent	Local area, far beyond site	Local area, far beyond site
Consequence	High	Medium
Probability	Probable (High)	Possible / frequent (Medium)
Significance	**High -**	**Low -**
Additional Assessment Criteria		
Degree to which impact can be reversed	*Partially reversable: The PV plant and buildings can be removed but the landscape will still show evidence of disturbance.*	
Degree to which impact may cause irreplaceable loss of resources	*Medium: The PV plant could cause a loss in landscape character or visual resource, especially when considering that tourist might do star gazing in the evenings.*	
Degree to which impact can be avoided	*Medium*	
Degree to which impact can be mitigated	*High*	
Cumulative Impact		
Extent to which a cumulative impact may arise	*Possible*	
Rating of cumulative impacts	**Without Mitigation**	**With Mitigation**
	Medium -	**Low -**

7.5.7.6 Mitigation

- The topography of the area be copied or mimicked and the slightly rolling topography be used as screens. This can be accomplished by creating berms to screen views from sensitive viewing points. This mitigation measure should however only be considered if feasible and on condition that no additional impacts be generated as a result of it.
- The components of the solar plant be carefully considered, and colours associated with the desert be used or material that will be non-reflective.
- Make use of a natural colour scheme, such as browns, are used when painting the buildings and the roofs.

- Dust suppression techniques should be in place during the construction phase and during the decommissioning phase if decommissioning will be considered at the site.
- The following are measures that must be considered in the lighting design of the Project:
  - Install light fixtures that provide precisely directed illumination to reduce light "spillage" beyond the immediate surrounds of the site.
  - Avoid high pole top security lighting along the periphery of the site and use only lights that are activated on illegal entry to the site.
  - Minimise the number of light fixtures to the bare minimum, including security lighting.
  - With the construction of the proposed project security lighting should only be used where necessary and carefully directed, preferably away from sensitive viewing areas.

7.6 NOISE IMPACT ASSESSMENT

This section is based on the Noise Impact Assessment undertaken for the proposed project by SLR (SLR, 2023) and is included in Appendix I.

7.6.1 Assessment of Construction Phase Impacts

7.6.1.1 Construction Noise Sources

Construction of the power supply infrastructure is expected to comprise the following operations and associated equipment with typical expected sound power levels given in Table 7-34.

Table 7-34: Expected construction operations and equipment sound power levels

Construction category	Equipment	Typical A-weighted Sound Power L_{WA} (dBA)
Site clearing and earthworks	Tracked excavators 28 t, 162 kW	104
	Dump trucks 23 t, 187 kW	102
	Vibratory roller 4 t, 29 kW	102
	Graders 20 t, 142 kW	103
	Bulldozers, 20 t, 142 kW	109
	Wheeled loaders 193 kW	108
	Trucks 4 axle	108
	Pumps, 20 kW	93
Foundations and structures (main plant, power lines etc)	Piling rig, rotary bored, 10 m, 450 mm piles, 29 kW	104
	Drilling, 250 mm Dia. bit	113
	Cutting concrete circular saw, 235 mm Dia., 1.5 kW	112
	Angle grinding, steel	108
	Wheeled mobile crane, 70 t	98
	Small cement mixers	89
	Cement mixer truck	103

Construction category	Equipment	Typical A-weighted Sound Power L_{WA} (dBA)
	Concrete pump, truck mounted	108
	Vibratory compactor	106
	Trucks 4 axle	108
	Air compressors	101
	Diesel generator 7.5 kW, 6 kVA, 3000 rpm	93
	Petrol generator mobile, 3.75 kW, 105 kg	103

Source: BS5228-1:2009+A1:2014 [13]

7.6.2 Predicted Construction Noise Levels

The total continuous broadband sound power level emissions of the main sites during construction are expected to be a maximum of approximately 112 dBA. This is approximately equal to a continuous equivalent sound pressure level ($L_{eq, T}$) of 84 dBA at 10 m from the source.

The associated impact radius (maximum) for daytime and night-time activities is 1 500 m (1.5 km) and 4 000 m (4.0 km) respectively.

7.6.2.1 Linear Infrastructure Surrounding Receptors

In the receiving environment adjacent to the power line construction routes, temporary or intermittent noise exposure may reach up to between 80 and 85 dBA at 10 m from source (*further reducing by approximately 6 dBA for each doubling of distance*) and may result in significant impacts within the #Gaingu Conservancy depending on the noise sensitivity profiles of the local biodiversity. It is noted that the construction noise sources for linear infrastructure are not stationery and thus only *temporary* relative the construction period.

The noise impacts at all identified receptors due to linear infrastructure have been assessed as **negligible**.

7.6.2.2 PV Plant Surrounding Receptors

No identified potential sensitive receptors exist within several (>5 km) kilometres of the proposed PV plant location. Due to the maximum impact radius of 1.5 km, the noise impact is assessed as **negligible**.

7.6.2.3 Construction Noise Impact Rating

Table 7-35 below indicates that the assessed construction noise impact will be **Low** without mitigation, and **Very Low** with mitigation.

