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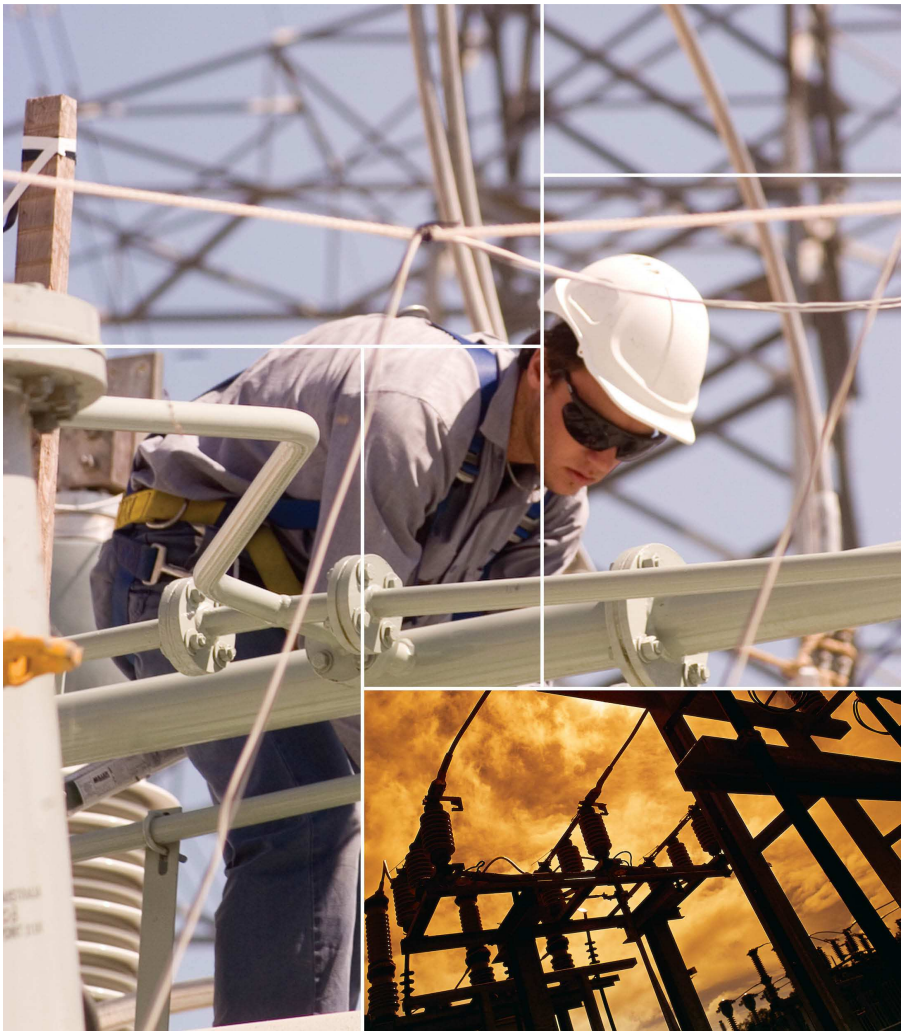

ENVIRONMENTAL IMPACT ASSESSMENT FOR THREE 10 MEGAWATT PHOTOVOLTAIC FACILITIES AT MARIENTAL, OMARURU AND OKAHANDJA, NAMIBIA

DRAFT SCOPING REPORT

16 June 2014

Prepared by:

aurecon

Leading. Vibrant. Global.

www.aurecongroup.com

Aurecon Namibia (Pty) Ltd
Tel: +264 (61) 297 7000
Email:
louise.corbett@aurecongroup.com

Prepared for:

NamPower

Powering the Nation and beyond

Namibia Power Corporation
Tel: +264 (61) 205 2385
Email:
lahja.amaambo@nampower.com.na

Document Control Record

Document prepared by:
Aurecon Namibia (Pty) Ltd
90/469
Aurecon Centre
189 Newton Street
Windhoek
Namibia

T +264 61 297 7000
F +264 61 297 7007
E namibia@aurecongroup.com
W aurecongroup.com

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Author Signature		**Verifier Signature**	
Name	Karen de Bruyn	Name	Louise Corbett
Title	Project staff	Title	Associate
Verifier Signature		**Approver Signature**	
Name	Diane Erasmus	Name	Andries van der Merwe
Title	Associate	Title	Technical Director

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NAMIBIA'S ENVIRONMENTAL MANAGEMENT ACT (NO. 7 OF 2007) REQUIREMENTS FOR SCOPING AND ENVIRONMENTAL IMPACT ASSESSMENT REPORTS WITH REFERENCE TO RELEVANT SECTIONS OF THIS SCOPING REPORT

The Scoping and Environmental Impact Assessment (EIA) process has resulted in the production of a comprehensive Draft Scoping Report (DSR), which provides detailed information relevant to the project.

Table 1 presents the structure of the comprehensive Scoping Report as well as the applicable sections that address the required information in terms of Environmental Management Act (No. 7 of 2007) and the 2012 EIA Regulations (No. 30 of 2012).

Table 1 | EMA requirements for Scoping and EIA Reports and location in this Scoping Report

EIA Regulations 2012		Section
Section 8 – Scoping Report		
8 (a)	The curriculum vitae of the EAP/s who prepared the report	Annexure B
8 (b)	A description of the proposed activity	Section 4
8 (c)	A description of the site on which the activity is to be undertaken and the location of the activity on the site	Section 6.1
8 (d)	A description of the environment that may be affected by the proposed activity and the manner in which the geographical, physical, biological, social, economic and cultural aspects of the environment may be affected by the proposed listed activity	Section 6
8 (e)	An identification of laws and guidelines that have been considered in the preparation of the scoping report	Section 1.2
8 (f)	Details of the public consultation process conducted in terms of regulation 7(1) in connection with the application, including	Section 2.2
	(i) the steps that were taken to notify potentially interested and affected parties of the proposed application	Section 2.2.2
	(ii) proof that notice boards, advertisements and notices notifying potentially interested and affected parties of the proposed application have been displayed, placed or given;	Will included in the Final Scoping Report
	(iii) a list of all persons, organisations and organs of state that were registered in terms of regulation 22 as interested and affected parties in relation to the application;	Annexure C
	(iv) a summary of the issues raised by interested and affected parties, the date of receipt of and the response of the EAP to those issues;	Annexure C
8 (g)	A description of the need and desirability of the proposed listed activity and any identified alternatives to the proposed activity that are feasible and reasonable, including the advantages and disadvantages that the proposed activity or alternatives have on the environment and on the community that may be affected by the activity;	Section 4.6
8 (h)	A description and assessment of the significance of any significant effects, including cumulative effects, that may occur as a result of the undertaking of the activity or identified alternatives or as a result of any construction, erection or decommissioning associated with the undertaking of the proposed listed activity;	Section 6

EIA Regulations 2012		Section
8 (i)	Terms of reference for the detailed assessment;	Not applicable – all impacts have been adequately dealt with in this Scoping Report.
8 (j)	A draft EMP	Annexure D
Section 15 – Assessment Report		
15(1)(a)	The curriculum vitae of the EAP who compiled the report	Annexure B
15(1)(b)	A detailed description of the proposed listed activity	Section 1.3
15(1)(c)	A description of the environment that may be affected by the activity and the manner in which the physical, biological, social, economic and cultural aspects of the environment may be affected by the proposed activity	Section 6
15(1)(d)	A description of the need and desirability of the proposed listed activity and identified potential alternatives to the proposed listed activity, including advantages and disadvantages that the proposed activity or alternatives may have on the environment and the community that may be affected by the activity	Section 4.6
15(1)(e)	An indication of the methodology used in determining the significance of potential effects	Section 5
15(1)(f)	A description and comparative assessment of all alternatives identified during the assessment process	Section 4.5 and Section 6
15(1)(g)	A description of all environmental issues that were identified during the assessment process, an assessment of the significance of each issue and an indication of the extent to which the issue could be addressed by the adoption of mitigation measures	Section 6
15(1)(h)	An assessment of each identified potentially significant effect, including - (aa) cumulative effects; (bb) the nature of the effects; (cc) the extent and duration of the effects; (dd) the probability of the effects occurring; (ee) the degree to which the effects can be reversed; (ff) the degree to which the effects may cause irreplaceable loss of resources; and (gg) the degree to which the effects can be mitigated	Section 6
15(1)(i)	A description of any assumptions, uncertainties and gaps in knowledge	Section 2.3
15(1)(j)	An opinion as to whether the proposed listed activity must or may not be authorised, and if the opinion is that it must be authorised, any conditions that must be made in respect of that authorisation	Section 7
15(1)(k)	A non-technical summary of the information	Refer to Executive Summary

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LIST OF FIGURES

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ABBREVIATIONS

AHP	Analytical Hierarchy Process
APV	Aquifer Pollution Vulnerability
BID	Background Information Document
CRR	Comments and Responses Report
dB(A)	Decibel
DSR	Draft Scoping Report
EAP	Environmental Assessment Practitioner
ECC	Environmental Compliance Certificate
ECO	Environmental Control Officer
EIA	Environmental Impact Assessment
EMA	Environmental Management Act (Act No. 7 of 2007)
EMP	Environmental Management Plan
Ha	Hectares
HIV/AIDS	Human Immunodeficiency Virus/ Acquired Immunodeficiency Syndrome
HPV	High Pollution Vulnerable
I&APs	Interested and Affected Parties
IPP	Independent Power Producer
IUCN	International Union for Conservation of Nature
KOP	Key Observation Point
kV	Kilo volt
LPV	Low Pollution Vulnerable
Mamsl	metres above mean sea level
MAP	Mean Annual Precipitation
MCDM	Multi-criteria Decision Making
MET: DEA	Ministry of Environment and Tourism: Directorate of Environmental Affairs
NEMA	Namibian Environmental Management Act (No. 7 of 2007)
PPP	Public Participation Process
PV	Photovoltaic
RA	Roads Authority
SAB	Southeast Kalahari (Stampriet) Artesian Basin
SACNASP	South African Council for Natural Scientific Professions
SANS	South African National Standards
TA	Traditional Authorities
TIA	Traffic Impact Assessment
ToR	Terms of Reference
VIA	Visual Impact Assessment
VAC	Visual Absorption Capacity
ZVI	Zone of Visual Influence

EXECUTIVE SUMMARY

1 INTRODUCTION AND BACKGROUND

The purpose of this section is to briefly introduce the proposed photovoltaic facilities and to describe the legislative context.

1.1 INTRODUCTION

Namibia Power Corporation (Pty) Ltd (NamPower) propose to purchase power from three Independent Power Producer (IPP) run photovoltaic (PV) (solar) energy facilities to reduce their high reliance on power imports as part of their security of supply plan. The Government of Namibia supports this move having created a Project Steering Committee made up of the Ministry of Mines and Energy (MME), the Electricity Control Board of Namibia and NamPower, to authorise and steer the proposed PV facilities.

The power would be generated from three individual PV solar energy facilities at three separate locations in Namibia namely; Mariental, Omaruru and Okahandja as indicated in Figure 1. The proposed facilities would each generate 10 megawatt (MW) and cover approximately 35 hectares (ha) at each location, dependent on final design. The selected IPP/ IPP's would build, own and operate each facility on sites owned by the State.

In terms of the Environmental Management Act (No. 7 of 2007) (EMA), an Environmental Impact Assessment (EIA) is required to obtain an Environmental Clearance Certificate (ECC) from the Ministry of Environment and Tourism: Department of Environmental Affairs (MET: DEA) before the projects can proceed. NamPower has appointed Aurecon South Africa (Pty) Ltd (Aurecon) to undertake the EIA study to investigate the potential biophysical and socio-economic environmental impacts. The findings will inform MET: DEA's decision-making and inform the design and operation of the three proposed PV facilities. Although NamPower is the applicant in the EIA process, NamPower will select a preferred IPP/IPPs after a tender process to construct and operate the facilities.

The Scoping process has investigated the potential significant positive and negative biophysical and socio-economic impacts associated with construction activities for the proposed 10 MW PV facilities. In addition to reporting on the potential impacts, the Scoping process also serves to provide an opportunity for Interested and Affected Parties (I&APs) to provide comment and participate in the process. This report serves to document the Scoping Phase and is structured as follows:

Section One:	Introduces the project and describes the legal framework.
Section Two:	Introduces the EIA process, describes the proposed public participation to be undertaken, lists the assumptions, uncertainties and limitations and describes the independence of the Environmental Assessment Practitioners.
Section Three:	Describes the Multi-criteria Decision Making (MCDM) process used to select the preferred site alternatives.
Section Four:	Describes the proposed project and identified alternatives. It also provides a motivation of the need for the proposed PVs.
Section Five:	Provides a description of the environment assessment methodology.

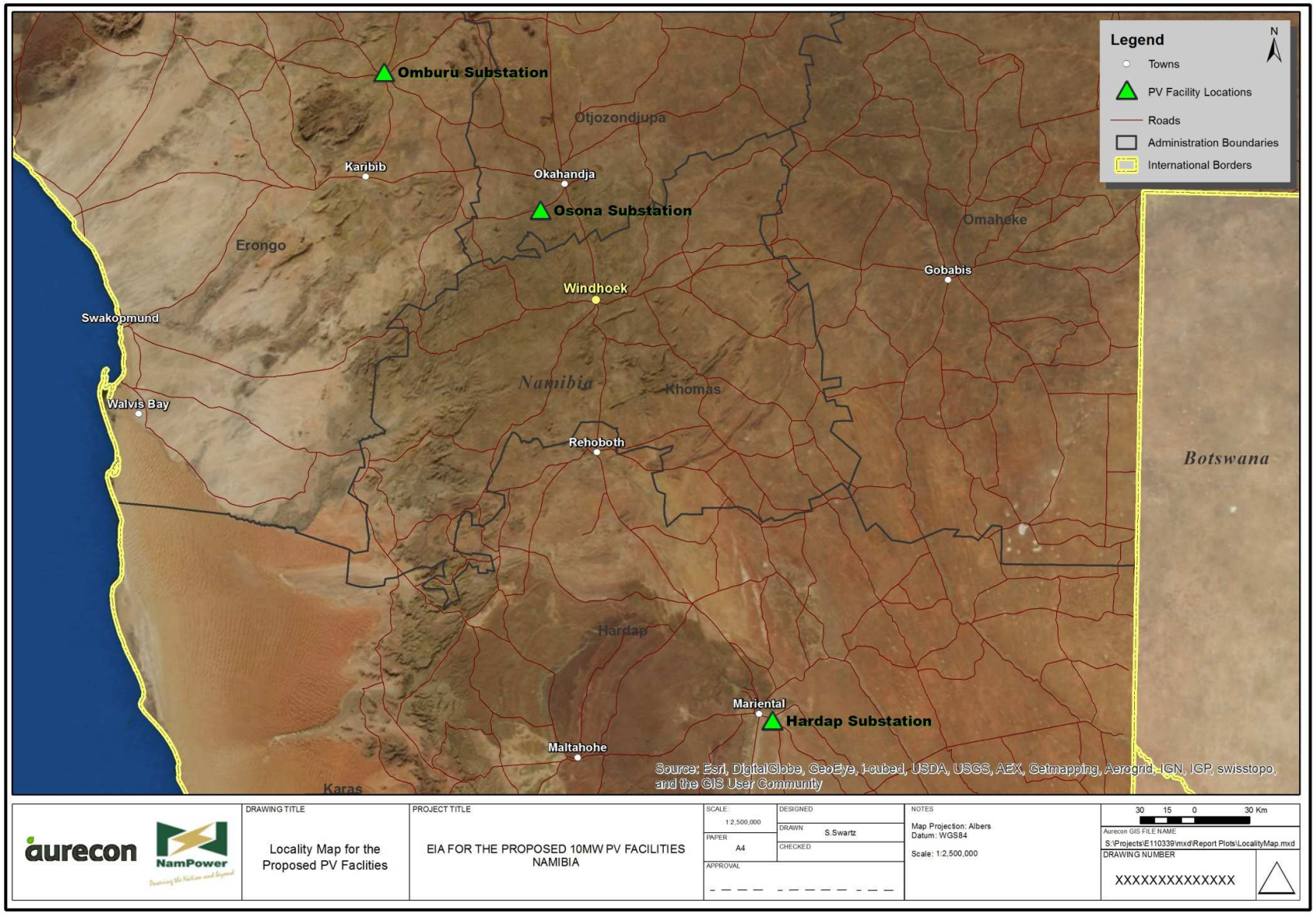


Figure 1 | Locality map indicating the location of the three proposed PV facilities at Mariental, Omaruru and Okahandja

Section Six: Provides a description of the environment followed by the assessment of the anticipated impact. It also provides mitigation measures to reduce negative impacts and enhance positive impacts.

Section Seven: Provides recommendations and concludes the report by describing the way forward.

1.2 LEGISLATIVE REQUIREMENTS

As mentioned previously, the EMA describes the EIA process that must be undertaken to obtain an ECC from the MET: DEA. In addition to the EMA, there are a host of legal and policy documents and guidelines to consider when undertaking an EIA as indicated in Table 2.

Table 2 | Relevant legislation and the applicability thereof

Legal Requirements		
Legislation considered	**Relevant Organ of State / authority**	**Aspect of Project**
The Constitution of the Republic of Namibia (1990)	Government of the Republic of Namibia	The Namibian government has adopted a number of policies that promote sustainable development. Most of these originate in clauses of the Constitution of the Republic of Namibia. In Article 95 (i), the State undertakes to actively promote and maintain the welfare of the people by adopting policies aimed at the utilisation of natural resources on a sustainable basis for the benefit of all Namibians. Articles 91(c) and 95(l) are also of particular relevance to sound environmental management practice, viz.). In summary, these refer to: • Guarding against over-utilisation of biological natural resources. • Limiting over-exploitation of non-renewable resources. • Ensuring ecosystem functionality. • Protecting Namibia's sense of place and character. • Maintaining biological diversity. • Pursuing sustainable natural resource use. The above therefore commits the State to actively promote and sustain environmental welfare of the nation by formulating and institutionalising policies to accomplish the abovementioned sustainable development objectives. Through implementation of the mitigation measures set out in this Scoping Report and Environmental Management Plan (EMP), the owner of the ECC shall be advocating for sound environmental management as set out in the Constitution.
EMA	MET:DEA	Part 2 of the Act sets out 12 principles of environmental management, as follows: • Renewable resources must be used on a sustainable basis for the benefit of present and future generations. • Community involvement in natural resources management and the sharing of benefits arising from the use of the resources, must be promoted and facilitated.

		• The participation of all I&APs must be promoted and decisions must take into account the interest, needs and values of I&APs. • Equitable access to environmental resources must be promoted and the functional integrity of ecological systems must be taken into account to ensure the sustainability of the systems and to prevent harmful effects. • Assessments must be undertaken for activities which may have significant effects on the environment or the use of natural resources • Sustainable development must be promoted in all aspects relating to the environment. • Namibia's cultural and natural heritage including, its biological diversity, must be protected and respected for the benefit of present and future generations. • The option that provides the most benefit or causes the least damage to the environment as a whole, at a cost acceptable to society, in the long term as well as in the short term, must be adopted to reduce the generation of waste and polluting substances at source. • The reduction, re-use and recycling of waste must be promoted; • A person who causes damage to the environment must pay the costs associated with rehabilitation of damage to the environment and to human health caused by pollution, including costs for measures as are reasonably required to be implemented to prevent further environmental damage. • Where there is sufficient evidence which establishes that there are threats of serious or irreversible damage to the environment, lack of full scientific certainty may not be used as a reason for postponing cost-effective measures to prevent environmental degradation; and • Damage to the environment must be prevented and activities which cause such damage must be reduced, limited or controlled. The proponent has the responsibility to ensure that the proposed activity, as well as the EIA process, conforms to the principles of this Act. In developing the EIA process, Aurecon has been cognisant of this need, and accordingly the EIA process has been undertaken in terms of this Act and the EIA Regulations (2012). Several listed activities in terms of the Act, are triggered as indicated in Table 3.
Electricity Act (Act No. 4 of 2007)	MME	The objectives of the Electricity Act is to establish the Electricity Control Board to: (a) exercise control over and regulate the provision, use and consumption of electricity in Namibia. (b) oversee the efficient functioning and development of the electricity industry and security of electricity provision. (c) ensure the efficient provision of electricity. (d) ensure a competitive environment in the electricity industry in Namibia with such restrictions as may be necessary for the security of electricity provision and other public interest. (e) promote private sector investment in the electricity industry. To achieve these objectives, the board must provide for the

		requirements and conditions for obtaining licences for the provision of electricity and to provide for other incidental matters. Part four of the Act provides information on the requirements pertaining to electricity generation, trading, transmission, supply, distribution, importation and export. The project will facilitate the generation, supply and distribution of electricity and therefore requires a license in terms of this Act. The application process is dealt with in Section 20 of the Act and will be applied for by the preferred IPP/ IPPs.
Regional Councils Act, 1992 (Act No. 22 of 1992)		The Regional Councils Act legislates the establishment of Regional Councils that are responsible for the planning and coordination of regional policies and development. The main objective of this Act is to initiate, supervise, manage and evaluate development in the regions. The relevant Regional Councils are considered to be I&APs and will be provided with the opportunity to comment on the proposed projects.
Traditional Authorities Act (Act No. 25 of 2000)	Ministry of Regional and Local Government, Housing and Rural Development	Namibian legislation recognises both statutory and customary forms of governance. The Traditional Authorities Act recognises Traditional Authorities (TAs), as the customary leadership of traditional communities as legal entities. Currently, 46 authorities in Namibia are officially recognised by the Ministry of Regional and Local Government, Housing and Rural Development in terms of the aforementioned Act. The primary functions of these authorities are to promote peace and welfare amongst the community members, as well as to supervise and ensure the observance of the customary law of that community by its members. The Act also stipulates that TAs should ensure that natural resources are used on a sustainable basis that conserves the ecosystem. The implications of this Act are that TAs must be fully involved in the planning of land use and development for their area. It is the responsibility of the TA's customary leaderships, the Chiefs, to exercise control on behalf of the state and the residents in their designated area. TA's will be provided with the opportunity to comment on the proposed projects.
Water Resources Management Act (Act No. 11 of 2013)	Ministry of Agriculture, Water and Forestry	This Act provides a framework for managing water resources based on the principles of integrated water resources management. It provides for the management, development, protection, conservation, and use of water resources. Should the proponent wish to undertake activities involving water abstraction and/or effluent discharge, the relevant permits will be applied for. Furthermore, any watercourse on/or in close proximity to the site and associated ecosystems should be protected in alignment with the principles above. Mitigations measures were included in the EMP to reduce impacts on watercourses that could not be avoided.
Pollution Control and Waste Management	MET and others	This Bill serves to regulate and prevent the discharge of pollutants to air and water as well as providing for general waste management. The Bill will repeal the Atmospheric Pollution Prevention Ordinance (11 of 1976) (below) when it comes into force.

Bill *(in preparation)*		In terms of water pollution, it will be illegal to discharge of, or dispose of, pollutants into any watercourse without a Water Pollution Licence (apart from certain accepted discharges). Similarly an Air Quality Licence will be required for any pollution discharged to air above a certain threshold. The Bill also provides for noise, dust or odour control that may be considered a nuisance. The Bill advocates for duty of care with respect to waste management affecting humans and the environment and calls for a waste management licence for any activity relating to waste or hazardous waste management. The proposed PV facilities would not entail the discharge to air and or water, but might result in the generation of noise and dust during the construction phase.
Atmospheric Pollution Prevention Ordinance (Act No.11 of 1976)	Ministry of Health and Social Services	This Ordinance serves to control air pollution from point sources, but it does not consider ambient air quality. Any person carrying out a 'scheduled process' which are processes resulting in noxious or offensive gases typically pertaining to point source emissions have to obtain a registration certificate from the Department of Health. Although we do not anticipate the development to generate noxious or offensive gasses, the proponent will ensure that a registration certificate (air pollution permit) is obtained, if required. As duty of care, the proponent should implement the necessary mitigation measures set out in this Scoping Report and the EMP in order to limit emissions to air in the form of dust during construction and operation.
National Heritage Act (Act No. 27 of 2004)	Ministry of Education and Culture: National Heritage Council	The Act makes provision for the protection and conservation of places and objects of heritage significance and the registration of such places and objects. Part V Section 46 of the Act prohibits removal, damage, alteration or excavation of heritage sites or remains, while Section 48 (ff) sets out the procedure for application and granting of permits such as might be required in the event of damage to a protected site occurring as an inevitable result of development. Part VI Section 55 Paragraphs 3 and 4 require that any person who discovers an archaeological site should notify the National Heritage Council. The National Heritage Council has been established to identify, conserve, manage and protect places and objects of heritage significance. Section 51 (3) sets out the requirements for impact assessment. It is important to note that no regulations have been formulated for the implementation of the National Heritage Act provisions concerning impact assessment. However, archaeological impact assessment of large projects has become accepted practice in Namibia. No objects of heritage concern were noted onsite. However, should any objects of heritage significance be identified during construction, the work must cease immediately and the necessary steps taken to seek authorisation from the Council as set out in the Archaeological Assessment in Annexure E3.

Nature Conservation Ordinance (Act No. 5 of 1996)	MET	The Nature Conservation Amendment of 1996 amends the Nature Conservation Ordinance of 1975, "so as to provide for an economically based system of sustainable management and utilization of game in communal areas; to delete references to representative authorities; and to provide for matters incidental hereto." Section 73. 1 reads: "No person other than the lawful holder of a permit granted by the local authority shall at any time pick ("pick", as defined in Section 1 (xxxviii), includes to cut off, chop off, pick off, take, gather, uproot, damage or destroy) or transport any protected plant provided." This Ordinance will be replaced by the Parks and Wildlife Bill (currently in draft version) which will regulate protected areas and all indigenous flora and fauna in Namibia. It also includes provisions for protection against alien species. Although the proposed sites for development are not located within protected areas, there is indigenous vegetation on the sites and therefore this Ordinance is relevant. A permit is required should any species onsite, with a protected status, be damaged or removed. If required, the proponent will apply for such a permit prior to commencing with construction.
Forestry Act (Act No. 12 of 2001)	Ministry of Water, Agriculture and Forestry: Forestry Council	The Act provides for the management and use of forests and forest products. It offers protection to any living tree, bush or shrub growing within 100 metres of a river, stream or watercourse on land that is not a surveyed erven of a local authority area and a licence would be required to cut and remove any such vegetation. Section 22. (1) provides: "Unless otherwise authorised by this Act, or by a licence issued under subsection (3), no person shall on any land which is not part of a surveyed erven of a local authority area as defined in section 1 of the Local Authorities Act, 1992 (Act No. 23 of 1992) cut, destroy or remove - (a) vegetation which is on a sand dune or drifting sand or on a gully unless the cutting, destruction or removal is done for the purpose of stabilising the sand or gully; or (b) any living tree, bush or shrub growing within 100 metres of a river, stream or watercourse." This is applicable to the project since the site is located outside the jurisdiction of the local authorities and trees that might be impacted on are in close proximity to watercourses. The proponent will apply for the relevant permit under this Act, if applicable.
Soil Conservation Act (Act No. 76 of 1969)	Ministry of Water, Agriculture and Forestry	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. This Act is applicable since soil could potentially be impacted on by the proposed facilities.
Public Health Act (Act No. 36	Ministry of Health and	The Act serves to protect the public from nuisance and states that no person shall cause a nuisance or shall suffer to exist on any land or

of 1919)	Social Services	premises owned or occupied by him or of which he is in charge any nuisance or other condition liable to be injurious or dangerous to health. The proponent should ensure that the facility is designed and operated in a way that is not unsafe, or injurious or dangerous to public health and that the noise and dust emissions which could be considered a nuisance remain at acceptable levels. This is mostly applicable during the construction phase.
Hazardous Substances Ordinance No 14 of 1974	Ministry of Health and Social Services	The manufacturing, storage, handling or processing of all hazardous substances are defined in the Hazardous Substances Ordinance, 1974. The Ordinance provides for the control of substances which may cause injury or ill-health to or death of human beings by reason of their toxic, corrosive, irritant, strongly sensitizing or flammable nature or the generation of pressure thereby in certain circumstances and for the control of the use, storage and dumping of such substances.
Relevant policies		
Policies considered	**Relevant Organ of State / authority**	**Aspect of Project**
Environmental Assessment Policy (1994)	MET: DEA	This policy aims to promote sustainable development and economic growth while protecting the environment in the long term by requiring environmental assessment prior to undertaking of certain activities. Annexure B of the policy contains a schedule of activities that may have significant detrimental effects on the environment and which require authorisation prior to undertaking. Please see Table 3 for a summary of the activities that would require authorisation for the proposed PV facilities.
National Integrated Resource Plan (NIRP)	Electricity Control Board	The goal of the NIRP is to identify the mix of resources for meeting short and long-term consumer energy needs in Namibia in an efficient and reliable manner, at the lowest reasonable cost. The NIRP focuses on electricity supply, but also takes into account the impact of developing other energy sources and demand side management measures capable of reducing electricity demand in the country. The following objectives are set to achieve this goal: • Reduction in the vulnerability of electricity supply to disruptions in supply caused by events outside of the country. • Increase in diversification, security, reliability and efficiency of electricity supply, including the substitution of electricity by other energy sources such as oil, gas, biofuels and solar in order to improve efficiency. • Development and implementation of the demand side management measures and programs. • Minimisation of costs and negative environmental and social impacts of electricity supply. • Increase in use of local resources for generation of electricity. • Provision of social benefits through increased economic growth, rural electrification and employment. • Increase the use of local resources to provide electricity services.

		The proposed PV facilities would contribute to reaching the NIRP goals.
Namibia's Vision 2030	Government of the Republic of Namibia	Namibia 2030 was formulated in order to provide a clear vision to guide long term planning towards improved quality of life for Namibian citizens. The Vision recognises environmental constraints and opportunities in formulating sub-visions, the sub-visions being that, *inter alia*: • Namibia's freshwater resources are kept free of pollution and are used to ensure social well-being, support economic development, and to maintain natural habitats. • Land is used appropriately and equitably, significantly contributing towards food security at household and national levels, and supporting the sustainable and equitable growth of Namibia's economy, whilst maintaining and improving land capability. • Namibia's diverse woodlands, savannahs and the many resources they provide, are managed in a participatory and sustainable manner to help support rural livelihoods, enhance socio-economic development, and ensure environmental sustainability. • The integrity of vital ecological processes, natural habitats and wild species throughout Namibia is maintained whilst significantly supporting national socio-economic development through sustainable low-impact, high quality consumptive and non-consumptive uses, as well as providing diversity for rural and urban livelihoods. • Despite high growth rates, Namibia's urban areas will provide equitable access to safety, shelter, essential services and innovative employment opportunities within an efficiently managed, clean and aesthetically pleasing environment. The proposed facilities are in support of this vision as they will support growth in the energy sector which will contribute to the national economy. Furthermore, the wider social benefits that will arise relate to livelihoods and income, and training and capacity building.
Ministry of Mines and Energy Strategic Plan (2012 – 2017)	MME	The MME Plan aims to ensure the development of Namibia's natural capital and its sustainable utilisation for the benefit of the country's social, economic and ecological well-being. It aims to improve energy supply by facilitating an increase in local electricity generation capacity, developing and implementing a national integrated energy plan and managing the National Energy Fund (MME, 2012).
Energy Policy Whitepaper (1998)	MME	The white paper aims to achieve the following policy goals: • security of supply. • social upliftment. • effective governance. • investment and growth. • economic competitiveness. • economic efficiency. • Sustainability. The white paper provides information pertaining to renewable energy

		including solar energy. To ensure the optimal mix of energy resources, the Government will evaluate all proposals for power generation according to their expected costs and benefits, and environmental and socio-economic impacts.
Relevant Guidelines		
Guidelines considered		
Draft Procedures and Guidelines for conducting EIA's and compiling EMP's, 2008	MET	These guidelines outline the procedures and principles that are to be followed for conducting EIA's and compiling EMP's. This EIA process is informed by national Environmental Guidelines where applicable and relevant.

1.3 LISTED ACTIVITIES IN TERMS OF ENVIRONMENTAL MANEGEMENT ACT

The EMA is the primary legislative guardian of the environment and therefore focusses on the management of environmental resources and accordingly, identifies activities that require authorisation prior to commencement. The proposed facilities would trigger a number of listed activities as included in Table 3, requiring authorisation prior to commencement.

Table 3 | Applicable listed activities in terms of EMA EIA Regulations

Activity	Description of Activity	Relevance of the activity
Activity 1 (a) Energy Generation, Transmission and Storage	The construction of facilities for the generation of electricity	The construction of three 10 MW PV facilities are proposed.
Activity 1 (b) Energy Generation, Transmission and Storage	The construction of facilities for – the transmission and supply of electricity	The construction of PV facilities entails associated infrastructure, including transmission lines and a small onsite substation to connect to existing substations.
Activity 5.1 (c) Land Use and Development	The rezoning of land from agricultural use to power industrial use	This relates to the rezoning of land from agriculture to power industrial.
Activity 8.1 Water Resource Developments	The abstraction of ground or surface water for industrial or commercial purposes	Ground water may be abstracted to provide water for the proposed project.
Activity 8.8 Water Resource Developments	Construction and other activities in water courses within flood lines.	Although the development area excludes surface water features, this activity is considered to be relevant as development could take place within close proximity to the flood lines.

Activity	**Description of Activity**	**Relevance of the activity**
Activity 8.9 Water Resource Developments	Construction and other activities in a catchment area.	Roads and buried cables may cross small drainage lines onsite.
Activity 10.1 (a) Infrastructure	The construction of – Public roads	The proposed project may include the construction of roads for access to the sites.

2 EIA APPROACH

The purpose of this section is to provide the reader with an overview of the proposed EIA methodology. As engagement with the public and stakeholders forms an integral component of the EIA process, it also provides a description of the proposed public participation. This is followed by a description on the assumptions and limitations of the EIA and the independence of the Environmental Assessment Practitioners (EAPs).

2.1 APPROACH TO THE PROJECT

The EIA process typically has three phases, namely the Initiation Application, the Scoping Phase, and the EIA Phase. Although this report is termed a Scoping Report, which typically documents the Scoping Phase of the process, it also includes an assessment of all potential environmental impacts that were identified through this process, including specialist assessments. The Report is therefore more comprehensive than a Scoping Report and documents information required for both Scoping and EIA Phases. Please refer to Figure 2 for a diagram outlining the proposed EIA process to be followed.

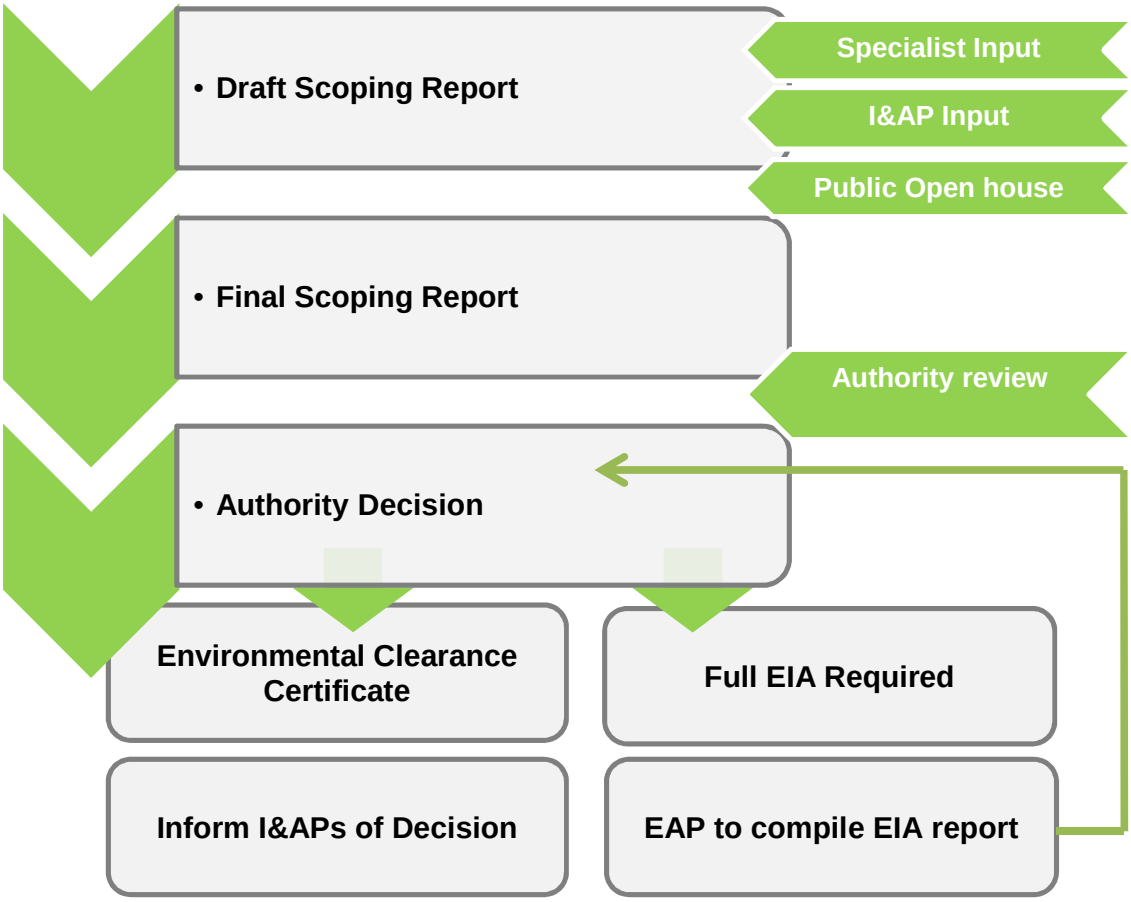


Figure 2 | The EIA process being followed

Table 4 lists the specialist studies undertaken as part of this process.

Table 4 | Specialist studies undertaken

Assessment	Company	Contact
Visual Impact Assessment	Visual Resources Management Africa	Steve Stead
Ecological Impact Assessment	Environment and Wildlife Consulting, Namibia	Peter Cunningham
Archaeological Impact Assessment	Quaternary Research Services	John Kinahan
Social Impact Assessment	Digby Wells	Jan Perold
Hydrogeological Desk Study	Karst Hydrological Consultants	Eric Tordiffe
Traffic Comment	Aurecon	Johan Kaber

The decision to extend the scope of the Scoping Report to include an assessment was taken on the basis of the following:

- The potential social and biophysical environmental impacts relating to this type of project are well understood and mostly site specific.
- As a whole, the receiving socio-economic and biophysical environment is not considered to be significantly sensitive.
- Specialists studies have already been compiled and are incorporated in the Scoping Report with proposed mitigation measures recommended.
- The project is supported politically and of an urgent nature.
- Any additional issues identified by I&APs during the Public Participation Process (PPP) will be considered and included in the Final Scoping Report and EMP.

Activities occurring in the Scoping and EIA Phases have been combined into one phase and involved the following key tasks:

- The EAPs including Louise Corbett and Karen de Bruyn undertook a field trip during March 2014. The main purpose was to familiarise the EAPs with the site, identify potential areas of concern and sensitive areas to inform the MCDM process (see Chapter 0).
- Desktop review of the biophysical and social characteristics of the area including any other relevant previous environmental studies.
- Identification of biophysical and socio-economic sensitivities of the proposed development allowing a high level screening.
- Identification of feasible alternatives.
- Identification of significant issues/impacts associated with each alternative to be assessed;
- Assessment of significance of potential environmental impacts.
- Preparation of a Draft Scoping Report and EMP.
- Identification and involvement of the relevant authorities and I&APs in order to elicit their interest in the project through the PPP as detailed in Section 2.2.2.
- Finalisation of the Scoping Report and EMP based on I&AP input.
- Authority review and decision-making.

2.2 THE PUBLIC PARTICIPATION PROCESS (PPP)

Consultation with the public forms an integral component of this investigation and involves I&APs such as directly affected landowners and neighbours, national-, regional- and local authorities,

environmental groups, civic associations, and communities. I&APs identify their issues and concerns about the proposed activity which they feel should be addressed in the EIA process. The PPP has therefore been structured to provide I&APs with an opportunity to gain more knowledge about the proposed projects, to provide input through the review of documents/reports, and to voice any issues of concern during the EIA process. The PPP undertaken to date is summarised in Table 5 and the PPP still to be undertaken is include in Table 6.

Table 5 | Summary of the PPP to date

Task	Details	Date
I&AP notification (relevant authorities and I&APs)		
I&AP identification	An I&AP database was developed for the project by establishing the jurisdiction of organisations in respect of the project as well as those living or working in proximity to the project sites. The database of I&APs includes the landowners, adjacent landowners, the local municipal officials, relevant national and regional government officials, and organisations in the area. A copy of the I&AP database is attached in Annexure C.	**March 2014 – ongoing**
Newspaper Advertisements	Adverts were placed in *The Namibian* and *Die Republikein* for two consecutive weeks advertising the project and inviting I&APs to register and raise comments.	**4 April 2014 and 10 April 2014**
Background Information Document	A Background Information Document (BID) was compiled and distributed to parties on the I&AP database. I&APs were invited to comment on the BID and register in the process from 4 April 2014 until 23 April 2014. A copy of the BID is included in Annexure C.	**4 April 2014 to 23 April 2014**
Addressing comments received	All comments received on the BID were collated into a Comments and Responses Report Version 1 (CRR1), along with responses from NamPower and the EAPs. CRR1 are included in Annexure C.	**23 April 2014 to 12 June 2014**
Review of Draft Scoping Report		
PPP including open house	All potential I&APs were informed of the availability of the Draft Scoping Report by means of letter drop, post, fax or email. Relevant government departments as listed in Annexure C were notified of the report and requested to submit comments. I&APs were also informed of the open house and invited to attend. The Draft Scoping Report was made available for review at the following locations: • Aurecon Windhoek Office (189 Newton Street, Windhoek). • Mariental Municipality. • Omaruru Municipality. • Okahandja Municipality . The report was also be made available on the Aurecon website (http://www.aurecongroup.com- indicate “Current Location” as “South Africa” and click on the “Public Participation” link) as well as the NamPower website (http://www.nampower.com.na/index.asp) under “Media and Projects”. Electronic copies of the reports were made available on request on a CD. Authorities and I&APs have been provided with 14 days to review the Draft Scoping Report and invited to submit comments in writing	**Comment period for the Draft Scoping Report: 18 June 2014 to 8 July 2014**

	to the Aurecon team. The closing date for comments is **8 July 2014.**	
Site notices	Site notices were placed at the access roads to the site to inform the general public of the proposed facilities and the PPP.	**23 to 25 June 2014**

Table 6 | PPP tasks still to be undertaken

Review of Draft Scoping Report		
Addressing comments received	All comments received on the Draft Scoping Report will be collated into a CRR2. The responses to these comments from the proponent and the EAP will also be provided in the CRR and will be included as an annexure to the Final Scoping Report.	**July 2014**
Notification of MET decision-making		
Notification of the Departments Decision	If MET authorises the project by way of an ECC, all registered I&APs would be notified of the decision.	

2.2.1 Issues Raised

All issues raised by I&APs during the comment period of the Draft Scoping Report will be recorded in a CRR, along with responses from NamPower and the EAPs.

To date, the following key issues and or comments were raised by I&APs and authorities:

- The Namib Botanical Gardens is interested in sourcing indigenous protected plant material requiring relocation from the proposed project sites before or during construction, to display within the gardens, and as stock for propagation. The area near Omaruru is typically rich in indigenous trees and succulents (including Aloe species) and other flora suitable for rescue, relocation and public display in the Namib Botanical Garden project.
- The Namib Botanical Gardens also have a particular interest in sourcing a variety of young, indigenous trees that would have to be relocated under the EMP. With support from the developers of the PV facilities, such specimens could then be relocated to the Namib Botanical Garden site near Swakopmund, to become part of an arboretum. The developer has been requested to contact the National Botanical Garden with regards to Search and Rescue efforts, with the aim of donating material to NBG to meet their objectives.
- A business owner near Osona expressed interest in and support for the solar project, as he is currently using a generator as the main power source.
- A landowner near Omburu questioned what will happen to fauna and flora underneath the panels and whether there will be enough distance between the ground and the panels to allow for fauna and flora to flourish.
- The Ministry of Agriculture, Water and Forestry expressed interest in the project, hoping to benefit by obtaining electricity for their water pump stations in close proximity to the sites.
- Stubenrauch Planning Consultants were appointed by the Mariental Municipality to prepare a Structure Plan for the town. The Structure Plan is a long-term plan that seeks to coordinate and guide future urban expansion through the guidance and control of land uses and urban growth. As such, they would be interested in the location of the proposed sights with particular interest in Mariental, to determine how such location will fit in with the proposed Structure Plan.

For responses the above comments refer to CRR1 in Annexure C5.

2.2.2 Stakeholder involvement

I&APs and authorities have been invited to participate in the process, as described in Table 5 and Table 6, to ensure that the final documentation satisfies the respective authority requirements and that they are fully informed with respect to the nature and scope of the proposed projects.

2.3 ASSUMPTIONS, UNCERTAINTIES AND GAPS IN KNOWLEDGE

In undertaking this investigation and compiling the Scoping Report, the following has been assumed:

- It is assumed that information obtained from NamPower is accurate and that NamPower is not withholding any information that could change the outcome of this process.
- The scope of this investigation is limited to assessing the environmental impacts associated with the proposed PV facilities and associated infrastructures to enable connection to the grid.
- It is assumed that other relevant authorisation and permits for the proposed PV facilities would be managed as part of a separate application.

The gaps in knowledge that were evident during the assessment include:

- As NamPower will not construct the facilities and preliminary design has not yet been undertaken, limited information regarding construction activities and phasing was available. The exact location of accommodation for construction workers has not been determined, but will be in the nearby towns.The exact location where the PV facility would connect to the grid is unknown at this stage and therefore it is proposed to assess a transmission line corridor to allow for flexibility in the routing of the transmission lines as the preliminary layouts could still change during the design process.
- Layouts and details of design were not provided.
- A commencement date of the construction phase was not provided.