[13] BSI Standards Publication BS5228-1:2009+A1:2014 Code of Practice for Noise and Vibration Control on Construction and Open Sites – Part 1: Noise

Table 7-35: Construction noise impact summary

Description of Impact		
Type of Impact	Direct	
Nature of Impact	Negative	
Phases	Construction	
Criteria	**Without Mitigation**	**With Mitigation**
Intensity	Moderate change (Medium)	Minor change (Low)
Duration	Short-term (1 to 5 years)	Short-term (1 to 5 years)
Extent	Beyond site (4 km)	Beyond site (1.5 km)
Consequence	Medium	Low
Probability	Possible / frequent (Medium)	Possible / frequent (Medium)
Significance	**Low -**	**Very Low -**
Additional Assessment Criteria		
Degree to which impact can be reversed	*Fully reversible*	
Degree to which impact may cause irreplaceable loss of resources	*None*	
Degree to which impact can be avoided	*High: Impact can be avoided through the implementation of preventative mitigation measures.*	
Degree to which impact can be mitigated	*High: Mitigation can easily be applied or is considered standard operating practice for the activity and will reduce the impact significance rating.*	
Cumulative Impact		
Extent to which a cumulative impact may arise	*Unlikely*	
Rating of cumulative impacts	**Without Mitigation**	**With Mitigation**
	Very low -	**Very low -**

Mitigation

- Construction activities should only occur during daytime hours, preferably between 7am and 6pm.
- Equipment and vehicles should always be in good working order and undergo regular servicing. A maintenance plan and register of vehicles and equipment should be provided and maintained by the contractor to the Environmental Control Officer.
- The permitted construction area footprint should be demarcated, and vehicles must not be permitted beyond the boundaries.
- Vehicles and auxiliary power systems should be turned off when not in use. Warm-up idling should not be permitted.

7.6.3 Assessment of Operational Phase Impacts

7.6.3.1 Linear Infrastructure Surrounding Receptors

The noise impacts at all identified receptors due to linear infrastructure have been assessed as **negligible**.

7.6.3.2PV Plant Surrounding Receptors

The noise emissions from the PV plant are assessed as **negligible**. A 33 kV substation can be expected to be inaudible beyond 500 m at most in a low ambient noise environment.

7.6.4 Assessment of Decommissioning Phase Impacts

The decommissioning phase impact significance is rated as per the construction phase, I.e., **Low** without mitigation, and **Very Low** with mitigation (Refer Table 7-35). The mitigation requirements are, where relevant to the activities, as per the construction phase recommendations.

7.7 SOCIO-ECONOMIC IMPACT ASSESSMENT

This section is based on the Socio-Economic Study and Impact Assessment undertaken for the proposed project by Ashby Associates cc (Ashby Associates , 2023) and is included in Appendix J.

7.7.1 Job Creation and Skills Development

The project will create new jobs in the construction and operation phases and will provide an opportunity for Namibians to gain skills.

Project phase	Activity/infrastructure
Construction	Building the Project's infrastructure
Operations	Running and maintaining the power plant and associated infrastructure.
Decommissioning and closure	This is an improbable scenario as most components will be replaced at the end of their lifetime due to the project's outputs continuing to be in demand. In the unlikely event of decommissioning, the repurposing or removing the infrastructure will require jobs similar to those for the construction phase.

Impact of various ownership models for the different project components

ILF recommended the construction and operations of the power plant to an IPP scheme, which is similar to a Design-Build-Operate-Transfer (DBOT) contractual framework. The water transmission system is recommended by ILF (2021) to be built using the Engineering-Procurement-Construction model but a Design-Build-Operate (DBO) model is also an option.

Although a foreign-owned company may want to bring in their own personnel, the Ministry of Home Affairs, Immigration, Safety and Security has strict requirements to try and maximise the number of Namibians employed in available jobs. The Engineering Council of Namibia has a comprehensive list of engineers and technicians operating in Namibia, by discipline, by professional level and by nationality which are summarised in Section 6.14.3.6**.**

Both the construction and operating phases of the project will result in much needed jobs for Namibians. Specifications in the bidding process can enhance contractual obligations to maximise the number of jobs taken up by Namibians and the skills transfer to Namibians. Work experience and skills development usually opens the door to further job opportunities and provides skills transfers to other Namibians, so the duration of this impact is permanent and cumulative. Although it is expected that unskilled and semi-skilled labour will be recruited from the coastal area, more highly trained and experienced staff are likely to be sourced nationally.

Overall, the significance for job creation and skills development is **Very high** as they are in a sector which will continue to be in demand for many years to come.

Table 7-36: Impact Assessment Summary - Jobs and Skills during construction and operation

Description of Impact: Job creation and skills development		
Type of Impact	Direct, indirect and induced jobs and skills	
Nature of Impact	Positive	
Phases	Construction and Operational	
Criteria	**Without Enhancement**	**With Enhancement**
Intensity	Prominent change (High)	Severe change (Very high)
Duration	Permanent (> 20 years)	Permanent (> 20 years)
Extent	Regional/National	Regional/National
Consequence	Very high	Very high
Probability	Definite / Continuous (Very high)	Probable (High)
Significance	**Very high +**	**Very high +**
Additional Assessment Criteria		
Degree to which impact can be reversed	*Irreversible: Any work experience proving you can perform well is a great asset for obtaining further work. A wide range of tangible and intangible skills are transferable between jobs and are also long-term assets.*	
Degree to which impact may cause irreplaceable loss of resources	*None. The impact will cause a gain of resources, not a loss.*	
Degree to which impact can be avoided	*Low: NamWater and government will not want to avoid this positive impact.*	
Degree to which impact can be enhanced:	*Medium enhancement can be achieved by up-skilling Namibians at every available opportunity.*	
Cumulative Impact		
Extent to which a cumulative impact may arise	*Possible: The construction of future PV plant should bring additional jobs and provide upward job mobility for skilled personnel.*	
Rating of cumulative impacts	**Without Mitigation**	**With Mitigation**
	Medium +	**High +**
Residual impact		
Residual impact discussion	*The project will add valuable skills and work experience to the Namibian workforce, especially in the fields of solar power and desalination.*	

7.7.1.1 Enhancement actions/measures

The following enhancement measures would increase jobs and develop skills for more Namibians.

- The competitive bidding process should include providing a recruitment weighting for the component of Namibian staff employed at all levels of its workforce.

- The bidding process should include proposals to involve Namibian Small and Medium Enterprises to be involved (e.g. using labour-based works) in the construction phase.
- NamWater should increase its capabilities to manage Public-private Partnerships (PPP) contracts by a combination of training staff (to a limited extent) but mainly by recruiting competent new staff members and by including external consultancy(ies) (ILF, 2021).
- NamWater should proactively give bursaries to Namibians in specific fields required for this project.
- NamWater must oversee that its contractors promote sound worker-management relationships and safe and healthy working conditions.

7.7.1.2 Monitoring

- Construction: The contractor should report to NamWater on the number of Namibians employed at all skill levels, as per contract.
- Operations: NamWater should publicly report annually on the progress made by the IPP, joint venture partner(s), contractors and NamWater itself, to transfer skills and jobs to Namibians.
- Both phases: NamWater should undertake regular observation inspections of health and safety procedures and of worker-management relations of the companies involved in constructing and operating this project.

7.7.2 Community Health and Safety

A construction camp is more likely to be required from workers who will build or extend the solar plant in the #Gaingu Conservancy. Due to the remoteness of the solar site and potential threats to poaching, it is recommended that a construction camp is located in Arandis which can bring economic benefits to the town. A camp in Arandis is almost certainly required because there is insufficient surplus housing in the town. The camp would be fenced to protect the workers belongings rather than to keep workers from entering the community.

Many residents across the world are fearful of construction sites and camps near their homes as they bring potential threats to their community health and safety. The threats come from unsuccessful jobseekers and potential burglars and from workers with wages to spend but no family members to inhibit them.

During operations, the plant is unlikely to induce threats to community health as they require relatively few staff (approximately 50). The project is unlikely to drive additional in-migration to the nearby towns, above the normal rate. The solar plant and additional power line do not carry or induce any human health risks to the community.

Project phase	Activity/infrastructure
Construction	Source: Non-resident construction workers on short term contracts, living away from their homes.

Potential negative social impacts could arise from a male-dominated construction workforce engaging in drinking excessive alcohol, becoming violent, and having unprotected sex or sharing drugs. Contracting sexually transmitted diseases (STIs), unwanted pregnancies and anti-social behaviour are potential threats to themselves, local residents near the construction camp and their own families. Unemployed jobseekers could potentially turn to crime.

The impact is assessed to be of **Medium** significance without mitigation and can be reduced to **Low** with mitigation as shown in Table 7-37.

Table 7-37: Impact Assessment Summary - Community Health and Safety

Description of Impact: Community health and safety		
Type of Impact	Direct	
Nature of Impact	Negative	
Phases	Construction	
Criteria	**Without Mitigation**	**With Mitigation**
Intensity	Moderate change (Medium)	Minor change (Low)
Duration	Permanent (> 20 years)	Permanent (> 20 years)
Extent	Local Beyond site	Local
Consequence	High	High
Probability	Possible / frequent (Medium)	Unlikely / improbable (Very low)
Significance	**Medium -**	**Low -**
Additional Assessment Criteria		
Degree to which impact can be reversed	*Partially reversible: Once the construction is complete, the source of the impact is removed but any long-term health consequences may not be reversible for the individuals affected.*	
Degree to which impact may cause irreplaceable loss of resources	*Low: The risk of severe health and breaches of security causing disability or death is very low. Burglaries & theft, STIs and pregnancies are not life-threatening.*	
Degree to which impact can be avoided	*High: No recruitment of workers at the construction sites; and zero tolerance to alcohol on site will avoid much of the impact.*	
Degree to which impact can be mitigated	*High: Several mitigation measures can be adopted.*	
Cumulative Impact		
Extent to which a cumulative impact may arise	*The coastal towns already have a high rate of in-migration. Many holiday makers, transient workers and short-stay visitors come to the coastal towns. This project is small by comparison and poses a very low cumulative impact.*	
Rating of cumulative impacts	**Without Mitigation**	**With Mitigation**
	Very low -	Insignificant

7.7.2.1 Mitigation

Mitigation actions/measures which need to be known by the bidders for the project's contracts:

- The construction contractor should not allow recruitment for unskilled and semi-skilled construction workers at the sites or camp, but only at the #Gaingu Conservancy offices.
- The construction contractor must operate an alcohol-free and drug-free worksite which will include daily testing of employees/contractors on entry to the work site, at the beginning of shifts and at random times on duty.

- The construction contractor must ensure that all armed security workers who may be engaged directly or by contract to provide security to the sites, are well trained so they do not cause a security risk to the workforce or nearby community.
- Free condoms should be always in supply in every ablution block and toilet.
- NamWater should ensure there are penalty clauses in the contracts for non-compliance with these mitigation measures.

7.7.2.2 Monitoring

- NamWater needs to monitor compliance with the above mitigation measures before construction begins and monthly during the phase, instigating penalties if transgressions occur.

7.7.3 Reduced Grazing within the #Gaingu Conservancy

The PV power plant will be located in the #Gaingu Conservancy and will be built in three stages in alignment with the expansion phases of SS1 of the desalination plant. The maximum size of land required from the conservancy for stage 3 will be 141 ha (for the solar PV array for SS1) – which is just under 350 football pitches.

The conservancy has a membership of about 3,000 people, many of whom try and farm with goats and livestock in this very dry region with low, sporadic rainfall (Figure 7-8). The proposed location is within the "Multiple Use: Livestock Priority Area" of the conservancy's management plan (Figure 7-9).