2.4 THE ENVIRONMENTAL TEAM

Aurecon have selected a team of highly experienced multi-disciplinary practitioners in order to execute these projects as efficiently as possible. The Project Director, Mr Andries van der Merwe is a certified Environmental Engineer registered with the Engineering Council of South Africa (*PrEng*) and holds a B Eng (Civil) degree. Mr van der Merwe has over 13 years' experience in the field of impact assessment.

The Project Leader, Miss Louise Corbett, an Associate in the Cape Town office, has a Bachelor's of Science (Hons) Degree in Environmental and Geographical Science from the University of Cape Town, specialising in Environmental Management. She has eight years' experience in the environmental field. Miss Corbett is a Registered *Professional Natural Scientist* with the South African Council for Natural Scientific Professions.

Mrs Ilze Rautenbach, one of the project staff, is an Environmental Practitioner in the Windhoek office with eight years' experience in the field. Mrs Rautenbach has a Masters of Philosophy (Environmental Management) degree and is registered with the Environmental Assessment

Practitioners Association of South Africa (EAPASA) and is a professional member with the Southern African Institute of Ecologists and Environmental Scientists (SAIEES).

Mrs Karen de Bruyn, one of the project staff, is an Environmental Practitioner with four years' experience in the field. Mrs de Bruyn has a Masters of Philosophy in Environmental Management and is also a registered *Professional Natural Scientist* with the South African Council for Natural Scientific Professions.

Aurecon and the above certified EAPs are bound by the code of conduct for South African Council for Natural Scientific Professions. The Curriculum Vitae's of the key Aurecon staff are attached as Annexure B.

Independence of the environmental consultant from the project proponent reduces the potential for bias in the environmental process. Neither Aurecon nor any of its sub-consultants are subsidiaries of NamPower nor is NamPower a subsidiary to Aurecon. Furthermore, all these parties do not have any interests in secondary or downstream developments that may arise out of the authorisation of the proposed project.

3 MULTI-CRITERIA DECISION MAKING

The purpose of this chapter is to describe the high level screening of alternative sites for the three 10 MW PV facilities based on the MCDM Model.

The MCDM Model is an open, transparent and interactive process that can be used for optimal site selection based on the major issues that will influence the viability and suitability thereof. MCDM is a discipline aimed at supporting decision makers who are faced with making numerous and conflicting evaluations. It highlights conflicts and derives a way to reach a recommendation in a transparent process. This process is well-suited to address complex technical strategic planning challenges, as is typically required in an alternatives assessment, since the MCDM prioritises options against a set of predetermined criteria.

In a typical MCDM model, options could typically include project, technology and sequencing alternatives. The identification and consideration of alternatives is a fundamental requirement in environmental assessment procedures globally. The principles of the EMA and the requirements of the Environmental Assessment Policy of 1994 identify the assessment of alternatives as one of the steps to be undertaken early in the project development. The MCDM process is however not designed for fatal flaw identification and thus only feasible alternatives should be considered. The site alternatives considered in the MCDM are described in Section 3.2.

Although several MCDM models are available internationally, not all are ideal for this specific category of application. The model used in this process was the Ideal Mode Analytical Hierarchy Process (AHP) Pairwise Comparison Model. The advantages of this specific model, in an application such as the selection of sites for development, include the following:

- It can tolerate a degree of inaccuracy and as such allows for the use of this model early in the project life cycle, before detailed engineering designs are available.
- It allows for testing of the consistency and sensitivity analysis of the rating.
- It allows for a degree of difference in interpretation of the rating scale by the various team members or specialists looking at the different aspects, as the results are normalised in the process, expressing the results as unit-less numerical values which indicate relative preference only.
- Its ease of use and transparency in a simple spreadsheet format.

This Chapter describes the high level screening of alternative sites for the three PV facilities. The aim is to identify the sites most suitable for detailed assessment. This approach ensures that resources are directed at sites that are feasible in terms of technical (including financial), biophysical and socio-economic considerations. This process is therefore considered an important step in assessing how the proposed development meets sustainable development goals.

3.1 MCDM METHODOLOGY

The selected MCDM model requires that pre-selected alternatives be developed, as described in Section 3.2 of this chapter, and evaluated against performance criteria, as described in Section 3.3 of this chapter. The options are then analysed by comparing them to one another (two at a time), allowing for consideration of whether the option is better or worse than the option it is being

compared against. A rating scale as indicated in Table 7, is used to compare the alternatives. A low rating means a weak preference and a higher rating means a stronger preference.

Table 7 | AHP Rating Scale

Rating	Description of Relative Rating
1	Equal
3	Weak preference
5	Essential or strong preference
7	Demonstrated preference
9	Absolute preference
2, 4, 6, 8	Intermediate values
Reciprocals of the above	If for criterion x, option A has a rating of one of the above when compared to option B (R_{XAB}), then option B has the reciprocal rating when compared to option A ($R_{XBA} = 1 / R_{XAB}$)

The project team use the rating scale above to rate the alternatives based on their judgment on which alternative is preferred, informed by data obtained from fieldwork and desktop review of available documentation. The relative preference is calculated for each of the alternatives, through calculating the geometric mean value across the matrix line, also referred to as the eigen vector. The results obtained indicate the relative preference of the alternatives against the specific criterion under consideration.

In order to test for consistency a Consistency Ratio formula is applied to confirm that criteria were accurately assessed and unbiased ratings were consistently assigned. A Consistency Ratio of less than 10 % is acceptable, whereas the rating would need to be reconsidered if the Consistency Ratio exceeds 10 %. Further sensitivity analyses were undertaken to test for accuracy of the findings as indicated in Section 3.8.

It is essential that the process for the selection of a preferred site at this early planning stage is robust and defendable. Once the optimal site is selected, the resources for a detailed study can be focused on such a site, rather than doing equally detailed studies on a variety of sites that may not meet certain essential criteria for functioning, for one or more reasons.

3.2 SITE ALTERNATIVES

NamPower identified three existing substations into which the proposed solar energy facilities could connect based on the following:

- Grid capacity.
- Network of existing transmission lines.
- Location of the largest source of demand.
- Average hours of sunshine in Namibia and solar radiation.

Based on the above, three substations were identified, namely the Hardap substation near Mariental, Omburu substation near Omaruru and Osona substation near Okahandja.

Each of the three alternatives per substation was 100 ha in extent and located within a 5 km radius of the substation as indicated in Figure 5, Figure 6 and Figure 7. Although a 10 MW PV facility would only require a footprint area of approximately 35 ha, a site of 100 ha was considered during

the MCDM process to allow for sufficient space for future expansions of the PV facilities up to 30 MW. All sites are located on farming land, currently used for either small stock grazing, hunting or small scale game farming.

All three substations have grid capacity and are close to the largest source of demand in Namibia. As indicated in Figure 3, Mariental receives on average 10 hours of sunshine per day and Omaruru and Osona receive approximately nine hours of sunshine per day. The identified towns receive approximately 6.2 kilowatt hour per m^2 per day which is considered to be a high radiation level (Figure 4).

NamPower identified three alternative sites at each of the preferred substations (referred to as Hardap1, Hardap2 and Hardap3 as indicated in Figure 5; Omburu1, Omburu2 and Omburu3 indicated in Figure 6; and Osona1, Osona2 and Osona3 indicated in Figure 7).

The MCDM process compared the three sites per substation against one another with consideration of the technical (including financial), biophysical and social implications.

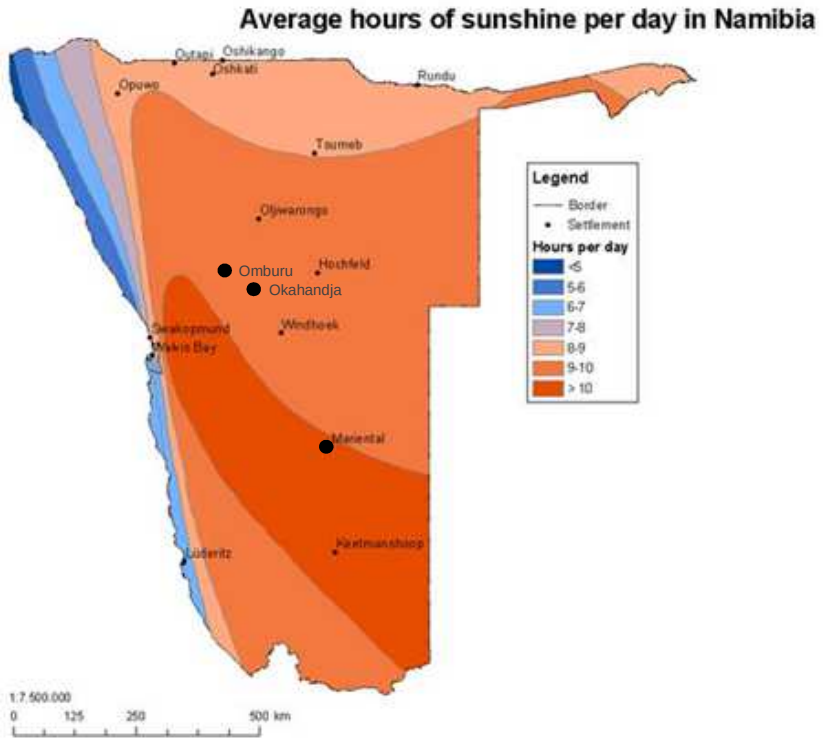


Figure 3 | Average hours of sunshine per day in Namibia (Source: NamPower)

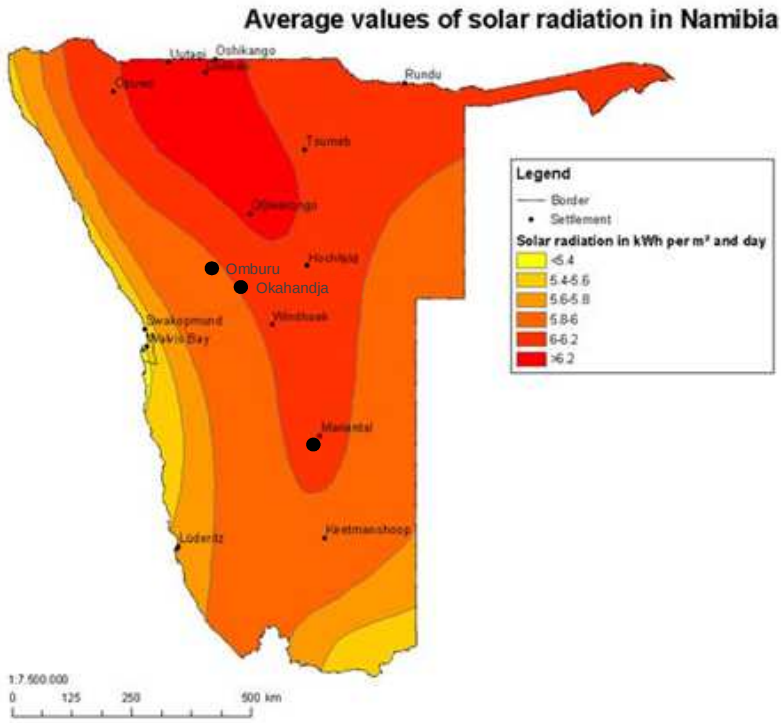


Figure 4 | Average values of solar radiation in Namibia (Source: NamPower)

3.3 CRITERIA FOR SITE SELECTION

The site selection criteria were chosen based on the broad definition of sustainability, which encompasses the biophysical, social and technical (including financial) criteria outlined below. This is to ensure that the approach to optimal development of a PV facility is holistic and integrated.
The criteria were selected based on issues identified by the EIA team and NamPower, as informed by expert knowledge. The criteria used in site selection in this process were grouped under three main categories:

- **Technical:** This is related to the impact that a given development will pose with regard to technical function, cost and efficiency. It also assesses the potential of each site to support a PV facility in terms of the land and infrastructure currently available (such as proximity to existing transmission lines and the substation, access roads, potential for expansion and the topography of the site). As the type of technology to be used would be the same for each site, this was not considered to be differentiating criteria and not considered in the MCDM Model. All financial considerations were incorporated into this category, as it relates closely to the technical aspects.
- **Biophysical:** This component refers to the need to select a site that minimises the risk to ecosystem functioning and environmental integrity. Therefore, the biotic criterion prioritises the anticipated impacts on habitat integrity, ecology, surface water features and avifauna.
- **Social:** This component considers how each site is affected in terms of social impacts on the communities, including nuisance and visual impacts. It further ranks each site in terms of the impact on cultural heritage factors, the degree to which the development would fragment the land and potential loss of agricultural land.

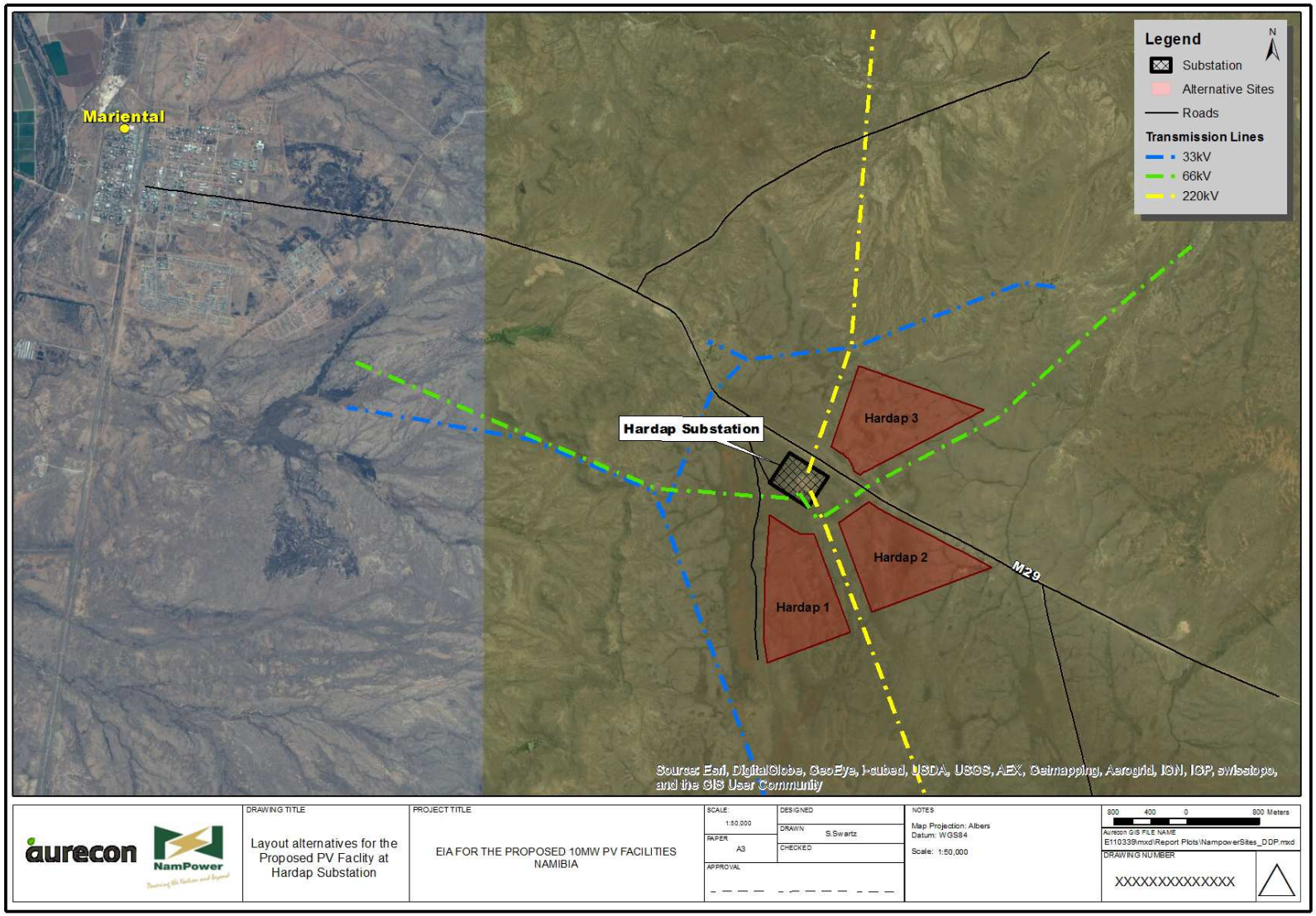


Figure 5 | Three alternative sites identified at Hardap substation

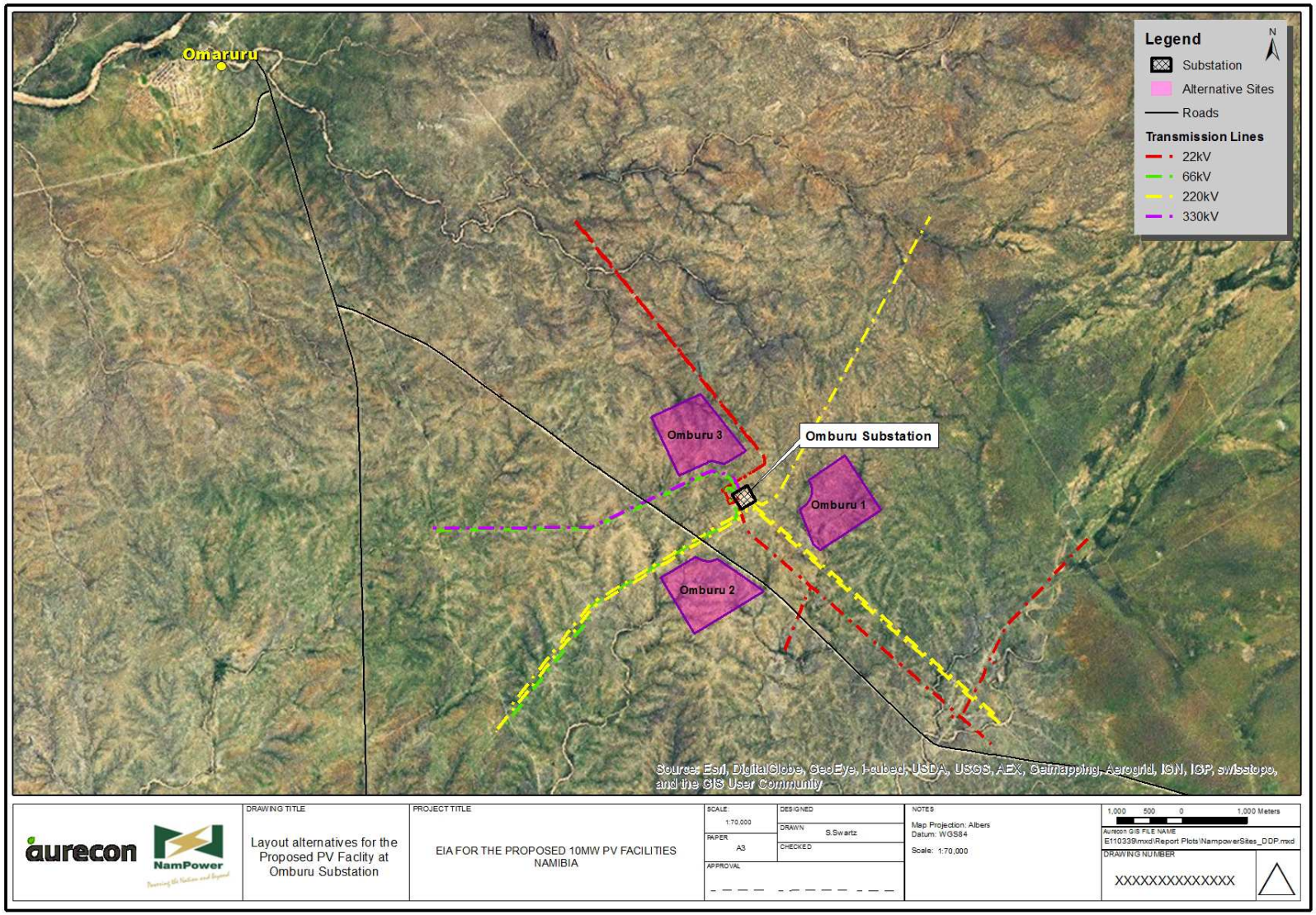


Figure 6 | Three alternative sites identified at Omburu substation

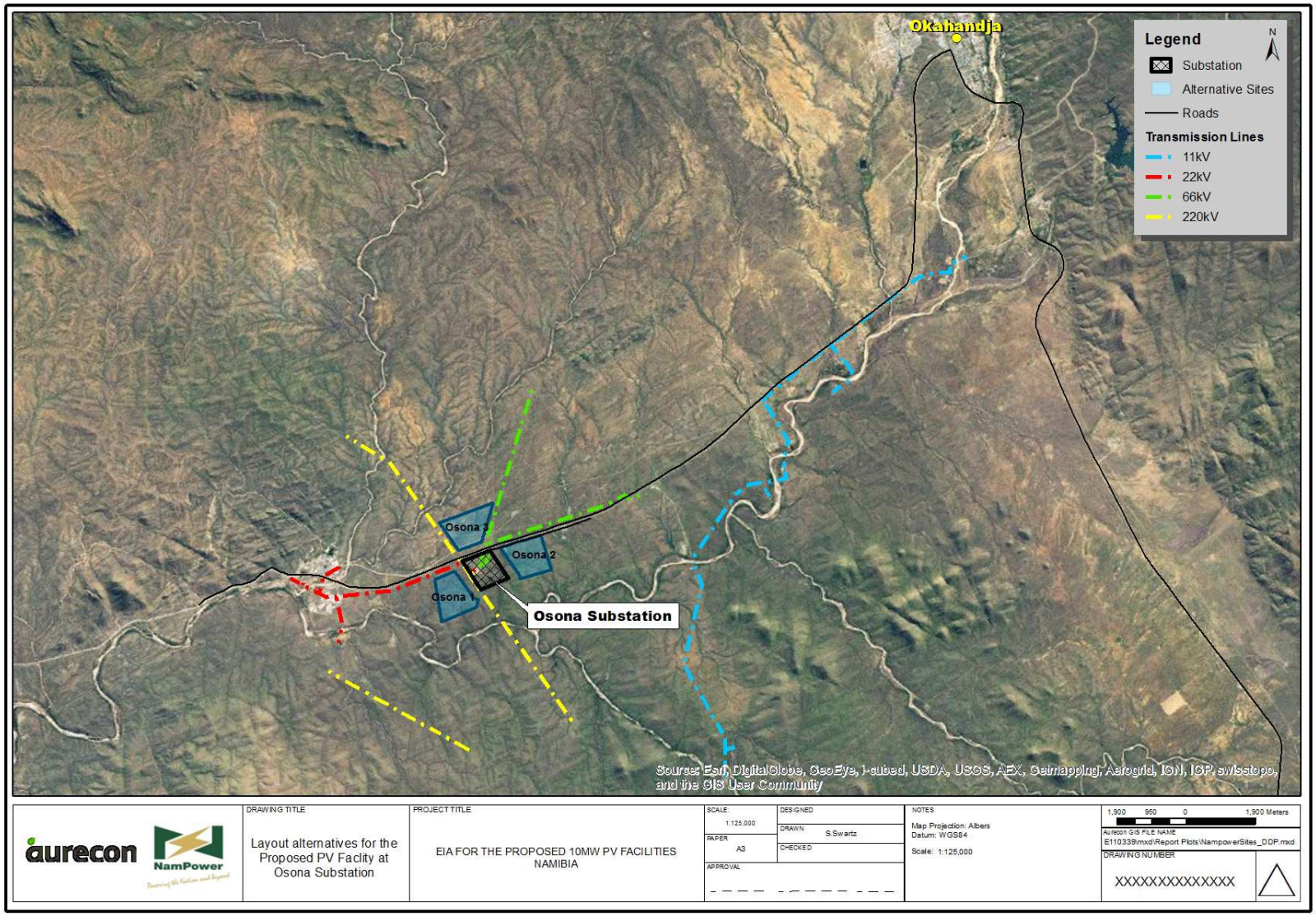


Figure 7 | Three alternative sites identified at Osona substation

While there are a number of criteria that need to be considered in the EIA process when assessing the significance of impacts related to the proposed PV facilities, only criteria that could differentiate one site against another were considered in this comparative process. Criteria that would apply to all sites equally were thus disregarded for this exercise. Criteria that differentiated between at least one set of alternatives, regardless of whether the other two sets of alternatives were rated equally for that criteria, were retained. The criteria are listed in Table 8.

After undertaking the site visits and the site selection workshop it was evident that a number of criteria would not differentiate between the alternative sites and were therefore not included in the MCDM process. The final criteria have been in Table 8. The reasons for excluding T3, T4, T5, part of S1, S2, S5 and S7 are included in Table 9.

Table 8 | Criteria for site selection (final list after site visit)

Criteria	
TECHNICAL / FINANCIAL CRITERIA	
T1	LAND - Availability and capital cost of land
T2	ACCESS - Cost of access road, transmission line and ease of integration
T6	TRANSMISSION - Transmission lines to integrate power station with substation crossing roads
T7	EXPANSION - Future development/expansion
T8	TOPOGRAPHY - Slope of area – topography (direction and degree)
BIOPHYSICAL CRITERIA	
B1	HABITAT - Uniqueness of habitat and proximity to protected areas or potential expansion of protected areas
B2	ECOLOGICAL – Potential footprint and habitat loss comparison
B3	WATER - Potential impact of facility on surface water
B4	AVIFAUNA - Potential impact of facility and associated infrastructure on avifauna
SOCIO-ECONOMIC CRITERIA	
S1	NUISANCES - Dust nuisances
S3	VISUAL - Impact on sense of place, with specific reference to value of landscape
S4	HERITAGE - Impact on heritage and archaeological resources
S5	FRAGMENTATION – Degree to which the property would be fragmented by the proposed development
S6	AGRICULTURE - Loss of agricultural potential

Table 9 | Reasons for excluding/ amending certain criteria

REASONS FOR EXLUSION		
TECHNICAL CRITERIA		
T3	WATER - Access to water source and associated cost	The availability of groundwater is considered to be the same across all three potential sites per substation, due to the proximity of the sites to one another. The availability of groundwater would thus not assist with differentiating between the sites. Furthermore, if it is necessary to source water from the local municipality, the length of a pipeline to each of the three sites would be approximately the same.
T4	FOUNDING - Founding suitability and cost implications	This criterion was excluded due to a lack of geotechnical information to inform founding suitability.

T5	STRATEGIC - Proximity to airfields and telescopes	None of the alternatives considered were located within 2km of an airfield or 20km of a telescope and therefore this criterion is no longer considered relevant. The distances mentioned here are arbitrary but are considered to be a sufficient distance to avoid impacts on airfields and or telescopes.
SOCIO-ECONOMIC CRITERIA		
S1	NUISANCES - Dust and noise nuisances	Noise could be a nuisance during the construction phase. However it was considered to be the same across all sites at each location due to the close proximity to each other and the uniformity of the sites. It was therefore excluded from the MCDM. Mitigation measures to address noise will be included in the EMP.
S2	PLANNING - Ease of planning integration and fit	As the three alternatives per substation are located relatively close to one another and the substation, the planning integration and fit was no longer considered to be a differentiating criterion.
S5	BUFFER - Buffer and distance to communities	The buffer criterion was replaced as no communities were located near to any of the sites. Fragmentation of the sites was considered instead, which indicates the degree to which the property would be fragmented by the development thereby reducing its current landuse potential.
S7	CAMP - Construction camp location and potential impact on communities	NamPower determined that no onsite construction camp would be allowed and that construction staff would all be housed in suitable nearby communities. This criterion is therefore no longer relevant.

The overall criteria categories were weighted as follows for the base case scenario to ensure that criteria considered more important in terms of site selection were given more significance in the process:

- Technical 50%.
- Biophysical 15%.
- Social 35%.

Due to the technical nature of the proposed development and the impact technical factors could have on the financial viability of the project, technical (including financial) criteria weighed 50% in the evaluation. The close proximity of the sites to one another and the relevant uniformity meant that biophysical and socio-economic criteria would not differentiate between the sites as much as technical criteria could and were therefore weighted as 15% and 35% respectively. This is deemed a fair weighting scenario for a base case, and variations on this scenario were considered in the sensitivity analysis as described in Section 3.8.

The aim of the sensitivity analysis was to confirm and test the robustness of the outcome.

3.4 MCDM WORKSHOP

The project team involved in the high level screening exercise is indicated in Table 10. The involvement of the project applicant is a critical component in the MCDM chapter as the technical and financial considerations, to which they provided input, were weighed against biophysical and socio-economic criteria in a transparent and robust manner.

Table 10 | Specialists involved with the MCDM process

Field of expertise	Name	Company name
MCDM facilitator	Andries van der Merwe	Aurecon
Biodiversity	Peter Cunningham	Environment and Wildlife Consulting
Heritage/Archaeology	John Kinahan	Quaternary Research Services
Technical	Margaret Mutschler Gloudina de Beer	NamPower
Social	Jan Perold	Digby Wells
Visual	Stephen Stead	Visual Resources Management Agency
Environmental Consultants	Karen de Bruyn Louise Corbett Ilze Rautenbach	Aurecon

Input into the process was based on the following:

- Desktop review of available information of the project and area.
- Discussions with NamPower and selected stakeholders.
- Site visit to each site.
- Expert knowledge, based on qualifications and experience.

The MCDM workshop was held over a day in Windhoek, after site visits had been completed. Following the individual assessment of relevant criteria by the relevant members of the project team, findings were presented and debated with the entire team. Where required after discussion, findings were refined. The section below is a summary of the assumptions and evaluations of each specialist. The individual inputs are presented in the following sections, with the integrated findings presented in Section 3.8. Feedback is grouped per criteria and presented per site.

Each discussion was concluded with a summary table to indicate the level of preference expressed as percentages (the larger the difference in percentage the larger the difference in preference).

3.5 INPUT INTO THE TECHNICAL (AND FINANCIAL) CRITERIA

3.5.1 T1 Availability and capital cost of land

Since all landowners of the potential alternative sites had entered into negotiations with NamPower, it was assumed that the landowners would make the land available for development. The availability of land was therefore not considered to be the differentiating factor. However, the cost of the land for each site was considered. Based on negotiations to date, it was evident that even though the sites were in close proximity to one another, the price was not uniform across all the sites.

3.5.1.1 Assumptions

The evaluation of this criterion was influenced by the following assumptions:

- All alternatives were available for the development.
- Cost of land would differ due to the price the respective landowners were willing to accept.

- If all three alternative sites are owned by one landowner, the price would be the same for all three sites.

3.5.1.2 Discussions

Hardap
Hardap1, Hardap2 and Hardap3 sites are all owned by the same landowner and hence all three sites were scored equally.

Omburu
All three sites proposed for Omburu Substation were owned by different landowners. Based on NamPower discussions with the various landowners, Omburu3 is preferred when compared to Omburu1 and Omburu2, based on the price of the land. Landowner consultations further indicated that Omburu1 would be more expensive than Omburu2.

Osona
The landowner of Osona1 and Osona3 had not agreed on a price or signed an option to purchase with NamPower and hence these sites were equally less preferred when compared to Osona2. The strong preference for Osona2 is as a result of the signed option to purchase and price negotiations that have already been initiated.

Table 11 indicates the relative preference of the various alternatives sites. The level of preference decreases from right to left.

Table 11 | Summary of preference at Hardap, Omburu and Osona based on T1

Location / Preference	Preferred		Least preferred
Mariental (Hardap)	Hardap1, Hardap2 and Hardap3 (33% each)	-	-
Omaruru (Omburu)	Omburu3 (73.1%)	Omburu1 (18.8%)	Omburu2 (8.1%)
Okahandja (Osona)	Osona2 (71.4%)	-	Osona1 and Osona3 (14.3%)

3.5.2 T2 Cost of access road

There are existing offsite roads at all three substations, as indicated in Figure 8, which could be used to access the sites.

Existing road to Hardap Substation Existing road to Omburu Substation Existing road to Osona Substation

Figure 8 | Existing offsite access roads to the three substations

However, internal access roads would be required in order to directly access the proposed sites. For a number of alternatives, the existing onsite access roads could be upgraded to act as internal roads for the development, but in other cases new onsite roads would need to be constructed in order to accommodate the construction and operational phase traffic.

3.5.2.1 Assumptions

The evaluation of this criterion was influenced by the following assumptions:

- It would be less cost intensive to upgrade an existing road than to construct a new access road.
- Shorter routes would be less expensive to build than longer routes.
- Any potential upgrades to the offsite road were excluded from the rating process.

3.5.2.2 Discussions

Hardap

There was an equally strong preference for the Hardap2 and Hardap3 sites, based on the ease of direct access to the site from the M29 road. Hardap1 was least preferred since the access route would potentially be directed around the substation to utilise existing roads, which would then require upgrades and would be longer in length and would therefore result in additional costs.

Omburu

The Omburu2 site was preferred due to it being adjacent to the existing main road, followed by Omburu3. Omburu3 was closer to the road compared to Omburu1 and was therefore preferred between the two.

Osona

In the case of Osona, all three potential sites were equidistant from the existing substation and road and were therefore equally ranked.

Table 12 indicates the preference of the various alternatives sites expressed as a percentage. The level of preference decreases from right to left.

Table 12 | Summary of preferences at Hardap, Omburu and Osona based on T2

Location / Preference	Preferred		Least preferred
Mariental (Hardap)	Hardap2 and Hardap3 (45.5%)		Hardap1 (9.1%)
Omaruru (Omburu)	Omburu2 (74.3%)	Omburu3 (19.4%)	Omburu1 (6.3%)
Okahandja (Osona)	Osona1, Osona2 and Osona3 (33.3%)		

3.5.3 T6 Ease of integration to substation and line road crossing

The proposed 10 MW PV facilities would need to connect to the existing substation, the new onsite substation and a 66 kV overhead transmission line. This criterion investigated the ease of integrating the new infrastructure with the existing substation and the cost of the line.

3.5.3.1 Assumptions

The evaluation of this criterion was influenced by the following assumptions:

- The further the PV facilities are from the respective substations, the longer and hence more expensive the new overhead transmission lines would be.
- The new PV facilities would not tie into existing overhead transmission lines, but rather directly to the substations.
- Transmission lines that cross roads pose more significant impacts than transmission lines that do not cross the main roads.

3.5.3.2 Discussions

At all three substations, at least one of the alternatives was located on the opposite side of road to the substation.

Hardap
Hardap1 and Hardap2 sites were on the same side of the road as the substation, whereas Hardap3 was located on the opposite side of the M29. Hardap1 and Hardap2 sites were therefore equally preferred since these alternatives could easily connect to the existing substation without having to construct a transmission line across the M29.

Omburu
There is a strong preference for Omburu1 site, which had multiple connection options to tie into the existing substation as opposed to Omburu3, which was slightly more preferred over Omburu2 since Omburu2 is on the opposite side of the road.

Osona
Osona1 site was strongly preferred over Osona2 and Osona3 based on the multiple connection options. Osona3 is least preferred since it was on the opposite side of the M87 road to the substation.

Table 13 indicates the preference of the various alternatives sites expressed as a percentage.

Table 13 | Summary of preferences at Hardap, Omburu and Osona based on T6

Location / Preference	Preferred		Least preferred
Mariental (Hardap)	Hardap1 and Hardap2 (47.4%)		Hardap3 (5.3%)
Omaruru (Omburu)	Omburu1 (74.3%)	Omburu3 (19.4%)	Omburu2 (6.3%)
Okahandja (Osona)	Osona1 (65.5%)	Osona2 (29.0%)	Osona3 (5.5%)

3.5.4 T7 Potential for future development or expansion

As discussed in Section 3.2, the preferred alternative sites should be able to accommodate an additional 20 MW PV facility. This would require an additional 60 ha to what is currently proposed for the 10 MW PV facilities. Ideally the potential future development area should be an intact site

without sensitive features. It should also have existing transmission lines or roads that split the site into smaller portions for ease of laying cables, transmission lines and placement of PV panels.

The majority of the sites have surface water drainage features traversing the site. Although this is not considered to be a fatal flaw, it could influence the viability of future developments. The layout of these drainage lines are considered important since an alternative site that is bisected by deep drainage lines would be less preferred to a site that has a minor drainage line in a corner that could easily be excluded from the development area. The degree to which the drainage lines and the buffering thereof would affect the shape of the remaining area was also considered. A square intact site was preferred over a number of small separated sites in irregular shapes. Each of the alternative sites considered were originally 100 ha in extent. This was to allow for sensitive areas to be buffered and excluded from the development area without being a limitation to the potential future expansion to a 30 MW PV development. However, Osona1 site was reduced as a small hill as indicated in Figure 9 was considered to be sensitive from a number of aspects whereas the remainder of the site was suitable for development. In order to avoid the exclusion of an imminently suitable area the site was reduced in size so that the small hill was excluded.

Figure 9 | Photos taken from hill in southern corner of Osona1, excluded from the 100 ha footprint

In addition to biophysical constraints of the sites, the proximity to existing transmission lines and roads could also be a limitation to future development. No PV development can take place within the servitude of existing transmission lines. This could limit the directions in which potential expansion was possible. For instance if the substation was north of the site with two transmission lines running east and west of the site, then expansion could only take place towards the south.

3.5.4.1 Assumptions

The evaluation of this criterion was influenced by the following assumptions:

- To construct an additional 20 MW, there should be at least an additional 60 ha available to accommodate the potential future expansions, excluding sensitive drainage lines adjacent to the site.
- The presence of drainage lines along the edges of the site was preferred over drainage lines in the middle of the site.
- Shallow drainage lines were preferred over deeper drainage lines, as this aspect would influence the buffer size required.
- Areas that were too steep must be excluded from the development area.
- Areas boxed in by existing infrastructure were limited for future development.

3.5.4.2 Discussions

Hardap

There were no pronounced surface water features or other sensitive areas at the Hardap1 site that constrained the development area. Hardap1 site was thus strongly preferred as it has the biggest buildable area for future expansion. Hardap3 site was the least preferred due to the limitations for expansion imposed by the road, servitudes along the existing transmission lines and the escarpment, which box this site in from all four corners. Hardap2 site could be expanded to the southeast, but the extent of the development area would be limited by drainage lines.

Omburu

There was a strong preference for Omburu3 site as a result of the limited number of drainage lines. This allows for potential expansion to the northwest. Omburu2 site was preferred next, as it could be expanded to the south. Omburu1 site was least preferred as a result of drainage lines cutting into the eastern corner of the 100 ha site. Omburu1 site could potentially be expanded to the north, but since the land is not owned by the Omburu1 landowner, NamPower have not discussed the project with the landowner.

Osona

There is a strong preference for the Osona3 site, which could easily be expanded northwards to the pronounced drainage line. Osona1 site could be expanded to the southwest. However, the land to which Osona1 could be expanded to is owned by a different landowner with whom NamPower have not discussed the project with and therefore this site is not preferred. Although Osona2 site could be expanded onto a hill, it is the least preferred since the development would then possibly be visible from M87. Therefore Osona1 and Osona2 are equally less preferred to Osona3. Table 14 indicates the preference of the various alternatives sites expressed as a percentage.

Table 14 | Summary of preferences at Hardap, Omburu and Osona based on T7

Location / Preference	Preferred		Least preferred
Mariental (Hardap)	Hardap1 (73.1%)	Hardap2 (18.81%)	Hardap3 (8.1%)
Omaruru (Omburu)	Omburu3 (63.0%)	Omburu2 (21.8%)	Omburu1 (15.1%)
Okahandja (Osona)	Osona3 (77.8%)		Osona1 and Osona2 (11.1%)

3.5.5 T8 Topography and cost to level the site (direction and degree)

PV facilities are generally constructed onsites that are relatively flat to avoid expensive costs to level extensive areas. In terms of the terrain, the site visit visual inspection of all alternative sites indicated that all areas were reasonably flat, with the exception of the deep drainage features located on some sites.

3.5.5.1 Assumptions

The evaluation of this criterion was influenced by the following assumptions:

- The lack of detailed terrain maps would not result in a biased outcome of the MCDM process.
- Assessment was based on visual observations made at each site and supported by aerial photographs.

3.5.5.2 Discussions

Hardap
While all three sites were relatively flat, Hardap1 appeared to be the flattest and hence was strongly preferred. Hardap2 was least preferred due to the undulating nature of the site.

Omburu
Based on the topography, Omburu3 was strongly preferred over the relatively flat Omburu2. Omburu3 has a gentle northwest slope which is preferred for PV construction. The least preferred site is Omburu1 due to the undulating nature of the site.

Osona
Osona1 site is strongly preferred over Osona2 due to the relatively flat topography of the area. Osona3 is least preferred as a result of pronounced drainage lines.

Table 15 indicates the preference of the various alternatives sites expressed as a percentage.

Table 15 | Summary of preferences at Hardap, Omburu and Osona based on T8

Location / Preference	Preferred		Least preferred
Mariental (Hardap)	Hardap1 (73.1%)	Hardap3 (18.8%)	Hardap2 (8.1%)
Omaruru (Omburu)	Omburu3 (64.8%)	Omburu2 (23.0%)	Omburu1 (12.2%)
Okahandja (Osona)	Osona1 (78.5%)	Osona2 (14.9%)	Osona3 (6.6%)

3.6 INPUT TO BIOPHYSICAL CRITERIA

3.6.1 B1 Uniqueness of the habitat an proximity to protected areas or potential expansion of protected areas

This is the measure of the species-level uniqueness at each site, taking into account numbers of range-restricted Central Namib endemic taxa, and the International Union for Conservation of Nature (IUCN) Threatened Status of species[1] likely to be present onsite, where available.

Sensitive habitat features that could be present on the sites include drainage lines, larger trees and rocky outcrops.

Development within protected areas or areas earmarked for potential expansion of protected areas is undesirable, as it conflicts with current or potential land use. However the proposed alternative sites are not located in close proximity to protected areas and have not been earmarked for future potential expansions of protected areas.

3.6.1.1 Assumptions

The evaluation of this criterion was influenced by the following assumption:

[1] http://www.iucnredlist.org/

- Sensitive features onsite (drainage lines, larger trees and rocky outcrops) provide unique habitats to species occurring in the areas.

3.6.1.2 Discussions

Since the alternative sites are located so close to one another the species composition is relatively similar across the area.

Hardap
A total of 12 species of trees and or shrubs less than one meter in height, and 15 species of grasses were encountered in the Hardap area of which four are protected. Larger protected tree species were scattered through the Hardap area. A few individuals of the invasive alien *Prosopis* species were observed onsite. Hardap1 site had 10 large plant species of which 1.3 % a protected. Hardap1 is the preferred site due to the low percentage of protected species occurring here and the relatively flat topography, with no rocky outcrops and only a few shallow drainage lines. Hardap2 has nine large plant species of which 3.7 % are protected and Hardap3 has 13 large plant species of which four percent are protected. Hardap3 is considered to support the most protected species out of the three Hardap alternatives and contained unique habitat for these species in the form of the escarpment and drainage lines. Therefore Hardap3 is the least preferred site.

Omburu
A total of 20 species of trees and or shrubs of less than one meter in height and 15 species of grasses were encountered in the Omburu area, of which only five species are protected. Larger protected tree species individuals are scattered throughout the area. No invasive alien species were observed on sites. Three larger plant species were noted on Omburu1, of which three percent of the population are protected. Omburu3 was considered to have the lowest level of diversity as well as dense vegetation which reduces diversity and was therefore preferred over Omburu2 and Omburu1 for development. Omburu2 has two species of which 2.3 % of the species population are protected and Omburu3 has three species of which 2.3 % of the species population are protected. Although Omburu1 has a large drainage line along the eastern side of the site, Omburu2 is the least preferred as a result of a granite ridge which is considered to be sensitive habitat.

Osona
A total of 13 species of trees and/or shrubs of less than 1 m in height and 19 species of grasses were encountered in the Osona area of which only two species are protected. Larger individuals of protected tree species were scattered throughout the area. A few individuals of the invasive alien *Prosopis* species were observed onsite. A large portion of Osona1 site was cleared approximately six months ago by the current landowner. The clearing of the site reduced the uniqueness of the site. Despite the clearing, 11 larger plant species were recorded at the site, of which 0.3 % are protected. Osona2 site has nine species of which 0.7 % are protected and Osona2 was therefore preferred over Osona3, which has eight larger plant species of which 0.7 % is protected. Osona3 is the least disturbed potentially creating unique habitats for species.

In order to support the species occurring in the area, sensitive habitat features such as drainage lines, larger trees and rocky outcrops should be avoided as far as possible. Table 16 indicates the preference of the various alternatives sites expressed as a percentage.

Table 16 | Summary of preferences at Hardap, Omburu and Osona based on B1

Location / Preference	Preferred		Least preferred
Mariental (Hardap)	Hardap1 (73.1%)	Hardap2 (18.8%)	Hardap3 (8.1%)
Omaruru (Omburu)	Omburu3 (73.1%)	Omburu1 (18.8%)	Omburu2 (8.1%)
Okahandja (Osona)	Osona1 (78.5%)	Osona2 (14.9%)	Osona3 (6.6%)

3.6.2 B2 Footprint and habitat loss

This criterion considered the habitat loss, especially sensitive features (drainage lines, larger trees and rocky outcrops), that would be associated with the development of the facility.

3.6.2.1 Assumptions

The evaluation of this criterion was influenced by the following assumptions:

- Development would result in complete habitat loss within an area of 100 ha (worst case scenario considered, although actual loss will be less).
- The impact at each site would be a function of the relative uniqueness of the habitat.

3.6.2.2 Discussions

Hardap

Hardap1 is the preferred site based on the relative uniformity of the area, with only a few small drainage lines present onsite. Hardap3 was the least preferred site based on the escarpment and drainage lines creating unique habitats. There is a slight preference for Hardap2 over Hardap3 since the drainage lines could be avoided by excluding the eastern corner from the development site.

Omburu

Omburu3 is considered to have the lowest level of habitat diversity and is therefore preferred over Omburu2 and Omburu1. Although Omburu1 has a large drainage line along the eastern side of the site, Omburu2 is the least preferred site as a result of the granite ridge which is considered to be a sensitive habitat.

Osona

As mentioned, a large portion of Osona1 was previously cleared, thereby reducing the ecological diversity and creating low quality habitat. Therefore Osona1 is the preferred site for development followed by Osona2 and then lastly Osona3. Osona3 is least preferred since the site is relatively undisturbed in comparison to the other two sites. Table 17 indicates the preference of the various alternatives sites expressed as a percentage.