Figure 7-8: Photograph of the proposed site for the Solar Power Plant

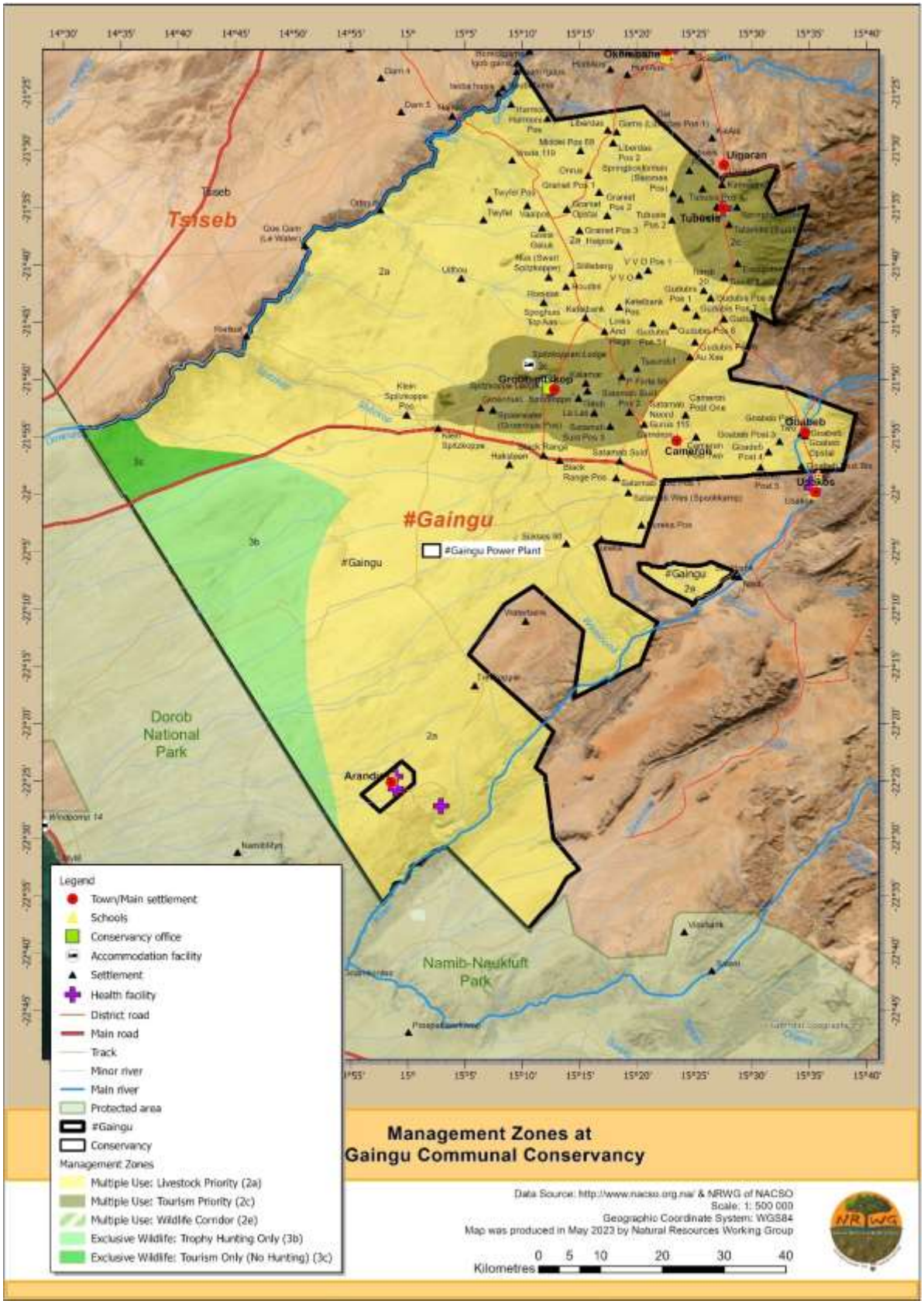


Figure 7-9: Approximate Location of the proposed Power Plant within the #Gaingu Conservancy

The solar power plant and associated infrastructure will cause some loss of grazing land within the conservancy. During construction, there will be a lot of movement and disturbance of land, beyond the immediate final footprint of the infrastructure. This will impact negatively on the little grazing which is currently available. Any compaction of the soil may hinder regrowth when rain does occur so steps must be taken to minimise the loss of grazing in such a fragile, arid environment.

The impact is assessed to be of **Medium** significance without mitigation and can be reduced to **Low** with mitigation as shown in Table 7-38.

Table 7-38: Impact Assessment Summary – Reduced Grazing during the construction and operational phases

Description of Impact: Reduced Grazing available to the #Gaingu Conservancy		
Type of Impact	Direct	
Nature of Impact	Negative	
Phases	Construction and Operational	
Criteria	**Without Mitigation**	**With Mitigation**
Intensity	Moderate change (Medium)	Negligible change (Very low)
Duration	Permanent (> 20 years)	Permanent (> 20 years)
Extent	Whole site and nearby surroundings	Whole site and nearby surroundings
Consequence	Medium	Low
Probability	Definite / Continuous (Very high)	Probable (High)
Significance	**Medium -**	**Low -**
Additional Assessment Criteria		
Degree to which impact can be reversed	*Partially reversable: When the plant is decommissioned, and all structures are removed, most land would be available for grazing once more.*	
Degree to which impact may cause irreplaceable loss of resources	*Medium: While the power plant is being constructed and in operation, the land will not be available for grazing livestock.*	
Degree to which impact can be avoided	*None. Impact cannot be avoided, and compensation is recommended.*	
Degree to which impact can be mitigated:	*High: Mitigation can be easily applied and will reduce the impact significance rating.*	
Cumulative Impact		
Extent to which a cumulative impact may arise	*Possible: An expansion of the PV field and BESS may happen in the future, which would result in further loss of grazing.*	
Rating of cumulative impacts	**Without Mitigation**	**With Mitigation**
	Medium -	**Low -**

7.7.3.1 Mitigation

- NamWater negotiates with the #Gaingu Conservancy Management Committee a compensation plan for the loss of land use.
- The construction and operations company recruits workers from the #Gaingu Conservancy whenever possible.

- The construction and operations company must strictly adhere to any rules and regulations regarding creating new tracks or other protective measures agreed with the constituency, prior to project commencement.

7.7.3.2 Monitoring

- NamWater, as project leader, meets the #Gaingu Conservancy annually to ensure compliance with any agreements which were negotiated.

7.8 CLIMATE CHANGE RISK ASSESSMENT

The following section is based on specialist inputs from SLR included in Appendix K. The assessment methodology used to assess the climate change risks to the project are presented in the specialist report.

7.8.1 Climate Change Risks to the Project

The following section presents an assessment of the climate change risks that may affect the Project during its life cycle. This assessment focuses on the anticipated changes in the climate that pose a direct or indirect risk to the Project's infrastructure, availability of natural resources (e.g., water), and supply chains, and would require the implementation of adaptation measures. This assessment has not considered the potential risks associated which the transition to a lower carbon economy as the Project is not deemed to be significantly at risk to changes in policies, legislation, technologies, or shifts in consumer demand.

7.8.2 Risk to the Solar PV Facility with a Rise in Temperature

It is projected that there will be an increase in mean annual temperature and maximum daily temperature. As such, the Project infrastructure may be operating under very different climate conditions in the foreseeable future than they would have in the past. This is a risk to the Project, as the basis of design, which includes the specific tolerances of the electrical components, is based on historical climate data and not on forward-looking climate projections. This poses a risk to the Project as the changes in climate variability and extremes as a result of climate change are beyond what has occurred in the past, and which has not been taken into account in the basis of design.

To illustrate the impact of rising temperatures on the Project's electrical infrastructure, the solar PV modules will be used as an example. It is estimated that an increase in temperature from 25°C to 30°C, 35°C, and 40°C, will result in a 1.7%, 3.4%, and 5.1%, respective, decrease in the efficiency, and therefore output, of the solar PV modules. This estimate is based on the temperature coefficient of peak power (-0.34% per 1°C increase in temperature) of the Longi bifacial monocrystalline module (LR5-72HBD-540M) [14]. Note that the preferred make and model of the solar PV modules will only be selected during the detailed design phase.

The risk of a reduction in the performance of the solar PV facility due to a rise in temperature is likely to **Low** (Table 7-39). The hazard rating is deemed to be high as the increase in mean annual temperature and maximum daily temperature is already occurring, with this trend projected to increase into the future. The vulnerability of the solar PV facility to the change in temperature is deemed to be low. This is because the solar PV facility has a relatively low sensitivity to the adverse effects of a changing climate, with relatively high capacity to adapt to the project changes (see recommended adaptation measures listed below). The

[14] Longi (2022). *Hi MO 5m: LR572HPH 540-560M*. **https://static.longi.com** [accessed on 28 February 2023].

exposure of the solar PV facility to a change in temperature is deemed to be high as the Project is located within an area already experiencing a rise in temperature, a trend which is projected to continue into the future.

Table 7-39: Assessment of the risk to the solar PV facility with a rise in temperature

Description of risk	
Type of Impact	Direct
Nature of Impact	Negative
Phases of Project	Operations
Assessment of risks	
Hazard	High
Vulnerability	Low
Exposure	High
Significance of risk	Low
Additional assessment criteria	
Degree to which impact can be reversed	*Irreversible (The reduction in performance is irreversible).*
Degree to which impact may cause irreplaceable loss of resources	*None (It is unlikely that a reduction in performance will result is an irreplaceable loss of resources as the Project site will have been mostly transformed).*
Degree to which impact can be avoided	*Low (It is unlikely that a reduction in performance is avoidable).*
Degree to which impact can be mitigated	*Medium (With the recommended adaptation measures, the extent of a reduction in performance can potentially be reduced).*

To mitigate to the potential risk, the following adaptation measures are recommended:

- Review the basis of design of the solar PV modules, inverters, transformers and substations, overhead powerlines, and BESS, taking into account the observed and projected change in temperature. If required, the basis of design should be updated accordingly.

7.8.3 Risk to the Solar PV Facility with an Increase in the Number of Fog Days

The solar PV facility is located in a region which experiences frequent coastal fog[15]. The fog is typically formed by warm air passing over the relatively cold surface waters of the Benguela current, which is cooled, and reaches saturation. It is projected that there will likely be a slight increase in the number of fog days along the coast, with a slight decrease in the number of fog days further inland.

The risk of a reduction in the performance of the solar PV facility due to an increase in the number of fog days is likely to **Low** (Table 7-40). The hazard rating is deemed to be low as the number of fog days further inland is projected to decrease in the future. The vulnerability of the solar PV facility to an increase in the number of fog days is deemed to be high as the performance of the facility is likely to be adversely affected with limited capacity to adapt to the changes. The exposure of the solar PV facility to the adverse effects of

[15] Haensler A., Cermak J., Hagemann S., and Jacob D. (2011). Will the Southern African west coast fog be affected by future climate change? Results of an initial fog projection using a regional climate model. *Erkunde*. Vol 63:3. pgs. 261-275

coastal fog is deemed to be low as the Project site is located further inland, where the effects of coastal fog are not as intense as along the coast.

Table 7-40: Assessment of the risk to the solar PV facility with an increase in the number of fog days

Description of risk	
Type of Impact	Direct
Nature of Impact	Negative
Phases of Project	Operations
Assessment of risks	
Hazard	Low
Vulnerability	High
Exposure	Low
Significance of risk	Very low
Additional assessment criteria	
Degree to which impact can be reversed	*Irreversible (The reduction in performance is irreversible).*
Degree to which impact may cause irreplaceable loss of resources	*None (It is unlikely that a reduction in performance will result is an irreplaceable loss of resources as the Project site will have been mostly transformed).*
Degree to which impact can be avoided	*Low (It is unlikely that a reduction in performance is avoidable).*
Degree to which impact can be mitigated	*Medium (With the recommended adaptation measures, the extent of a reduction in performance can potentially be reduced).*

To mitigate to the potential risk, the following adaptation measures are recommended:

- The solar PV facility should be located further inland, as is proposed, where the adverse effects of coastal fog are less intense than along the coast.