Table 17 | Summary of preferences at Hardap, Omburu and Osona based on B2

Location / Preference	Preferred		Least preferred
Mariental (Hardap)	Hardap1 (62.7%)	Hardap2 (28%)	Hardap3 (9.4%)
Omaruru (Omburu)	Omburu3 (76.3%)	Omburu1 (17.6%)	Omburu2 (6.1%)

Okahandja (Osona)	Osona1 (78.5%)	Osona2 (14.9%)	Osona3 (6.6%)

3.6.3 B3 Potential impact of facility on surface water

Surface water features such as rivers, drainage lines, pans and wetlands are considered to be sensitive ecological areas. In addition to these features being important from a biophysical point of view, it is also crucial to exclude them from development areas from a technical point of view. Flash floods could dislodge panels or damage infrastructure. Therefore a buffer of at least 100m is recommended along larger drainage lines to prevent damage to infrastructure. The buffer zones would be considered 'No–go' areas meaning no development could take place within those areas, thereby reducing the area available for development.

This criterion does not consider water contamination as a primary concern, but rather the physical disturbance of these sensitive areas.

3.6.3.1 Assumptions

The evaluation of this criterion was influenced by the following assumptions:

- Constructing around drainage features would make the PV layout and cable routing more complex (since it is assumed that no construction would be permitted in this area).
- A buffer of 100 m would be sufficient to contain a 1:100 year flood.

3.6.3.2 Discussions

Hardap

Due to the lack of prominent surface water features at Hardap1 the site is preferred over Hardap2 and Hardap3. The escarpment along the boundary of Hardap3 could be buffered and are therefore preferred over Hardap2. Hardap2 is least preferred based on presence of the drainage lines which would require buffering.

Omburu

There is a strong preference for Omburu3 site due to the shallow depth of the few drainage lines onsite. By developing Omburu3, few drainage lines would be impacted as opposed to Omburu1 which has many deep drainage lines and is therefore least preferred. The drainage lines that traverse Omburu2 are more widespread and there is a medium preference for this site.

Osona

Osona1 has the shortest length of drainage lines traversing the site and was therefore preferred. While not as suitable as Osona1 for this criterion, Osona2 was preferred over Osona3 as it has wide shallow drainage lines that could easily be avoided by the development.Osona3 has a very deep drainage line with numerous side channels that would require buffering of large areas. Table 18 indicates the preference of the various alternatives sites expressed as a percentage.

Table 18 | Summary of preferences at Hardap, Omburu and Osona based on B3

Location / Preference	**Preferred**		**Least preferred**
Mariental (Hardap)	Hardap1 (63.7%)	Hardap3 (25.8%)	Hardap2 (10.5%)

Omaruru (Omburu)	Omburu3 (67.4%)	Omburu2 (22.6%)	Omburu1 (10.1%)
Okahandja (Osona)	Osona1 (73.1%)	Osona2 (18.8%)	Osona3 (8.1%)

3.6.4 B4 Potential impact of facility and associated infrastructure on avifauna

A number of impacts on avifauna could result during the construction, operation and decommissioning phases of the proposed PV facilities, namely:

- Disturbance and displacement of seasonal influxes of large terrestrial birds from nesting and/or foraging areas.
- Mortality from birds colliding with new power lines while flying between resource areas.
- Disturbance and displacement of resident or visiting raptors from foraging areas.
- Electrocution of large birds when perched on power infrastructure.
- Injury or mortality of wetland birds when using possible flight lines in and out of resource areas in the broader vicinity (resulting from collisions with the PV infrastructure or associated new transmission lines.
- Permanent habitat loss for some avifauna species.
- Displacement of terrestrial species from a broader area, either temporarily or permanently, by construction and maintenance activities.

3.6.4.1 Assumptions

The evaluation of this criterion was influenced by the following assumptions:

- It is assumed that sites that are boxed in by existing transmission lines would have a less significant impact on avifauna since the area is already impacted on.
- Sites with rocky areas, larger trees and/ or drainage lines would be preferred by birds over sites with no unique habitats and hence would be more sensitive to development.

3.6.4.2 Discussions

Hardap

Hardap1 site was preferred over Hardap2 and Hardap3 due to the lack of unique habitats found onsite. Hardap3 was the least preferred since it had a number of sensitive habitats.

Omburu

Omburu3 site is uniform with very little unique habitat for bird species and was therefore preferred over Omburu1 and Omburu2. There was a very slight preference for Omburu1 over Omburu2 since Omburu2 was considered to be more unique due to larger trees creating nesting spots for birds.

Osona

Although Osona3 had rocky areas and numerous surface water features that could attract bird species, it was still preferred over Osona1 and Osona2 which were both close to the Swakop River which is a likely corridor for bird movement. Osona1 is slightly preferred over Osona2 since Osona1 was previously cleared with very few large trees remaining.

Table 19 indicates the preference of the various alternatives sites expressed as a percentage.

Table 19 | Summary of preferences at Hardap, Omburu and Osona based on B4

Location / Preference	Preferred		Least preferred
Mariental (Hardap)	Hardap1 (57.4%)	Hardap3 (36.1%)	Hardap2 (6.5%)
Omaruru (Omburu)	Omburu3 (74.7%)	Omburu1 (13.4%)	Omburu2 (11.9%)
Okahandja (Osona)	Osona3 (73.1%)	Osona1 (18.8%)	Osona2 (8.1%)

3.7 INPUT INTO SOCIO-ECONOMIC CRITERIA

3.7.1 S1 Dust nuisance

During the construction phase clearing of vegetation would be required and this could result in dust. In addition, the transport of material and equipment on gravel roads could also result in additional dust.

3.7.1.1 Assumptions

The evaluation of this criterion was influenced by the following assumption:

- Densely vegetated sites would be able to rehabilitate faster as opposed to sparsely vegetated sites, hence reducing the length of time for which dust would be problematic.

3.7.1.2 Discussions

Hardap
Hardap1 and Hardap2 sites are both equally preferred over Hardap3, based on the existing ground cover.

Omburu
There was no particular preference for any of the Omburu sites, which were thus ranked equally.

Osona
Osona1 and Osona3 were equally preferred over Osona2 which was bisected by a gravel road currently used for transporting sand from the Swakop River to the Gross Barmen development.

The road is used on a frequent basis creating fine dust, as indicated in Figure 10, which could result in a dust layer on the panels reducing the efficiency thereof. The red arrow indicates dust from ongoing truck.

Figure 10 | Current dust levels at Osona2

Table 20 indicates the preference of the various alternatives sites expressed as a percentage.

Table 20 | Summary of preferences at Hardap, Omburu and Osona based on S1

Location / Preference	Preferred		Least preferred
Mariental (Hardap)	Hardap1 and Hardap2 (42.9%)		Hardap3 (14.3%)
Omaruru (Omburu)	Omburu1, Omburu2 and Omburu3 (33.3%)		
Okahandja (Osona)	Osona1 and Osona3 (45.5%)		Osona2 (9.1%)

3.7.2 S3 Impact on sense of place, with specific reference to the value of landscape

Namibia is known for its vast open areas and the generally undisturbed nature of the landscape. By developing areas that would be visible from tourism nodes, it could detract from this experience. However, the only tourist destination in close proximity to any of the sites was the Gross Barmen resort, currently under construction in close proximity to the Osona substation.

3.7.2.1 Assumptions

The evaluation of this criterion was influenced by the following assumptions:

- A digital elevation model was used to determine the meters above mean sea level of the proposed site in relation to the surrounding areas. An area with a low digital elevation model would have low visibility whereas areas with a high digital elevation model would be visible to surrounding areas.
- Sites that were closer to existing infrastructure would have less of an impact as the visual qualities would already have been impacted on.
- Although all three substations and alternative sites are located in remote areas of Namibia, all three substations were in close proximity to existing roads from where people could potentially view the developments. It was assumed that the existing substation and many powerlines already decrease the overall scenic quality.

3.7.2.2 Discussions

Hardap

Hardap1 site is located on the same side of the road as the substation which could act as a buffer in the foreground, moderating visual exposure to people travelling along the M29 gravel road. Hardap3 is slightly preferred over Hardap2 although a setback on the northern extent would be required as the site extends beyond a small escarpment. Hardap2 is the least preferred site since it is located the furthest from the substation and would be visible from the M29.

Omburu

Omburu area experiences some tourist traffic traveling between Swakopmund and Windhoek, but the area remains remote with few permanent residents. Omburu1 site is located the furthest from the existing road at a lower elevation and would therefore be the least visible to people travelling along the road. Omburu1 is strongly preferred over Omburu2 and Oburu3 since both sites are located along the existing road at a slightly higher elevation potentially having high visibility. Omburu3 is the least preferred since the site is situated on a prominent area that will have the highest visibility of the three alternatives.

Osona

Once the Gross Barmen Resort is operational tourists might travel along the M87 route. Gross Barmen would become a tourist destination and would be affected by the potential for higher levels of visual impact created by the proposed PV structures. Osona1 is situated at a lower elevation to the other two options which would be the least visible to people traveling along the M87. In addition, the site is screened by a strip of dense vegetation and which would furthermore ensure that the site is not visible. Osona1 site was thus strongly preferred over Osona2 and Osona3. The northern portions of the Osona2, close to the M87, are screened by some medium to large sized trees along the road. Osona2 was the least preferred due to the proximity of the site to the road used to access Gross Barmen.

Table 21 indicates the preference of the various alternatives sites expressed as a percentage.

Table 21 | Summary of preferences at Hardap, Omburu and Osona based on S3

Location / Preference	Preferred		Least preferred
Mariental (Hardap)	Hardap1 (63.7%)	Hardap3 (25.8%)	Hardap2 (10.5%)
Omaruru (Omburu)	Omburu1 (63.7%)	Omburu2 (25.8%)	Omburu3 (10.5%)
Okahandja (Osona)	Osona1 (63.7%)	Osona3 (25.8%)	Osona2 (10.5%)

3.7.3 S4 Impact on heritage and archaeological resources

Heritage and archaeological features are protected under the National Heritage Act (No. 27 of 2004).

3.7.3.1 Assumptions

The evaluation of this criterion was influenced by the following assumptions:

- Current knowledge of the alternative sites is assumed to provide a sufficient basis for comparison at this stage of the evaluation exercise.
- Any removal or collection would require a permit.

- Heritage features should be avoided if possible.

3.7.3.2 Discussions

Hardap
Hardap1 and Hardap2 sites are equally preferred over Hardap3 which has a slightly higher density of archaeological features and is less disturbed than Hardap1 and Hardap2.

Omburu
Omburu 3 is strongly preferred over Omburu1 and Omburu2 sites, since no heritage features were identified onsite. A potential grave was identified on Omburu2 increasing the preference for Omburu1 over Omburu2. The grave was indicated by a number of rocks lying in close proximity to one another. It was assumed this was once a dense collection of rocks that have been dispersed by cattle. Small white pieces of quartz were found between the dispersed rocks of the grave. This represents fat, milk and fertility (pers. comm. Kinahan, 2014) indicating that it was possibly a woman's grave. Men's graves tend to occur in groups and are typically covered with pieces of ochre. The grave is not located on the preferred site and therefore no impacts associated with it are anticipated. Mitigation measures to protect or relocate the possible grave could be recommended and the presence thereof onsite was not seen as a fatal flaw. However, as stated above there was a strong preference for Omburu3, based on the lack of heritage features identified.

Osona
Gross Barmen, located close to the Osona Substation, is a historical settlement. Due to the close proximity of the proposed sites it was anticipated that there may be heritage or archaeological finds, however none were identified. A slight preference was identified for Osona1 as a result of the previous vegetation clearing which would have already disturbed any potential heritage features that might have been present. Osona2 and Osona3 were equally ranked as least preferred as neither yielded significant heritage features and both were relatively undisturbed. Table 22 indicates the preference of the various alternatives sites expressed as a percentage.

Table 22 | Summary of preferences at Hardap, Omburu and Osona based on S4

Location / Preference	Preferred		Least preferred
Mariental (Hardap)	Hardap1 and Hardap2 (42.9%)		Hardap3 (14.3%)
Omaruru (Omburu)	Omburu3 (64.9%)	Omburu1 (27.9%)	Omburu2 (7.2%)
Okahandja (Osona)	Osona1 (71.4%)		Osona2 and Osona3 (14.3%)

3.7.4 S5 Degree of property fragmentation

Property fragmentation is defined as the extent to which establishment of the PV facility on a particular site would affect the remainder of the property on which that site is located. This depends on the size of the property in relation to the site footprint, as well as its shape. Whether or not a property is currently traversed by a main road would be relevant, as this would indicate an existing fragmentation of the property.

Property fragmentation would constitute a negative socio-economic impact on properties, related to the type of landuse. On properties used for game or livestock farming, for instance, it could affect/restrict animal movement patterns to such a degree that it decreases the economic viability of the property.

A site on a corner of land would not fragment the farm as the farmer could easily move stock and equipment around it. A site in the middle of the farm would however increase the effort involved in moving stock or equipment around (see Figure 11).

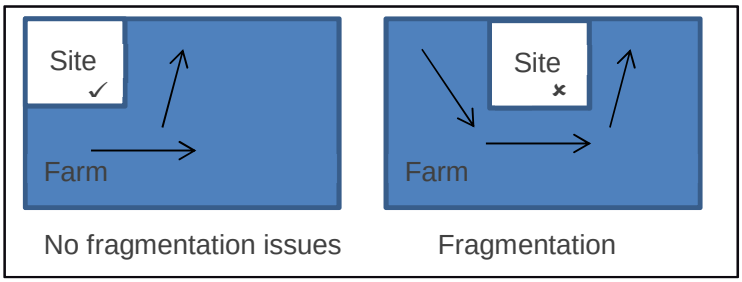


Figure 11 | Illustration showing how a site can fragment a farm

3.7.4.1 Assumptions

The evaluation of this criterion was influenced by the following assumption:

- Only the portion of the property which comprises the site would be purchased by NamPower and current landuse activities on the property would occur around the site.

3.7.4.2 Discussions

Hardap

Hardap1 and Hardap2 sites were preferred over Hardap3 since development of the latter would result in significant fragmentation. There is a slight preference for Hardap2 over Hardap1 based on the layout of the farm portion and relation of the proposed site thereon.

Omburu

Omburu3 and Omburu1 are both relatively large farms and the proposed sites are located in the corner of the respective properties with low potential for fragmentation. Omburu3 is preferred over Omburu1 as the site is located in the south-eastern corner of the property and would not fragment the property. Omburu2 is located in the middle of a small farm portion which would result in significant fragmentation of the property and hence this site was the least preferred.

Osona

Osona3 was preferred due to the large size of the property that would not be fragmented by the proposed site which is located along the boundary of the farm. Osona2 could potentially result in a low level of fragmentation. Osona1 is situated on a small farm portion and would fragment the small area tremendously and this site was therefore least preferred.

Table 23 indicates the preference of the various alternatives sites expressed as a percentage.

Table 23 | Summary of preferences at Hardap, Omburu and Osona based on S5

Location / Preference	Preferred		Least preferred
Mariental (Hardap)	Hardap2 (64.9%)	Hardap1 (27.9%)	Hardap3 (7.2%)
Omaruru (Omburu)	Omburu3 (65.5%)	Omburu1 (29.0%)	Omburu2 (5.5%)
Okahandja (Osona)	Osona3 (78.5%)	Osona2 (14.9%)	Osona1 (6.6%)

3.7.5 S6 Loss of agricultural potential

The areas investigated are all currently used for stock farming and/or game farming as indicated in Table 24. No intensive crop production is undertaken. Therefore the assessment of agricultural potential is based on the grazing potential of the site.

Table 24 | Current land-uses of proposed alternatives sites

Area	Site	Farm portion	Current land uses
Hardap	1	Khoichas 89	Game and small-stock farming
	2	Khoichas 89	Game and small-stock farming
	3	Khoichas 89	Game and small-stock farming
Omburu	1	Omapayu Nord 74	Game and cattle farming
	2	Kamombonde Ost 86 Ptn 1	Game farming
	3	Omaruru Townlands 85	Not specified
Osona	1	Gross Barmen 7	Game and cattle farming
	2	Portion 85 of Osona Commonage 65	Game and cattle farming
	3	Gross Barmen 7	Game and cattle farming

3.7.5.1 Assumptions

The evaluation of this criterion was influenced by the following assumption:

- A high presence of palatable grass species was assumed to have higher agricultural potential than sites with predominantly annual grass species as predominantly annual grass species are indicative of previous disturbance and they are less palatable.

3.7.5.2 Discussions

Hardap

Hardap3 site is preferred for development based on the presence of annual grass, with the least preference for Hardap1. Hardap2 is preferred over Hardap1 as a result of higher levels of disturbance at Hardap2, as opposed to Hardap1.

Omburu

Omburu3 was previously disturbed by overgrazing, resulting in dense vegetation with very little agricultural grazing potential. There was a medium preference for Omburu2 as the site is also densely vegetated, but it has more grazing potential than Omburu3. Omburu1 is least preferred due to the predominant annual grass species decreasing the grazing potential.

Osona

The cleared section of Osona1 is dominated by annual grasses with very few trees onsite. Osona1 is preferred for development as a result of the previous disturbance. Although Osona2 has high densities of perennial grasses it is preferred over Osona3 which is dominated by perennial grasses. Table 25 indicates the preference of the various alternatives sites expressed as a percentage.

Table 25 | Summary of preferences at Hardap, Omburu and Osona based on S6

Location / Preference	Preferred		Least preferred
Mariental (Hardap)	Hardap3 (63.7%)	Hardap2 (25.8%)	Hardap1 (10.5%)
Omaruru (Omburu)	Omburu3 (75.1%)	Omburu1 (17.8%)	Omburu2 (7.0%)
Okahandja (Osona)	Osona1 (62.7%)	Osona2 28(%)	Osona3 (9.4%)

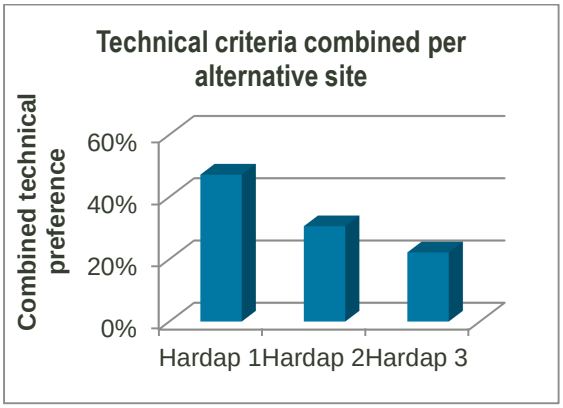
3.8 SUMMARY OF RESULTS

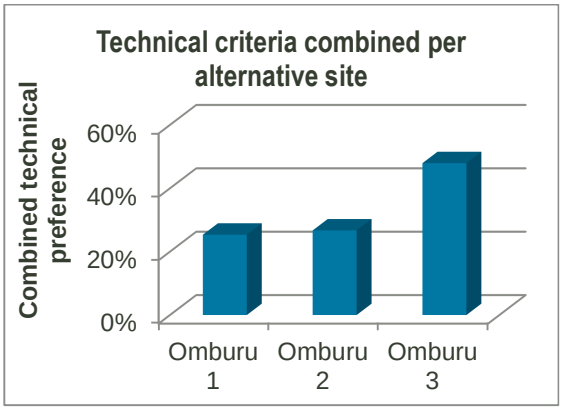
Using the methodology for site selection described in this Chapter, each criterion was evaluated separately by the relevant project team member. The summary of results in this section has been structured to indicate how sites ranked in terms of combined technical, combined biophysical and combined socio-economic criteria categories. The overall site preference was then determined through combining these results (combined per criteria category), using the defined weighting scenarios as described.

When considering the technical criteria only, Hardap1, Omburu3 and Osona1 are still the preferred sites as indicated in Figure 12. This is based on the fact that it is cheaper to build PV facilities on land available for purchase that are relatively flat and close to existing infrastructure to ease integration to the national grid.

Consideration of the biophysical and socio-economic criteria only (sensitivity analyses 3), shows a stronger preference for Hardap1, Omburu3 and Osona1. This is influenced by that fact that these sites are most disturbed, have fewer unique habitats onsite and would have the least disturbance to avifauna.

When only considering the socio-economic criteria, as indicated in Figure 14, Hardap1 and Hardap2 are equally preferred and Omburu3 and Osona1 remain the uncontested preferred sites. Regardless of the equal preference for Hardap1 and Hardap2 based on socio-economic criteria, Hardap1 is the overall preferred site since the preference for combined criteria for Hardap2 and Hardap3 did not exceed the combined preference of Hardap1.





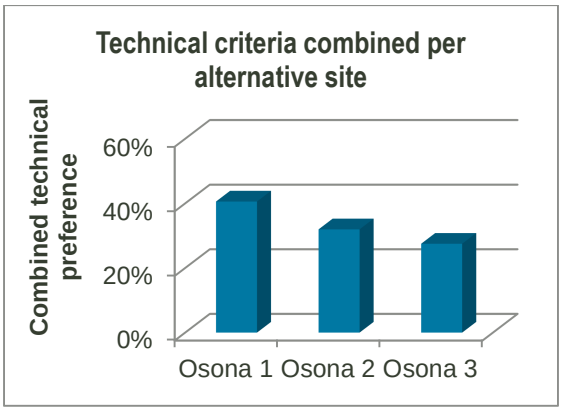
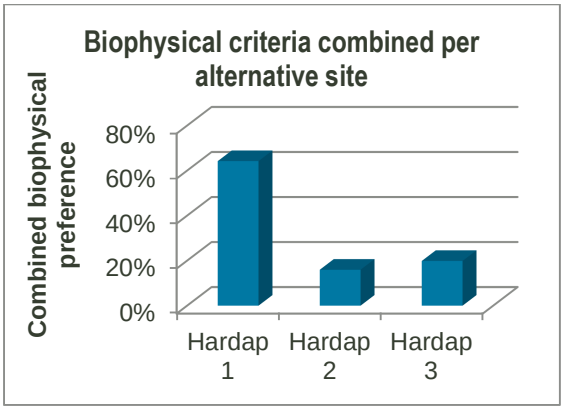
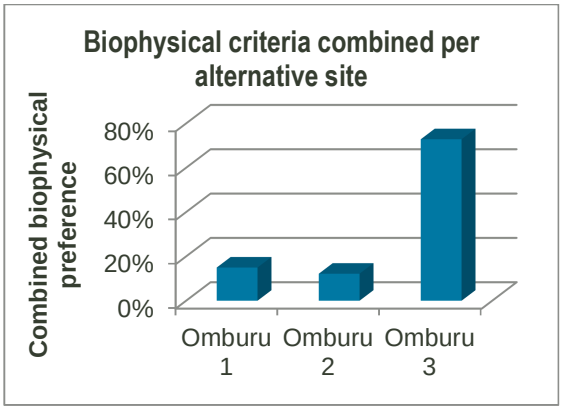


Figure 12 | Preference based on combined technical criteria





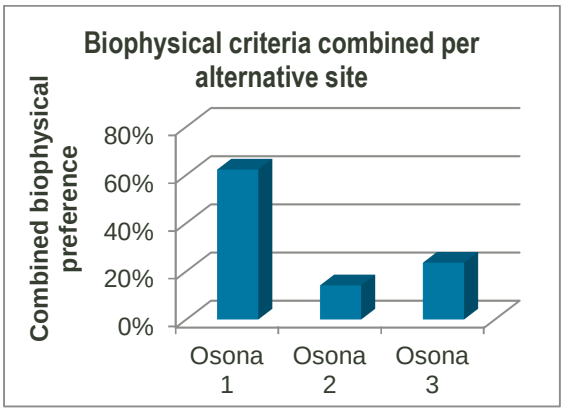
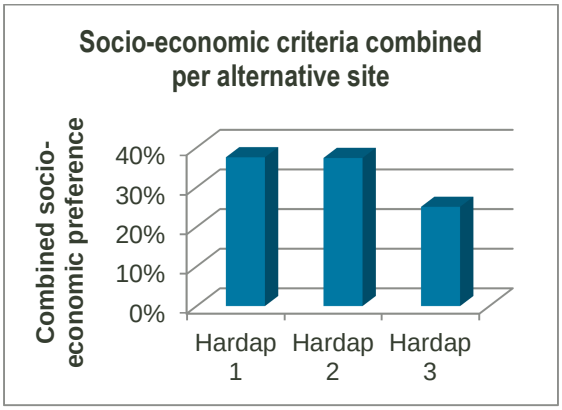
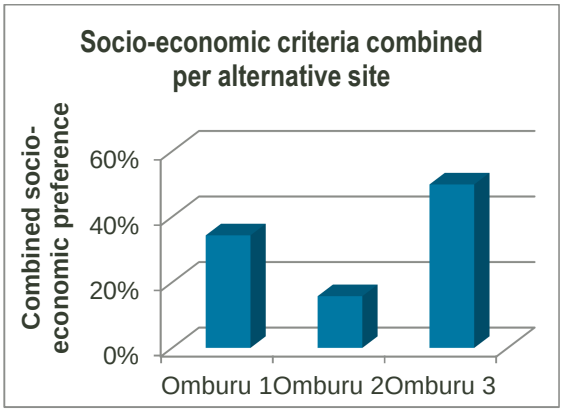


Figure 13 | Preference based on combined biophysical criteria





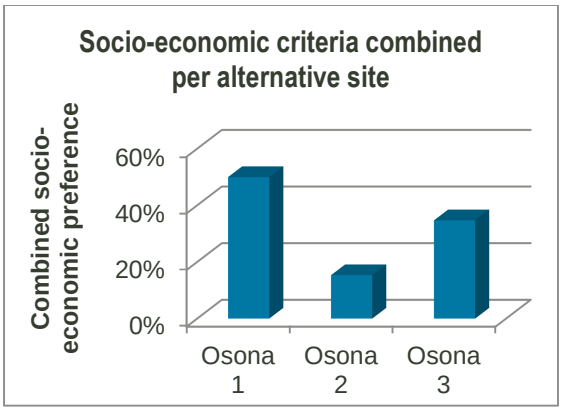


Figure 14 | Preference based on combined socio-economic criteria

3.9 SENSITIVITY ANALYSIS

The base case (with a weighting of Technical 50%, Biophysical 15% and Socio-economic 35%) indicated an overall preference for Hardap1, Omburu3 and Osona1 sites as indicated in Figure 15. To test whether the base case is robust, a sensitivity analysis was done by plotting the relative preference i.e. changing the weighting of technical, biophysical and socio-economic in alternative scenarios.

To test the robustness of the base case, three sensitivity analyses were done by changing the overall weighting of the three main criteria categories as follows:

- Sensitivity analysis 1 (Technical 33.4%, Biophysical 33.3% and Socio-economic 33.3%).
- Sensitivity analysis 2 (Technical 100%, Biophysical 0% and Socio-economic 0%).
- Sensitivity analysis 3 (Technical 0%, Biophysical 50% and Socio-economic 50%).

As indicated in the figures below, the base case outcome was plotted against the outcome of each of the sensitivity analyses for ease of comparison. In all cases the overall preferred site remained the same (typically with a change in the relative margin by which it is preferred), although the sequence of the second and third ranked sites reversed in some instances. The preferred sites remained Hardap1, Omburu3 and Osona1 throughout as indicated in Figure 16, Figure 17 and Figure 18.

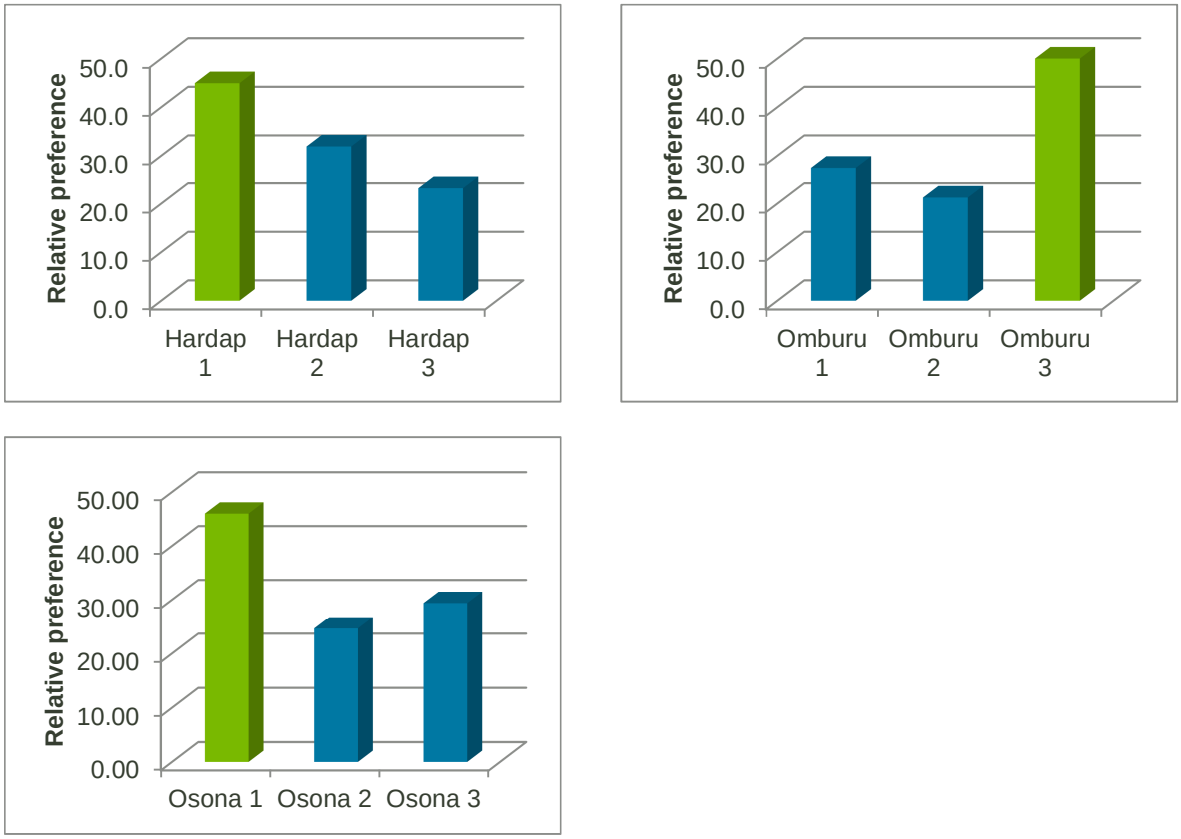


Figure 15 | Preference based on base case (Technical- 50%, Biophysical- 15% and Socio-economic- 35%) (Preferred sites are indicated in green)

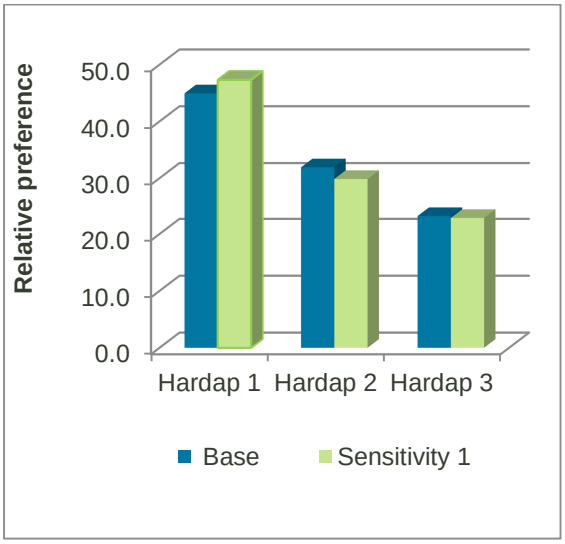
This sensitivity analysis confirmed the Hardap1, Omburu3 and Osona1 as the preferred sites in all three instances, although it is clear that the relative preference of Hardap1 is greater with the sensitivity analysis 1 and 2 than with the base case. Omburu3 was equally preferred in the base scenario and sensitivity analysis 1.

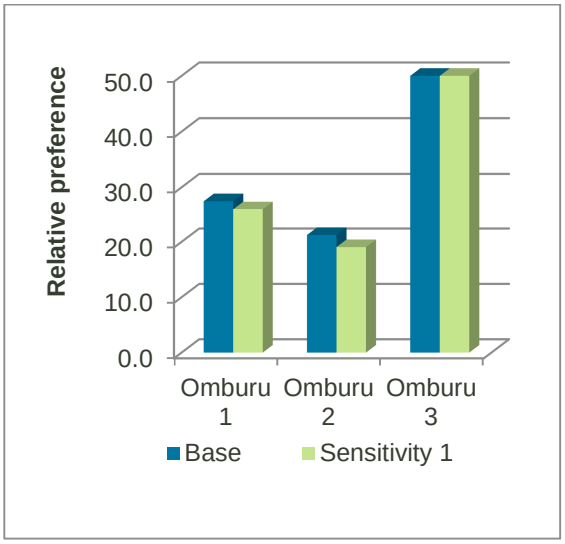
The consistency in results (in terms of overall preferred sites) confirms that it would be safe to narrow the focus of studies to these sites moving forward in the process.

3.10 PREFERRED ALTERNATIVES FOR EACH SITE

It can be concluded that the application of the selected MCDM model has yielded reliable results, given the wide focus of the different criteria and the consistency of the outcomes throughout the application of the model. As such, exclusion of sites for further, more detailed analysis in the assessment phase of the project can be based on these results with a high degree of confidence.

Due to the preferred rating of Hardap1, Omburu3 and Osona1 based on an integrated analysis of technical, biophysical and socio-economic criteria, only these sites are assessed in this Scoping Phase.





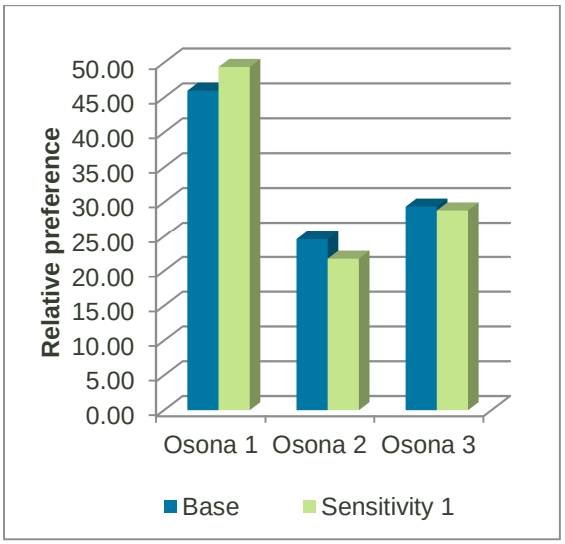
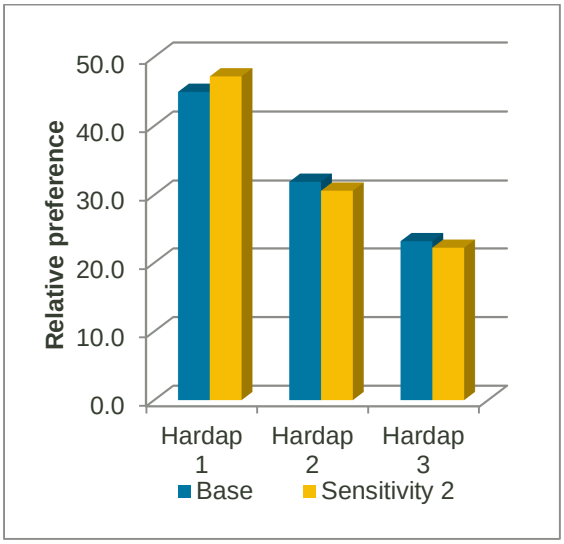
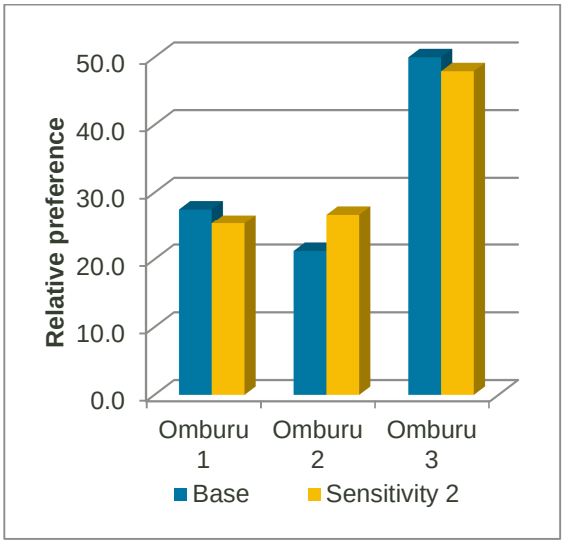


Figure 16 | Outcome of sensitivity analysis 1





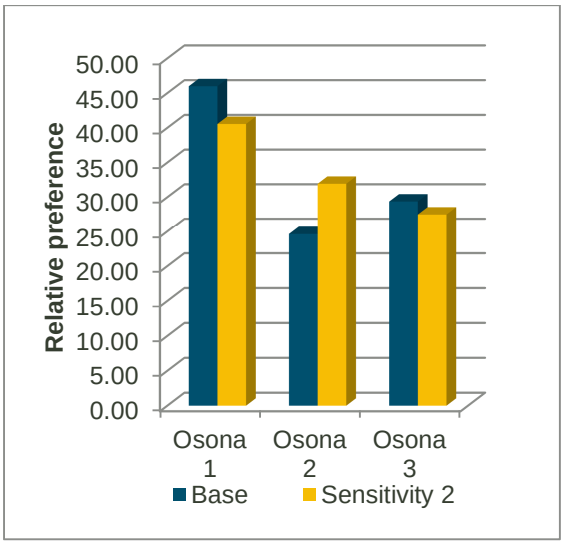
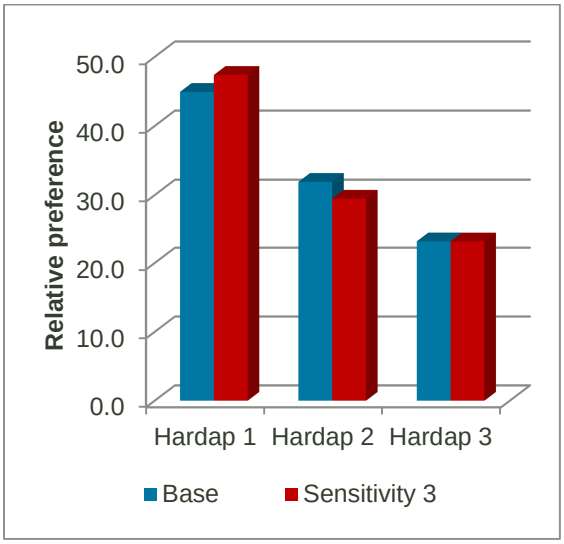
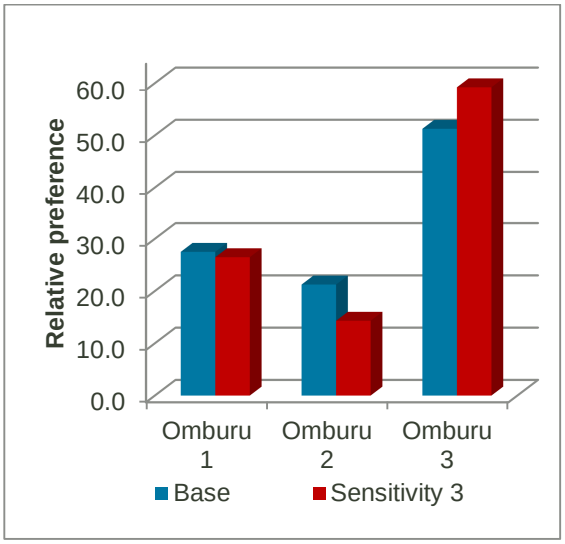


Figure 17 | Outcome of sensitivity analysis 2





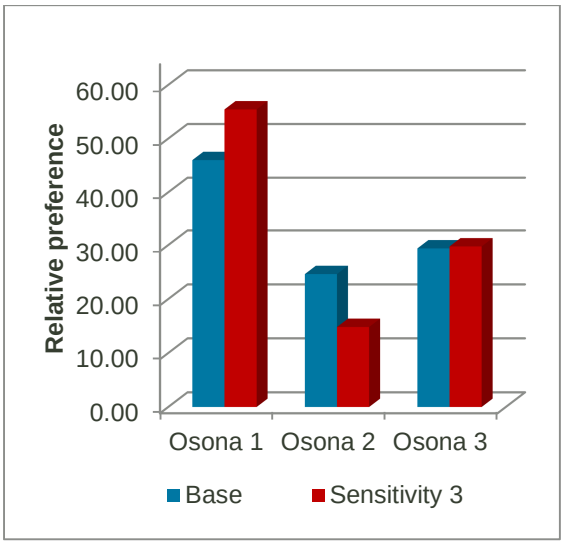


Figure 18 | Outcome of sensitivity analysis 3

4 DESCRIPTION OF THE PROPOSED PROJECTS

The purpose of this section is to provide a technical description of the activities associated with the proposed PV facilities, followed by a description of the feasible project alternatives. This section concludes with a motivation for the proposed projects.

4.1 PROPOSED PROJECT

NamPower identified three existing substations into which each of the proposed PV facilities could feed, based on the existing grid capacity, network of existing transmission lines, the national map of solar radiation indicating the average sunshine hours per day and location of the largest source of demand. The three substations identified were the Hardap substation near Mariental, Omburu substation near Omaruru and Osona substation near Okahandja.

After undertaking the MCDM process as described in Section 3, three sites, one per substation, were selected for PV development namely:

- 35 ha of Koichas Farm (Farm Number 89) close to Mariental, Hardap Region (referred to as Hardap PV site).
- 35 ha of the Omaruru Townlands (Portion B of Townlands 85) close to Omaruru, Erongo Region (referred to as Omaruru PV site)[2].
- 35 ha of Farm Gross Barmen (Portion C of Farm Number 7) near Okahandja, Otjozondjupa Region (referred to as Osona PV site).

The proposed 35 ha sites have taken cognisance of the environmentally sensitive areas identified during the MCDM process. All three sites are located on farming land and are currently used for stock grazing, transmission line corridors or are uninhabited.

Each of the proposed 10 MW PV facilities will be similar in design and layout and would consist of the following:

- **Photovoltaic component**: numerous rows of PV panels and associated support infrastructure to generate electricity.
- **Transmission corridor**: one overhead 66 kV transmission line located within a transmission corridor to connect the proposed onsite substation to the existing main substation.
- **Onsite substation**: the onsite substation to collect the electricity produced onsite and step it up to the correct voltage to transfer via the transmission line to the existing main central substation.
- **Access road corridor**: a corridor to accommodate the access road for constructing, servicing and maintaining the facility.
- **Buildings**: operation and maintenance buildings to house control systems, equipment and a guard cabin for security.

[2] Purchase of land arrangement to be done by NamPower after the EIA process has been concluded.

- **Additional infrastructure**: includes a boundary fence for safety and security reasons; water supply infrastructure for groundwater abstraction and stormwater infrastructure, if required.

The project components are described in more detail in the following sections.

4.1.1 PV component

PV facilities use light energy from the sun to generate electricity through a process known as the PV effect. The PV cells absorb light energy which energises the electrons to produce electricity. Figure 19 depicts a typical PV facility in an arid environment.

Figure 19 | Example of a PV facility (Aurecon, 2013)[3]

PV panels are approximately 2 m long and 1 m wide. These panels would be arranged into modules that are durable due to the sturdiness of the structure and few moving parts. The PV modules would be physically mounted to a galvanized steel frame (which provides an earthing connection) and are oriented in an optimal position for maximising the daily irradiance (in the southern hemisphere they are tilted northwards). Fixed Mounting Structures are usually situated in an east to west direction, however tracking systems (such as the single-axis tracker shown in Figure 20) would be oriented in a north to south direction and track the sun from east to west.

The final design of the foundations will depend on the geotechnical conditions of the site which will only be investigated after the decision on the EIA process.

[3] Aureocn, 2013. Proposed Photovoltaic Energy Facilities on Badenhorst Dam Farm near De Aar, Northern Cape: Final EIA Report. Report No. 8343

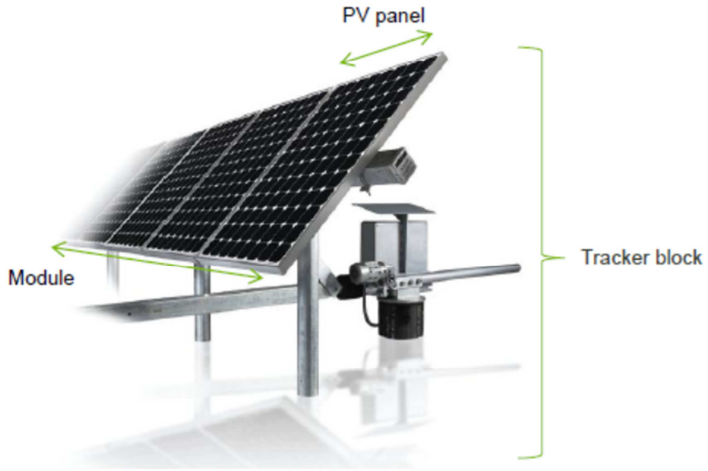


Figure 20 | Single axis tracking system indicating the various parts of a PV module (Aurecon, 2013)

4.1.2 Transmission lines and substations

It is envisaged that each of the PV facilities would require an onsite substation. This substation would feed into the existing substations namely Hardap, Omburu and Osona substations by means of an overhead 66 kV transmission line. The physical dimensions of all substations and electrical buildings that would be required are indicated in Table 26. Inverter cabins would be required to convert the Direct Current power into Alternating Current energy which is compatible with the National Grid.

Table 26 | Proposed substations and inverters

Substations	Dimensions
Onsite Substations	Approximately 100 m x 60 m x 25 m
Inverter Cabins	Approximately 15 m x 5 m x 4 m

It is proposed to assess a transmission line corridor to allow for flexibility in the routing of the transmission lines as the preliminary layouts could still change during the design process. The width of the proposed transmission corridor ranges from 100 m to 150 m as indicated in Figure 21, Figure 22 and Figure 23 below. Specialists have thus assessed the proposed transmission corridors as these would contain the footprint of all of the proposed transmission lines and substations.