7.8.4 Risk to Employees with a Rise in Temperature

An increase in extreme heat can increase the risk of employees suffering from heat stress during the construction and operational phases. Heat stress can adversely affect an employees' health and productivity, and in extreme cases, result in loss of life. Elderly employees or employees with pre-existing medical conditions, such as diabetes, are typically more vulnerable to the adverse effects of extreme heat.

The risk of employees suffering from heat stress due to a rise in temperature is likely to be **Very Low** (Table 7-41). According to the Global Facility for Disaster Reduction and Recovery, the hazard rating for extreme heat is low. This is because there is between 5% and 25% chance that at least one period of prolonged exposure to extreme heat, resulting in heat stress, will occur in the next five years. The vulnerability of employees to extreme heat is deemed to be very low as they are likely to be acclimatised to the warm desert climate, with a greater tolerance to the extreme heat than a person from a cooler climate. The exposure of the employees is likely to be high as the Project is located in an area that is already experiencing extreme heat, a trend which is projected to continue into the future. Furthermore, the outdoor nature of the construction and operational activities, increases the exposure of the workers to the adverse effects of extreme heat.

Table 7-41: Assessment of the risk to employees with a rise in temperature

Description of risk	
Type of Impact	Direct
Nature of Impact	Negative
Phases of Project	Construction and operations
Assessment of risks	
Hazard	Medium
Vulnerability	Very low
Exposure	High
Significance of risk	Very Low
Additional assessment criteria	
Degree to which impact can be reversed	*Partially reversible (In general, the negative impacts of heat stress are reversible. In extreme cases (i.e., death), the impacts may be irreversible).*
Degree to which impact may cause irreplaceable loss of resources	*None (It is unlikely that employees suffering from heat stress will result in an irreplaceable loss of resources).*
Degree to which impact can be avoided	*High (With the recommended adaptation measures, it is likely that the adverse effects of employees suffering from heat stress can be avoided).*
Degree to which impact can be mitigated	*Medium (With the recommended adaptation measures, it is likely that the adverse effects of workers suffering from heat stress can be reduced).*

To mitigate to the potential risk, the following adaptation measures are recommended:

- Develop and implement an employee health awareness program to educate employees (and contractors) about the importance of drinking water and identifying the early signs of heat stroke/dehydration; and
- Provide employees with appropriate personal protective equipment (PPE) to reduce the risk of heat stroke/dehydration.

7.9 GHG EMISSIONS ASSESSMENT

The following section is based on specialist inputs from SLR included in Appendix L.

A solar PV facility has been incorporated into the Project to reduce the demand on the national grid, which already exceeds the supply, and to reduce the operational costs of the desalinisation plant and water carriage system. The desalinisation plant and water carriage system is assessed in a separate report.

This assessment has not applied the standard SLR impact assessment methodology as this approach is not deemed to be appropriate for assessing the impact of the Project's GHG emissions in terms of the contribution to atmospheric GHG emissions concentrations, one of the main drivers of global warming and anthropogenic climate change. This is because climate change in an unprecedented challenge and existing impact assessment methodologies cannot sufficiently capture the scale of the issue. While the extent of GHG emissions may be global, the impacts are not evenly distributed across the globe. Some places may experience imperceptible impacts, while other areas may experience catastrophic impacts. Furthermore, while the Project would definitely contribute to global GHG emissions concentrations, the direct impact of these emissions in unclear.
This assessment will thus use an alternative approach based on the following two criteria:

- Assess the contribution of the Project's annual operational emissions to Namibia's GHG emissions trajectory; and
- Comparison of the emissions intensity of the Project against the intensity of two alternative technologies. There are presently two scenarios for the solar PV facility, which are detailed below:
    - **Scenario 1**: The solar PV facility provides 30% of the electricity required by the desalinisation plant and water carriage system, with the remaining 70% is provided by the national grid.
    - **Scenario 2**: The solar PV facility (including BESS) provides 42% of the electricity required by the desalinisation plant and water carriage system, with the remaining 58% is provided by the national grid. Scenario 2 is the preferred alternative but is subject to the relaxation of the current regulations which restrict purchased electricity to 30% of total annual consumption.

These criteria are discussed in more detail in the specialist report (Appendix L).

7.9.1 Scope 1 and 2 Emissions

The total scope 1 and 2 emissions for scenario 1 (i.e., 30% solar PV and 70% grid) was calculated to be 139 799 tCO_2e, with an average of 5 178 tCO_2e per annum. The total emissions for scenario 2 (i.e., 42% solar PV and 58% grid) was calculated to be 120 982 tCO_2e, with an average of 4 481 tCO_2e per annum. The emissions of scenario 2 are lower than scenario 1, as a greater proportion of the electricity required for the desalinisation plant and water carriage system would be provided by solar PV.

7.9.2 Scope 3 Emissions

The total scope 3 emissions for scenario 1 (i.e., 30% solar PV and 70% grid) was calculated to be 2 903 839 tCO_2e, with an average of 107 550 tCO_2e per annum. The total emissions for scenario 2 (i.e., 42% solar PV and 58% grid) was calculated to be 4 196 656 tCO_2e, with an average of 155 432 tCO_2e per annum. The emissions of scenario 2 are higher than scenario 1 due to the greater CAPEX and OPEX, and the emissions of purchasing products and services, and capital goods. For a more detailed breakdown of the scope 3 emissions, refer to Appendix B of the specialist report in Appendix L.