4.1.3 Access roads

Internal access gravel roads from the main access roads to the PV facilities would be required. The lengths of the proposed roads vary between 500 m and 1 km. Where possible, the layout of these roads would be designed to coincide with the existing dirt tracks. The design of the new access point would be undertaken by a professional engineer to ensure the safety of road users.

Based on the limited design information currently available, it is proposed to assess access road corridors to allow for changes to the access road routings within the corridors during detailed design.

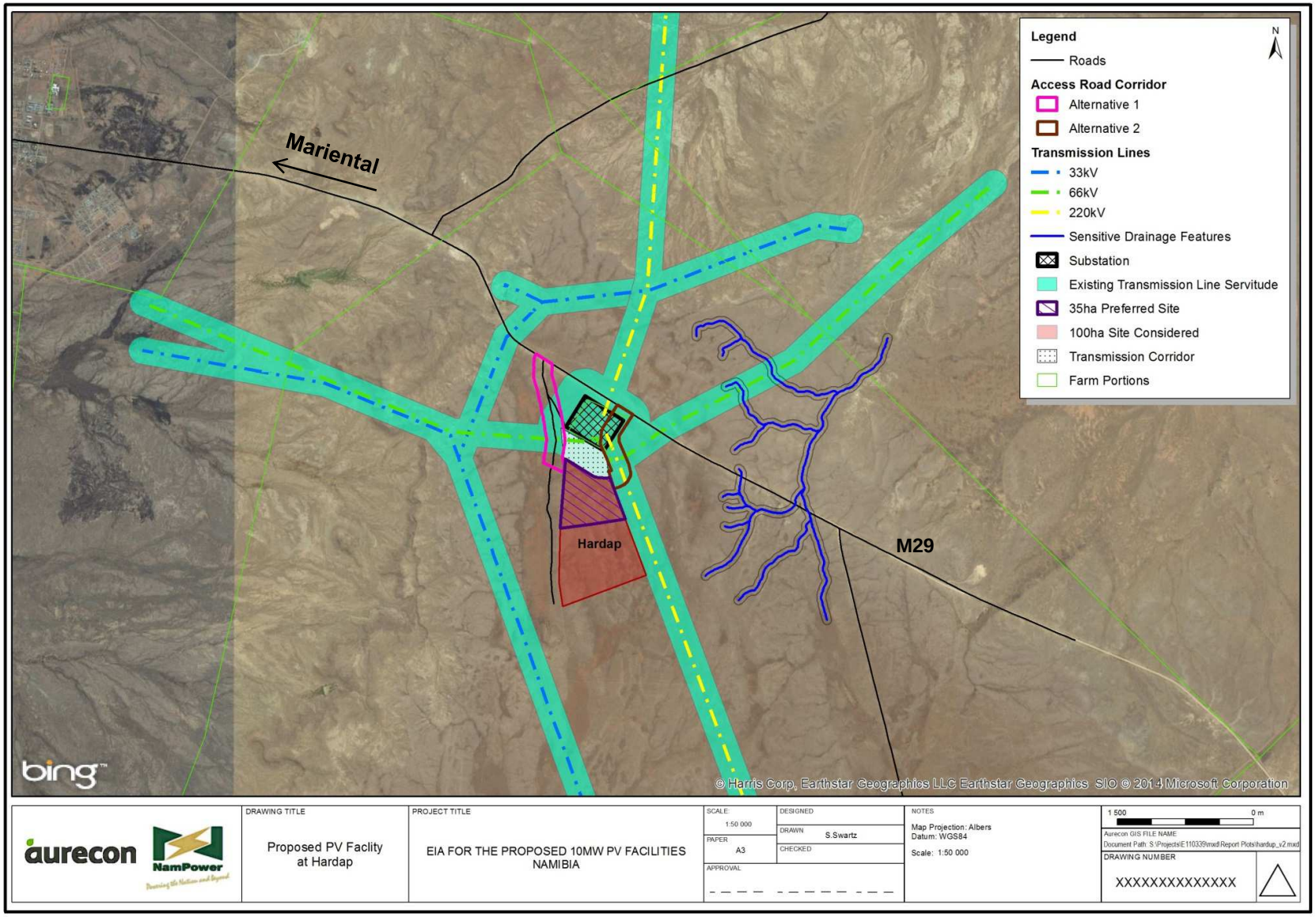


Figure 21 | Proposed site for Hardap PV development indicating the transmission (indicated with polka dots) and road corridor alternatives

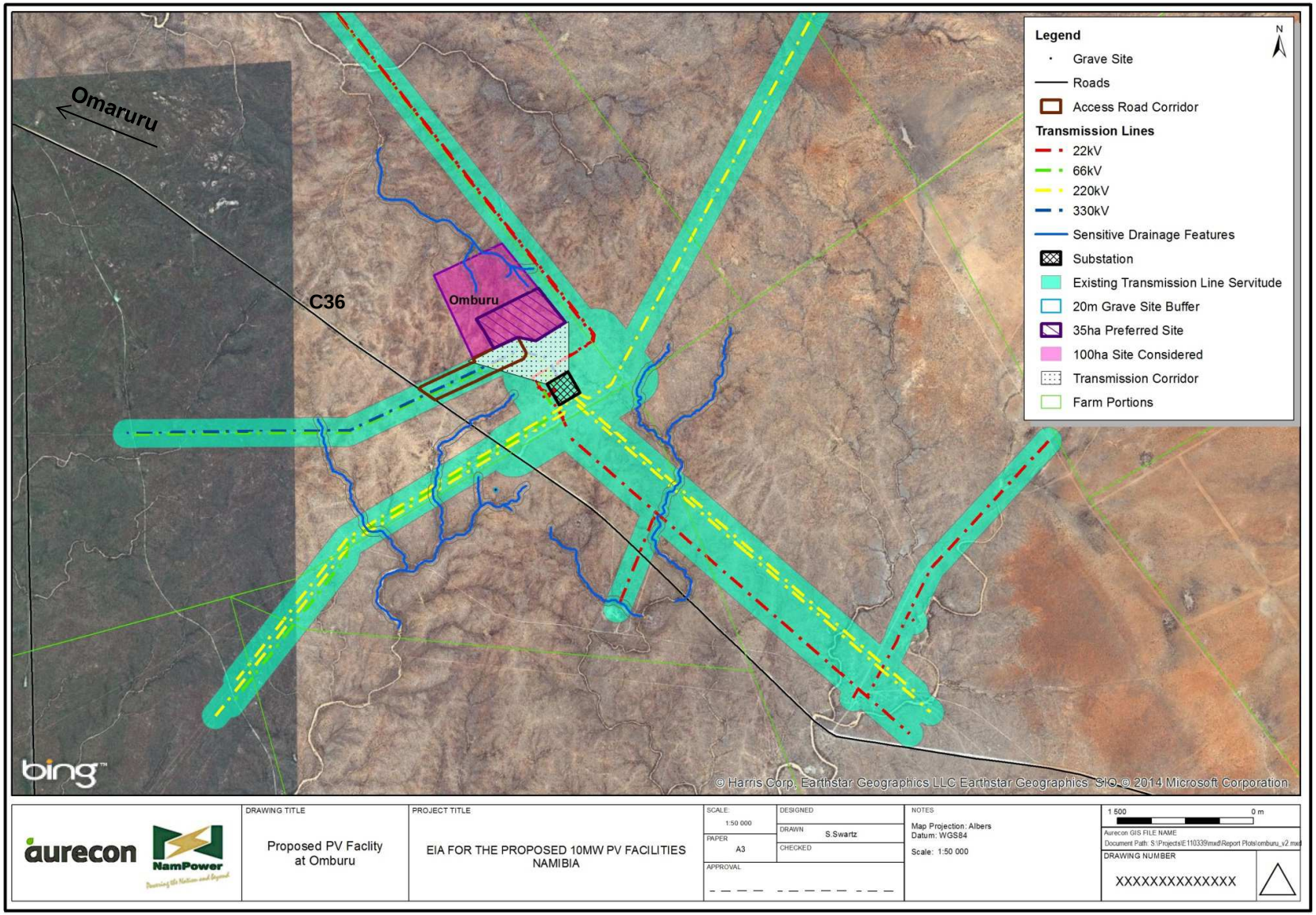


Figure 22 | Proposed site for Omburu PV development indicating the transmission (indicated with polka dots) and road corridor alternatives

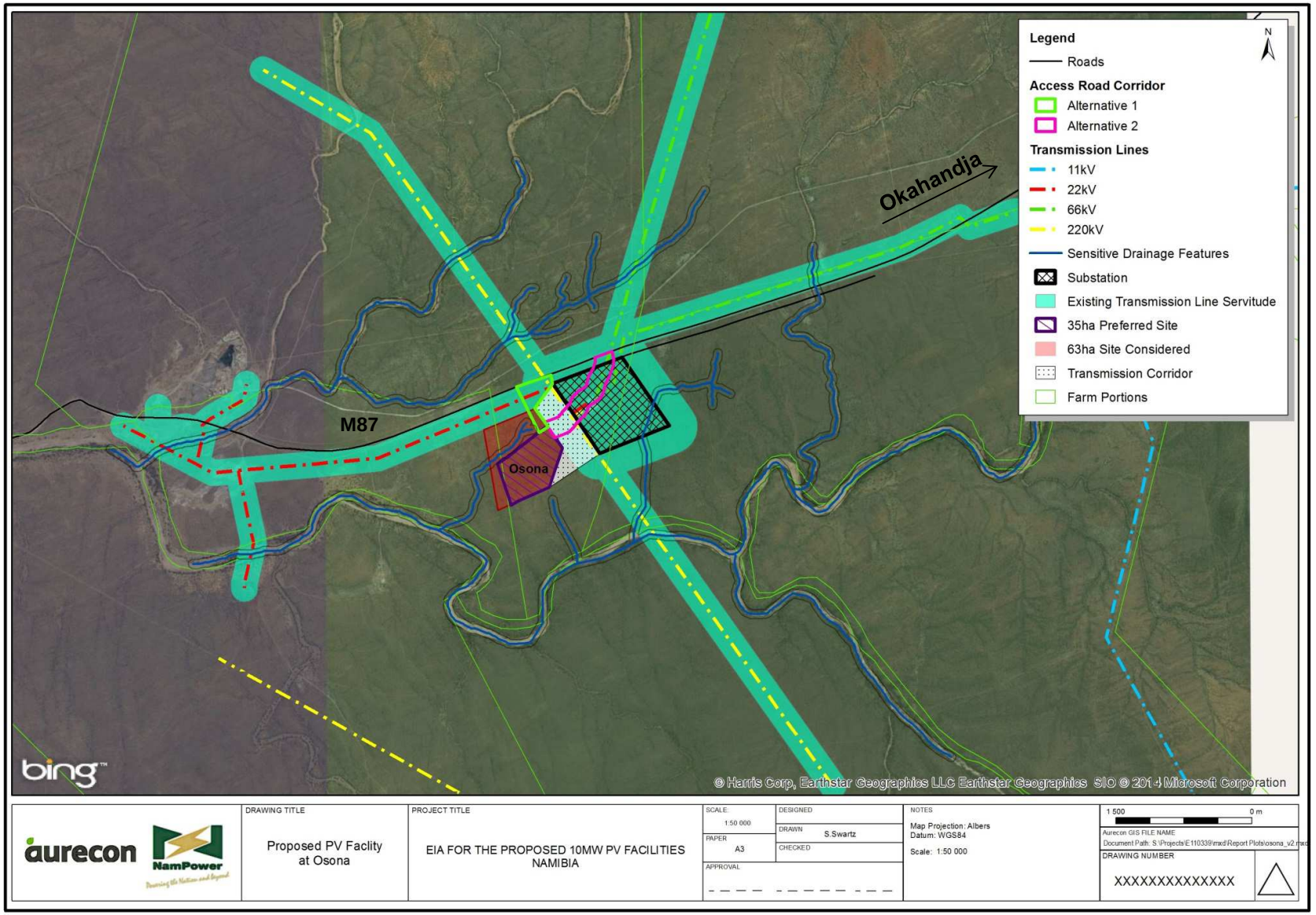


Figure 23 | Proposed site for Osona PV development indicating the transmission (indicated with polka dots) and road corridor alternatives

4.1.4 Additional infrastructure

Buildings for operation and maintenance purposes would be required. The anticipated dimensions of these structures are listed in Table 27. It is expected that the highest building would not be higher than two storeys. All of the buildings would be constructed within the 35 ha footprint.

Table 27 | Dimensions of buildings required

Buildings	Dimensions
Interconnection (Substation) Building	Approximately 25 m x 15 m x 5 m
Interconnection (Inverter) Cabin	Approximately 15 m x 4 m x 5 m
Operation and Maintenance Building	Approximately 30 m x 1 5m x 4 m

As stated earlier, additional infrastructure would also include boundary fences for safety and security. The fences would either be electrical or barbed wire fences, depending on the preference of the developer. A guard cabin would also be required for 24 hour security.

Water would be required during both construction and operational phases for office use and solar panel cleaning. It is proposed to abstract groundwater and each PV facility would therefore require water supply infrastructure for abstraction. Any application for permits for water abstraction will be undertaken outside of the EIA process.

The natural slope of the site could potentially be interrupted by the planned roads. In order to ensure that stormwater is managed effectively, stormwater infrastructure might be required. This will be incorporated within the final detailed designs should this be required.

4.2 CONSTRUCTION PHASE

The construction phase of each 10 MW facility would last up to 18 months. Based on similar projects in South Africa, approximately 75 job opportunities would be created. The majority of employment opportunities during the construction phase would be reserved for Namibians. Onsite construction camps will not be required as staff would be accommodated in the nearby towns.

Approximately 483 466ℓ of water would be required per annum (an average of 1 343 ℓ per day) totalling 725 199 ℓ for the duration of the construction phase. The quantity of water used during construction is heavily dependent on the foundation/concrete requirements of the facility design and hence the geotechnical evaluation (and subsequent founding condition analysis) would have a significant impact on the water usage. The approximate volumes provided here are however very conservative so it is unlikely that this volume would increase.

Laydown areas are used throughout the construction period to store equipment and materials. All laydown areas will be within the 35 ha assessed for development. Delivery of construction material and equipment will require heavy transport vehicles, but no abnormal or hazardous loads are expected (with the exception of the main substation transformer, which may be an abnormal load dependent on size). The typical equipment to be transported would include steel, cement, panels, transformers, cables and machinery. It is estimated that 60 truckloads transporting in total 120 40-foot containers would be required per 10 MW PV facility throughout the 18 month construction period. Construction vehicles are to make use of the existing roads to transport equipment and material to the construction site.

During the construction phase some vegetation clearing would be required in order to undertake construction activities. Where possible, vegetation would be left uncleared in order to limit disturbance to mitigate erosion and dust and to encourage natural rehabilitation of the surrounding areas onsite. Topsoil would be temporarily stored onsite and finally distributed over the surface of the site in preparation for vegetation rehabilitation, as required by the EMP (Annexure D).

Some excavation would be required in order to fix the panels to the ground surface. This could generate spoil material. Spoil is earth material excavated during construction and it is expected to be reused onsite within the 35 ha site. During the construction phase, different types of control measures would be used to limit soil migration across the site. These mitigation measures are described in the EMP, included in Annexure D. The disturbed areas would be rehabilitated to as natural a vegetated state as possible.

4.3 OPERATIONAL PHASE

It is anticipated that each of the PV facilities would have a lifespan of approximately 25 years. During this time, the remainder of the farm will continue to be used for agricultural purposes and existing servitudes would remain. It is uncertain how many permanent employment opportunities would be created during the operational phase, but it is expected to be less than ten for security and maintenance jobs. Toilet and ablution facilities for operational personnel must include infrastructure (for example a French drain) to prevent any unwanted substances from infiltrating the aquifer environment.

To ensure that maximum sunlight reaches the PV panels it is important to undertake regular cleaning of the panels. Dust, dirt, pollen, and bird droppings can reduce the efficiency of PV panels. The frequency of panel cleaning would depend on the site conditions however, with most South African installations in the Northern Cape PV panels are washed twice a year. It is anticipated that a similar frequency of cleaning would be required at the three sites. Only water will be used with a squeegee and no detergents would be added. Water for the cleaning of the panels biannually would be sourced through groundwater abstraction onsite and would equate to a maximum 46 400 ℓ of water per annum per 10 MW PV facility.

It is expected that some panels might break and need to be replaced throughout the operational phase. PV panels are considered to be electronic waste (also referred to as e-waste) and also hazardous waste. The EMA has legislated that no waste should be discarded at any waste disposal site that has not been declared or approved by MET. In order to implement the waste hierarchy, components of broken panels would be recycled, if possible. Any hazardous waste generated, that cannot be recycled, would be disposed of at specially engineered landfill sites.

4.4 DECOMMISSIONING PHASE

In terms of EMA it is necessary to consider the environmental impacts of decommissioning of any development. However, it is unlikely that this development would be decommissioned. It would more likely be upgraded or converted to another type of commercial or industrial use than be returned to its original land use which is grazing land (open space). The possibility of extending the life of the facility or upgrading the proposed facility to more advantageous technologies could be investigated at the end of the Power Purchase Agreement.

However, should decommissioning be considered to be the favourable option, it would potentially take between 6 to 12 months. After disconnecting the PV infrastructure from the electricity network, the module components would be removed and recycled as far as possible. The structures would be dismantled and the concrete foundations would be removed. All underground cables would be excavated and removed. The buildings would be demolished and removed by an authorised company.

The rehabilitation of the disturbed areas would form part of the decommissioning phase. The aim would be to restore the land to its original substratum characteristics (or as near as possible).

4.5 ALTERNATIVES

According to the EMA EIA Regulations alternatives must be considered during the EIA process. These Regulations state that "*alternatives, in relation to a proposed activity, means different means of meeting the general purpose and requirements of the activity, which may include alternatives to:*

(a) the property on which or location where it is proposed to undertake the activity;
(b) the type of activity to be undertaken.
(c) the design or layout of the activity.
(d) the technology to be used in the activity.
(e) the operational aspects of the activity".

The 2008 Draft Guidelines (Republic of Namibia, 2008) state that EIAs should consider the impacts of:

- "*the proposed activity for the proposed project under consideration.*
- *the no-action alternative.*
- *other alternatives to the proposed activity that fulfils the general objective or need*".

The alternative types pertinent to the project are described in the subsequent sections.

4.5.1 Location alternative

No location alternatives would be assessed in this EIA process as three alternative locations per site were previously scoped during the MCDM process, as described in Section 3.2. Therefore the three preferred locations considered in this report are Hardap1, Omburu3 and Osona1. Please note that these are not alternatives to one another and it is preferred to construct a 10 MW PV facility at each of these sites.

4.5.2 Technology alternative

Two technology alternatives will be considered at all three PV facilities, namely:

- **Fixed Tilt PV:** This is typically a rack mounted system of panel arrays on frames and installed at a fixed angle (see Figure 24a). These arrays would be uniformly aligned to facilitate efficient capture of sunlight.
- **Single-Axis Tracking PV:** The panels are fixed on a single axis that follows the sun movement to ensure maximum exposure to sunlight as indicated in in Figure 24b.

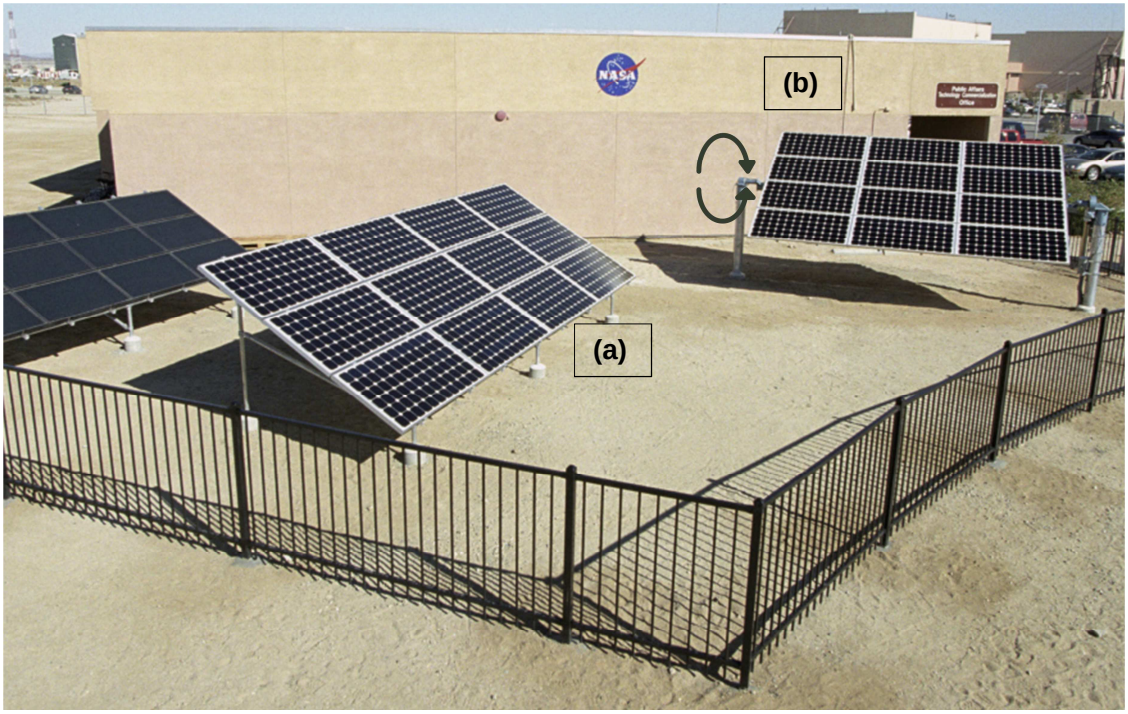


Figure 24 | Fixed tilt (a) and single axis tracking system (b)

The PV modules, fixed to the tracking system, are arranged into tracker blocks as indicated in Figure 24. These tracker blocks would be uniformly aligned to facilitate efficient sun-tracking.

There is a slight height difference between the two systems with fixed axis being approximately 5 m above the natural ground level and single axis being up to 15 m above the ground.

4.5.3 Access and haulage alternatives

The following access road alternatives, as indicated in Figure 21, Figure 22 and Figure 23 will be considered:

- **Hardap1**: two access road alternatives will be considered with Hardap Road 1 following the existing farm road running northwest of the substation. Hardap Road 2 follows the existing access road to the substation and this would be extended to the proposed site.
- **Omburu3**: one access road alternative (Omburu Road 1) following the existing transmission service road to provide direct access to the main road.
- **Osona1**: two access road alternatives will be considered with Osona Road 1 being a new access road to connect the proposed PV to the main road via the shortest distance. Osona Road 2 follows the existing substation access road.

4.5.4 'No-go' alternative

The assessment of alternatives must at all times include the 'No-go' option as a baseline against which all other alternatives must be measured. The 'No-go' option means the *status quo* remains i.e. used for small stock grazing, game farming with servitudes across the sites.

4.5.5 Alternatives to be assessed

Based on the investigations and reasons provided above, it is proposed that the following alternatives be assessed:

Hardap PV facility

- Preferred location alternative: Hardap1.
- **Technology**: Fixed tilt PV and Single-axis tracking.
- **Access and haulage routing**: two access road alternatives namely Hardap Road 1 and Hardap Road 2.
- 'No–go' alternative.

Omburu PV facility

- Preferred location alternative: Omburu3.
- **Technology**: Fixed tilt PV and Single-axis tracking.
- **Access and haulage routing**: one access road alternative Omburu Road 1.
- 'No–go' alternative.

Osona PV facility

- Preferred location alternative: Osona1.
- **Technology**: Fixed tilt PV and Single-axis tracking.
- **Access and haulage routing**: two access road alternatives namely Osona Road 1 and Osona Road 2.
- 'No–go' alternative.

4.6 MOTIVATION FOR THE PROJECT

Section 8 (g) of the EMA requires *"a description of the need and desirability of the proposed listed activity and any identified alternatives to the proposed activity".*

This Scoping Report considers the need and desirability in light of Namibia's 2030 Vision and the Energy Policy Whitepaper of 1998. This information allows the authorities to contemplate the strategic context of a decision on the proposed activity. This section seeks to provide the context within which the need and desirability of the proposed activity should be considered.

Namibia has a high reliance on power imports (on average 60 %, but up to 80 % during dry seasons). A number of Namibia`s energy import agreements are about to end and if not renewed, Namibia is likely to face a capacity deficit in its electricity generation from 2015. This is based on current growth forecasts of its electricity demands (peak demand of 534 MW with a 4 % per annum growth)[4]. In order to address the potential capacity deficit, and to take advantage of the good solar resource in Namibia, NamPower is proposing to purchase electricity from IPPs.

The need for renewable energy is well documented and reasons for the desirability of solar energy include:

- Utilising the most abundant natural resource available to Namibia;
- Meeting nationally appropriate emission targets in line with global climate change commitments.
- Enhancing energy security by diversifying generation.
- Creating a more sustainable economy for the future.

[4] UNDP Environmental Finance Services, July 2011. Concentrating Solar Power Technology Transfer for Electricity Generation in Namibia, (CSP TT) NAM.

Renewable energy is recognised internationally as a major contributor in diminishing the negative effects of climate change, as well as providing a wide range of biophysical environmental, economic and social benefits that can contribute towards long-term global sustainability. These impacts include, amongst others, reduction of greenhouses gases emitted per unit of electricity, reduced reliance on fossil fuelled power stations, employment benefits and associated social upliftments, improvement in electricity security and diversity, and expenditure in local economy. The proposed PV facilities are therefore expected to contribute positively towards climate change mitigation as indicated in Section 6.14. The establishment of the proposed PV facilities would also help to meet the current national electricity demand, which far exceeds supply. Furthermore, the proposed projects would assist Namibia in meeting its international obligations by aligning domestic policy with internationally agreed strategies and standards as set by the Kyoto Protocol and United Nations Convention on Biological Diversity, to which Namibia is a signatory.

The manner in which the PV facilities align with the key relevant polices and plans are set out in Table 28 below.

Table 28 | Compatibility with relevant policies

Policy	Objective / Principle	Alignment
Namibia's Vision 2030	• Land is used appropriately and equitably, significantly contributing towards food security at household and national levels, and supporting the sustainable and equitable growth of Namibia's economy, whilst maintaining and improving land capability.	The project will assist in maximising renewable energy outputs and contribute towards Namibia's economy.
Energy Policy Whitepaper (1998)	• Achieve security of supply. • Contribute to social upliftment. • Achieve effective governance. • Ensure investment and growth. • Improve economic competitiveness. • Ensure economic efficiency. • Promote sustainability. • To ensure the optimal mix of energy resources.	The project will facilitate growth in the energy sector thereby contributing to all of these identified principles.

5 ASSESSMENT METHODOLOGY

This section describes the assessment methodology utilised in determining the significance of the construction and operational impacts of the proposed project.

5.1 ASSESSMENT METHODOLOGY

This section outlines the proposed method for assessing the significance of the potential environmental impacts including both operational and construction phase impacts.

For each impact, the **EXTENT** (spatial scale), **MAGNITUDE** and **DURATION** (time scale) would be described. These criteria would be used to ascertain the **SIGNIFICANCE** of the impact, firstly in the case of no mitigation and then with the most effective mitigation measure(s) in place. The mitigation described in the Scoping Report would represent the full range of plausible and pragmatic measures.

The tables below indicated the scale used to assess these variables, and defines each of the rating categories.

Table 29 | Assessment criteria for the evaluation of impacts

CRITERIA	CATEGORY	DESCRIPTION
Extent or spatial influence of impact	**Regional**	Beyond a 10 km radius of the candidate site.
	Local	Within a 10 km radius of the candidate site.
	Site specific	Onsite or within 100 m of the site.
Magnitude of impact (at the indicated spatial scale)	**High**	Natural and/ or social functions and/ or processes are *severely* altered
	Medium	Natural and/ or social functions and/ or processes are *notably* altered
	Low	Natural and/ or social functions and/ or processes are *slightly* altered
	Very Low	Natural and/ or social functions and/ or processes are *negligibly* altered
	Zero	Natural and/ or social functions and/ or processes remain *unaltered*
Duration of impact	**Construction period/ decommissioning period**	Up to 4 years
	Medium Term	5-15 years after construction
	Long Term	More than 15 years after construction

The **SIGNIFICANCE** of an impact is derived by taking into account the temporal and spatial scales and magnitude. The means of arriving at the different significance ratings is explained in Table 30 .

Table 30 | Definition of significance ratings

SIGNIFICANCE RATINGS	LEVEL OF CRITERIA REQUIRED
High	• High magnitude with a regional extent and long term duration. • High magnitude with either a regional extent and medium term duration or a local extent and long term duration. • Medium magnitude with a regional extent and long term duration.
Medium	• High magnitude with a local extent and medium term duration. • High magnitude with a regional extent and construction period or a site specific extent and long term duration. • High magnitude with either a local extent and construction period duration or a site specific extent and medium term duration. • Medium magnitude with any combination of extent and duration except site specific and construction period or regional and long term. • Low magnitude with a regional extent and long term duration.
Low	• High magnitude with a site specific extent and construction period duration. • Medium magnitude with a site specific extent and construction period duration. • Low magnitude with any combination of extent and duration except site specific and construction period or regional and long term. • Very low magnitude with a regional extent and long term duration.
Very low	• Low magnitude with a site specific extent and construction period duration. • Very low magnitude with any combination of extent and duration except regional and long term.
Neutral	• Zero magnitude with any combination of extent and duration.

Once the significance of an impact has been determined, the **PROBABILITY** of this impact occurring as well as the **CONFIDENCE** in the assessment of the impact would be determined using the rating systems outlined in Table 31 and Table 32 and respectively. It is important to note that the significance of an impact should always be considered in concert with the probability of that impact occurring. Lastly, the **REVERSIBILITY** of the impact is estimated using the rating system outlined in Table 33.

Table 31 | Definition of probability ratings

PROBABILITY RATINGS	CRITERIA
Definite	Estimated greater than 95 % chance of the impact occurring.
Probable	Estimated 5 to 95 % chance of the impact occurring.
Unlikely	Estimated less than 5 % chance of the impact occurring.

Table 32 | Definition of confidence ratings

CONFIDENCE RATINGS	CRITERIA
Certain	Wealth of information on and sound understanding of the environmental factors potentially influencing the impact.
Sure	Reasonable amount of useful information on and relatively sound understanding of the environmental factors potentially influencing the impact.
Unsure	Limited useful information on and understanding of the environmental factors potentially influencing this impact.

Table 33 | Definition of reversibility ratings

REVERSIBILITY RATINGS	CRITERIA
Irreversible	The activity will lead to an impact that is in all practical terms permanent.
Reversible	The impact is reversible within 2 years after the cause or stress is removed.

Despite attempts at providing a completely objective and impartial assessment of the environmental implications of development activities, environmental assessment processes can never escape the subjectivity inherent in attempting to define significance. The determination of the significance of an impact depends on both the context (spatial scale and temporal duration) and intensity of that impact. Since the rationalisation of context and intensity will ultimately be prejudiced by the observer, there can be no wholly objective measure by which to judge the components of significance, let alone how they are integrated into a single comparable measure.

This notwithstanding, in order to facilitate informed decision-making, environmental assessments must endeavour to come to terms with the significance of the potential environmental impacts associated with particular development activities. Recognising this, Aurecon has attempted to address potential subjectivity in the current EIA process as follows:

- Being explicit about the difficulty of being completely objective in the determination of significance, as outlined above.
- Developing an explicit methodology for assigning significance to impacts and outlining this methodology in detail. Having an explicit methodology not only forces the assessor to come to terms with the various facets contributing towards the determination of significance, thereby avoiding arbitrary assignment, but also provides the reader with a clear summary of how the assessor derived the assigned significance.
- Wherever possible, differentiating between the likely significance of potential environmental impacts as experienced by the various affected parties.
- Utilising a team approach and internal review of the assessment to facilitate a more rigorous and defendable system.

Although these measures may not totally eliminate subjectivity, they provide an explicit context within which to review the assessment of impacts.

5.2 ASSESSMENT OF CUMULATIVE IMPACTS

Environmental Assessment Policy in Namibia requires that, “as far as is practicable”, cumulative environmental impacts should be taken into account in all environmental assessment processes. EIAs have traditionally, however, failed to come to terms with such impacts, largely as a result of the following considerations:

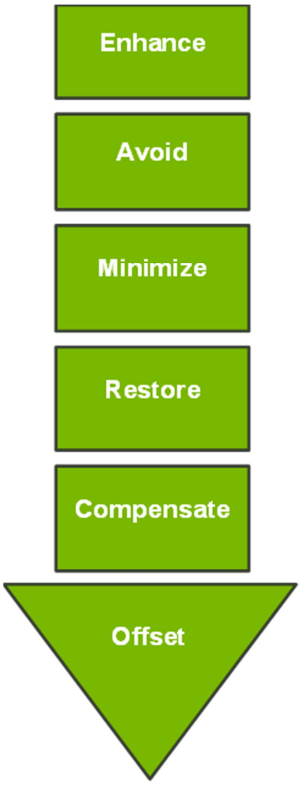
- Cumulative effects may be local, regional or global in scale and dealing with such impacts requires coordinated institutional arrangements.
- Environmental assessments are typically carried out on specific developments, whereas cumulative impacts result from broader biophysical, social and economic considerations, which typically cannot be addressed at the project level.

Cumulative impacts were considered and assessed as far as possible for each of the anticipated impacts, as included in Section 6.

5.3 MITIGATION MEASURES

For each impact assessed, mitigation measures have been proposed to reduce and/ or avoid negative impacts and enhance positive impacts as included in Section 6. These mitigation measures are also incorporated into the EMP to ensure that they are implemented during the planning, construction and operational phases. The EMP (Annexure D) forms part of the Scoping Report, as such its implementation would become a binding requirement should this project be authorised.

There is a hierarchy of actions which can be undertaken to respond to any proposed project or activity. These cover avoidance, minimisation and compensation. It is possible and considered sought after to enhance the environment by ensuring that positive gains are included in the proposed activity or project. If negative impacts occur then the hierarchy follows the steps as indicated in Figure 25.



Impact avoidance: This step is most effective when applied at an early stage of project planning. It can be achieved by:

- not undertaking certain projects or elements that could result in adverse impacts;
- avoiding areas that are environmentally sensitive; and
- putting in place preventative measures to stop adverse impacts from occurring.

Impact minimisation: This step is usually taken during impact identification and prediction to limit or reduce the degree, extent, magnitude, or duration of adverse impacts. It can be achieved by:

- scaling down or relocating the proposal;
- redesigning elements of the project; and
- taking supplementary measures to manage the impacts.

Impact compensation: This step is usually applied to remedy unavoidable residual adverse impacts. It can be achieved by:

- rehabilitation of the affected site or environment, for example, by habitat enhancement;
- restoration of the affected site or environment to its previous state or better; and
- replacement of the same resource values at another location (off-set), for example, by wetland engineering to provide an equivalent area to that lost to drainage or infill.

Figure 25 | Hierarchy of mitigation

6 BIOPHYSICAL AND SOCIO-ECONOMIC BASELINE DESCRIPTION AND IMPACT ASSESSMENT

This section forms the focus of this EIA process as it describes the baseline of the proposed sites and contains a detailed assessment of the construction and operational impacts associated with the proposed project. Mitigation measures to enhance positive impacts and reduce negative impacts are described for each of the anticipated impacts.

This section describes the affected environment and the potential impacts on the biophysical and socio-economic environments, which may occur due to the proposed project and activities described in Section 4. These include potential impacts, which may arise during the operation of the proposed development as well as the potential construction related impacts as indicated in Table 34. These impacts on the biophysical and socio-economic environment were assessed, in terms of the methodology outlined in Section 5 and relevant mitigation measures have been proposed to reduce and/ or avoid negative impacts and enhance positive impacts.

It should be noted that the baseline description in this section describes the 100 ha portions originally considered at the start of the EIA process, as well as the surrounding area, but only assesses the impacts of the preferred 35 ha sites.

Table 34 | Anticipated impacts assessed in Scoping Report, as identified by stakeholders and the EIA team

Potential impacts	Assessments undertaken
Disturbance of flora, fauna and avifauna	• Ecology Impact Assessment by Environment and Wildlife Consulting considering fauna, flora and avifauna.
Impact on agricultural resources	• Assessment by Aurecon EIA team.
Impacts on surface water resources including sedimentation and erosion	• Assessment by Aurecon EIA team and Ecology Impact Assessment.
Impact on groundwater	• Assessment by Aurecon EIA team.
Impacts on heritage resources	• Heritage Impact Assessment by Quaternary Research Services.
Visual impacts	• Visual Impact Assessment by Visual Resource Management Africa.
Social impacts	• Social Impact Assessment by Digby Wells.
Noise and dust pollution	• Assessment by Aurecon EIA team.
Impact on energy production	• Assessment by Aurecon EIA team.
Increased traffic	• Desktop Assessment by Aurecon Transport Engineers.
Storage of hazardous substances onsite	• Assessment by Aurecon EIA team.
Impact of waste	• Assessment by Aurecon EIA team.
Impact on Climate change	• Assessment by Aurecon EIA team.
Cumulative impacts	• Assessment by Aurecon EIA team.

The assessment of potential impacts will help to inform and confirm the selection of the preferred alternatives to be submitted to MET: DEA for consideration, and will also determine the required

mitigation measures to be used to inform design and management of the project. In turn, MET: DEA's decision on the environmental acceptability of the proposed projects and the setting of conditions of authorisation (should the project be authorised by way of an ECC) will be informed by this section, amongst other information contained in this Scoping Report.

6.1 GENERAL DECRIPTION OF THE THREE SITES

6.1.1 Location

The **Hardap PV site** is located in the Hardap Region of Namibia, approximately 274 km southeast of Windhoek. Mariental is approximately 8 km to the northeast of the proposed Hardap PV site south of the M29 gravel road.

The **Omburu PV site** is located within the Erongo Region of Namibia, on the southeast corner of the Omaruru Townlands east of the C36 gravel road. The closest town, Omaruru, is located about 11 km to the north. Okahandja, located in the Otjozondjupa Region of Namibia, is the closest town to the proposed Osona PV site.

The proposed **Osona PV site** lies 3 km from Gross Barmen Hot Springs and approximately 19 km from Okahandja, south of the tarred M87 road.

6.1.2 Climate

Namibia receives approximately 300 days of sunshine per annum. Summer is from October to April and day time temperatures can reach up to 40 ºC. Average summer temperatures range from 20 ºC to 34 ºC. In winter, from June to September, average night time temperatures range from 6 °C to 10 °C and daytime temperatures range between 18 °C and 22 °C. The average annual rainfall varies from less than 50 mm along the coast to 350 mm in the central interior and 700 mm in the Caprivi. The rainy season is from October till April[5].

The **Hardap** Region receives relatively low levels of rainfall, with an annual precipitation between 59 mm to 339 mm, normally during the months of January to March. However, rainfall levels of from 17 mm up to 545 mm have been recorded. The mean potential evaporation is estimated at between 3 400 mm/annum and 3 600 mm/annum.

The average rainfall of the **Omburu** area ranges between 300 mm and 350 mm per annum, but variations of 179 mm and 587 mm have been recorded. Evaporation is estimated to be 3 000 mm/annum.

The average rainfall of the **Osona** in the Okahandja area is estimated at between 300 mm/annum and 400 mm/annum, with most of the rainfall events occurring during December to March. Variations ranging from 52 mm to 978 mm have been recorded. Some severe thunder storms during this period can cause intense flash floods down the river systems. The mean potential evaporation is estimated at between 3 000 mm/annum and 3 200 mm/annum.

[5] http://www.info-namibia.com/info/weather and http://www.weather-and-climate.com/average-monthly-Rainfall-Temperature-Sunshine-in-Namibia accessed on 22 May 2014.

6.1.3 Topography and surrounding landuses

The general topography of the proposed **Hardap** PV site is flat with an elevation ranging between 1 100 and 1 200 metres above mean sea level (mamsl). Figure 26 indicates that the gradient is flat with a slight westerly aspect. The topography is related to the Fish River which flows in a southerly direction to the east of the site at the town of Mariental. The cut back slopes from the river erosion have left a small escarpment, which is visible on the terrain model in Figure 26 below.

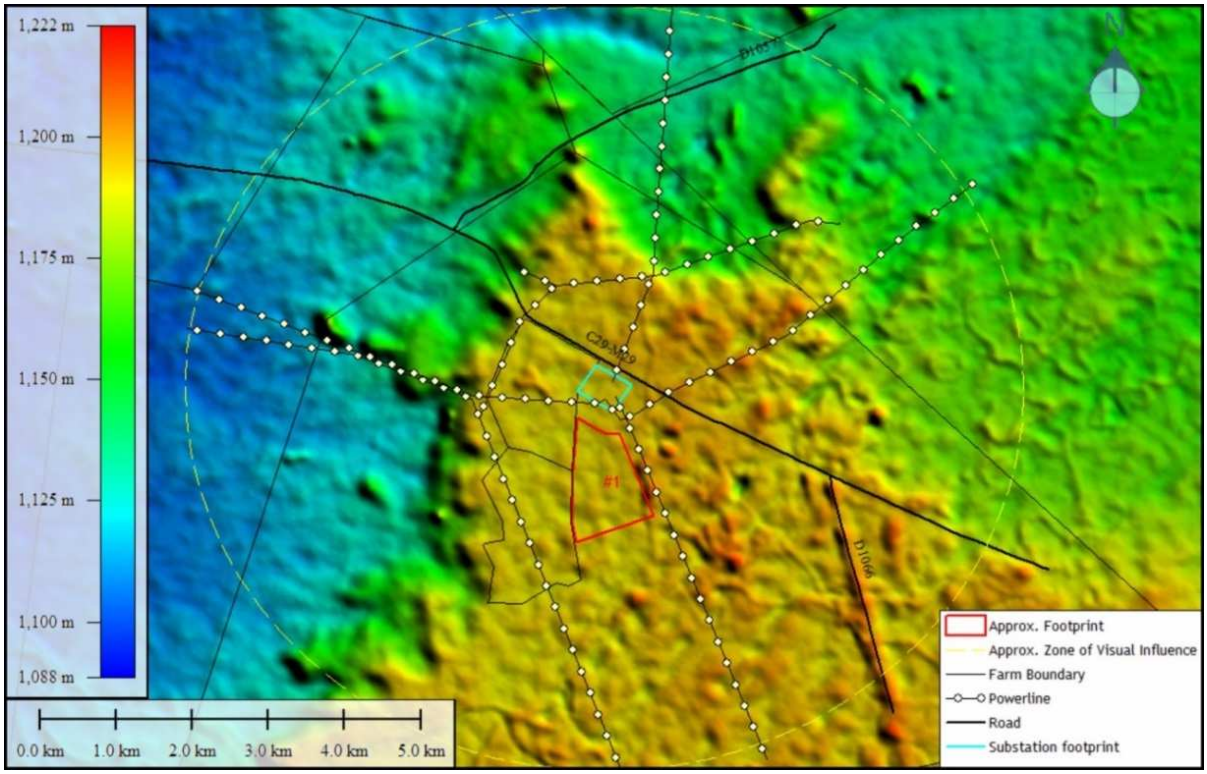


Figure 26 | Hardap site regional terrain model

The **Omburu** study area generally comprises undulating plains gradually decreasing in elevation from 1 280 mamsl, around the substation to 1 240 mamsl toward the west as indicated in Figure 27. Erongo Mountain, rises to the west of the area, with its two highest peaks at elevations of 2 216 mamsl (Erongo) and 2 319 mamsl (Hohenstein). The Omburu site has both a northern aspect and a southern aspect with a watershed between them. The only topographic feature of the site is the strong ridgeline which runs east to west through the site.

The topography of the **Osona** study area comprises undulating plains varying between 1 220 mamsl and 1 280 mamsl, with hills sharply rising to elevations of up to 1 631 mamsl toward the north. The area is a predominantly flat landscape with the Northern Erongo Mountains in the background to the north, and the Okakango and the Okamita river systems to the south defining the regional topography. The elevation of the site ranges from 1 240 mamsl to 1 280 mamsl as indicated in Figure 28. The site faces predominantly north with a slight gradient.

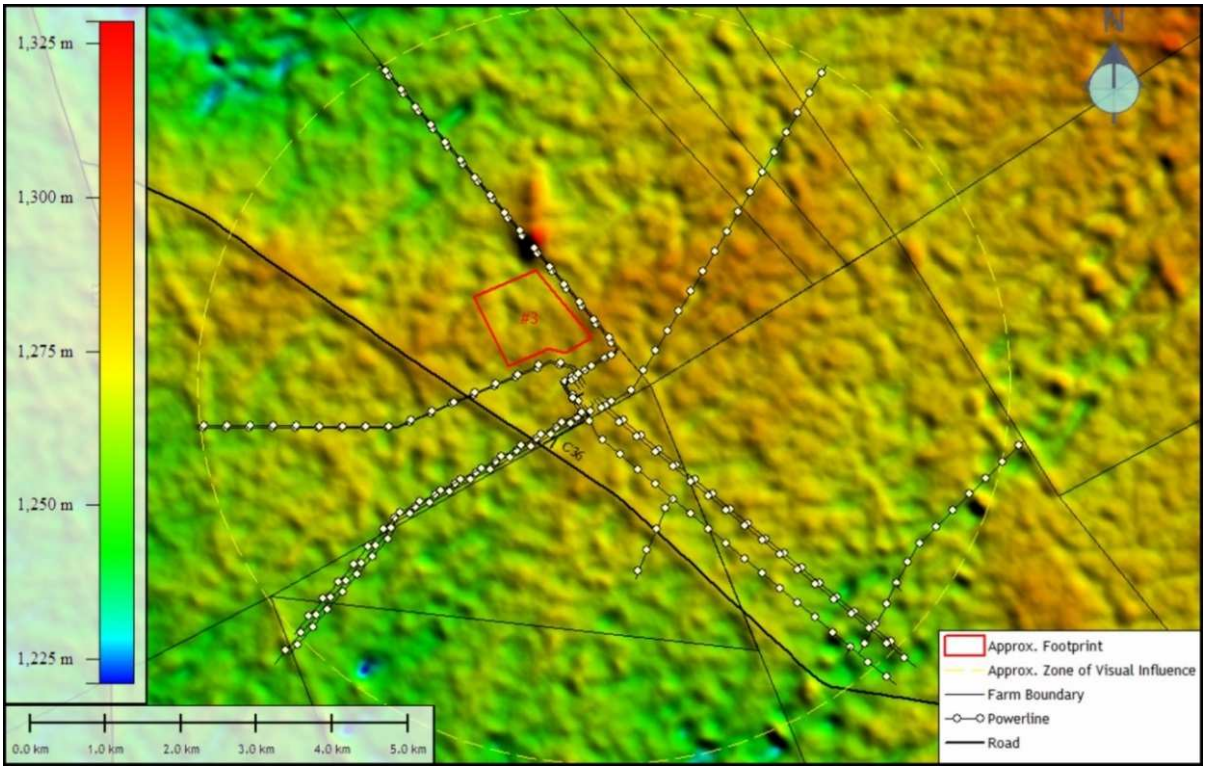


Figure 27 | Omburu regional terrain model

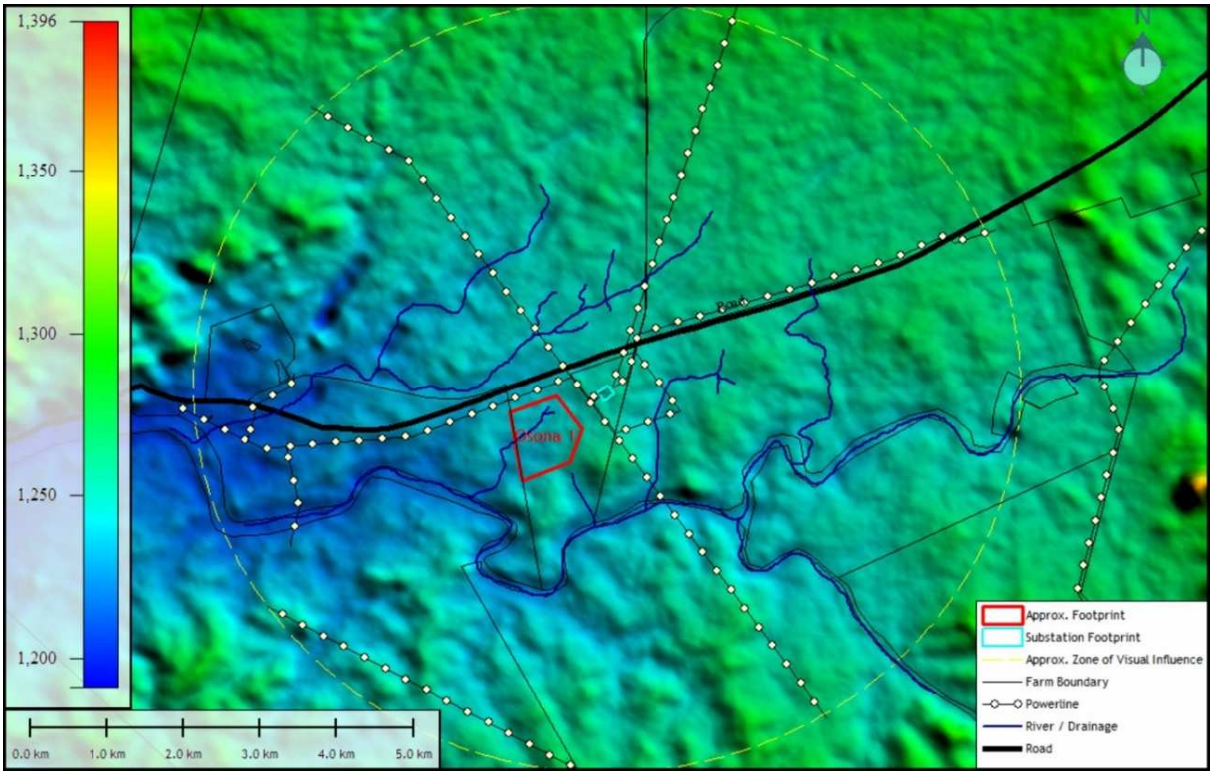


Figure 28 | Osona regional terrain model

6.1.4 Geology

Characteristics of the geomorphology of the **Hardap** study area are closely related to the geology, typically revealing the flat-lying Kalahari Group. The western parts of the study area form cliffs of the Weissrand Escarpment, where sandstone of the Nossob and Auob Members, basalt of the

Kalkrand Formation occur beneath calcrete deposits of the Kalahari Sequence. The Hardap Substation is located in an area covered by Tertiary to Quaternary sand, gravel, calcrete and calcrete-cemented conglomerate of the Kalahari Group.

The **Omburu** study area is underlain entirely by Salem granite, which intruded into the Damara Supergroup. To the north and northwest of Omaruru, outcrops of the Swakop Group consisting of marble bands, mica schist, calc-silicate rocks and quartzite, are overlain by mica schist and quartzite of the Kuiseb Formation occur. The Omburu Substation is located within the boundary area of the tectonostratigraphic zone of the Northern Central Zone and Southern Central Zone of the Damara Orogen. Miller reports that the Southern Central Zone contains numerous plutons of Damaran granites, the boundary between the northern and southern parts being the north east-trending Omaruru Lineament along which the lower Swakop Group rocks thicken rapidly northwards.

The **Osona** substation is located within the Okahandja Lineament Zone. This is a relatively narrow zone containing high-temperature low-pressure schists of the Kuiseb Formation and inter-fingering calc-silicate layers and marble bands of the passive margin Tinkas Formation (Swakop Group, Damara Supergroup) along its northern edge.

6.2 ECOLOGY (FLORA AND FAUNA) OF THE THREE SITES

The construction and operational phases of the proposed developments could potentially impact on the bio-physical environment, because of habitat destruction and disruption. An Ecological Impact Assessment was undertaken by Peter Cunningham of Environment and Wildlife Consulting Namibia to assess the potential impacts. The study was informed by a comprehensive literature review followed by a site survey from 3 to 5 March 2014. The findings and recommendations are summarised below and the full Ecological Impact Assessment is included in Annexure E1.

6.2.1 Description of the Biophysical Environment

6.2.1.1 Hardap PV facility

The vegetation type of the Mariental area could be described as Dwarf Shrub Savannah. The habitat is uniform with no unique features such as significant drainage lines and/or broken terrain (rocky ridges/outcrops).

Four percent of the tree/ shrub species found at the proposed Hardap PV site are protected species. The Dwarf Shrub Savannah is badly underrepresented, with 0 %-2 % coverage by the state protected area network. The Hardap Recreational Resort, 30 km northwest of Mariental, is the only protected area in the immediate vicinity. The only communal conservancies in the general area include Oskop and Huibes. The major wildlife resources in the Oskop and Huibes conservancies include kudu, oryx, ostrich, springbok and steenbok. No freehold conservancies are located in the general area.

South-central Namibia, in general, is regarded as “low” in overall (total) terrestrial diversity. This is also the case for Mariental with an estimated 50 to 99 species. The most dominant species in the area are *Catophractes alexandri* (taller grey spindly shrubs indicated with arrows) and *Leucosphaera bainesii* (short flowering shrubs) shown in Figure 29.

Figure 29 | *Catophractes alexandri* and *Leucosphaera bainesii*, as indicated by the white arrows, were the most dominant species in the area

The terrestrial endemism of plants in South-central Namibia is "low to average". For Mariental, plant endemism is very low with only one endemic species expected to occur in the general area. Mariental is therefore not viewed as a "hot spot" floristically and has the lowest species to area ratio of all the regions of Namibia with very few endemic species (less than 3 % of plants occurring in this region). At least 26 to 51 species of larger trees and shrubs (less than one meter in height) and at least 22 to 44 (64 species altogether) species of grasses occur in the general or immediate Mariental area, of which a moderate proportion are endemics.

The high percentage of endemic reptile species (39 %) associated with the general south-central part of Namibia underscores the importance of area. It is estimated that at least 64 species of reptile occurs in the Mariental area. Eight amphibian species are anticipated to occur in the area, but due to a lack of open surface water within the immediate vicinity of the proposed development site and the fact that none of the amphibians are exclusively associated with the proposed development site, the overall effect on amphibians on the immediate site is reduced. Sixty mammal species are expected to occur in the area with the most important mammal species being those classified as rare, namely the Angolan wing-gland bat (*Cistugo seabrae)*, Woosnam's desert rat (*Zeltomys woosnami)* and small spotted cat (*Felis nigripes*) under Namibian legislation and near threatened straw-coloured fruit bat (*Eidolon helvum)*, brown hyena (*Hyaena brunnea*) and leopard (*Panthera pardus*) and vulnerable cheetah (*Acinonyx jubatus)* and small spotted cat *(Felis nigripes*) by the IUCN (2013). Very little is known about *F. nigripes* as a carnivore in a sheep producing part of Namibia such as Mariental, but it could face unwarranted persecution. Other species of concern are the pangolin (*Manis temminckii*) and various bat species.

Of the 137 breeding resident bird species occurring in the Mariental area, the only endemic species known or expected is the Rosy-faced Lovebird (*Agapornis roseicollis*). Other important species include various raptors e.g. Martial eagle (*Polemaetus bellicosus*) and Tawny eagle (*Aquila rapax*), which are declining throughout Namibia.

The following plant species were identified onsite during the site assessment:

- A few individual protected tree species (4 %) were observed.

- *Anthephora argentea* and *Stipagrostis amabilis* are viewed as the most important grasses from the general area.
- Aloes are protected throughout Namibia with *Aloe hereroensis*, not included as a tree species, but also viewed as important. However, no Aloe species were observed during the site visit.
- Ferns in the general Mariental area include at least eight indigenous species and two endemic species. No endemic species were observed during the site visit.
- The only endemic herb namely *Barleria dinteri* observed during the site visit, occurs throughout Namibia (including Botswana, South Africa and Swaziland) and is not unique to the Mariental area.

6.2.1.2 Omburu PV facility

The Savannah Biome of which the Omaruru area forms part, is underrepresented in the protected area network in Namibia which covers 37 % of the land area, but only 7.5 % of the biome. Ephemeral rivers such as the Omaruru River and the general Erongo Mountains (located west of Omaruru) and western escarpment are viewed as sites of special ecological importance due to the biotic richness, large desert dwelling mammals and high value for human subsistence and tourism (ecosystem services). This biotic richness is mostly associated with the intersections of the rocky terrain and major ephemeral river courses in the area. The Omburu PV site has dense patches of *Acacia reficiens* (i.e. bush thickened/encroachment) and a drainage line to the north as indicated in Figure 30.

Figure 30 | *Stipagrostis uniplumis* in an *Acacia reficiens* dominated landscape in the Omburu area

The Omaruru area is not part of the communal conservancy system[6] in Namibia with the closest such conservancy being the #Gaingu Conservancy, west of the Erongo Mountains west of Omaruru. Some farms towards the south of Omaruru i.e. Wilhelmstal area belongs to the Okawi Conservancy which is part of the Freehold Conservancy system. No formally protected areas are located in the general Omaruru area. The closest protected areas are the Dorob National Park and

[6] Many of the wildlife populations have decreased due to human-wildlife conflict, and conservancies have attempted to address these concerns by compensating the farmers for their losses.

the Gross Barmen Hot Springs located approximately 150 km and 100 km to the west and south east, respectively.

The general Omaruru area is regarded as “average” in overall (total) diversity while the overall terrestrial endemism is “high”. The overall diversity and abundance of large herbivorous mammals (big game) is viewed as “high” with five to six species while the overall diversity of large carnivorous mammals (large predators) is determined as “average” with three species occurring.

It is estimated that at least 77 reptile, seven amphibian, 87 mammal and 217 bird species (mainly breeding residents), at least 79 to 110 larger trees and shrubs and up to 111 grasses are known to or expected to occur in the general Omaruru area of which a moderate proportion (especially reptiles at 44 %) are endemics.

The most important mammal species from the general area are as follows:

- those classified as rare under the Namibian legislation e.g. Angolan wing-gland bat (*Cistugo seabrai)* and hedgehog (*Atelerix frontalis angolae*) and vulnerable galago (*Galago moholi)*, aardwolf (*Proteles cristatus)*, brown hyena (*Hyaena brunnea)*, cheetah (*Acinonyx jubatus)*, small spotted cat (*Felis silvestris)*, bat-eared fox (*Otocyon megalotis)*, Cape fox (*Vulpes chama)* and giraffe (*Giraffa camelopardalis*).
- those classified as near threatened under Namibian legislation such as the straw-coloured fruit bat (*Eidolon helvum)*, Commerson’s leaf-nosed bat (*Hipposideros commersoni)*, striped leaf-nosed bat (*Hipposideros vittatus)*, brown hyena (*Hyaena brunnea)* and leopard (*Panthera pardus*) and vulnerable cheetah (*Acinonyx jubatus*) and by the IUCN (2013).
- The black mongoose (*Galerella nigrata*) is the only Namibian endemic carnivore known from the general Erongo Mountain area, making it another important species.

The high percentage of endemic reptile species (44 %) associated with the general area underscores the importance of the area. The most important reptiles in the area are viewed as the endemic Dwarf Python (*Python anchietae*), Namibian Wolf Snake (*Lycophidion namibianum*) and African Flat Gecko (*Afroedura africana*). As tortoises are viewed as the group of reptiles under most threat in Namibia, the Leopard Tortoise (*Stigmochelys pardalis*), known or expected to occur in the area, is another important species although is the most common and widespread species in Namibia.

The most important endemic amphibians from the general area are Hoesch’s pygmy toad (*Poyntonophrynus hoeschi*) and marbled rubber frog (*Phrynomantis annectens*), as well as the near threatened giant bullfrog (*Pyxicephalus adspersus*).

The most important endemic bird species known or expected to occur in the general area are viewed as Monteiro’s Hornbill (*Tockus monteiri*), Damara Hornbill (*Tockus damarensis*), Gray’s Lark (*Ammomanopsis grayi*), Herero Chat (*Namibornis herero*), Rüppell’s Korhaan (*Eupodotis rueppellii*), Rüppell’s Parrot (*Poicephalus rueppellii*) and various larger raptors (e.g. eagles and vultures).

The site assessment revealed the following:

- Only a few individual protected tree species (7 %) were observed in the Omburu PV area.
- A high percentage of perennial palatable grasses (29.3 %) were observed in the area.

- No Aloe species, endemic *Commiphora* or endemic fern species were observed during the site visit.
- No substantial lichen hotspots were observed.
- The near-endemic herb *Leucos pechuelii* was observed, but it occurs throughout Namibia and it is not unique to the Omaruru area.

6.2.1.3 Osona PV facility

The habitat at the Osona site is uniform with no unique features such as significant drainage lines and broken terrain (rocky ridges or outcrops). A large part of this area has been cleared of woody vegetation and can be considered to be already disturbed as indicated in Figure 31.

Figure 31 | Section of proposed area previously cleared with grasses now re-establishing

The Savannah Biome, of which the Gross Barmen area forms part, is underrepresented in the protected area network in Namibia, covering 37 % of the land area, but only 7.5 % of the biome. Although the Thornbush Savannah is not classified as an area of special ecological importance, certain features such as mountains, inselbergs (granite domes) and ephemeral drainage lines throughout this vegetation type are important. The Swakop River is viewed as a site of special ecological importance due to its high value for human subsistence and tourism.

The most important tree or shrub species occurring in the general area are *Cyphostemma bainesii* (endemic), *Cyphostemma currorii*, *Cyphostemma juttae* (endemic), *Erythrina decora* (endemic), *Heteromorpha papillosa* (endemic) and *Manuleopsis dinteri* (endemic). Aloes are protected throughout Namibia, with *Aloe hereroensis* and *A. zebrina* not included as a tree species, but also viewed as important.

The Gross Barmen area is not part of the communal conservancy system in Namibia with the closest conservancy being the Ovitoto Conservancy to the east of Okahandja. The closest Freehold Conservancies are the Okawi (farms to the west of Gross Barmen) and Khomas Hochland (farms to the south of Gross Barmen) Conservancies. The closest formally protected areas are the Gross Barmen Hot Springs and Von Bach Recreation Resort located approximately 1 km and 25 km to the west and east, respectively. The general Gross Barmen area is regarded as "average to high" in overall (all terrestrial species) diversity while the overall terrestrial endemism is "high". It is estimated that at least 78 reptile, nine amphibian, 85 mammal, 209 bird species (breeding residents), 79 to 110 larger trees and shrubs and up to 111 grasses are known to or expected to occur in the general Gross Barmen area of which a moderate proportion (especially reptiles at 36 %) are endemics.

Endemic reptile species known or expected to occur in the general Osona area make up 35.9 % of the reptiles from the general area. Reptiles of greatest concern are the Leopard tortoise (*Stigmochelys pardalis*) and Kalahari tent tortoise (*Psammobates oculiferus*) which are often consumed by humans. Anchietae's dwarf python (*Python anchietae*) and Southern African python (*P. natalensis*) are also of concern as they are indiscriminately killed throughout their range. Therock monitor (*Varanus albigularis*) as well as the various thick-toed gecko's (*Pachydactylus* sp.) of which 80 % are considered to be endemic to the Osona area and are also considered species of concern. Other important species are the blind snakes (*Rhinotyphlops* species of which two species in Namibia are endemic) and thread snakes (*Leptotyphlops* species of which one species is endemic). These could be associated with the sandier soils in the area. Of the nine species of amphibians expected to occur in the general Osona area, three species are of conservation value, with two species being endemic namely Hoesch's pygmy toad (*Poyntonophrynus hoeschi)* and marbled rubber frog (*Phrynomantis annectens*) as well as the giant bullfrog (*Pyxicephalus adspersus*), which is considered to be near threatened.

Central Namibia has between 161 and 200 endemic vertebrates (all vertebrates included). The overall diversity and abundance of large herbivorous mammals (big game) is viewed as "high" with seven to eight species while the overall diversity of large carnivorous mammals (large predators) is determined at three species. Of the 85 species of mammals expected to occur in the general Osona area, 5.9 % are endemic and 36.5 % are classified under international conservation legislation. The most important groups are rodents (12 % endemic), bats (4.5 % endemic) and carnivores (5.9 % endemic). The most important species from the general area, other than the endemic species, are probably all those classified as near threatened (straw-coloured fruit bat *Eidolon helvum*, striped leaf-nosed bat (*Hipposideros vittatus)*, Blasius's horseshoe bat (*Rhinolophus blasii)*, brown hyena (*Hyaena brunnea)* and leopard (*Panthera pardus*) and vulnerable cheetah (*Acinonyx jubatus)*, small spotted cat (*Felis nigripes)* and Hartmann's mountain zebra (*Equus zebra hartmannae*) by the IUCN (2013).

Ten of the 14 endemics birds to Namibia (i.e. 71 % of all endemics) are expected to occur in the general Osona area which underscore the importance of this area. Furthermore, 21 % are classified as southern African endemics (or 6 % of all the birds expected) and 79 % are classified as southern African near-endemics (or 23 % of all the birds expected). The most important species known or expected although not exclusively associated with the general Osona area are viewed as various larger raptors and vultures, Monteiro's hornbill (*Tockus monteiri*) and Damara hornbill (*Tockus damarensis*), Rüppells parrot (*Poicephalus rueppellii*), Rosy-faced lovebird (*Agapornis roseicollis*) and rockrunner (*Achaetops pycnopygius*), all of which breed in the general area, but not exclusively associated with the area.

The site assessment revealed the following:

- Only a few individual protected tree species (1 %) were observed in the area.
- A high percentage of perennial palatable grasses (50.6 %) were observed in the area. The most important grass expected in the area is the endemic *Setaria finite* associated with ephemeral drainage lines.
- Ferns in the general Osona area include at least 18 indigenous species. No endemic species were observed.
- No Aloe species, endemic Commiphora or endemic fern species were observed.
- No substantial lichen hotspots were observed during the site visit.
- The near-endemic herb *Leucos pechuelii* observed occurs throughout Namibia except the Namib Desert (including southern Angola) and is not unique to the Omaruru area.

6.2.2 Ecological Impact Assessment

Construction phase impacts anticipated for the three PV facilities

During the construction phase site specific destruction of vertebrate fauna, unique flora and special habitats will occur. The loss of habitat might also result in the potential spread of weeds and alien invader plants, fragmentation of the natural vegetation and the loss of protected species. All three of the proposed sites are fairly uniform and therefore the magnitude of the impacts at all three sites were considered to be low, of site specific extent and occurring for a short term duration and therefore of **low (-)** significance. With the implementation of the mitigation measures it can be reduced to **very low (-)** significance.

The magnitude of the impact of the proposed roads and transmission corridors at all three sites are considered to be low magnitude, of site specific extent and occurring for a short term duration and therefore of **low (-)** significance. With mitigation it could be reduced to **very-low (-)**. Although Hardap Road 1 and Hardap Road 2 are rated equally as per the above paragraph, Hardap Alternative Road 1 is slightly preferred as it follows an existing track and is therefore expected to have slightly less impact on the overall environment. Osona Road 1 and Osona Road 2 are also rated equally as per above paragraph, but Osona Alternative Road 2 is preferred as this follows an existing track and is therefore expected to have slightly less impact on the overall environment.

The new pylon infrastructures are to cover short distances between the existing substations and the proposed PV facilities. Short pylon routes in areas with numerous existing pylon infrastructure are not expected to add to the overall impact on pylon sensitive birds (i.e. the impact is already present), but longer new pylon routes are. The proposed transmission lines would range from 260 m to 760 m. The habitat loss for avifauna species and increased collision rates with pylon infrastructure are expected to impact on larger bird species particularly and would have a regional extent, high magnitude over long term. Therefore the significance is rated as **high (-)** without mitigation. With proper mitigation measures the magnitude of this impact could be low, but due to the regional scale and long term duration, this impact will have a **medium (-)** significance. This rating was the same for all three PV facilities proposed. **Medium (-)** significance is considered to be acceptable as the transmission lines would be relatively short in comparison to existing transmission lines and no critical issues are foreseen.

Operational phase of the three PV facilities

During the operational phase localised site specific destruction of vertebrate fauna (e.g. road kills; fence and pylon mortalities) may continue, together with the potential spread of weeds and alien invader plants. The magnitude of the impacts is considered to be medium, of regional extent with a

long term duration, and therefore of **high (-)** significance without mitigation. With mitigation measures this rating could be reduced to **low (-)**. This rating was the same for all three PV facilities proposed.

It is anticipated that animals would not be affected as much as avifauna and therefore the impact on avifauna was assessed separately. For impacts on avifauna, the habitat loss and increased collision rates with pylon infrastructure are expected to continue to a have a regional extent, high magnitude of long term duration. Therefore the significance is rated as **high (-)** without mitigation. With proper mitigation measures the magnitude of this impact could be low, but due to the regional scale and long term duration, this impact will have a **medium (-)** significance. This rating was the same for all three PV facilities and alternatives proposed. **Medium (-)** significance is considered to be acceptable as the transmission lines would be relatively short in comparison to existing transmission lines and no critical issues are foreseen.

Decommissioning phase of the three PV facilities

During the decommissioning phase site specific general disturbances will definitely occur as a result of the increased activity in the area. The decommissioning of the PV arrays could potentially provide ideal habitat for alien vegetation to establish onsite. These impacts are rated very low magnitude, site specific and certain to occur during the decommissioning period and are therefore rated as **very low (-)** significance with and without mitigation. This rating was the same for all three PV facilities and alternatives proposed.

The magnitude of the impact of the proposed roads and transmission corridors at all three sites are considered to be very low, of site specific extent and occurring during the decommissioning phase, and therefore of **very low (-)** significance with mitigation. Hardap Road 1 and Osona Road 2 are slightly preferred as the decommissioning impact would have slightly less impact on the overall environment.

No impacts to avifauna are expected during the decommissioning phase as infrastructure would be removed from the site thereby eliminating the potential for collisions.

6.2.2.1 Cumulative impacts

Assessment of cumulative impacts includes an assessment of the impacts of the proposed projects (including all proposed alternatives) taken in combination with the impacts of other known projects (including a 4.5 MW PV project approximately 1.5 km from the proposed Osona PV site) for the area or secondary impacts that may arise from changes in the social, economic or ecological environment.

Given that the vegetation found on all sites are not of high importance or sensitivity and is widespread, the cumulative impacts on vegetation are not considered to be significant. Although additional transmission lines will add to the total transmission network being constructed throughout Namibia, these additional lines are limited in number and length and are not considered to add significantly to the impacts on a cumulative basis from the proposed PV facilities.

6.2.2.2 'No-go' alternative

The 'No-go' option is the baseline (i.e. current situation continue) against which the various impacts are compared. For all three proposed PV facilities the 'No–go' alternative is considered to have a **neutral** significance as agricultural activities will continue.

6.2.3 Mitigation Measures

The following mitigation measures are proposed, for all three projects and all alternatives, to mitigate the ecological impacts, namely the loss of natural vegetation; the disturbance or mortality of fauna and the potential spread of weeds and alien invader plants throughout the project lifecycle:

- Avoid development and associated infrastructure in sensitive areas e.g. ephemeral drainage lines and associated riparian vegetation, rocky ridges (broken terrain).
- Implement maximum speed limits (e.g. 40 km/h) as this would result in fewer faunal road mortalities and associated dust pollution problems. Temporary speed humps could also be used to limit the speed at which people travel.
- No off road driving shall be allowed.
- Limit construction to daylight hours. Where extended hours are required this must be approved by the engineer and focused lighting must be used for least impact.
- Identify and demarcate (e.g. with red and white tape) protected and unique plant species (i.e. *Acacia erioloba, Albizia anthelmintica, Boscia albitrunca, B. foetida, Faidherbia albida, Parkinsonia africana, Ziziphus mucronata* before the commencement of construction activities. These species should be avoided if possible, or a permit should be applied for the removal thereof[7].
- Prevent the planting of potentially alien invasive plant species (e.g. *Tecoma stans, Pennisetum setaceum*, etc.) for ornamental purposes (e.g. around offices, etc.) should this be thought necessary. Alien species often “escape” and become invasive causing further ecological damage. Incorporate indigenous vegetation (especially the protected species – i.e. *A. erioloba, Albizia anthelmintica, B. albitrunca, B. foetida, Faidherbia albida, Parkinsonia africana, Ziziphus mucronata*) into the developments.
- Implement a policy of “no tolerance” towards the existing invasive alien plant species (i.e. *Prosopis* sp.) in the area. Physical remove and destroy these species on a continued basis within the proposed sites. Such activity would be beneficial to the overall ecology of the areas.
- Prevent and discourage the collecting of firewood as dead wood has an important ecological role, especially during the development phase(s). Such collecting of firewood, especially for economic reasons, often leads to abuses e.g. chopping down of live and/or protected tree species such as *A. erioloba* which is a good quality wood.
- Prevent and discourage the setting of snares (poaching), illegal collecting of veld foods (e.g. tortoises), indiscriminate killing of perceived dangerous species (e.g. snakes) and the collection of wood as this would diminish and negatively affect the local fauna, especially during the construction phase(s).
- Initiate a suitable and appropriate refuse removal policy as littering could result in certain animals becoming accustomed to humans and associated activity and result in typical problem animal scenarios e.g. baboon, black-backed jackal.
- Do not use electric fencing, reaching ground level, around the PV sites as these fences can result in the mortality of numerous species. Should electric fencing be used then the first 50 cm from ground level should not be electrified to prevent accidental mortalities.
- Prevent and discourage fires especially during the construction phase(s) as this could easily cause runaway veld fires.

[7] To obtain a permit application would typically take one month.

- Rehabilitation of the disturbed areas i.e. initial development access route “scars” and associated tracks, construction activities, especially excavation sites should be conducted during and directly after the construction phase. Rehabilitation should include the removal of all construction waste, ripping of temporary tracks and construction sites and topsoil replacement in construction areas should these be extensive. Rehabilitation should be performed to the satisfaction of the Environmental Control Officer (ECO).
- Prevent domestic pets from accompanying workers during the construction phase as pets can cause considerable damage to local fauna. Cats also interbreed and transmit diseases to the indigenous African Wildcat found in the area. The indiscriminate and wanton killing of the local fauna by such pets should be avoided at all cost.
- Initiate a policy of capture and removal of fauna (e.g. slow moving species such as tortoises and chameleon) encountered serendipitously within the construction areas. Such fauna should be removed and taken to other areas with similar habitat.
- Initiate a policy against the illegal removal of unique flora (e.g. all Aloe species, etc. that may be encountered prior to and during construction) within the proposed construction areas. Such flora should be removed to other areas of similar habitat in the area or stored (cared for in onsite nursery conditions) and replanted as part of the overall natural landscaping.
- Avoid the use of herbicides and rather use manual cutting/pruning/clearing of vegetation. This should assist with re-establishment of perennial grasses, which would favour eventual rehabilitation of the area. Do not clear cut the area as this could lead to soil erosion and related problems and topsoil loss, but rather only clear the tree/shrubs hampering development activities.
- Investigate the option of using grazing animals i.e. sheep during/after the growing season to keep vegetation manageable and reduce biomass. Proper veld management should be encouraged based on the rainfall, regrowth and numbers of sheep. It is advised that the area be rested for at least two seasons to get the perennial grasses established before grazing commences. Heavy grazing regime during or after growth season (between November and March) should keep grass short throughout.
- Should grazing be unsuccessful, the use of herbicide could be considered and investigated by an ecologist. Application procedures should cover at least the application frequency, quantity and type of herbicide to use.
- Maintain a firebreak, at least 6 m wide, around the perimeter to prevent fire from spreading.
- Educate and inform contractors on dangerous and protected species to avoid and the consequences of illegal collection of such species.
- Employ a qualified ECO during the construction phase to ensure the appropriate management of the wildlife and ecological processes. This would ensure proper management.

The following mitigation measures are specifically recommended to protect avifauna:

- Attach coils/ flappers to new above ground pylon routes longer than 100 m to increase visibility and prevent further bird mortalities. The number of coils and the distances apart shall be confirmed once detailed designs have been undertaken.
- If nesting on pylon structures become problematic, “dummy poles” could be erected for species such as sociable weaver.

Additional construction phase mitigations for birds are not required as activities generally result in birds avoiding the area. The mitigation measures listed above are relevant to all three of the proposed PV facilities and associated infrastructures, for all alternatives.

6.2.4 Ecological Impact Table

Table 35 indicates the significance of the various ecological impacts and how these were derived.

6.2.5 Ecological summary

The Hardap Site, Osona Site and Omburu Site along with the transmission corridors are suitable for PV development purposes as these areas do not have any vertebrate fauna (i.e. amphibians, birds, mammals and reptiles) and flora (i.e. larger tree/shrubs and grasses) exclusively associated with the proposed areas and no significantly unique habitats such as drainage lines and rocky areas occur within the project footprint. As such, the significance of the potential impacts, after mitigation, are considered to be acceptable.

In the case of the alternative access roads no difference in significance was found, however the following are slightly preferred, though the other alternatives are also acceptable:

- Hardap site: Hardap access road 1.
- Osona site: Osona access road 2.

6.3 AGRICULTURAL RESOURCES OF THE THREE SITES

The clearing of the site during construction could result in soil erosion by wind and water. Soil erosion causes land degradation and a reduction in agricultural potential. The major issues surrounding soil erosion are the loss of the top soil layer required for plant growth, reduction of soil nutrients, siltation of aquatic systems as well as the general land and ecosystem degradation. In addition to soil degradation, the direct loss of 35 ha of agricultural area per PV facility is also an impact and was assessed by the Aurecon EIA team.

6.3.1 Description of the Environment

6.3.1.1 Agricultural potential for crop production (for Hardap, Omburu and Osona areas)

Climate, geology, soils, terrain, land capability, current agricultural practices and agricultural potential all affect agricultural potential and hence are described below.

Climate

Climate of the proposed study areas are described in Section 6.1.2. However, as the Mean Annual Precipitation (MAP) is relevant to determine the agricultural potential, it is repeated here for ease of reference. The average MAP for the Hardap area is approximately 199 mm per year, 325 mm per year for Omburu and approximately 515 mm per year for Osona area. Considering that 500 mm is the minimum amount of rain required for sustainable dry land farming, the average MAP of 199 mm is extremely low. Therefore without some form of supplementary irrigation, natural rainfall for the Hardap area is insufficient to produce sustainable harvests. This is reflected in the lack of dry land crop production within the area.

Table 35 | Assessment of ecological impacts for the all three sites

Phase	Project	Key impacts	Mitigation	Extent	Magnitude	Duration	SIGNIFICANCE	Probability	Confidence	Reversibility
Construction	All three PV facilities	Destruction of vertebrate fauna	Without Mitigation	Site specific	Low	Short term	Low (-)	Definite	Certain	Reversible
			With mitigation	Site specific	Very low	Construction period	Very low (-)	Definite	Certain	Reversible
		Loss of unique flora and special habitats as a result of access road alternatives and transmission corridors	Without Mitigation	Site specific	Low	Long term	Low (-)	Definite	Certain	Irreversible
			With mitigation	Site specific	Very low	Construction period	Very low(-)	Definite	Certain	Reversible
		Habitat loss and pylon infrastructure potentially increase collision rates with bird species	Without Mitigation	Regional	High	Long term	High (-)	Probable	Sure	Irreversible
			With mitigation	Regional	Low	Long term	Medium (-)	Probable	Sure	Reversible
Operational	All three PV facilities	Destruction of vertebrate fauna (e.g. road kills; fence and pylon mortalities)	Without Mitigation	Regional	Medium	Long term	High (-)	Definite	Certain	Irreversible
			With mitigation	Site specific	Low	Long term	Low (-)	Definite	Certain	Reversible
		Pylon infrastructure potentially increase collision rates with bird species	Without Mitigation	Regional	High	Long term	High (-)	Probable	Sure	Irreversible
			With mitigation	Regional	Low	Long term	Medium (-)	Probable	Sure	Reversible
Decommissioning	All three PV facilities	Provide ideal habitat for alien vegetation to establish	Without Mitigation	Site specific	Very low	Decommission period	Very Low (-)	Probable	Certain	Reversible
			With mitigation	Site specific	Very low	Decommission period	Very Low (-)	Probable	Certain	Reversible
		Access road alternatives and transmission corridor	Without Mitigation	Site specific	Low	Long term	Low (-)	Definite	Certain	Irreversible
			With mitigation	Site specific	Very low	Construction period	Very low (-)	Definite	Certain	Reversible
		Impact on Avifauna	No impacts anticipated							
'No–go' Option		No further disturbance of area	NA	Site specific	Zero	Long term	Neutral	Unlikely	Unsure	NA

Slope

As mentioned in Section 6.1.3, the Hardap area is relatively flat. The Omburu and Osona study areas comprises undulating plains. The slope of the sites would not be a limiting factor in terms of agriculture potential as a slope of less than 10 % is considered feasible.

Land use

The areas proposed for PV development are currently used for small stock grazing, game farming with servitudes across the sites. No crops are produced on these sites.

Soils

Figure 32, Figure 33 and Figure 34 indicates the dominant soil types of the respective areas as well as the potential for crop cultivation.

As indicated Figure 32, the dominant soil in the Hardap area is petric calcisols. Calcisol is soil with a substantial secondary accumulation of lime and is common in arid and semi-arid environments[8]. Petrocalcic horizons tend to be shallow which limits the suitability for agriculture as confirmed by the soil potential indicated in Figure 32.

The dominant soil for the Omburu area is eutric regosols, which are soils with no significant profile development. As indicated in Figure 33, the potential for crop production is moderate.

The dominant soil at Osona area is a mixture of eutric regosols and lithic leptosols. Leptosols are shallow soil over hard rock or highly calcareous material. The deeper soil tends to be extremely gravelly and/or stony making it unattractive for rainfed agriculture, because of the inability to retain water[9].

Agricultural potential

By taking all the site characteristics (climate, geology, land use, slope and soils) into account, the agricultural potential for each of the proposed sites is considered to be low for crop production. This agricultural potential rating is primarily due to low rainfall and soil characteristics.

6.3.1.1 Grazing potential (for Hardap, Omburu and Osona areas)

The grazing potential is fairly high for the Hardap area. The average plant production is medium to low with low to medium (5 % to 15 %) variation in green vegetation biomass depending on the location. Grasses are varied with various *Stipagrostis* species characteristic of most of the area as indicated in Figure 35. The most palatable species are *Anthephora pubescens*, *A. ramosa*, *Digitaria eriantha*, *Panicum arbusculum* and *Setaria appendiculata* (Cunningham, 2014).

[8] http://en.wikipedia.org/wiki/World_Reference_Base_for_Soil_Resources accessed on 28 May 2014
[9] http://en.wikipedia.org/wiki/Leptosols accessed on 28 May 2014

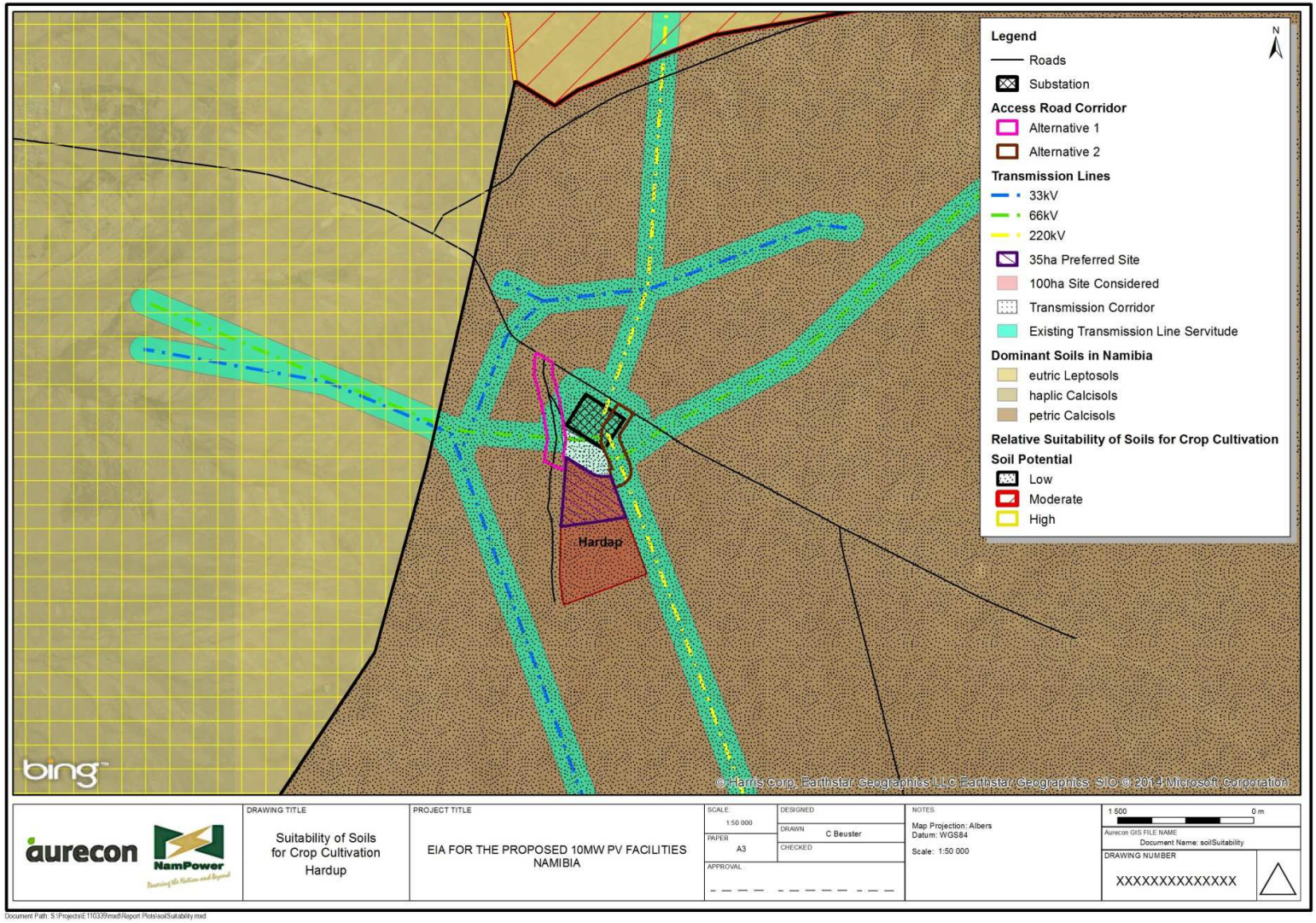


Figure 32 | Dominant soil types and the potential for crop cultivation of the Hardap site[10]

[10] All soil maps sourced from http://www.uni-koeln.de/sfb389/e/e1/download/atlas_namibia/e1_download_physical_geography_e.htm#dominant_soils. Accessed on 22 May 2014.

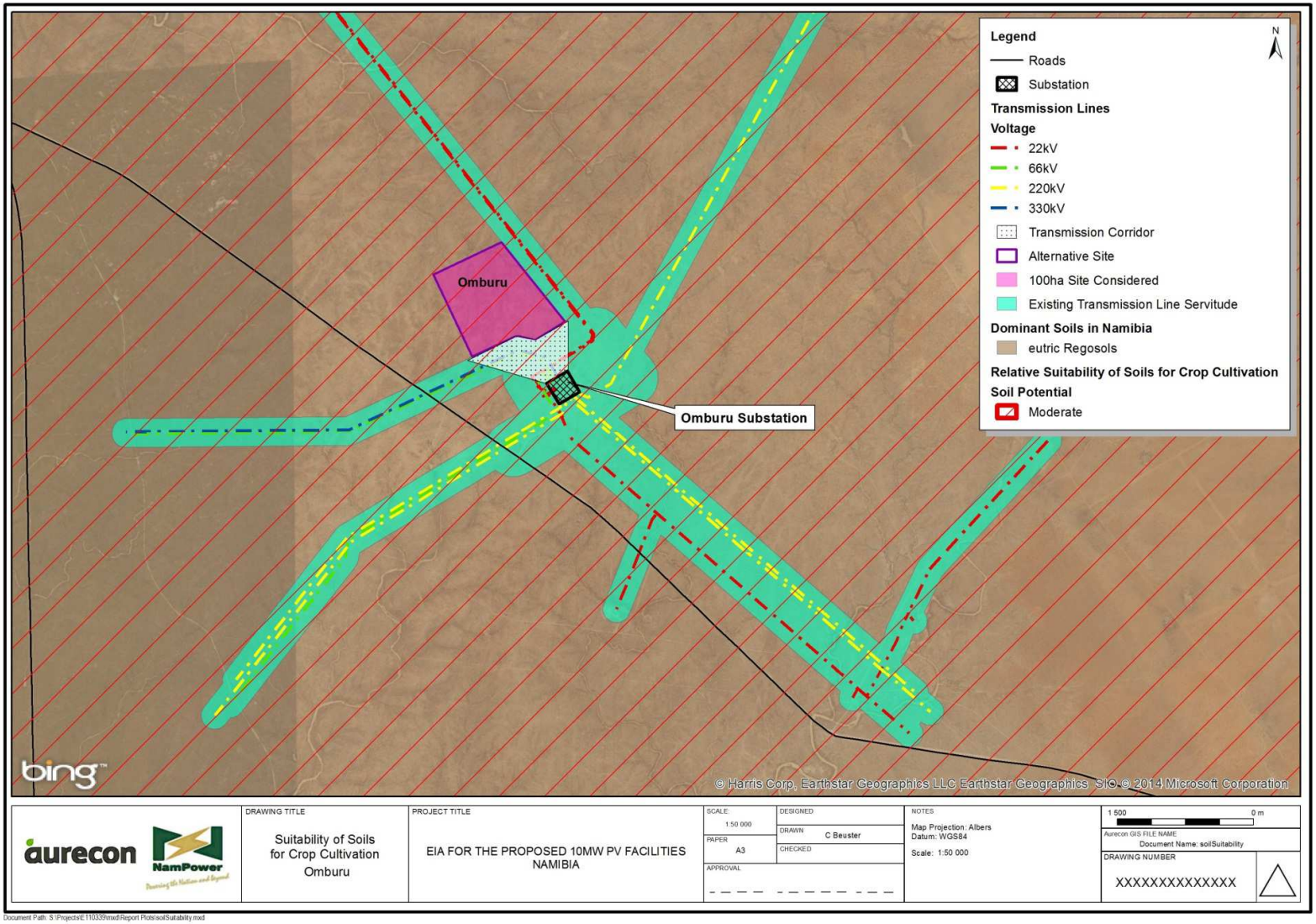


Figure 33 | Dominant soil types and the potential for crop cultivation of the Omburu site

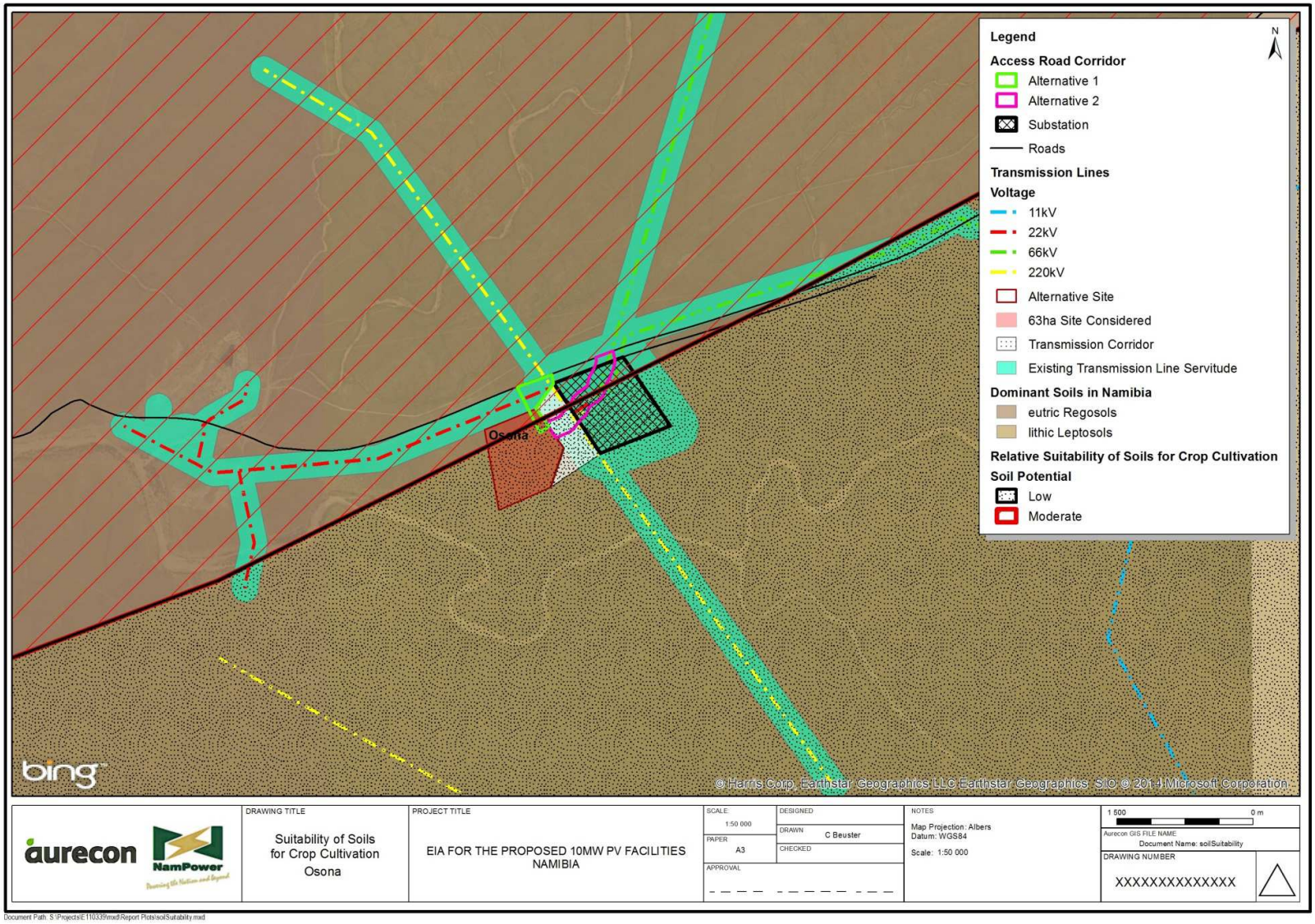


Figure 34 | Dominant soil types and the potential for crop cultivation of the Osona site

Figure 35 |*Stipagrostis uniplumis* perennial palatable tuft-forming species (Cunningham, 2014)

The average plant production and the variation thereof at Omburu, are viewed as medium (10 % to15 % depending on the locality). The availability of hardwoods is low, whilst availability of browse and graze is average. Bush thickening (encroachment) is dominated by *A. reficiens* in the general area with a common density of 2 000 to 3 000 plants per ha. During the site visit, a high percentage of perennial palatable grasses (29.3 %) were observed in the Omburu site area. Large areas are barren of grasses due to overgrazing and bush thickening (see Figure 36).