7.9.3 Contribution to Namibia's GHG Emissions Trajectory

Table 7-42 presents the calculated contribution of the Project's scope 1 and 2 emissions to Namibia's business-as-usual GHG emissions trajectory, as well as the trajectory based on the emissions reduction commitments contained in the updated Nationally Determined Contributions (NDC) (see Section 4.2 of the specialist report). The business-as-usual emissions trajectory was extrapolated up to 2050 using the average year-on-year growth in emissions from 2021 to 2030. The NDC emissions trajectory was extrapolated up to 2050 using Namibia's near-term (i.e., 2030) emissions reduction commitments and long-term ambition of achieving net-zero emissions by 2050.

The impact of the Project's GHG emissions on the business-as-usual GHG emissions trajectory is likely to be **Low**, ranging from 0.013% to 0.022%. The impact of the Project's GHG emissions on the NDC GHG emissions trajectory is likely to be **Low** in the near-term (i.e., up to 2030), **Medium** in medium-term (i.e., up to 2040), and **High to Very high** in the long-term (i.e., up to 2050). For a more detailed breakdown of the contribution of the contribution of the Project's emissions to Namibia's GHG emissions trajectory refer to Appendix C of the specialist report in Appendix L.

The medium- and long-term impacts of the Project's GHG emissions should be interpreted with caution for several reasons. Firstly, the emissions reduction commitments contained in Namibia's updated NDC are very ambitious and subject to receiving significant international financial support. Secondly, the calculations do not take account of potential reductions in the carbon intensity of the national grid over time.

Table 7-42: Percentage contribution to Namibia's GHG emissions trajectory

Year	Business-as-usual GHG emissions trajectory		NDC GHG emissions trajectory	
	Scenario 1	Scenario 2	Scenario 1	Scenario 2
2024	0.015%	0.013%	0.022%	0.019%
2025	0.016%	0.014%	0.028%	0.025%
2026	0.017%	0.015%	0.036%	0.031%
2027	0.018%	0.016%	0.049%	0.043%
2028	0.018%	0.016%	0.067%	0.058%
2029	0.018%	0.016%	0.102%	0.088%
2030	0.019%	0.016%	0.205%	0.177%
2031	0.019%	0.016%	0.219%	0.190%
2032	0.019%	0.016%	0.236%	0.204%
2033	0.019%	0.017%	0.255%	0.221%
2034	0.019%	0.017%	0.276%	0.239%
2035	0.019%	0.017%	0.298%	0.258%
2036	0.019%	0.017%	0.324%	0.281%
2037	0.020%	0.017%	0.354%	0.306%
2038	0.020%	0.017%	0.388%	0.336%
2039	0.020%	0.017%	0.429%	0.371%
2040	0.020%	0.017%	0.477%	0.412%
2041	0.020%	0.017%	0.534%	0.462%
2042	0.020%	0.018%	0.605%	0.523%
2043	0.020%	0.018%	0.693%	0.600%
2044	0.021%	0.018%	0.808%	0.699%
2045	0.021%	0.018%	0.961%	0.831%
2046	0.021%	0.018%	1.175%	1.017%
2047	0.021%	0.018%	1.498%	1.297%
2048	0.021%	0.018%	2.037%	1.763%
2049	0.021%	0.019%	3.116%	2.697%
2050	0.022%	0.019%	6.357%	5.501%
MIN	**0.015%**	**0.013%**	**0.022%**	**0.019%**
MAX	**0.022%**	**0.019%**	**6.357%**	**5.501%**

7.9.4 Comparison of the GHG Emissions of Three Technology Alternatives

Table 7-43 presents the calculated GHG emissions of the Scenario 1 (30% from solar PV facility and 70% from national grid) and Scenario 2 (42% from solar PV facility and 58% from national grid) in comparison to

the emissions of sourcing 100% of the electricity required for the desalinisation plant and water carriage system from the national grid.

For Scenario 1, the GHG emissions were calculated to be 25% lower than sourcing 100% from the national grid. For Scenario 2, the GHG emissions were calculated to be 35% lower than sourcing 100% from the national grid. As the GHG emissions of both Scenario 1 and Scenario 2 are lower than the alternative, sourcing 100% from the national grid, the impact is deemed to be **Positive.**

Table 7-43: Comparison of GHG emissions of three technology alternatives

Year	GHG emissions of Scenario 1 (tCO_2e)	GHG emissions of Scenario 2 (tCO_2e)	GHG emissions of 100% national grid (tCO_2e)
2024	3 333	2 885	4 455
2025	3 620	3 133	4 839
2026	3 832	3 316	5 121
2027	4 222	3 654	5 642
2028	4 314	3 733	5 765
2029	4 406	3 813	5 888
2030	4 501	3 896	6 016
2031	4 599	3 980	6 147
2032	4 700	4 067	6 282
2033	4 805	4 158	6 422
2034	4 912	4 251	6 564
2035	5 002	4 329	6 685
2036	5 096	4 410	6 810
2037	5 191	4 493	6 938
2038	5 289	4 577	7 068
2039	5 388	4 663	7 201
2040	5 491	4 752	7 339
2041	5 594	4 841	7 477
2042	5 703	4 935	7 622
2043	5 811	5 029	7 767
2044	5 925	5 128	7 919
2045	6 039	5 226	8 072
2046	6 157	5 328	8 229
2047	6 278	5 433	8 391
2048	6 402	5 540	8 556
2049	6 529	5 650	8 726
2050	6 659	5 763	8 900
TOTAL	**139 799**	**120 982**	**186 841**
Reduction in emissions	***-25%***	***-35%***	**-**

8. ENVIRONMENTAL IMPACT STATEMENT AND CONCLUSIONS

The following provides a summary and overview of the ESIA process undertaken for the proposed development of the #Gaingu PV Power Plant and associated infrastructure and the findings, a reasoned opinion recommending whether the project should proceed or not, and a conclusion.