Figure 36 | Red umbrella-thorn (*Acacia reficiens*) were one of the most dominant species in the Omburu area

A high percentage of perennial palatable grasses (50.6 %) were observed in the Osona area. Species with commercial potential that could occur in the general Osona area include *Harpagophytum procumbens* (Devil's claw), harvested for medicinal purposes and often over-

exploited, and *Citrullus lanatus* (Tsamma melon) which potentially has a huge economic benefit[11]. No *H. procumbens* and only *C. lanatus* were observed. The availability of hardwoods can be considered to be low to moderate and grazing and browsing as average to good in the general area.

6.3.2 Agricultural Impact Assessment

The primary impact on agricultural activities of the proposed developments includes the clearing of vegetation and potential levelling of the site. This would effectively eliminate the impacted land's agricultural potential in terms of crop production (or in this case, grazing) during the construction phase, and would continue until decommissioning. However, the construction of the PV facilities would influence an insignificant portion of the farms total area (less than 1 % of the total area) as indicated in Table 36. The remaining land would continue to function as it did, prior to the development.

Table 36 | Summary of the layout alternatives indicating the development and remaining footprint area

PV facility	Total Footprint (ha) and Remaining land (ha)	% of land remaining undeveloped
Hardap PV facility	Total farm size: 1 214 906 ha (Remaining land: 1 214 871 ha)	99 %
Omburu PV facility	Total footprint: 93 106 ha (Remaining land: 93 071)	99 %
Osona PV facility	Gross Barmen Total footprint: 666 447.2 ha (Remaining land: 666 412.2 ha) Portion 85 of Osona Commonage Total footprint: 122490.4 ha (Remaining land: 122455.4 ha)	99%

Construction phase impacts anticipated for the three PV facilities

The loss of agricultural land and potential degradation of soil resources during the construction phase for the PV facilities (all alternatives and associated infrastructure), are considered to be of low magnitude, site specific extent and long term and therefore of **low (-)** significance without mitigation. The significance of this impact could be reduced to **very low (-)** with mitigation.

Operational phase of the three PV facilities

There would be no operational phase impacts on agriculture.

Decommissioning phase of the three PV facilities

The potential impacts associated with the decommissioning phase are associated with the removal of structures and rehabilitation that could create habitat for invader alien plant species. This impact

[11] The fruits are mostly used as fodder, but also for the production of citron peel or pectin. The makataan is used for making jam or preserve and can also be pickled. (http://www.plantzafrica.com/plantcd/citrullanat.htm Accessed on 27 May 2014)

is considered to be of very low magnitude, site specific extent expected to be restricted to the decommissioning phase and therefore of **very low (-)** significance with and without mitigation.

6.3.2.1 Cumulative impacts

The remainder of the farms will continue to be used for agricultural purposes or as servitudes. Therefore the areas to be impacted on are insignificant in the greater scheme of things. Apart from a 4.5 MW PV project approximately 1.5 km from the proposed Osona PV site, there are no major developments currently being undertaken within close proximity to the study areas that would result in impacts to unaffected agricultural land and therefore no cumulative impacts are anticipated. Although the 4.5 MW PV project near Osona would add to cumulative impacts this is not considered to be a significant cumulative impact given the vast agricultural area around the site.

6.3.2.2 'No-go' impacts

The 'No-go' impact would allow the *status quo* to continue and the impact would be considered **neutral** as magnitude would be considered zero meaning natural and/ or social functions and/ or processes remain unaltered.

6.3.3 Mitigation measures

The following generic mitigation measures are recommended for the potential impact on agriculture:

- Normal agricultural activities shall continue in unaffected areas.
- Stocking rates shall be temporarily reduced during the construction phase in order to reduce the risk of overgrazing of the remaining land portions.
- Land rehabilitation and re-vegetation shall commence immediately upon completion of construction and/ or decommissioning. It is recommended that areas around roads, stockpiles and PV panels are visually monitored for signs of erosion during audits. A photographic record of the onsite conditions will also aid in the identification of erosion problems. This photographic record is to be undertaken on a quarterly (3 month) basis.
- The soil erosion monitoring and management plan included in the EMP shall be implemented.
- More palatable species shall form part of the re-vegetation plan to enable faster stocking initiation.
- Use grazing to control vegetation within the sites instead of herbicides, during operation.
- Prevent and discourage fires especially during the construction phase as this could easily cause runaway veld fires (especially as large areas currently have a good grass biomass due to the lack of stock farming activities) affecting the local fauna, and also cause problems (e.g. loss of grazing and domestic stock mortalities, etc.) for the neighbouring farms.

6.3.4 Agricultural Impact Table

Table 37 indicates how the significance ratings of the agricultural impacts were derived.

Table 37 | Assessment of agriculture impacts

Project	Key impacts	Mitigation	Extent	Magnitude	Duration	SIGNIFICANCE	Probability	Confidence	Reversibility
All three PV facilities	Construction phase	Without Mitigation	Site specific	Low	Long term	Low (-)	Definite	Sure	Irreversible
		With mitigation	Site specific	Low	Construction phase	Very low (-)	Definite	Sure	Reversible
	Operational phase	No impacts anticipated							
	Decommissioning phase	Without Mitigation	Site specific	Very low	Short term	Very low (-)	Probable	Sure	Reversible
		With mitigation	Site specific	Very low	Short term	Very low (-)	Probable	Sure	Reversible
	'No–go' Option	NA	Site specific	Zero	Long term	Neutral	Unlikely	Unsure	NA

6.3.5 Agricultural summary

All three PV facilities and all alternatives can proceed from an agricultural perspective as none of the proposed sites are considered to have high agricultural potential and the impacts on agriculture are considered to be acceptable.

6.4 SURFACE WATER RESOURCES OF THE THREE SITES

The proposed PV facilities could impact on freshwater features due to the nature of the construction activities. Clearing of vegetation during the construction phase could result in erosion of the freshwater channels near the proposed construction areas. An increase in erosion could lead to sedimentation increasing the turbidity of water features. The disturbance of the site by means of compaction of the soils would also impact on the surface and subsurface water flow on the site. The impacts were assessed by the Aurecon EIA team and are provided below.

6.4.1 Description of the Environment

The Fish River flows to the north of the proposed Hardap site. Only a small portion of the western part of the study area falls within the catchment of the Fish River Basin. There are no prominent surface water features within the 35 ha footprint and the drainage of the area consists primarily of ephemeral surface streams. The project footprint is located in close proximity to the existing NamPower's Hardap Sub-station (see Figure 63). The land on which the project is to be located is vacant and privately owned land, currently zoned for agricultural purposes. The property on which the proposed project site is located is currently used for commercial game farming. Game kept on the property includes springbuck, oryx (gemsbok), eland, and zebra. The proposed footprint (35 ha) comprises just less than 1 % of the property on which it is located.

The proposed site for the Omburu PV facility is located on the water divide of the Omaruru River Basin and the Swakop River Basin. The south flowing streambeds in the area flow into the Kahn River which is a main tributary of the Swakop River, whereas the north flowing streambeds end up in the Omaruru River nearby. There are two prominent drainage lines to the north of the proposed site, one of which is visible in Figure 37.

Figure 37 | Dry riverbed of drainage line north of the proposed site

The Osona study area lies just north of the Swakop River. Main tributaries of the Swakop River in the area are the ephemeral Otjiseva River, draining most of the catchment around Windhoek in the south, and the Waldau River which drains a limited area to the north. Surface drainage of the study area is westward towards the Swakop River.

6.4.2 Groundwater Impact Assessment

Hardap, Omburu and Osona PV facilities, including associated infrastructure (all alternatives), are expected to have limited impacts on surface water features as the prominent drainage lines, together with a buffer of 100 m, were excluded from the 35 ha development areas. However residual impacts, such as erosion and sedimentation, are likely to occur if the site is not properly designed, constructed and decommissioned.

Construction phase impacts anticipated for the three PV facilities
As no prominent surface water features are located in close proximity to the proposed development area the potential impacts during the construction phase were rated as very low magnitude, site specific extent and limited to the construction phase and therefore of **very low (-)** significance with and without mitigation.

Operational phase of the three PV facilities
The impacts associated with the operational phase are considered to be of very low magnitude, site specific extent with long term respectively and therefore of **very low (-)** significance with or without mitigation.

Decommissioning phase of the three PV facilities
The impacts associated with the decommissioning phase is considered to be of low magnitude, local extent with short term duration and therefore of **low (-)** significance without mitigation. The significance of this impact could be reduced to **very low (-)** with mitigation.

6.4.2.1 Cumulative impacts

Although there are no major projects affecting undisturbed areas underway in close proximity to the proposed sites, any additional clearing of vegetation could result in change of land cover which could be alter the flow, water quality and habitat of the streams. The proposed activities are outside of the identified surface drainage features and provided the construction and operation activities of the project remain contained within the allocated areas, the overall cumulative impact should be limited and of a very low if not negligible significance. Although a 4.5 MW PV project is proposed approximately 1.5 km from the proposed Osona PV site, the EIA required for such a project would limit the cumulative impacts to acceptable levels.

6.4.2.2 'No-go' development

The 'No–go' impact would allow the *status quo* to continue and the impact would be considered **neutral** as magnitude would be considered zero meaning natural and/ or social functions and/ or processes remain unaltered.

6.4.3 Mitigation measures

The following mitigation measures are proposed for the construction phase for all three projects and alternatives:

- A buffer of 100 m shall be maintained adjacent to the identified streams.
- Should construction activities for the proposed infrastructure need to take place within the drainage features (i.e. linear development including roads and transmission lines) it should transect the streams at right angles and be limited as far as possible to ensure minimum disturbance of this area.
- Disturbed areas shall be rehabilitated as soon as possible after construction has been completed and revegetated with suitable indigenous vegetation.
- Disturbed areas shall be visually monitored every three months and kept free of invasive alien plant growth and to ensure that these areas do not become subject to erosion. Any regrowth of invasive alien plants should be removed.
- Rubble, sand and waste material resulting from the construction activities shall not be disposed of in any stream and drainage channels as it will impede on the flow in these channels.
- Contaminated runoff from the construction site shall be prevented from entering the streams.
- All materials on the construction site shall be appropriately stored and contained.
- Construction workers shall be provided with ablution facilities at the construction site which are located at least 100 m away from the river systems or freshwater features and regularly serviced.
- Should stormwater infrastructure be required, a management plan must be in place to ensure as a minimum that the structures are visually monitored after large rainfall events to ensure that blockages or eroded areas do not develop.
- A decommissioning plan shall be drawn up and approved that addresses the removal of the PV facilities and infrastructure post operation phase. The decommission plan should address aspects such as monitoring and management of invasive alien plants and erosion of the site after the activities on the sites are complete.

6.4.4 Surface water Impact Table

Table 38 indicates how the significance ratings of the surface water impacts were derived.

6.4.5 Surface water summary

There is no preference between the different alternatives and all alternatives are suitable.

6.5 GROUNDWATER FEATURES OF THE THREE SITES

A Hydrogeological desktop assessment was compiled by Karst Hydrogeological Consultants in order to determine the potential impacts on groundwater and to determine the feasibility of groundwater abstraction. A total volume of 483 466 ℓ of water would be required, over a period of 18 months (on average 895 ℓ per day), for the construction of each 10 MW facility. The projected annual water requirement for operational purposes at each facility is given as 46 400ℓ. The desktop survey determined the groundwater resources available in a 5 km radius surrounding each site and whether there is sufficient groundwater available for construction and operation of the proposed PV facilities. The findings and recommendations are provided below and the full report is included in Annexure E2.

Table 38 | Assessment of surface water impacts

Project	Key impacts	Mitigation	Extent	Magnitude	Duration	SIGNIFICANCE	Probability	Confidence	Reversibility
All PV facilities	Construction phase- disturbance to surface water features	Without Mitigation	Site specific	Very low	Construction phase	Very low (-)	Definite	Sure	Irreversible
		With mitigation	Site specific	Very low	Construction phase	Very low (-)	Definite	Sure	Reversible
	Operational phase	Without Mitigation	Site specific	Very low	Long term	Very low (-)	Probable	Sure	Irreversible
		With mitigation	Site specific	Very low	Long term	Very low (-)	Probable	Sure	Reversible
	Decommissioning phase	Without Mitigation	Local	Low	Short term	Low (-)	Probable	Sure	Reversible
		With mitigation	Site specific	Very low	Decommissioning phase	Very low (-)	Probable	Sure	Reversible
	'No–go' Option	NA	Site specific	Zero	Long term	Neutral	Unlikely	Unsure	NA

6.5.1 Description of the Environment

6.5.1.1 Hardap PV facility

Hardap study area falls within the western edge of the Southeast Kalahari (Stampriet) Artesian Basin (SAB) in the south-eastern part of Namibia. This basin is the largest groundwater basin in the country, which extends eastwards into Botswana and South Africa, with an area of approximately 71 000 km^2. Groundwater within the SAB is mainly abstracted by commercial farmers for their domestic, livestock, game and irrigation purposes, whilst the towns of Stampriet and Gochas are supplied from bulk groundwater abstraction by NamWater. Since the SAB is an important groundwater resource for several and different users, the entire basin has been declared a Groundwater Control Area, which includes the area proposed for the Hardap PV facility. The SAB is further situated within the catchments of the ephemeral Nossob and Auob River systems. These rivers only flow occasionally for short periods during the rainy season. Only a small portion of the western part of the study area falls within the catchment of the Fish River Basin, whilst the main part falls within the Auob Basin

Of specific environmental concern is the presence of outcrops of the Auob Member to the east of the study area, which constitutes a major aquifer in the rest of the SAB. These outcrops form part of the groundwater recharge area for the confined Auob Aquifer farther to the east, implying that any anthropomorphic pollution activities at or near these outcrops could have a delayed groundwater pollution effect on the aquifer to the east.

A number of large scale faults are recognised to the east and south of the study area, showing mainly a northsouth trend. Faults and fractures often present a secondary porosity in normally dense rock-types, which can then act as suitable preferential groundwater flow zones and aquifers. From this perspective, it is important that such fault and fracture zones be searched and identified in the field when exploring for groundwater in the study area.

A total of 10 boreholes and one spring could be identified within the 5 km radius around the Hardap Substation. The existing borehole data it could be concluded that the groundwater potential in the study area is limited. However, in terms of drilling a new borehole for water supply to the PV facility, it may be concluded that finding a borehole that produces the lowest yield recorded (500 ℓ/ h) at an existing borehole would yield 4 000 ℓ/ day (pumping at 8 hours per day), which is greater than what would be required for construction purposes.

However, according to the Hydrogeological Map of Namibia the Hardap Substation is located in an area which is considered to be underlain by primary aquifers of moderate groundwater potential.

6.5.1.2 Omaruru PV facility

Omburu study area falls partly within the declared Omaruru Groundwater Control Area and is also located on the water divide of the Omaruru River Basin and the Swakop River Basin. As described in 6.1.4, the study area is underlain entirely by Salem granite, which from a hydrogeological point of view has very poor groundwater properties with possible low groundwater potential due to faults or fractures.

The faults in the area, however, may present suitable target zones for exploration of secondary aquifers. Groundwater recharge in the area would be only from the infiltration of rain water along the perceived fault at fracture zones.

A total of 8 boreholes could be identified within the 5 km radius around the Omburu Substation. The existing borehole yields vary between 1 500 ℓ/h and 2 300 ℓ/h, which are more than sufficient for the purposes of construction and operation of the 10 MW facility.

6.5.1.3 Osona PV facility

Osona study area does not fall within a declared groundwater control area although all public streams are considered to be water protection areas.

The study area also falls within the Swakop River Basin. The alluvium in the riverbeds is important for storing runoff rain water during flood events to recharge the primary alluvial aquifers. Where faults and fracture zones cut across the rivers, with substantial alluvium in the riverbeds, groundwater recharge to such secondary aquifers is enhanced.

Osona study area is located primarily within the Kuiseb Formation that has poor hydrogeological properties generally. A number of northwest to southeast, as well as northeast to southwest, trending faults can be observed.

The faults in the area may present suitable target zones for exploration of secondary aquifers, especially where they cut across quartzite beds near the rivers. Groundwater recharge to the area is attributed mainly to direct infiltration of local rainfall as well as from surface run-off along the riverbed that recharges the alluvial aquifers. The alluvial aquifers in the Swakop River have proved to be viable sources of groundwater in the area, historically. Due to the unconfined and shallow nature of these aquifers, they are highly vulnerable to pollution.

A total of nine boreholes, two wells and one spring could be identified within a 5 km radius from the proposed site for development. The boreholes drilled in the Kuiseb schist appear to have considerably lower yields (2 000 to 400 ℓ/h) than the wells and boreholes in the alluvium of the Swakop River (10 000 to 4 500ℓ/h). It is thus assumed that the riverbed alluvium presents a better option for groundwater potential than the Kuiseb schist.

According to the Hydrogeological Map of Namibia the Osona study area is located in an area which is considered to be underlain by secondary aquifers of generally low to locally moderate groundwater potential. Should groundwater abstraction be considered within the Swakop River, the deepest alluvium fill should be investigated, especially where prominent faults cut across the river. Another solution would be to investigate the condition of the abandoned boreholes, previously operated by NamWater, with the option to take these over. The third option would be to negotiate with NamWater on the possibility to supply water from the Von Bach to Gross Barmen pipeline.

In terms of drilling a new borehole for water supply to the PV facility, it is concluded that finding a borehole that produces the lowest yield (400 ℓ/h) would yield 3 200 ℓ/day (pumping at 8 hours per day), which is twice the 1 343.3 ℓ/day required for construction purposes.

6.5.2 Groundwater Impact Assessment

Construction phase impacts anticipated for the three PV facilities
The typical construction phase impacts likely to impact on groundwater resources with regards to the proposed project are as follows:

- Over exploitation/ abstraction.
- Aquifer damage by improper drilling.
- Pollution by solid waste and wastewater.
- Decreased health and safety from increased waste production.

Over exploitation / abstraction
A reduction in groundwater recharge due to drought conditions causes a lowering of the groundwater table in all areas (Hardap, Omburu and Osona), but over exploitation could also become a factor due to unnecessary increased water demand.

The amount of water intended for use during the construction phase of the PV sites is minimal and should therefore pose no threat to over exploitation of these resources.

Aquifer damage by improper drilling
Incorrect drilling methods can cause leakage of poor quality groundwater, from one aquifer, into another aquifer of better quality groundwater, thus destroying the useful aquifer through anthropogenic pollution. Furthermore, the pollution vulnerability of an area must be taken into consideration in the likelihood of an impact occurring. It is expected that the impact of groundwater level decrease due to pumping from one borehole for the supply of water for construction purposes at the site will be minimal.

Pollution by solid waste and wastewater
The borehole WW1425 near the Hardap site is located in a high pollution vulnerable (HPV) area for the unconfined Kalahari Aquifer, whilst the confined Nossob Aquifer has low pollution vulnerability. Therefore the Aquifer Pollution Vulnerability (APV) indices are restricted to the source points (boreholes).

The boreholes near the Omburu site are also located in low pollution vulnerable (LPV) areas of the unconfined Salem Granite Aquifers. This assumption should, however, be treated with some caution when considering the proximity of a fault near the boreholes. The fault can act as a preferential flow path for infiltrating surface water that eventually reaches the groundwater table, thus transmitting pollutants to the aquifer. Another issue with regard to groundwater pollution is the short surface drainage towards the Omaruru Riverbed. This riverbed acts as a major groundwater source for the Omaruru town and for irrigation farmers who depend on groundwater from the Omburu compartment. Indiscriminate waste disposal (solid or water borne) along the basin divide could result in unwanted contaminants polluting the groundwater in the riverbed aquifers, which are regarded as highly vulnerable to groundwater pollution.

The boreholes near Osona Substation are located in LPV areas of the unconfined Kuiseb Aquifers. This assumption should, however also be treated with some caution when considering the proximity of faults near the boreholes. The faults can act as preferential flow paths for infiltrating surface water that eventually reaches the groundwater table, thus transmitting pollutants to the aquifer. The two wells near Osona site reveal an extreme APV, due to their large diameter, whilst the remaining four boreholes, in the unconfined alluvial bed of the Swakop River are considered to

have a high APV. Another issue, related to the aquifer pollution vulnerability, of the alluvial aquifers in the Swakop Riverbed in the area is the confluence of the Otjiseva River with the Swakop River.

Although the disposal of wastewater could cause groundwater pollution, it is unlikely that any large volumes will be generated onsite during the construction phase. It is also important that the disposal activities and sites comply with minimum requirements for environmental protection needs, as required by law.

The issue of APV at each site is unlikely to be an issue as solid waste and sludge generation will be minimal and properly controlled, avoiding the local disposal of any possible water contaminants during the construction phase. Onsite sanitation for construction workers is expected to consist of portable chemical toilets, the waste product of which will be regularly disposed of away from the site.

Health and safety by increase waste production

Although the disposal of wastewater could cause groundwater pollution, it is unlikely that any large volumes will be generated onsite during the construction phase, due to no construction housing onsite. Onsite sanitation for construction workers is expected to consist of portable chemical toilets, the waste product of which will be regularly disposed of away from the site. As such health and safety issues are unlikely to arise.

Potential impacts to groundwater during the construction phase of all three proposed projects, could be rated as having between medium and very low magnitude, vary between regional and site specific and are limited to the short term, suggesting an average overall significance between **low (-)** and **medium (-)**. With proper mitigation measures the overall impacts could be reduced to **very low (-)** significance, with the probability dropping to unlikely.

Operational phase impacts anticipated for the three PV facilities

In addition to water requirements for panel washing and maintenance, each PV facility is likely to accommodate a security guard onsite who will require ongoing water supply for domestic and office use. This may influence the potential groundwater pollution of the general groundwater environment at each site. The amount of water required during the operation phase for each 10 MW facility is approximately 46 400 ℓ per annum. This is considered to be negligible in terms of borehole yield. Considering this small daily demand for operational purposes, the groundwater specialist suggested that the possibility of rainfall harvesting from the intended solar panels be investigated. The viability of such an option would, however, depend on the surface area covered by the panels. *However, the Aurecon EIA team does not agree that rainfall harvesting should be investigated the rainwater should be allowed to infiltrate the soil to encourage rehabilitation and re-establishment of cleared areas.*

Solid waste and litter that are generated during the operational phase should be collected in suitable bins and disposed of at approved disposal sites.

Given the limited abstraction required, (approximately 46 400 ℓ/annum) limited human activity onsite and given that adequate sanitation is proposed, this impact is considered to be of very low magnitude, regional extent and long term in duration and therefore of **low (-)** significance without mitigation. The significance of the impact could be reduced to **very low (-)** with mitigation.

Decommissioning phase impacts anticipated for the three PV facilities
No decommissioning impacts are anticipated.

6.5.2.1 Cumulative impacts

Economic activities found in the areas are mainly related to commercial farming communities, relying on boreholes for stock and game watering. It may happen that if a new, high yielding, borehole is drilled for water supply of the 10 MW facilities, other farmers may want to drill additional boreholes causing over abstraction. Future projects in the areas may also want to abstract ground water, which could cause groundwater resources to become over exploited. The increase in water demand could then negatively influence the aquifer recharge of each area. However, in the context of the wider landscape and the low water demand at each site, it represents only a very small part of the overall catchments. Although a 4.5 MW PV project is proposed at a site approximately 1.5 km from the proposed Osona PV site, should it also abstract groundwater the proponent of this project (InnoSun (Pty) Ltd) would need to apply for a permit and DWA would need to take all permit applications for the area into consideration. Given the limited volume of water required for PV facilities it is unlikely that the impacts of the two facilities would be significantly different to the other PV sites.

The cumulative ground water impacts are considered to be of very low magnitude, regional extent and long term in duration and therefore of **low (-)** significance without and with mitigation.

6.5.2.2 'No-go' alternative

The 'No–go' impact would allow the *status quo* to continue and the impact would be considered **neutral** as magnitude would be considered zero meaning natural and/ or social functions and/ or processes remain unaltered.

6.5.3 Mitigation Measures

The following mitigation measures are proposed for the construction phase for all three PV facilities and associated infrastructures:

- A licence from DWAF is required for any boreholes to be drilled for water abstraction in order to control the amount of water abstracted from ground water resources.
- The abstraction of groundwater needs to be properly controlled within a prescribed water demand management plan to be compiled prior to the commencement of the activity, as required by typical licence conditions. Proper groundwater abstraction management must be implemented, which will include the regular monitoring of groundwater level fluctuations.
- A critical groundwater level must be determined by a groundwater specialist and the groundwater table must be maintained above such critical levels during water abstraction periods throughout the project lifecycle.
- Any legal requirements, including specific licence conditions should be implemented by the project proponent.
- A 'No–go' zone around watercourses must be demarcated during construction to prevent further loss of vegetation, erosion and watercourse sedimentation.
- Any disturbed areas shall be rehabilitated as soon as possible after construction has been completed and re-vegetated with suitable indigenous vegetation. Measures included in EMP must be implemented.

- Contaminated runoff from the construction site shall be prevented from entering the existing streams found in close proximity to the sites. Measures included in EMP must be implemented.
- Any solid waste, in the form of construction waste, surplus soils, sludge, domestic waste, etc., shall be properly stored. The storage area shall be lined to prohibit polluted surface water runoff before waste is removed to an appropriate landfill site.
- No solid waste sites shall be established in highly vulnerable groundwater pollution areas.
- Construction workers shall be provided with ablution facilities (located at least 100 m away from any river system and regularly serviced) at the construction site.
- Clearing of debris, sediment and hard rubble associated with the construction activities shall be undertaken during and post construction to ensure it does not impact drainage lines.
- Water levels in the surrounding boreholes (within the 5 km radius) must be measured at least once a year to provide an accurate a data base for record keeping.

6.5.4 Groundwater Impact Table

Table 39 indicates how the significance ratings of the groundwater impacts were derived.

6.5.5 Groundwater Summary

The projected water demand volumes are relatively small in relation to general water supply purposes and could be achieved from at least one production borehole at each site. There were no preference for any of the project alternatives and all three PV facilities can proceed.

6.6 ARCHAEOLOGICAL RESOURCES OF THE THREE SITES

An Archaeology Impact Assessment (AIA) was undertaken by Quaternary Research Services to determine and assess potential impacts on heritage and archaeological features and remains as required under the National Heritage Act (Act No. 27 of 2004).

The AIA was informed by a literature survey to identify known archaeological, cultural and historic sites in the project area followed by a field survey undertaken during March 2014 to verify findings. The AIA is included in Annexure E3 and a brief summary is provided below.

6.6.1 Description of the Environment

As indicated in Figure 38, the three NamPower PV sites at Hardap, Omburu and Osona are all located within the relatively high archaeological dense area associated with the central highlands and escarpment of the country[12]. Within this distribution are archaeological sites representative of the entire 800 000 year recorded sequence of human and ancestral human occupation of Namibia.

[12] Data sourced from the archaeological GIS database in which archaeological data are combined with an array of environmental spatial data.

Table 39 | Assessment of groundwater impacts

Project	Key impacts	Mitigation	Extent	Magnitude	Duration	SIGNIFICANCE	Probability	Confidence	Reversibility
All PV facilities	Construction phase	Without Mitigation	Local to Regional	Low to medium	Short term	Low (-) to Medium (-)	Probable	Unsure	Reversible
		With mitigation	Local	Very Low	Short term	Very Low (-)	Probable	Unsure	Reversible
	Over exploitation/ abstraction during operational phase	Without Mitigation	Regional	Very low	Long term	Low (-)	Probable	Unsure	Reversible
		With mitigation	Local	Very low	Long term	Very Low (-)	Probable	Unsure	Reversible
	Decommissioning	No impacts are anticipated							
	'No–go' Option	NA	Site specific	Zero	Long term	Neutral	Unlikely	Unsure	NA

The archaeological sequence represented by these sites includes mid- to late Pleistocene stone artefact sites (mainly Early and Middle Stone Age) which are particularly prevalent in the southern part of the distribution and to the immediate west of the escarpment. In the central area of Namibia, the archaeology is strongly representative of the later part of the sequence dating to within the Holocene period (i.e. the last 11 000 years). These sites include stratified deposits of Later Stone Age occupation levels in caves and rock shelters, large numbers of rock art sites, as well as recent nomadic pastoral and metal-working sites. A small number of significant sites relating to the early colonial era include mission stations, early mines and farming settlements, wagon routes, wells, cemeteries and sites relating to various military events.

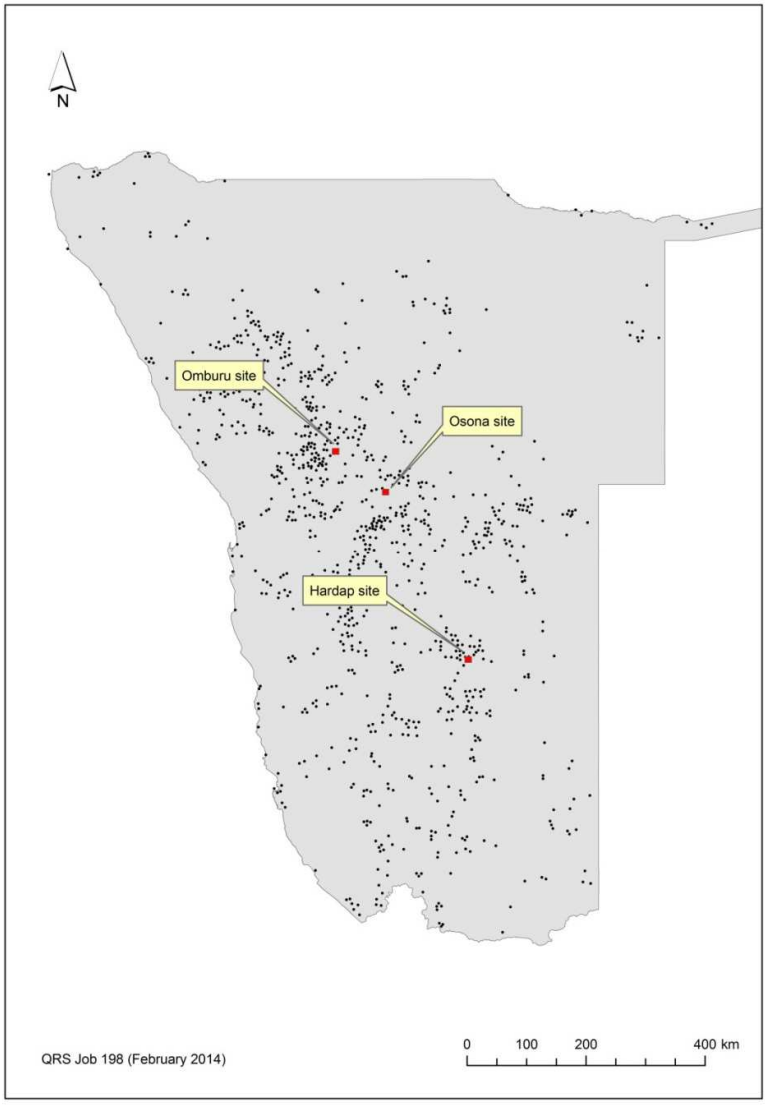


Figure 38 | Location of the three NamPower PV sites at Hardap, Omburu and Osona in relation to the generalized distribution of archaeological sites in Namibia

6.6.1.1 Hardap PV facility

The Hardap substation is situated on the northern outcrop of the Weissrand Plateau, a major landform feature of southern Namibia. From available archaeological database records as indicated in Figure 39, the Weissrand Plateau is associated with extensive mid- to late Pleistocene surface artefact scatters. These scatters represented a deflated accumulation that has also been extensively dispersed by sheet erosion. The artefact scatters are therefore very rarely found in

primary context and have little research potential. Younger material related to Holocene occupation of the area is also represented in the database records, with a single recorded rock art site.

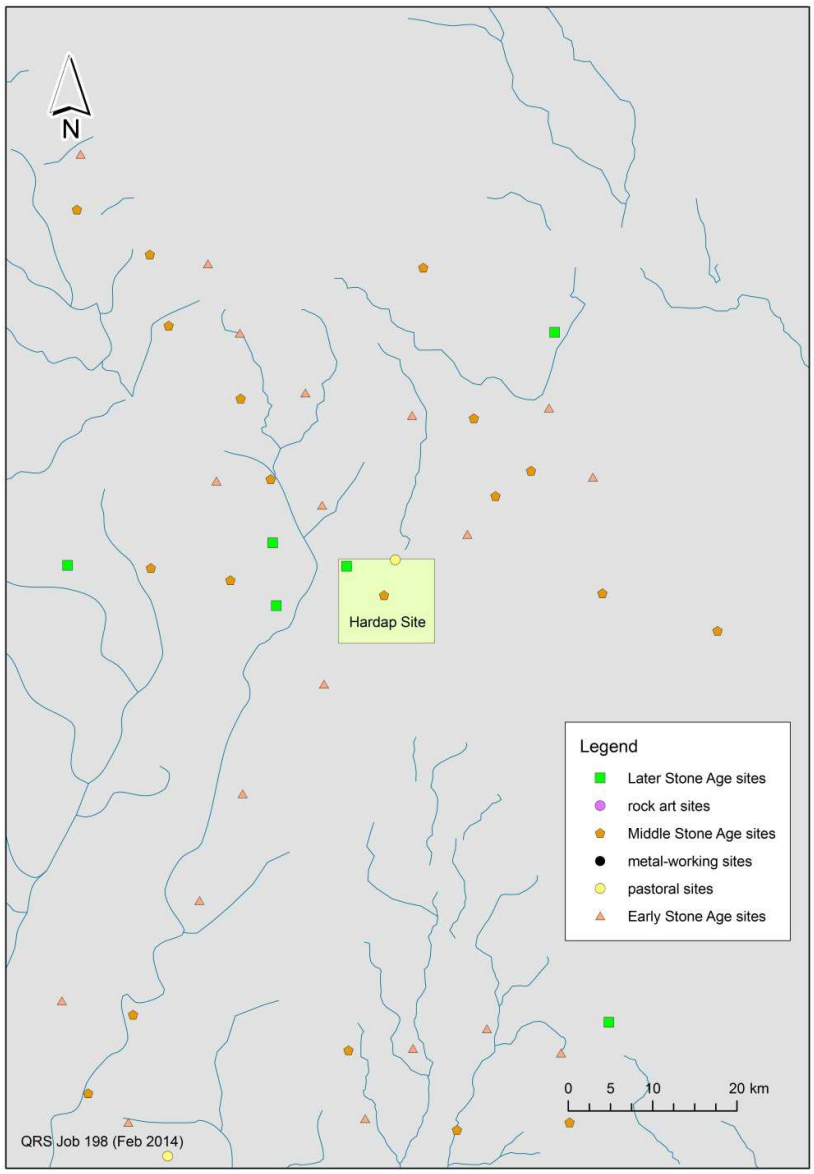


Figure 39 | Regional archaeological setting of the Hardap PV site

As mentioned, the desktop findings were verified with a site walk through. The archaeology sites recorded during the field survey are indicated in Figure 40.

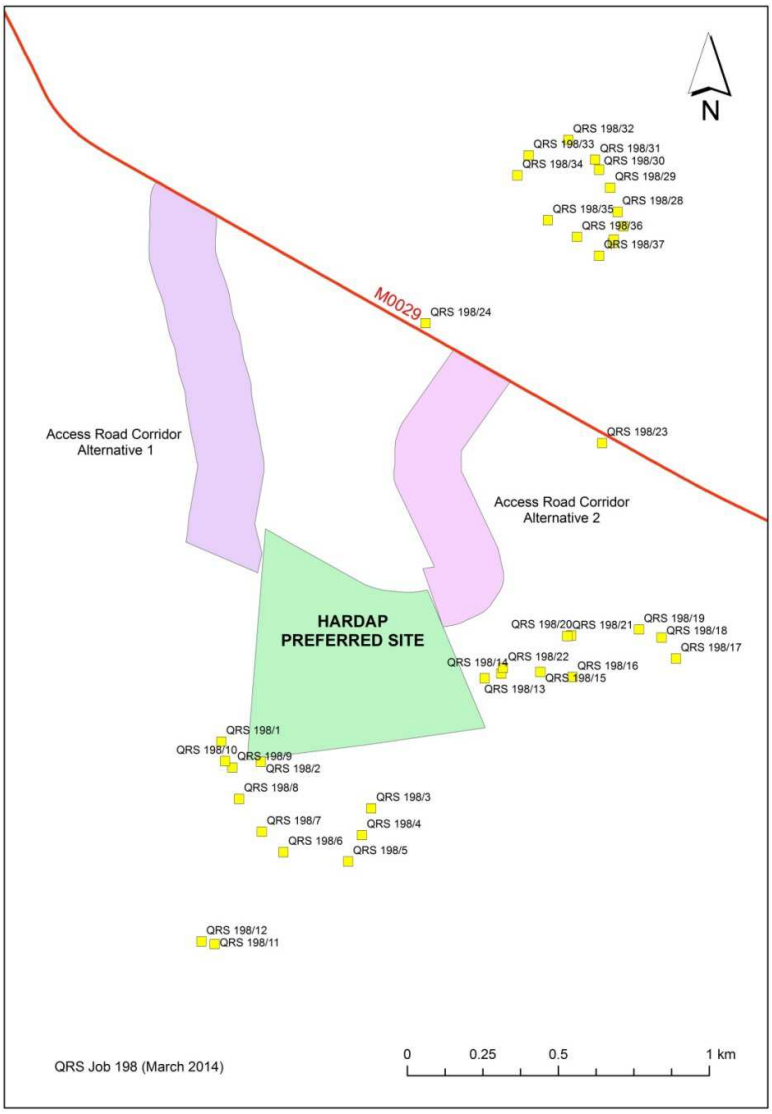


Figure 40 | The Hardap site in relation to archaeological sites recorded during the field survey

Figure 41 shows artefacts that could be described as isolated late Pleistocene artefact finds, collected outside of the Hardap site boundary but within the surrounding area.

Figure 41 | Mid-Pleistocene polyhedral and Mid-Pleistocene pebble tool (both artefacts are quartzite *in situ* found at Site QRS 198/1)

6.6.1.2 Omburu PV facility

The Omburu substation lies in an area of rocky, deeply bisected terrain with dense savannah thornbush cover. The available archaeological database records indicate that this area has significant local concentrations of late Holocene archaeological sites. However, these sites are strongly associated with prominent outcrops and similar features and there are no examples of these within the site as indicated in Figure 42.

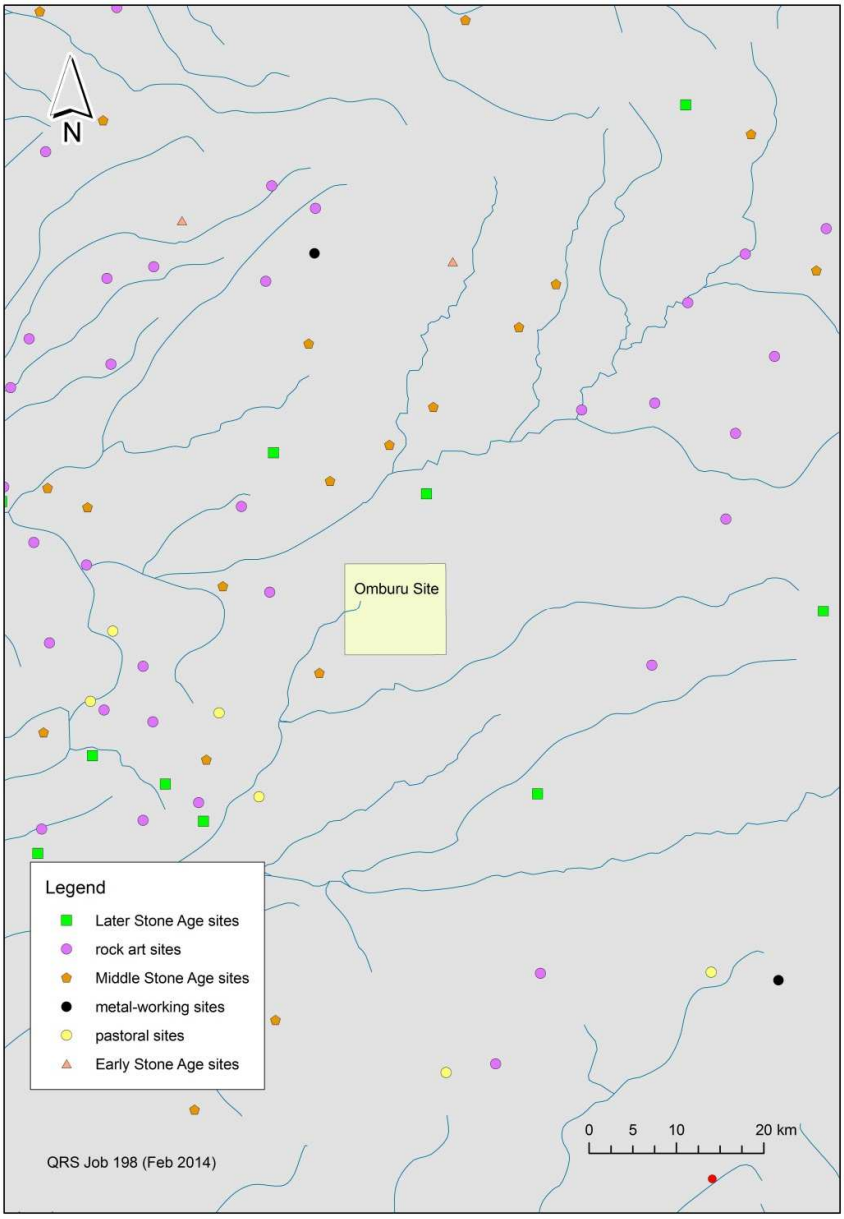


Figure 42 | Regional archaeological setting of the Omburu PV site

The archaeology sites recorded during the field survey are indicated in Figure 43.