8.1 SUMMARY AND OVERVIEW OF THE ESIA PROCESS AND FINDINGS

Water demand in Namibia continues to increase due to economic development, population growth and urbanisation. The number of people affected by water scarcity continues to grow. Without water basic human rights cannot be met and development cannot proceed. It is, thus, essential to secure a diversified, climate-independent supply of water for the CCA and CAN.

NamWater is the national water utility of Namibia. NamWater undertook a Feasibility Study for the proposed development of a desalination plant and a water carriage system to supply water to the Central Coast, Windhoek and en-route users (Arandis, Usakos, Karibib and Okahandja). The primary objective of the Feasibility Study, which was informed by the findings of the Scoping phase, was to investigate feasible and affordable water supply options that would diversify and secure supply alternatives to the target areas and identify the preferred project alternative(s) to be considered in the Impact Assessment phase. The development and implementation of the desalination plant to meet the water demands of the CCA SS1 was found to be imperative and considered to be the most viable project. Based on the findings of the Feasibility Study, NamWater has thus decided to proceed with SS1 only.

During the Feasibility Study, different solutions for providing a RE power supply in combination with the national utility supply were considered for the different supply scenarios of the desalination plant.

This report discusses the power supply option related to SS1, which is the development of the proposed #Gaingu Power Plant and associated infrastructure which is proposed to be located within the #Gaingu Conservancy. The new desalination facility and components are discussed and assessed in a separate report.

As with any substantial development, the proposed Project is likely to result in a range of environmental and social impacts, being both negative and positive (some of which are motivating factors discussed above). Negative and positive impacts identified and assessed as part of this ESIA are summarised in Table 8-1.

Table 8-1: Summary of the significance of potential impacts associated with the proposed project

Impact/Issue	Without Mitigation	With Mitigation
Biophysical Impacts		
Surface water		
Contamination of surface water resources in construction phase	**Medium**	**Low**
Contamination of surface water resources in operational phase	**Medium**	**Low**
Contamination of surface water resources in decommissioning phase	**Medium**	**Low**
Flooding in construction, operation, decommissioning phases	**Medium**	**Low**

Impact/Issue	Without Mitigation	With Mitigation
Alteration of natural drainage patterns and flow during construction, operational and decommissioning phases	Medium	Low
Terrestrial Biodiversity and Ecology		
Impact of disturbance and destruction of habitat and organisms	High	Low
Impact of disturbance of animals and interference with their behaviour	Medium	Very low
Impact of light pollution	Low	Very low
Impact from vehicle tracks	High	Low
Avifauna		
Impact of physical/ human disturbance of birds, including noise and light disturbance for PV plant	Medium	Low
Impact of physical/human disturbance of birds, including noise and light disturbance for powerline	Low	Insignificant
Impact of direct and indirect modification/ loss/ destruction of bird habitat at the PV plant	Medium	Medium
Impact of direct and indirect modification/ loss/ destruction of bird habitat for the powerline	Medium	Low
Impact of attraction of birds to novel habitats through the artificial provision of scarce resources	Medium	-
Impact of bird electrocutions on power line infrastructure	Medium	Very low
Impact of bird collisions on infrastructure such as solar PV panel arrays and fencing	Low	Very low
Impact of bird collisions with power line infrastructure	Medium	Low
Physical Impacts		
Heritage		
Impact to heritage resources – powerlines	Medium	Low
Impact to heritage resources – PV plant	Low	Very low
Visual		
Impact of dust created during the construction phase	Low	Low
Impact of dust created during the operational phase	Medium	Medium
Alteration of the landscape character during the construction phase	Medium	Medium
Change in sense of place during operational phase	High	High
Visibility of the project	High	High
Light impact	High	Low
Noise		

Impact/Issue	Without Mitigation	With Mitigation
Construction noise impact	Low	Very Low
Socio-economic		
Job creation and skills development	Very high +	Very high +
Community health and safety	Medium	Low
Reduced Grazing Capacity within the #Gaingu Conservancy	Medium	Low

Based on the baseline receiving environments conditions, the majority of the negative **biophysical impacts** were assessed to have a **medium** to **low** significance prior to implementing any mitigation actions. With the exception of the impact of disturbance and destruction of habitat and organisms and the impact from vehicle tracks on the terrestrial ecology and biodiversity which significance was assessed to be high, can both be mitigated to reduce to low significance. The availability of mitigation actions and their implementation as included in the ESMPs would further reduce the significance of any negative impact further. Most negative impacts could have mitigation applied to reduce significance to range between **medium** or **very low** (with the exception of the impact on the *attraction of birds to novel habitats through the artificial provision of scarce resources* in which adaptive management measures are proposed).

Negative physical impacts to **visual, noise and heritage** were assessed to range in significance between **high** and **low** prior to mitigation being applied. Mitigation is expected to reduce significance to low/ very low except for four assessment criteria (*Dust creation during construction*, *Alteration of the landscape character during the construction phase, Change in sense of place during operational phase and Visibility of the project*) for which mitigation could not be applied to reduce their significance.

From a socio-economic perspective, both positive and negative assessment criteria were identified. However, mitigation measures can be adopted to reduce the negative impact significance to **low**. The remaining social impact is considered to have a **Very High** beneficial (positive) result for Namibia and can be developed on and refined to increase their effectiveness.

While several negative environmental impacts have been identified, the majority of these without mitigation are considered to be of **medium to low** significance and are not considered fatal flaws. Mitigation would reduce the significance of these impacts further. Conversely, the proposed project is aligned with Namibia planning objectives and are likely to result in significant national and regional socio-economic benefits by supporting the increase in the security of water supply to the central coastal areas through providing power to the NamWater Desalination Plant project. On this basis, it is SLR's opinion that, subject to the implementation of the ESMP, the proposed #Gaingu PV Power Plant Project should be approved and granted an ECC.

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