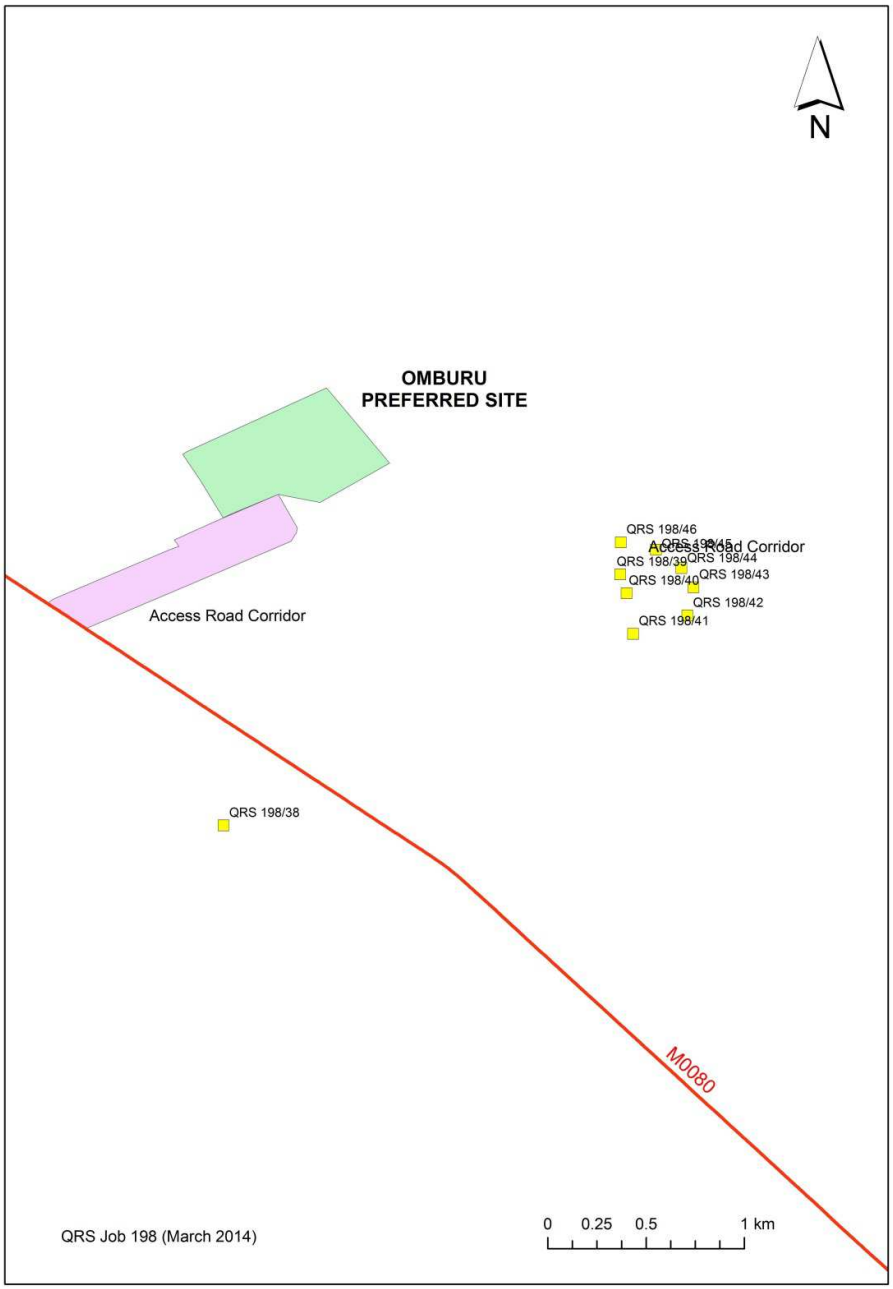


Figure 43 | The Omburu site in relation to archaeological sites recorded during the field survey

The finding at site QRS 198/38 seen in Figure 43, was identified as a suspected isolated burial site. As indicated in Figure 44, the suspected burial site is marked by a few dispersed rocks. It is possible that these rocks could once have been stacked on top of each other and that through time the rocks have dispersed. This suspected burial site is not located on the preferred site and therefore the project would not have an impact on it.

Figure 44 | Suspected burial cairn Site QRS 198/38 (notebook measures 140 mm)

The other archaeology finds indicated in Figure 43, could be described as dispersed scatter flaked hydrothermal vein quartz.

6.6.1.3 Osona PV facility

The Osona substation lies in the upper Swakop River valley, an area of open area with dense savannah thorn bush and well developed riparian woodland. The available archaeological database records do not indicate any significant concentrations of archaeological sites in this area. However, detailed surveys in adjacent parts of the central highlands have revealed dense local concentrations of large pre-colonial settlement sites. Of particular interest is the fact that Gross Barmen (Otinene otjinene) was an important gathering point for internally displaced people in the late 19th century and it is therefore anticipated that some remains of this period would be found onsite.

Figure 45 indicates the archaeological findings in the vicinity of the Osona site according to the database records.

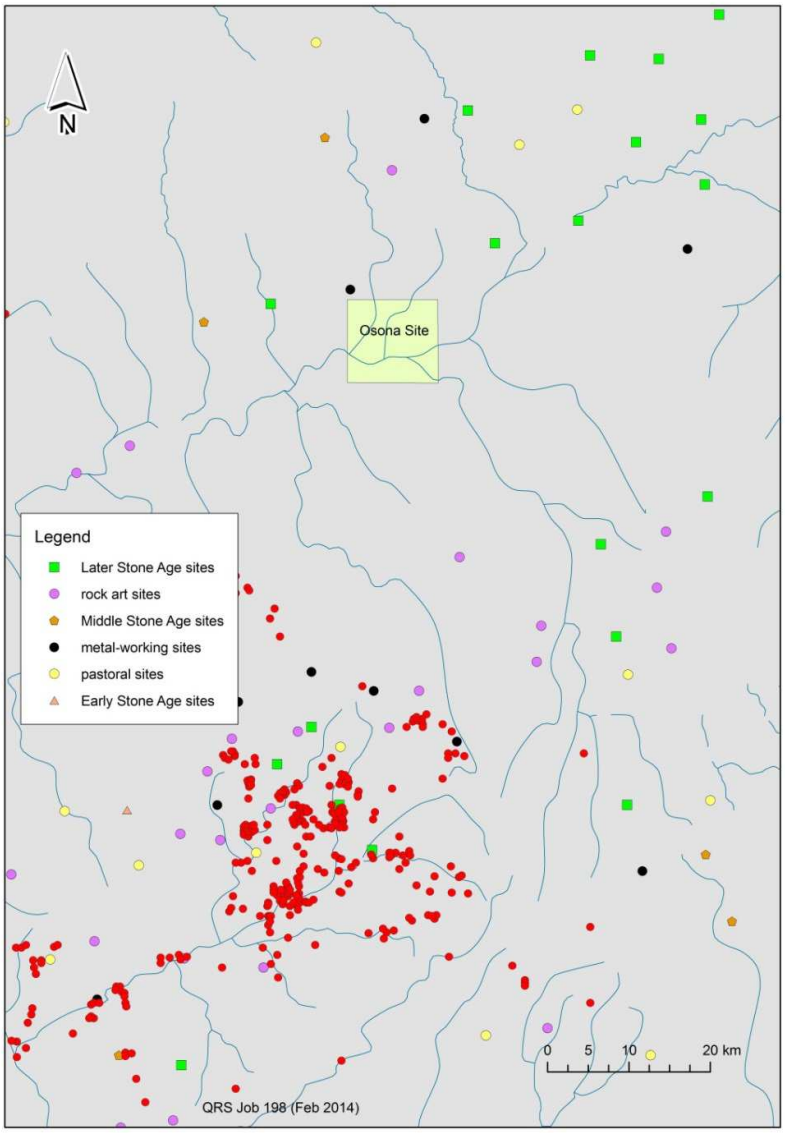


Figure 45 | Regional archaeological setting of the Osona PV site

Figure 46 indicates two sites that are located close to the proposed PV facility. The findings at site QRS 198/49 can be described as a dispersed scatter flaked hydrothermal vein quartz, and QRS 198/50 as an isolated upper grindstone associated with schist outcrop. No archaeology sites of significance were identified during the site assessment.

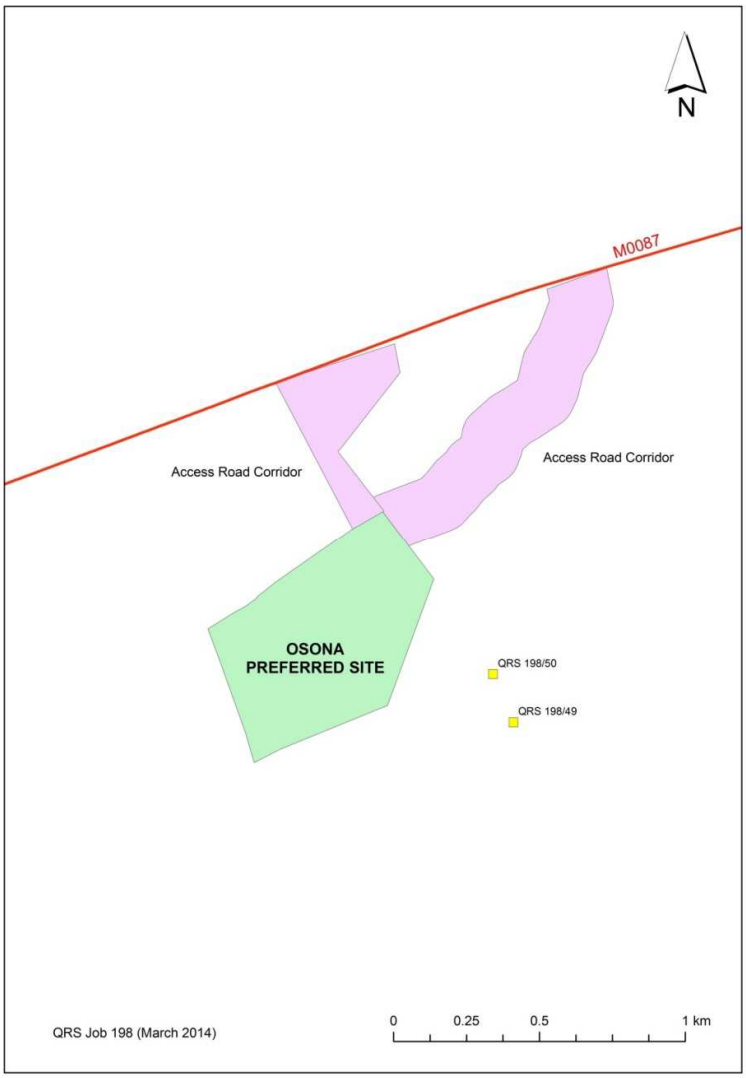


Figure 46 | The Osona site in relation to archaeological sites recorded during the field survey

6.6.2 Archaeology Impacts Assessment

Construction phase impacts anticipated for the three PV facilities

It is predicted that the three proposed projects would have little impact on the archaeology of the sites. Any such impacts would occur mainly at the construction stage (all components of the project) and may include disturbance or outright destruction of relatively insignificant archaeological sites. The archaeological sites pose no risk to the proposed development.

The extent of the impacts for all sites would be local, being confined to the immediate vicinity of the sites, although it must be pointed out that the project would greatly affect the landscape setting of the archaeological sites, thereby disrupting their landscape integrity. The magnitude of the impacts is considered to be medium, of local extent (as the finds are only locally significant), and of long-term duration, and therefore **medium (-)** significance. With mitigation, these impacts would be of **low (-)** significance. Damage to archaeological sites cannot be reversed. The impact rating is the same for the PV facility and all additional infrastructure and alternatives.

Operational phase impacts anticipated for the three PV facilities
The magnitude of the operational impacts is considered to be medium, of local extent (as the finds are only locally significant), and of long-term duration, and therefore **medium (-)** significance. With mitigation, these impacts would be of **low (-)** significance. Damage to archaeological sites cannot be reversed. The impact rating is the same for the PV facility and all additional infrastructure and alternatives.

Decommissioning phase impacts anticipated for the three PV facilities
No decommissioning phase impacts on archaeology are anticipated.

6.6.2.1 Cumulative impacts

Cumulative impacts are not simple to assess, since archaeological resources, in particular, are point-specific. Each is unique and, while the general locations of archaeological sites can often be predicted, there is no guarantee that a site would be found in an expected location. For this reason one cannot be sure how many archaeological sites would be lost relative to the number and type of sites occurring in the local and wider regions and hence cumulative impacts are not assessed here.

6.6.2.2 'No-go' alternative

The 'No–go' alternative would result in maintenance of the *status quo*. Impacts to archaeological resources would continue at a very limited scale through trampling by grazing livestock and possibly collection of artefacts by visitors to the farm, while the cultural landscape would remain relatively unchanged and experience **neutral** impacts.

6.6.3 Mitigation Measures

6.6.3.1 Hardap, Omburu and Osona PV facilities

It is recommended that construction planning should take cognisance of the possibility that archaeological sites may be found in the course of site work. Any such sites should be physically marked as advised in the Chance Finds procedure described in detail in the AIA and briefly below.

The "chance finds" procedure shall be adhered to as it covers the actions to be taken from the discovery of a heritage site or item, to its investigation and assessment by a trained archaeologist or other appropriately qualified person.

Action by person identifying archaeological or heritage material

a) If operating machinery or equipment stop work.
b) Identify the site with flag tape.
c) Determine GPS position if possible.
d) Report findings to foreman.

Action by foreman

a) Report findings, site location and actions taken to superintendent
b) Cease any works in immediate vicinity.

Action by superintendent

a) Visit site and determine whether work can proceed without damage to findings
b) Determine and mark exclusion boundary.

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

Action by archaeologist (as appointed by project proponent at the time)

a) Inspect site and confirm addition to GIS.
b) Advise National Heritage Council of Namibia and request written permission to remove findings from work area.
c) Recovery, packaging and labelling of findings for transfer to National Museum.

In the event of discovering human remains

a) Actions as above.
b) Field inspection by archaeologist to confirm that remains are human.
c) Advise and liaise with National Heritage Council of Namibia and Police.
d) Recovery of remains and removal to National Museum or National Forensic Laboratory, as directed.

Monitoring requirements in the event of chance finds will include:

a) Condition assessment of archaeological sites prior to commencement of construction.
b) Conventional standards of excavation and documentation.

In addition to the adoption of the "chance finds" procedure in the EMP, the following appropriate mitigation measures/actions will be implemented:

- Integration of archaeological findings database into sensitivity map.
- Site induction for all personnel and contractors to create awareness of the known sites (no sites are known at this stage).
- Excavation, if required, should be completed as soon as possible.
- Should an excavation permit be required, an application shall be submitted to the National Heritage Council. The permit approval process can take at least one month.
- **Osona PV site only:** in view of the dense grass cover at the time of the survey, a final site walk down of the Osona site should be undertaken by a heritage practitioner prior to construction.

6.6.4 Archaeology Impact Table

Table 40 indicates how the significance ratings of the various archaeology impacts were derived.

6.6.5 Archaeology summary

The field survey and assessment presented here confirms the relatively low archaeological significance indicated by a desk assessment carried out in advance of the field investigation. The significance of impacts on the archaeology of the proposed PV sites is considered to be **low (-)**.

There is no preference between the different alternatives and all alternatives are suitable from an archaeological point of view.

Table 40 | Assessment of archaeology impacts

	Project	Key impacts	Mitigation	Extent	Magnitude	Duration	SIGNIFICANCE	Probability	Confidence	Reversibility
Construction phase	**All three PV facilities**	Disturbance or destruction of Heritage resources	Without Mitigation	Local	Medium	Long term	Medium (-)	Probable	Medium	NA
			With mitigation	Local	Low	Long term	Low (-)			
Operational phase	**All three PV facilities**	Disturbance or Destruction of Heritage resources	Without Mitigation	Local	Medium	Long term	Medium (-)	Probable	Medium	NA
			With mitigation	Local	Low	Long term	Low (-)	Probable	Low	NA
Decommissioning phase	**All three PV facilities**	Disturbance or Destruction of Heritage resources	No impact anticipated							
'No–go' (for Hardap, Omburu and Osona PV)		All PV facilities	NA	Site specific	Zero	Long term	Neutral	Probable	Unsure	NA

6.7 VISUAL PROPERTIES OF THE THREE SITES

Namibia is characterised by wide open plains, sparse settlements and open spaces. The topography of the area is relatively flat, although there are a few ridge-shaped hills and larger flatter plateaus. It is therefore anticipated that the visibility of projects may impact on the visual quality of the area.

Mr Stephen Stead, of Visual Resource Management Africa cc, was appointed to undertake a Visual Impact Assessment (VIA) to determine potential visual impacts of the proposed Hardap PV, Omburu PV and Osona PV facilities. The VIA included a desktop review of relevant literature and maps to determine the landscape context followed by a site visit (conducted from 3 March 2014 to 5 March 2014) to determine the extent of the visibility of the site. The visibility of the proposed project, the visual absorption capacity (VAC)[13] of the area and the landscape character of the sites were determined to define the visual impact. In terms of the VRM methodology, landscape character is derived from a combination of scenic quality, receptor sensitivity to landscape change, and distance of the proposed landscape modification from key receptor points. The findings and recommendations of the study are provided below. The VIA is included in Annexure E4.

6.7.1 Description of the Environment

6.7.1.1 Hardap PV facility

Apart from the closest town, Mariental approximately 8 km to the northeast of the site, the following landscape features define the regional landscape character:

- C29 gravel road and Hardap Substation (Figure 47).
- Small escarpment topography.
- Tourism facilities (Figure 48).

C29 gravel road and Hardap Substation

The site has a strong visual association with the Hardap substation and associated power lines, reducing the scenic quality. The combined effect of the large substation and the numerous power lines dominates the landscape character of the surrounding areas as indicated in Figure 47.

Topography

Topography of the Hardap site is described in Section 6.1.3, but are summarised here for ease of reference. The Hardap PV site is located on a raised plateau with the elevation ranging from 1 200 to 1 205 mamsl. The gradient is flat with a slight westerly aspect related to the Fish River.

Tourism facilities

The B1 highway, passing through Mariental, is the main tourist route from South Africa to Windhoek. Some of the top safari and hunting experiences in Namibia can be found at lodges like Lapa Lange and Anib Lodge along the C29 road. The Hardap Dam on the Fish River lies 22 km northwest of Mariental and is the location of the annual Mariental triathlon.

[13] The VAC is defined as the "physical capacity of the landscape to absorb proposed development activities and still maintain its inherent visual character and quality." *(www. fs.fed.us/publications/documents/psw_gtr035_04_yeomans)*

Figure 47 | View of the Hardap Substation as seen from the C29 Gravel Road

Figure 48 | Photograph of Lapa Lange signage on C29 which passes Hardap substation

The approximate location of the proposed PV facility in the landscape is represented by the red dotted line in Figure 49. Due to the close proximity of the large Hardap substation and the numerous power lines radiating out from the site, the visual resources of the area surrounding the substation (which includes the proposed site) are visually degraded.

Key Observation Points (KOPs) are defined as *"people (receptors) located in strategic locations surrounding the property that make consistent use of the views associated with the site where the landscape modifications are proposed"* i.e. from where the development will be most visible from.

The KOP location for the Hardap PV facility was along the C29 gravel road located to the south of the existing Hardap substation meaning that the project would be visible to people travelling along the C29 gravel road. Views from the C29 gravel road of the proposed site have the substation in the foreground with a moderate to low VAC. The substation acts as a buffer and moderates visual

exposure. Therefore, the relative value of the visual resources of the area could be defined as Class IV[14], since the scenic quality of the site is reduced due to the visual link to the adjacent Hardap substation, the remoteness of the location and low receptor sensitivity to landscape change. A Class IV visual objective was therefore assigned to the site as it has low visual resources.

Figure 49 | View south from C29 Gravel Road towards proposed site of the approximate height of the 15 m PV structures

Figure 50 and Figure 51 indicate the Zone of Visual Influence (ZVI) of the fixed tilt PV structures and the single axis tracking PV structures. The potential visibility of the proposed fixed tilt PV structures alternative would be *moderate to low* in extent with the ZVI contained within two kilometres. This is due to the existence of the Hardap substation and power lines which already dominate the landscape context. The potential visibility of the proposed project with single axis tracking PV structures is very similar in pattern and is described as having a *moderate* extent with the ZVI experienced predominantly within the 5 km distance zone.

6.7.1.2 Omburu PV facility

Apart from the closest town, Omaruru, approximately 10 km to the northwest of the site, the following landscape features define the regional landscape character:

- Omburu Substation and C36 gravel road.
- Game farming.
- Farmsteads.

Omburu Substation and C36 gravel road

The substation and surrounding power lines lie 0.5 km to the southeast of the proposed site. The substation was constructed to service the growing electrical supply in the region. The combined visual effect of the large substation and the numerous power lines dominates the landscape character of the surrounding area as indicated in Figure 52.

[14] The Class IV objective is to provide for management activities which require major modifications of the existing character of the landscape. The level of change to the landscape can be high, and these management activities may dominate the view and be the major focus of the viewer's (s') attention.

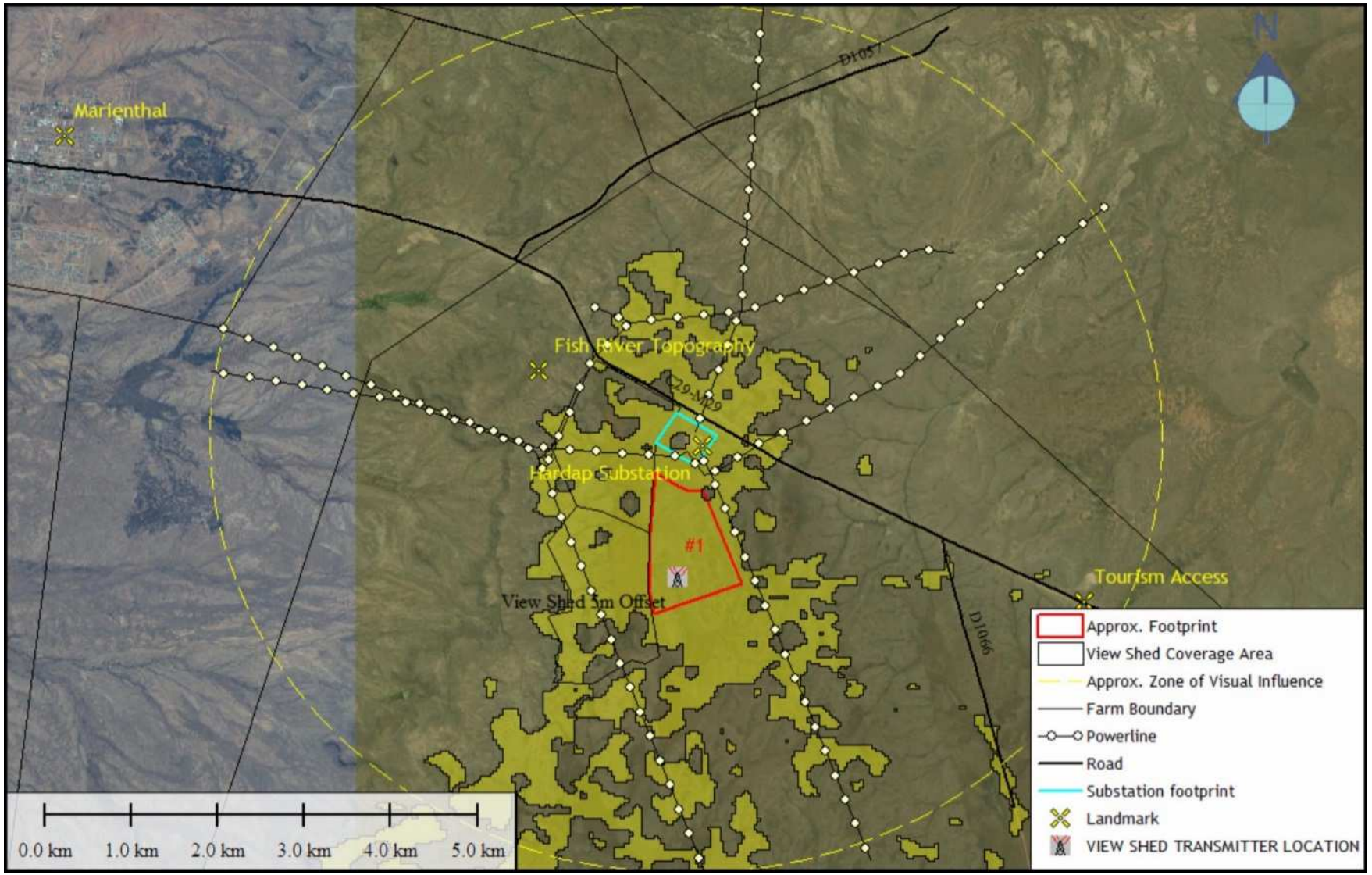


Figure 50 | Proposed Hardap site viewshed for fixed tilt PV at a height of 5 m (restricted to 5 km ZVI)

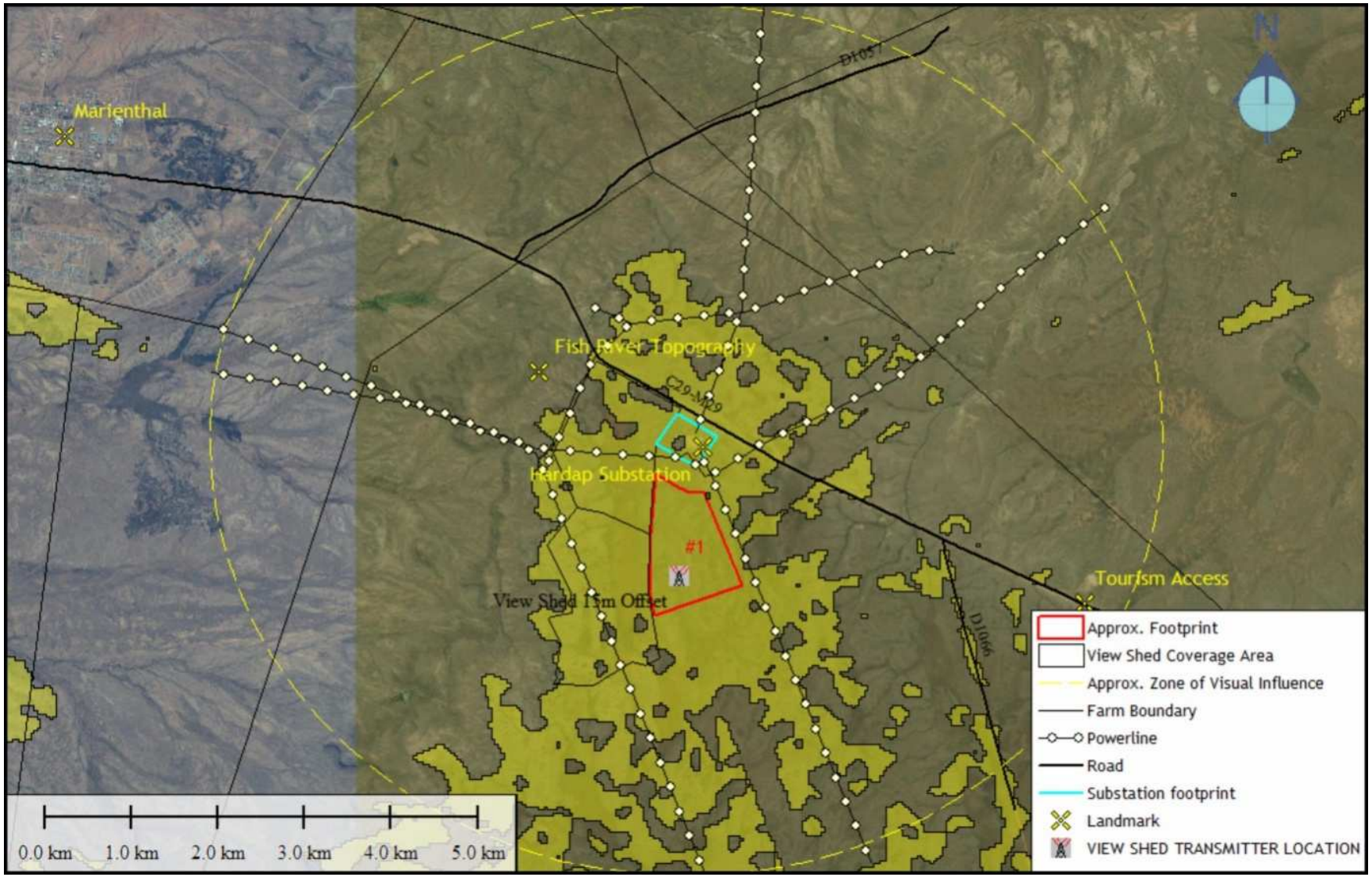


Figure 51 | Proposed Hardap site viewshed for tracking PV at a height of 15 m (restricted to 5 km ZVI)

Game Farming and Farmsteads

Omaruru is an important game farm area with a variety of guest farms and lodges. Only 10 km² of the Erongo Region is cleared for cultivation which includes small areas at Omaruru and Okombahe. Small stock farming is the most important agricultural activity in the region. This is mostly practised on the communal land, where goats and sheep are run on conservancy land.

Figure 52 | Photograph from C36 road depicting Omburu Substation

The Omburu site has low scenic qualities as a result of the close proximity of the existing substation as indicated in Figure 52. Due to low levels of receptor sensitivity and low scenic qualities of the site, the visual inventory rating using the VRM matrix was defined as Class IV. However, the site is located on a ridgeline which results in a high viewshed with the potential to extend to game farms and possible future tourism activities in the north (close to Omaruru town). It is therefore necessary to ensure that the overall surrounding landscape quality remains intact. As the site has moderate visual qualities the VRM Class III were assigned with management objectives to ensure that the level of change to the characteristic landscape are moderate.

The approximate location of the proposed PV facility in the landscape is represented by the red dotted line in Figure 53. Due to the close proximity of the large Omburu substation and the numerous power lines radiating out from the site, the visual resources of the area surrounding the substation (which includes the proposed site) are visually degraded.

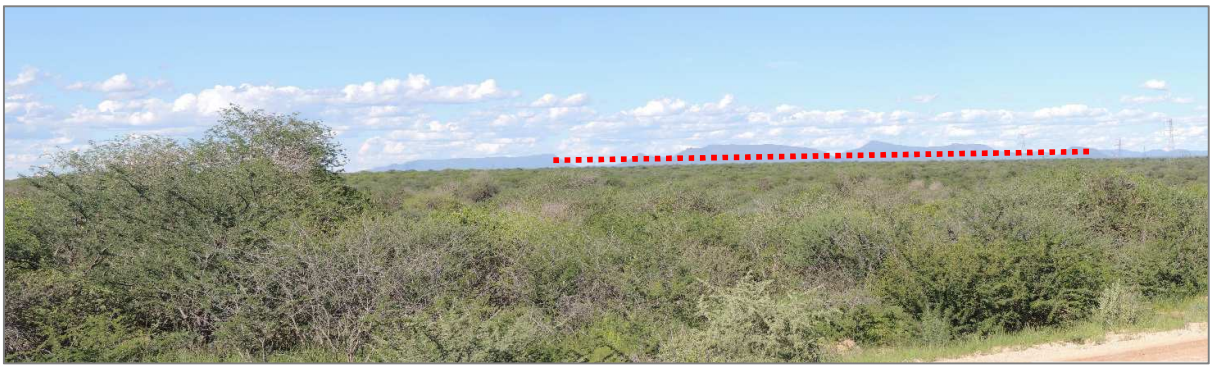


Figure 53 | View towards site from C36 gravel road with approximate location of 15 m height PV structures

Figure 54 and Figure 55 indicate the ZVI of the fixed tilt PV structures and the single axis tracking PV structures. The potential visibility of the proposed fixed tilt PV structures alternative would be

moderate in extent extending in all compass directions but strongly fragmented by the undulation of the surrounding terrain. The ZVI would be experienced mainly within 4 km, given the close proximity to the existing Omburu substation and power lines. The potential visibility of the proposed project with single axis tracking PV structures would have a *high* extent extending in all compass directions but without the fragmentation.

6.7.1.3 Osona PV facility

Apart from the closest town, Okahandja, approximately 18 km to the northeast of the site, the following landscape features define the regional landscape character:

- Osona Substation.
- D1972 road.
- Gross Barmen Hot Springs Resort.

Osona Substation

The Osona substation was constructed to service the growing needs of the area. The site is approximately 2.1 ha and 20 m in height and there are four power lines which feed into the substation. The combined visual effect of the large substation and the numerous power lines dominates the landscape character of the surrounding area as indicated in Figure 56.

D1972 road

The existing tarred road from Okahandja to Gross Barmen Hot Springs Resort (D1972) runs adjacent to the site as indicated in Figure 57. Given the close proximity to the Gross Barmen resort, it is very likely that tourist traffic is carried on this road.

Gross Barmen

The proposed area for development lies 3 km from Gross Barmen Hot Springs and a proportion of the tourist traffic in the area will make use of the D1972 access route to the springs, which is adjacent to the site. The main attraction of the resort is its hot mineral spring water and a large birding dam. The nearby Von Bach Dam, outside of Okahandja, is also a favourite spot for water sport enthusiasts and anglers. Okahandja has an open-air curio market which attracts tourists and the town is a popular stopover point for tourists.

The combined visual effect of the large substation and the numerous power lines dominates the landscape character of the surrounding area. The site is zoned agricultural and the nearest receptor (KOP) is the D1972 road located adjacent the site to the north and the Gross Barmen Hot Springs. Type of users would include tourists making use of the D1972 road to access the warm baths of Gross Barmen to the west. This increases the potential that users would be more sensitive to landscape change.

Due to medium levels of scenic quality and receptors with moderate sensitivity to landscape change (located in the foreground), the Visual Inventory was defined as Class III where the level of change to the characteristic landscape should be moderate in terms of the management objectives for the area. Management activities may attract attention, but should not dominate the view of the casual observer, and changes should repeat the basic elements found in the predominant natural features of the characteristic landscape.

The approximate location of the proposed PV facility in the landscape is represented by the red dotted line in Figure 60.

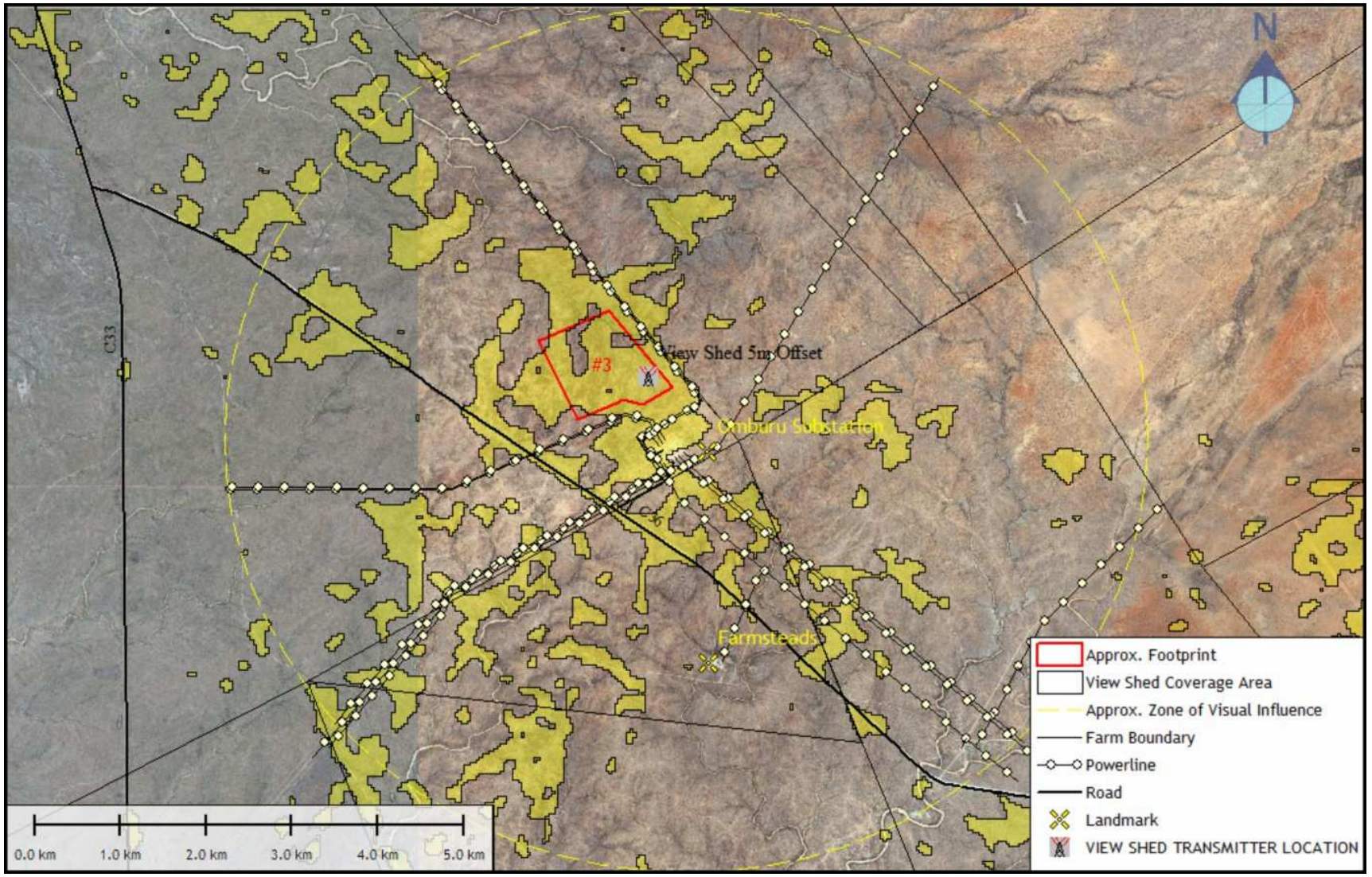


Figure 54 | Proposed Omburu site viewshed fixed tilt PV at a height of 5 m (restricted to 5 km ZVI)

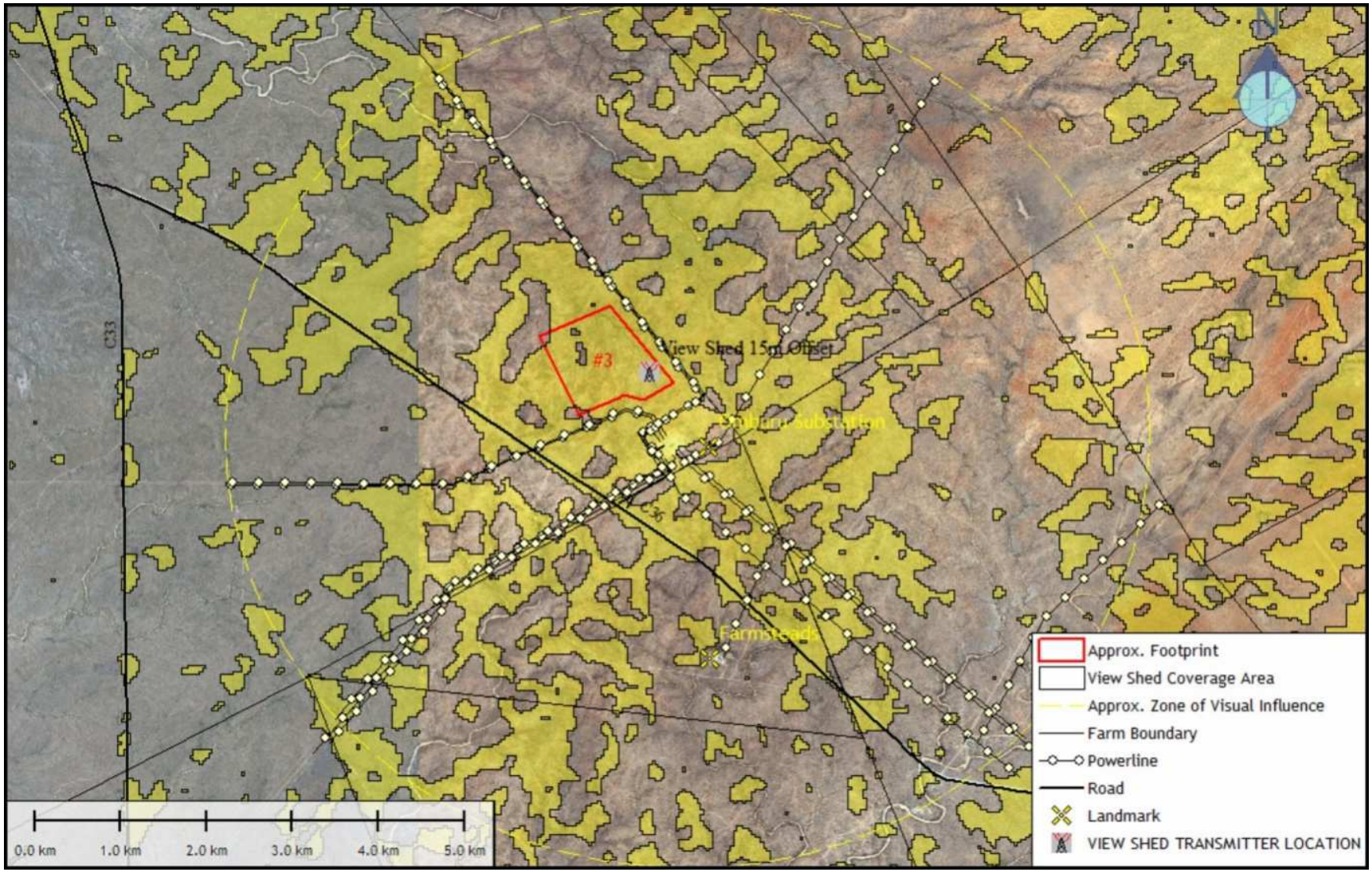


Figure 55 | Proposed Omburu site viewshed at a height of 15 m (restricted to 5 km ZVI)

Figure 56 | Photographs depicting the Osona substation sense of place

Figure 57 | D1972 road sense of place

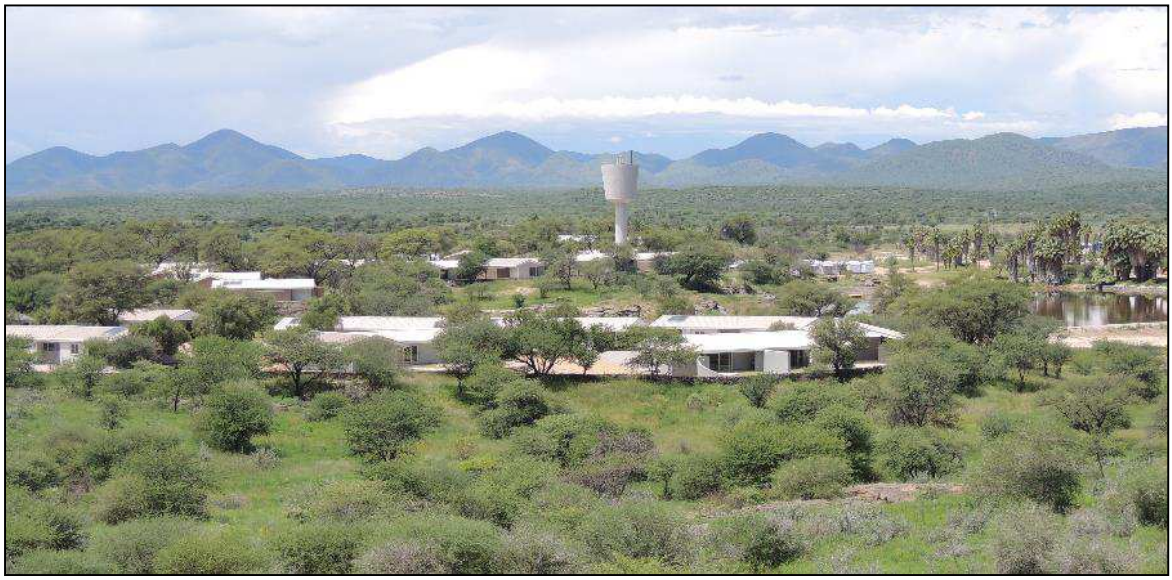


Figure 58 | Gross Barmen Resort

Figure 59 | View from M87 road towards proposed site with the red dotted line indicating the approximate height of the 15m PV structures

As indicated in Figure 60, the approximate location of the Gross Barmen development in the landscape is represented by the red dotted line.

Figure 60 | View from the site towards Gross Barmen taken from the Osona site

Due to the close proximity of the large Osona substation and numerous power lines radiating out from the site, the visual resources of the area surrounding the substation (which includes the proposed site) are visually degraded. However, due to the undulating terrain and thick bush vegetation, the scenic quality of the site is *moderate* as it looks like the surrounding areas.

Figure 61 and Figure 62 indicate the ZVI of the fixed tilt PV structures and the single axis tracking PV structures. The potential visibility of the proposed fixed tilt PV structures alternative would be *moderate* in extent with the main extent of the visibility being directed towards the north, west and southwest as the site is slightly elevated compared to the surrounding areas to the north. There is some visual absorption created by the undulating terrain, the vegetation screening and the existing substation within 0.2 km. The potential visibility of the proposed project with single axis tracking PV structures would have a *high* extent with the same directionality as the fixed tilt PV structure. The ZVI for the 15 m alternative would be experienced in a much larger area as the size and scale of the proposed landscape modification would dominate the adjacent substation and protrude above the adjacent tree screening, with the landscape change being experienced into the background areas.

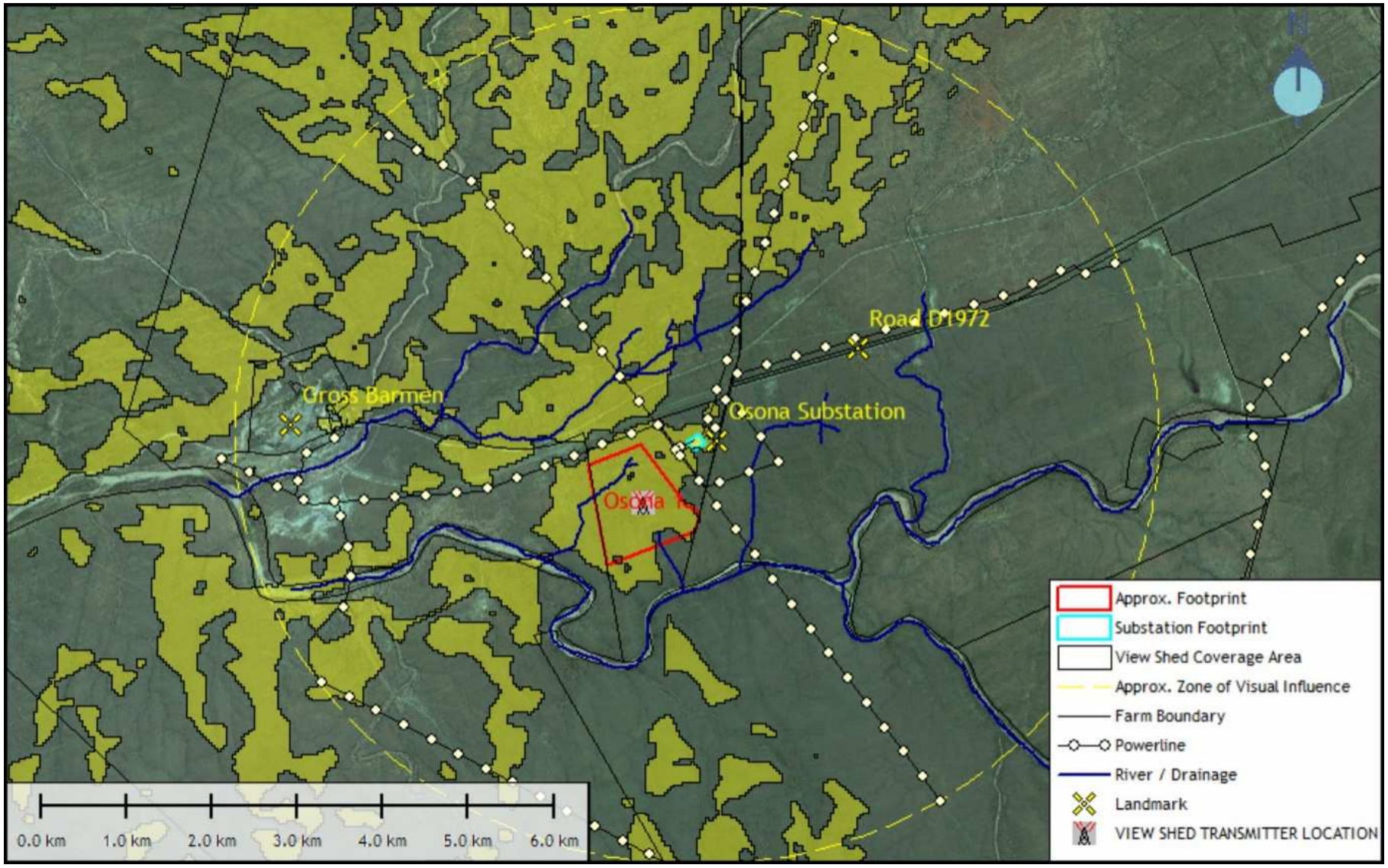


Figure 61 | Proposed Osona site viewshed fixed tilt PV at a height of 5 m (restricted to 5 km ZVI)

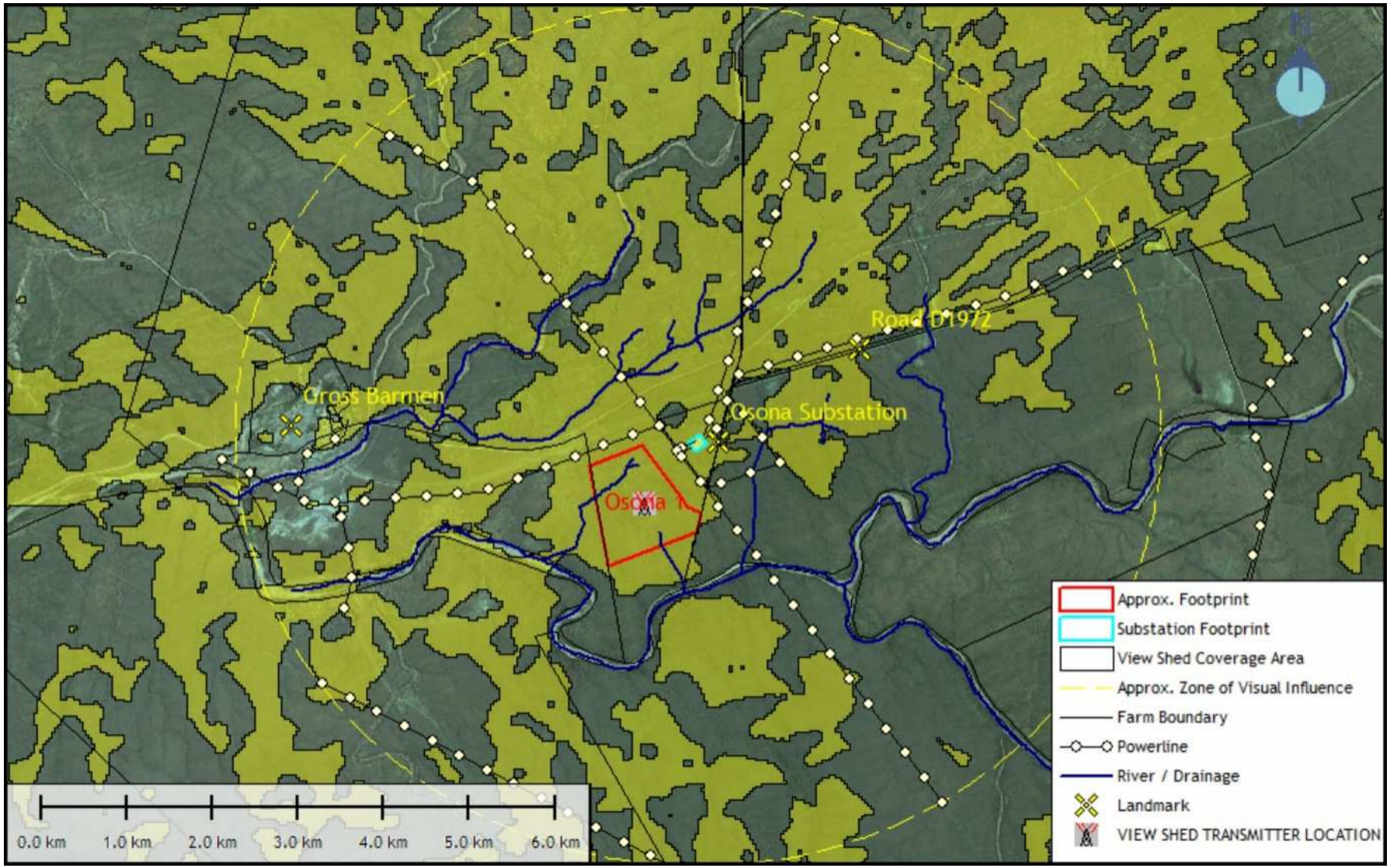


Figure 62 | Proposed Osona site viewshed at a height of 15 m (restricted to 5 km ZVI)

6.7.2 Visual Impact Assessment

Construction phase risks to the environment could include the change to the surrounding landscape character created by the clearing of vegetation on the site, movement of vehicles, construction of roads, power lines and construction of the PV structures. In order to construct single-axis tracking PV cranes of approximately 20 m in height are required. New lights at night will be introduced for security which could contribute to the visual impact. Operational risks to the environment would include the maintenance of PV structures, movement of vehicles as well as lights at night.

Construction phase impacts anticipated for the three PV facilities
Hardap: For fixed tilt PV the potential visual impact was considered to be of low magnitude, local extent, taking place during construction phase and therefore of **very low (-)** significance with and without mitigation. For single-axis tracking PV the potential visual impact was considered to be of medium magnitude, local extent, taking place during construction phase and would be reversible and therefore of **low (-)** significance with and without mitigation. For Hardap road 1, the potential visual impact was considered to be of low magnitude, local extent, sure to take place during construction phase and would be reversible and therefore of **low (-)** significance without mitigation. The significance rating could be reduced to **very-low (-)** with the implementation of mitigation measures. For Hardap road 2, the potential visual impact was considered to be of very low magnitude, local extent, sure to take place during construction phase and would be reversible and therefore of **very low (-)** significance with and without mitigation.

Omburu: For fixed tilt PV the potential visual impact was considered to be of low magnitude, local extent during construction phase and therefore of **very low (-)** significance with and without mitigation. In order to construct single-axis tracking PV cranes of approximately 20 m in height are required. The potential visual impact was considered to be of high magnitude, regional extent, taking place during construction and therefore of **medium (-)** significance with and without mitigation. If the height of the single axis tracking is restricted to 8 m, the significance will be reduced to **low (-)** making this technology acceptable. For road access, the potential visual impact was considered to be of low magnitude, local extent, sure to take place during construction phase and would be reversible and therefore of **very low (-)** significance with or without mitigation.

Osona: Both the hot mineral spring water and a large birding dam at Gross Barmen should not be impacted on by the PV facility. However, if Gross Barmen is expanded there is the possibility that the PV site would be visible to the tourist. For fixed tilt PV the potential visual impact was considered to be of low magnitude, local extent and construction term and therefore of **very low (-)** significance with and without mitigation. For single-axis tracking PV the potential visual impact was considered to be of high magnitude, regional extent and construction term and therefore of **medium (-)** significance with and without mitigation. If the height of the single axis tracking is restricted to 7 m, the significance will be reduced to **low (-)** making this technology acceptable For Osona road 1, the potential visual impact was considered to be of medium magnitude, local extent and construction term and would be reversible and therefore of **low (-)** significance without mitigation. The significance rating could be reduced to **very low (-)** with the implementation of mitigation measures. For Osona road 2, the potential visual impact was considered to be of low magnitude, local extent and construction term and therefore of **very low (-)** significance with and without mitigation.

Operational phase impacts anticipated for the three PV facilities

Hardap: For fixed tilt PV the potential visual impact was considered to be of low magnitude, local extent, long term and therefore of **low (-)** significance and could be reduced to **very low (-)** with and without mitigation. For single-axis tracking PV the potential visual impact was considered to be of medium magnitude, local extent, long term and would be reversible and therefore of **medium (-)** significance with and without mitigation. For Hardap road 1, the potential visual impact was considered to be of low magnitude, local extent, long term and would be reversible and therefore of **low (-)** significance without mitigation. The significance rating could be reduced to **very-low (-)** with the implementation of mitigation measures. For Hardap road 2, the potential visual impact was considered to be of very low magnitude, local extent, long term and would be reversible and therefore of **very low (-)** significance with and without mitigation.

Omburu: For fixed tilt PV the potential visual impact was considered to be of low magnitude, local extent and long term and therefore of **low (-)** significance without mitigation. The significance of this impact could be reduced to **very low (-)** with mitigation. For single-axis tracking PV the potential visual impact was considered to be of high magnitude, regional extent and long term and therefore of **high (-)** significance without mitigation. The significance of this impact could be reduced to **medium (-)** with mitigation. If the height of the single axis tracking is restricted to 8 m, the significance will be further reduced to **low (-)** making this technology acceptable. For road access, the potential visual impact was considered to be of low magnitude, local extent, and long term and therefore of **low (-)** significance with or without mitigation.

Osona: For fixed tilt PV, the potential visual impact was considered to be of low magnitude, local extent and long term and therefore of **low (-)** significance without mitigation. The significance of this impact could be reduced to **very low (-)** with mitigation. For single-axis tracking PV the potential visual impact was considered to be of high magnitude, regional extent and long term and therefore of **high (-)** significance without mitigation and **medium (-)** with mitigation. If the height of the single axis tracking is restricted to 8 m, the significance will be further reduced to **low (-)** making this technology acceptable For Osona road 1, the potential visual impact was considered to be of medium magnitude, local extent and long term and therefore of **medium (-)** significance without mitigation. The significance rating could be reduced to **very low (-)** with the implementation of mitigation measures. For Osona road 2, the potential visual impact was considered to be of low magnitude, local extent and long term and therefore of **very low (-)** significance with and without mitigation.

Decommissioning phase impacts anticipated for the three PV facilities

Hardap: As all visual impacts of all phases of the proposed PV project are reversible after decommissioning, including the removal of the PV structures and unrequired infrastructure. For both fixed tilt PV and single-axis tracking the potential visual impact was considered to be of low magnitude, local extent and, decommissioning term, and therefore of **very low (-)** significance with and without mitigation. For road alternatives 1, the potential visual impact was considered to be of low magnitude, local extent and decommissioning term therefore of **low (-)** significance without mitigation. The significance rating could be reduced to **very-low (-)** with the implementation of mitigation measures. For road alternative 2, the potential visual impact was considered to be of very low magnitude, local extent and decommissioning term therefore of **very low (-)** significance without mitigation.

Omburu: As all visual impacts of all phases of the proposed PV project are reversible after decommissioning, including the removal of the PV structures and unrequired infrastructure. For

both fixed tilt PV and single-axis tracking PV on the Omburu Site the potential visual impact was considered to be of low magnitude, local extent and decommissioning term and therefore of **very low (-)** significance with and without mitigation. For road access, the potential visual impact was considered to be of low magnitude, local extent and long term and would be reversible and therefore of **very-low (-)** significance with or without the implementation of mitigation measures.

Osona: As all visual impacts of all phases of the proposed PV project are reversible after decommissioning, including the removal of the PV structures and unrequired infrastructure. For both fixed tilt PV and single-axis tracking PV on the Osona Site the potential visual impact was considered to be of low magnitude, local extent and decommissioning term and therefore of **very low (-)** significance with and without mitigation. For Osona road 1 and Osona road 2, the potential visual impact was considered to be of low magnitude, local extent and decommissioning term and therefore of **low (-)** significance without mitigation. The significance rating could be reduced to **very-low (-)** with the implementation of mitigation measures.

6.7.2.1 Cumulative impacts

Cumulative impacts were assessed and the main issue identified was the potential for the proposed project to set a precedent for other PV type projects in the area, resulting in a massing effect which would potentially dominate the surrounding landscape character (and tourist related land users where relevant).

The anticipated cumulative impact of the fixed tilt PV alternative is considered to have a medium magnitude, permanent local extent and therefore **medium (-)** significance that could be reduced to **low (-)** with mitigation measures. In comparison, the cumulative impact of the single axis tracking PV alternative is considered to be of high magnitude, permanent local extent and therefore **high (-)** significance and could be reduced to **medium (-)** with implementation of mitigation measures. It should be noted that the developer of the PV facility would not be responsible for the implementation of the mitigation measure for cumulative impacts and as such cannot guarantee the reduction of the significance of this potential impact. However, the likelihood of this impact occurring is considered to be unlikely.

With respect to the Osona PV, InnoSun (Pty) Ltd is proposing to construct a 4.5 MW PV facility in the Osona area in close proximity to the proposed Osona PV (approximately 1.5 km apart). Although both facilities would be connected to same substation, no change in the significance of cumulative impacts is anticipated as the InnoSun PV facility would be located north east of the substation and hence is unlikely to be visible to road users.

6.7.2.2 'No-go' Alternative

The 'No–go' alternative considers the *status quo* i.e. the site remains the same and the proposed development does not go ahead. It is the baseline to compare the proposed activities against during the Impact Assessment process. The 'No–go' alternative for all three sites is considered to be permanent and site specific with zero magnitude and therefore it is considered to be **neutral**.

6.7.3 Mitigation Measures

6.7.3.1 General mitigation measures applicable for Hardap, Omburu and Osona PV facilities

The following mitigation measures are proposed to reduce the visual impacts:

- Access roads shall be kept clean, and measures taken to minimise dust from construction activities and from traffic on gravel roads.
- In order to reduce dust, place the construction yard away from the new access road and retain as much of the adjacent vegetation as is possible.
- If site clearing is required, the topsoil shall be conserved and used for rehabilitation. The remainder could be used for site development, and any surplus disposed of in a manner that appears natural, as approved by the ECO.
- Site offices and structures shall be limited to single storey and should be sited carefully to reduce visual intrusion. Colours should reflect hues of the surrounding vegetation and/or the ground (grey green). Door and window frame colour should be similar to either the roof or wall colours.
- Limit the size of signage and use colour tones that are visible but not dominating, so that size and colour contrast do not dominate the attention of the casual observer.
- Littering shall be regarded as a serious offence and no contaminants are to be allowed to enter the environment by any means.
- Rehabilitation of all impacted areas shall commence during the construction phase, if feasible, and continue until the state of the vegetation meets the requirements of the ecological assessment and is satisfactory to the ECO.
- The fencing shall be grey in colour and located as close as possible around the PV site. If possible, natural waterways and drainage lines indicated as sensitive areas should not be fenced in.
- All lighting shall be kept to a minimum, within the requirements of safety and efficiency.
- Where such lighting is deemed necessary, low-level lighting, which is shielded to reduce light spillage and pollution, shall be used.
- No naked light sources are to be directly visible from a distance. Only reflected light should be visible from outside the site.
- External lighting shall use down-lighters shielded in such a way as to minimise light spillage and pollution beyond the extent of the area that needs to be lit.
- Security and perimeter lighting shall also be shielded so that no light falls outside the area needing to be lit. Unnecessarily tall light poles shall be avoided.
- All PV structures, associated structures and fencing shall be removed and recycled, as far as possible during decommissioning. Where it is not possible to recycle material the waste shall be disposed of at a registered landfill site.
- If internal roads cannot be used by the landowner, then they shall be rehabilitated.
- All impacted footprint areas shall be rehabilitated and restored as per the requirements of the ecological assessment.

To reduce the potential cumulative effects, it is recommended that regional management authorities timeously draw up clear environment management guidelines ensuring a 50 m ‘No–go’ buffer adjacent roads is implemented, as well as allowing a 100 m buffer between PV projects where the natural vegetation is retained to act as biodiversity corridors and reduce combined views of different projects. This mitigation measure cannot be implemented by the developer and is therefore included here only for the attention of the regional management authorities and should not form part of the EMP.

In addition to the above mitigations, the following specific recommendations are made for the proposed Osona PV facility:

- A 50 m 'No–go' buffer shall be retained from the road, for this project as well as any future phases that may occur, to ensure that the magnitude of the visual impact is moderated by tree screening adjacent the D1972 road.

6.7.4 Visual Impact Tables

Table 41 indicates how the significance ratings of the various visual impacts were derived.

6.7.5 Visual summary

The VIA concluded that all sites are suitable for development due to the close proximity to the adjacent large substations and power lines which moderated the scenic qualities and receptor sensitivities.

For the Hardap PV facility, either of the PV type alternatives (fixed tilt or single axis tracking PV) are suitable. The access road alternative 2 follows the existing substation access road which marginally reduces the magnitude of the impact, although not the significance, and is therefore the slightly visually preferred alternative.

For Omburu only the fixed tilt PV is suitable as the single axis tracking at 15 m height would extend the visual influence to lower lying terrain to the north and south. The single axis tracking PV type structures should not be used unless the height could be restricted to 8 m or the area around the Omburu substation becomes a zoned solar energy node, due to the high impacts of this technology in this location. By introducing the height restriction on the single axis tracking PV panels, it could reduce the significance of the visual impact from **medium (-)** to **low (-)**.

For Osona, only the fixed tilt PV is suitable. The single axis tracking at 15 m height has the potential for the proposed project setting a precedent for further higher magnitude visual impacts to the surrounding landscape which has tourism activities in the area (Gross Barmen Resort). Single axis tracking could however be considered if the height is restricted to 7 m which would reduce the significance of the impact from **medium (-)** to **low (-)**. The preferred road access is Alternative 2 as it is aligned along the existing substation road and does not reduce the screening potential of the PV structures as seen from the adjacent road.

6.8 SOCIO-ECONOMIC CHARACTERISTICS OF THE THREE SITES

The Socio-Economic Impact Assessment was undertaken by Digby Wells Environmental to determine and assess potential impacts on communities and human activities in the project's area of influence.

The study was informed by a desktop review of available documents to obtain relevant baseline socio-economic information on the affected areas. A field survey was undertaken from 26 February to 8 March 2014 to verify findings. Interviews were also conducted with key informants to ascertain perceptions, identify potential impacts as well as mitigation measures. The study is included in Annexure E5 and a brief summary is provided below.

Table 41 | Assessment of Visual impacts for all three PV facilities

	Project alternatives	Mitigation	Extent	Magnitude	Duration	SIGNIFICANCE	Probability	Confidence	Reversibility
Construction phase	Hardap fixed tilt PV	Without mitigation	Local	Low	Construction	Very Low (-)	Probable	Sure	Reversible
		With mitigation	Local	Very Low	Construction	Very Low (-)	Probable	Sure	Reversible
	Hardap Single Axis PV tracking	Without mitigation	Local	Medium	Construction	Low (-)	Probable	Sure	Reversible
		With mitigation	Local	Medium	Construction	Low (-)	Probable	Sure	Reversible
	Hardap Road Access 1	Without mitigation	Local	Low	Construction	Low (-)	Probable	Sure	Reversible
		With mitigation	Local	Very Low	Construction	Very Low(-)	Probable	Sure	Reversible
	Hardap Road Access 2	Without mitigation	Local	Very Low	Construction	Very Low(-)	Probable	Sure	Reversible
		With mitigation	Local	Very Low	Construction	Very Low(-)	Probable	Sure	Reversible
	Omburu fixed tilt PV	Without mitigation	Local	Low	Construction	Very Low (-)	Probable	Sure	Reversible
		With mitigation	Local	Very Low	Construction	Very Low (-)	Probable	Sure	Reversible
	Omburu Single Axis PV tracking	Without mitigation	Regional	High	Construction	Medium (-)	Probable	Sure	Reversible
		With mitigation	Regional	High	Construction	Medium (-)	Probable	Sure	Reversible
	Omburu Road Access 1	Without mitigation	Local	Low	Construction	Very Low (-)	Probable	Sure	Reversible
		With mitigation	Local	Very Low	Construction	Very Low (-)	Probable	Sure	Reversible
	Osona fixed tilt PV	Without mitigation	Local	Low	Construction	Very Low (-)	Probable	Sure	Reversible
		With mitigation	Local	Very Low	Construction	Very Low (-)	Probable	Sure	Reversible
	Osona Single Axis PV tracking	Without mitigation	Regional	High	Construction	Medium (-)	Probable	Sure	Reversible
		With mitigation	Regional	High	Construction	Medium (-)	Probable	Sure	Reversible
	Osona Road Access 1	Without mitigation	Local	Medium	Construction	Low (-)	Probable	Sure	Reversible
		With mitigation	Local	Very Low	Construction	Very Low(-)	Probable	Sure	Reversible
	Osona Road Access 2	Without mitigation	Local	Low	Construction	Very Low (-)	Probable	Sure	Reversible
		With mitigation	Local	Very Low	Construction	Very Low (-)	Probable	Sure	Reversible
Operational phase	Hardap fixed tilt PV	Without mitigation	Local	Low	Long Term	Low (-)	Probable	Sure	Reversible
		With mitigation	Local	Low	Long Term	Very Low (-)	Probable	Sure	Reversible
	Hardap Single Axis PV tracking	Without mitigation	Local	Medium	Long Term	Medium (-)	Probable	Sure	Reversible
		With mitigation	Local	Medium	Long Term	Medium (-)	Probable	Sure	Reversible
	Hardap Road	Without mitigation	Local	Low	Long Term	Low (-)	Probable	Sure	Reversible

	Project alternatives	Mitigation	Extent	Magnitude	Duration	SIGNIFICANCE	Probability	Confidence	Reversibility
	Access 1	With mitigation	Local	Very Low	Long Term	Very Low (-)	Probable	Sure	Reversible
	Hardap Road Access 2	Without mitigation	Local	Very Low	Long Term	Very Low (-)	Probable	Sure	Reversible
		With mitigation	Local	Very Low	Long Term	Very Low (-)	Probable	Sure	Reversible
	Omburu fixed tilt PV	Without mitigation	Local	Low	Long Term	Low (-)	Probable	Sure	Reversible
		With mitigation	Local	Very Low	Long Term	Very Low(-)	Probable	Sure	Reversible
	Omburu Single Axis PV tracking	Without mitigation	Regional	High	Long Term	High (-)	Probable	Sure	Reversible
		With mitigation	Regional	High	Long Term	Medium (-)	Probable	Sure	Reversible
	Omburu Road Access 1	Without mitigation	Local	Low	Long Term	Low (-)	Probable	Sure	Reversible
		With mitigation	Local	Very Low	Long Term	Low (-)	Probable	Sure	Reversible
	Osona fixed tilt PV	Without mitigation	Local	Low	Long Term	Low (-)	Probable	Sure	Reversible
		With mitigation	Local	Very Low	Long Term	Very Low(-)	Probable	Sure	Reversible
	Osona Single Axis PV tracking	Without mitigation	Regional	High	Long Term	High (-)	Probable	Sure	Reversible
		With mitigation	Regional	High	Long Term	Medium (-)	Probable	Sure	Reversible
	Osona Road Access 1	Without mitigation	Local	Medium	Long Term	Medium (-)	Probable	Sure	Reversible
		With mitigation	Local	Very Low	Long Term	Very Low(-)	Probable	Sure	Reversible
	Osona Road Access 2	Without mitigation	Local	Low	Long Term	Very Low (-)	Probable	Sure	Reversible
		With mitigation	Local	Very Low	Long Term	Very Low (-)	Probable	Sure	Reversible
Decommissioning phase	Hardap fixed tilt PV	Without mitigation	Local	Low	Construction	Very Low (-)	Probable	Sure	Reversible
		With mitigation	Site	Very Low	Construction	Very Low (-)	Probable	Sure	Reversible
	Hardap Single Axis PV tracking	Without mitigation	Local	Low	Construction	Low (-)	Probable	Sure	Reversible
		With mitigation	Local	Very Low	Construction	Low (-)	Probable	Sure	Reversible
	Hardap Road Access 1	Without mitigation	Local	Low	Construction	Low (-)	Probable	Sure	Reversible
		With mitigation	Local	Very Low	Construction	Very Low (-)	Probable	Sure	Reversible
	Hardap Road Access 2	Without mitigation	Local	Very Low	Construction	Very Low(-)	Probable	Sure	Reversible
		With mitigation	Local	Very Low	Construction	Very Low	Probable	Sure	Reversible
	Omburu fixed tilt PV	Without mitigation	Local	Low	Construction	Very Low (-)	Probable	Sure	Reversible
		With mitigation	Site	Very Low	Construction	Very Low (-)	Probable	Sure	Reversible
	Omburu Single Axis PV tracking	Without mitigation	Local	Low	Construction	Very Low (-)	Probable	Sure	Reversible
		With mitigation	Site	Very Low	Construction	Very Low (-)	Probable	Sure	Reversible
	Omburu Road Access 1	Without mitigation	Local	Low	Long Term	Very Low (-)	Probable	Sure	Reversible
		With mitigation	Local	Very Low	Long Term	Very Low (-)	Probable	Sure	Reversible
	Osona fixed tilt PV	Without mitigation	Local	Low	Construction	Very Low (-)	Probable	Sure	Reversible
		With mitigation	Site	Very Low	Construction	Very Low (-)	Probable	Sure	Reversible

	Project alternatives	Mitigation	Extent	Magnitude	Duration	SIGNIFICANCE	Probability	Confidence	Reversibility
	Osona Single Axis PV tracking	Without mitigation	Local	Low	Construction	Very Low (-)	Probable	Sure	Reversible
		With mitigation	Site	Very Low	Construction	Very Low (-)	Probable	Sure	Reversible
	Osona Road Access 1	Without mitigation	Local	Low	Construction	Low (-)	Probable	Sure	Reversible
		With mitigation	Local	Very Low	Construction	Very Low(-)	Probable	Sure	Reversible
	Osona Road Access 2	Without mitigation	Local	Low	Construction	Low (-)	Probable	Sure	Reversible
		With mitigation	Local	Very Low	Construction	Very Low(-)	Probable	Sure	Reversible
	'No–go' alternative	NA	Site	Zero	Permanent	Neutral	NA	Sure	NA

6.8.1 Description of the environment

Namibia is divided into thirteen regions. The three NamPower PV sites namely; Hardap, Omburu and Osona are located in Hardap, Erongo and Otjozondjupa regions respectively. The regions of Erongo and Otjozondjupa have relatively high populations, whereas Hardap is one of the least populated regions. The country is classified as a lower middle-income country, with a per capita Gross Domestic Product of approximately US$ 7 800 per annum. However, it is one of the countries in the world with the greatest disparity between rich and poor; the country's Gini-coefficient is 0.59[15].

The main drivers of Namibia's economy are mining, fisheries, agriculture and tourism. Agriculture is especially important for the economy of rural areas (which accounts for just less than 60 % of the population). Approximately 70 % of Namibians are dependent on subsistence agriculture for their livelihood.

The country is currently experiencing the Human Immunodeficiency Virus/ Acquired Immunodeficiency Syndrome (HIV/AIDS) pandemic threatening the social and economic fabric of the country. Namibia is ranked sixth in the world in terms of HIV/AIDS prevalence, with an overall prevalence rate of over 13 % among the adult population. The Ministry of Health and Social Services provides free condoms to government organisations and operates just less than 40 regional health care centres, the majority of which offer confidential testing, counselling and treatment including free access to anti-retroviral medication. A number of Non-Governmental Organisations and United Nations agencies support HIV/AIDS mitigation and care services throughout the country.

6.8.1.1 Hardap Substation (Mariental)

The Hardap region is bordered in the north by the Erongo, Khomas and Omaheke regions and in the south by the Karas region. The region is bordered by Botswana and South Africa to the east and the Atlantic Ocean to the west. Hardap region is divided into six constituencies. The proposed Hardap PV facility is to be situated within Mariental Rural Constituency. Other main urban centres in the local study area include Aranos, Gochas, Maltahohe, Gibeon, Stampriet, Rehoboth, and Kalkrand.

Land uses within the vicinity of the proposed project site are relatively limited due to the aridity of the area. The only pertinent land uses are game and small stock farming (e.g. goat and sheep). No major residential land uses are evident in the area immediately surrounding the proposed project area; the closest farmstead is situated just more than 2 km north of the site.

[15] The Gini-coefficient, developed in 1912 by Italian statistician Corrado Gini, is a mathematical measure of income inequality. Its theoretical maximum value is 1 – which would imply that a single person receives 100 % of the total income and the remaining people receive none – and its theoretical minimum value is 0 – in which case everyone receives exactly the same income. The Gini-coefficient of the United States of America is between 0.45 and 0.5, while that of Sweden is 0.23.

Figure 63 | NamPower's Hardap sub-station

6.8.1.2 Omburu Substation (Omaruru)

The Omburu substation is located in Erongo region, Namibia`s sixth largest region. The region borders the Oshana region to the northeast, Otjozondjupa region and Khomas region to the east, and Hardap region to the south with the Atlantic Ocean on the west. Erongo region is divided into seven constituencies namely; Walvis Bay Urban, Walvis Bay Rural, Swakopmund, Arandis, Dâures, Omaruru and Karibib (see Figure 67).

The Omaruru constituency is administered by the Omaruru Local Municipality, which has its offices in Omaruru town.

Erongo region has the second highest income per capita[16] in the country after the Khomas region, this is derived from mining, fishing and tourism. Significant mining activities in the region are Rössing Uranium, the Navachab gold mine, and Langer Heinrich Uranium.) None of these are located in close proximity to the proposed Omburu PV site.

Omaruru town is connected to the site with the C36 roadway, which is a gravel road stemming off the B2 national road. Land uses within the surrounding area include cattle and game farming, limited residential land uses (e.g. homesteads) and the road connecting Omaruru to Okahandja, which is mostly used by farmers residing adjacent to the road. The site is located on vacant and unpopulated state land, where agriculture and gaming activities are practiced. The property is owned by Omaruru Local Municipality, and is currently zoned for agricultural use.

[16] *Income per capita:* Income divided by number of persons in the region.

6.8.1.3 Osona Substation (Okahandja)

The Osona substation lies within the Otjozondjupa region which is situated in the upper central part of Namibia and shares its northeastern border with Botswana. The region shares borders with other regions Omaheke and Khomas to the south and southeast, Erongo to the southwest, and Oshikoto and Kavango to the northeast and west. Otjozondjupa region comprises seven constituencies namely; Grootfontein, Otavi, Okakarara, Otjiwarongo, Okahandja, Tsumkwe and Omatako. Otjiwarongo is the region`s administrative headquarters and is also the most populated in the region. The proposed PV project is situated within the Okahandja constituency.

This region has a well-established agricultural sector, of which most activity is concentrated within the cattle farming industry. The local study area's industrial sector is relatively well established and is based on diamond cutting factories (e.g. NamGem), meat processing (e.g. MeatCo), and construction companies. The location of Okahandja close to Windhoek makes it attractive for industries. The retail sector is relatively well developed, and will become more prominent as several retail chains intend to establish branches in town.

Major land uses within the surrounding area of the project site include commercial cattle and game farming, limited residential land uses (e.g. homesteads), the M87 road, and the Gross Barmen resort, a well-known local tourism attraction. The main access road to the resort is the M87 roadway, which passes the proposed project site. Several freehold conservancies are located in the area surrounding the proposed project area. These conservancies are relatively removed from the site with the closest freehold area situated 10 km northwest of the Osona sub-station. The project footprint is located on vacant privately-owned land, currently zoned for agricultural purposes. The property on which it is located is currently used for commercial cattle farming purposes.

6.8.2 Socio-economic Impact Assessment

The impacts described below are applicable to each of the three PV facilities and their various alternatives and were assessed in terms of the socio-economic assessment methodology described in the Socio-economic Impact Assessment included in Annexure E5.

6.8.2.1 Construction-related impacts applicable to all three PV facilities

Employment creation and economic benefits

Jobs will be created in the immediate and surrounding project area depending on the recruitment practices as well as the ease with which the contractor will be able to identify and recruit suitably skilled locals. The project may also lead to indirect job creation such as jobs from refuse removal and security services. The jobs created will increase spending power, from the wages and salaries earned, as well as from local procurement of goods, materials and services. The impact is considered to be of low magnitude, regional extent and limited to the construction phase, and therefore of **low (+)** significance without mitigation. With mitigation, these impacts would be of **medium (+)** significance.

Impacts related to the presence of construction workers

Despite the intention to make use of local recruits, it is likely that part of the project workforce will originate from outside the local area. The presence of non-local construction workers may have a variety of social consequences i.e. conflicts with locals, pressure on housing supply, engaging in promiscuous sexual activities, increase in crime and negligence. The impact is considered to be of a local extent and to occur during construction, and is therefore predicted to be of **medium (-)** significance without mitigation. With mitigation, these impacts would be of **low (-)** significance.

Displacement of current land uses

The proposed sites are currently used for livestock and game farming (Hardap 1 and Osona) or are state owned (Omburu 1) and the current land uses will change during the construction phase. This would constitute a small degree of displacement of current economic activities. The impact is considered to be site specific and of long term duration, and therefore of **medium (-)** significance with and without mitigation.

Physical-intrusion impacts

Construction activities would affect the immediate physical environment of the sites with regard to increased traffic on roads, noise and dust generation, safety issues as well as visual intrusion. The impact is considered to be site specific and to occur during construction, and therefore of **low (-)** significance without mitigation. With mitigation, these impacts would be of **very low (-)** significance.

6.8.2.2 Operation-related impacts applicable to all three PV facilities

Employment creation and contribution to the local economy

It is expected that a limited number of skilled or semi-skilled employees will be required to operate the facility. These employees may be sourced locally, regionally or even internationally. This could result in indirect job creation as well as economic benefits to the local community. The impact is considered to be regional in extent and of long term duration, and therefore of **medium (+)** significance with and without mitigation.

6.8.2.3 Decommissioning-related impacts applicable to all three PV facilities:

Change in employment requirement

Decommissioning activities may create a temporary spike on the project's workforce requirements. The net effect of decommissioning on employment will however be negative unless it is possible to secure jobs for all the facilities' former personnel at other operations. The impact is considered to be local in extent and of decommissioning duration, and therefore of **medium (-)** significance without mitigation. With mitigation, these impacts would be of **low(-)** significance.

Restoration of previous land uses

After decommissioning the project, the land could be re-sold to the owners to resume current land use. This will be dependent on the feasibility of rehabilitating the project site to its former state. Alternatively, the site could be used for future residential development if it forms part of the urban edge (Omburu and Osona), Hardap site is already part of Mariental`s

urban edge. The impact is considered to be site specific in extent and of long term duration, and therefore of **low (+)** significance with and without mitigation.

6.8.2.4 Cumulative impacts applicable to all three PV facilities

Cumulative socio-economic impacts are expected to occur as a result of the combined effect of the proposed project(s) and other current or planned operations (such as the 4.5 MW PV facility near Osona) in the respective areas and in Namibia as a whole. The identified cumulative impacts are described below.

Contribution to reliable electricity

The projects when combined with other various energy projects that are planned at national level, would make a significant contribution towards meeting the country`s electricity demand. Sufficient and reliable electricity supply has numerous socio-economic benefits at national level as well as positive spinoffs for the industrial sector. Adequate electricity supply is one of the necessary conditions for Namibia's progress towards achieving development objectives such as those enshrined in Vision 2030 and the Millennium Development Goals (MDGs). The impact is considered to be regional in extent and of long term duration, and therefore of **high (+)** significance with and without mitigation.

Contribution to development of renewable energy

Development of renewable energy means reduced dependence on fossil fuels and other non-renewable energy sources. Currently, Namibia has 415 MW[17] installed capacity. The construction of three 10 MW PV facilities would not only increase the country's generation capacity but it would also increase reliance on renewable energy may thus be conceptualised as the inverse of the social costs specific to non-renewable energy. The projects will help to develop the in-country skills and knowledge base that will facilitate the implementation of future solar energy projects. The impact is considered to have a regional extent and be of long term duration, and therefore of **high (+)** significance with and without mitigation.

Contribution to population influx

Due to its small size, it is doubtful whether these PV projects by themselves will be large enough to elicit any substantial in-migration of job seekers. However, it is possible that they will contribute a small percentage to the existing influx particularly in the Mariental and Okahandja areas. This influx would have the potential to add to the impacts described earlier in respect of the presence of non-local construction workers. The impact is considered to be local in extent and of medium term duration, and therefore of **medium (-)** significance with and without mitigation.

6.8.2.5 'No-go' alternative

The implication of the 'No-go' alternative on the socio-economic environment of the study area will simply be that none of the positive or negative impacts identified will materialise.

[17] 120 MW Van Eck power Station; Paratus/ANIXAS Diesel Generator Power Station (24MW and 22MW respectively) and Ruacana 249 MW

Similarly, the potential contributions predicted with regards to cumulative impacts will also be negated. As the 'No-go' is the baseline against which the other impacts are measured no impacts would result.

6.8.3 Mitigation Measures

The following mitigation measures are recommended to improve positive socio-economic impacts and reduce negative socio-economic impacts:

- The contractor shall be required to employ local labour where possible. The requirement to employ local labour must be incorporated in the contractor`s contract. Follow-up compliance monitoring shall be undertaken.
- The tender criteria shall require training and skills development of the workforce by the contractor. Where possible, training shall be aimed at providing skills to employees that will enable them to apply for permanent positions during the operation of the facilities.
- Recruitment by the contractor shall be contracted from one or more central office(s) in the nearest town. The IPP must investigate the location of the nearest offices.
- Where possible encourage the use of local suppliers for procurement of goods, materials and services.
- The IPP shall engage with relevant regional and constituency committees to set up a database for skills and small businesses. The database will facilitate local employment and procurement of resources; it must be set up before the construction contractor has been appointed.
- Investigate opportunities that encourage indirect employment creation in the informal sector. This can be done in-house by the IPP or through a specialist consultant. Should food stalls be allowed, institute a periodic health and safety inspections on them.
- If feasible, labour-based methods of construction must be used.
- The IPP shall provide the relevant municipal councillors with information on the required number of non-local construction workers that are to be included in service delivery plans.
- Implement awareness campaigns targeted at HIV/AIDS, alcohol and substance abuse as well as gender based violence prevention in neighbouring communities.
- The IPP shall ensure the health of its employees and their dependants by adopting rigorous health programmes, including those to combat HIV/AIDS and tuberculosis.
- Awareness and prevention programmes for HIV/AIDS and Sexually Transmitted Diseases must be set as conditions by the contractor for all suppliers and sub-contractors.
- The contractor shall provide an adequate supply of free condoms to all workers and these must be located in accessible areas on the construction sites;
- Introduce a voluntary counselling and testing programme during the construction phase and continue this through operations. This is to be undertaken in conjunction with the existing voluntary counselling and testing programmes of NamPower.
- The contractor shall undertake a HIV/AIDS and Sexually Transmitted Diseases prevalence survey amongst all workers regularly. The results of the survey shall be made available to management and workers at the same time in statistical terms to ensure confidentiality.

- The IPP shall align awareness campaigns with those of other institutions in the area and must use various common-practice methodologies in order to ensure social and cultural sensitivity.
- Daily construction activities shall end before nightfall
- Implement clear identification of construction workers (including identifiable attire and tags.
- Establish clear rules and regulations for access to the construction sites.
- Liaise with local Community Policing Forums and police.
- Train construction workers in the use of fire-fighting equipment that is available onsite.
- Ensure sufficient supply and adequate facilities (waste disposal, ablutions, entertainment) onsite.
- Refuse shall be discarded in sealed bins or cover skips and shall be removed from site at regular intervals (at least once a week) and disposed at approved disposal sites.
- Strictly enforce rules of conduct with regard to sanitation, water and waste management onsite as stipulated in the EMP.
- Ensure adequate monetary compensation to property owners for the parcel of property purchased.
- Ensure that set travelling speeds are enforced by monitoring vehicle travelling speed and erecting speed signs as well as humps.
- Implement adequate maintenance of roads to prevent deterioration of road surfaces due to heavy vehicle traffic.
- Ensure that junctions of access roads and public roads are regulated at all times, with construction vehicles yielding to oncoming traffic.
- Restrict unauthorised access to the construction site through appropriate fencing and security.
- Appoint Community Liaison Officers to work together with the ECO to ensure communication, and prompt addressing of problems.
- The contractor shall be required to employ skilled or semi-skilled local labour (depending on their capacity to operate the facility). The requirement to employ local labour must be incorporated in the contractor`s contract. Follow-up compliance monitoring shall be undertaken.
- Recruitment by the contractor shall be contracted from one or more central office in the nearest town. The IPP must investigate location of the nearest offices.
- Where possible encourage the use of local suppliers for procurement of goods, materials and services.
- Implement training and capacity building programmes to enhance the ability of local community members to take advantage of available employment opportunities.
- Maximise the use of local labour on decommissioning activities.
- Provide adequate notification to staff and other stakeholders of the pending decommissioning.
- Provide staff with references so that they can pursue work with other companies.
- If feasible, assist staff in finding employment at other operations.

6.8.4 Socio-economic Impact Table

Table 42 indicates how the significance ratings of the various socio-economic impacts were derived.

6.8.5 Socio-economic summary

The field survey and assessment presented here confirms that there will be negative and positive social impacts attributed to the proposed project. The identified social impacts are identical for all the three project sites. The implementation of mitigation measures is expected to reduce the significance of negative impacts to acceptable levels, while positive impacts will on average be significantly enhanced to maximise benefits to the surrounding communities. No difference will result from the alternatives being considered.

6.9 NOISE QUALITIES OF THE THREE SITES

The three PV facilities are proposed in rural areas and people occupying surrounding areas might be sensitive to any additional noise. Noise is generally defined as unwanted sound transmitted through a compressible medium such as air. Sound in turn, is defined as any pressure variation that the ear can detect. Human response to noise is complex and highly variable as it is subjective rather than objective. Potential noise impacts were therefore assessed qualitatively based by the Aurecon EIA team. The findings and recommendations are provided below.

6.9.1 Description of the Environment

The closest town to the proposed Hardap PV site is Mariental at 8 km away, Omburu PV site located approximately 11 km from Omaruru and Okahandja, located 19 km from the proposed Osona PV site. The current noise levels are that of a typical farming environment and the major source of noise generation would be the access roads (the M29 gravel road adjacent to the Hardap substation, the C36 gravel road adjacent to the Omburu substation and the tarred M87 road adjacent to the Osona substation). Apart from the landowners, the closest receptors to Hardap are people travelling along the M29 road. The only receptors identified in the Omburu region, apart from the landowners, were the people travelling along the C36 gravel access road and livestock/ game farmers in the surrounding areas. However these receptors are unlikely to be sensitive to noise. Two receptors were identified within the Osona area, namely Gross Barmen Hot Springs Resort and the D1972 access road. The D1972 is located adjacent to the site which is 3 km from the Gross Barmen resort. The receptors (people in cars, trucks and on bicycles) travelling along the D1972 are unlikely to be sensitive.

Table 42 | Assessment of socio-economic impacts

	Key Impacts	Mitigation	Extent	Duration	SIGNIFICANCE	Probability	Confidence	Reversibility
Construction phase for all three facilities	Employment creation during construction	Without Mitigation	Regional	Construction period	Low (+)	Very likely	Sure	N/A
		With mitigation	Regional	Construction period	Medium (+)	Very likely	Sure	N/A
	Presence of construction workers	Without Mitigation	Local	Construction period	Medium (-)	Very likely	Sure	Reversible
		With mitigation	Site specific	Construction period	Low (-)	Very likely	Sure	Reversible
	Displacement of land uses	Without Mitigation	Local	Construction period	Medium (-)	Very likely	Sure	Reversible
		With mitigation	Local	Construction period	Medium (-)	Very likely	Sure	Reversible
	Physical intrusion impacts	Without Mitigation	Site specific	Construction period	Low (-)	Very likely	Sure	Reversible
		With mitigation	Site specific	Construction period	Very low (-)	Very likely	Sure	Reversible
Operational phase for all three facilities	Employment creation during operation	Without Mitigation	Regional	Long term	Medium (+)	Very likely	Sure	N/A
		With mitigation	Regional	Long term	Medium (+)	Very likely	Sure	N/A
Decommissioning phase for all three facilities	Change in employment requirements during decommissioning	Without Mitigation	Local	Decommissioning	Medium (-)	Very likely	Sure	N/A
		With mitigation	Site specific	Construction period	Low (-)	Very likely	Sure	Reversible
	Restoration of previous land uses	Without Mitigation	Site specific	Long term	Low (+)	Very likely	Unsure	Reversible
		With mitigation	Site specific	Long term	Low (+)	Very likely	Unsure	Reversible

6.9.2 Noise Impact Assessment

Construction phase impacts anticipated for the three PV facilities

The construction phase is expected to have the most notable impact on environmental noise levels. Construction related noise is mostly associated with the use of diesel mobile equipment, earthworks, concrete batching and building finishing operations. The level and character of the construction noise will be highly variable as different activities with different plant/ equipment take place at different times, over different periods, in different combinations, in different sequences and on different parts of the construction site. It is anticipated that noise levels would dramatically reduce within one to two km of the site and hence would have limited impact on the nearest sensitive receptors who are located further away than this.

The noise impacts are considered to be of medium magnitude, local extent and construction and therefore of **low (-)** significance, which will be reduced to **very low (-)** significance with mitigation.

The probability of the impact arising is probable, the confidence in the assessment is considered as sure and the impact is reversible.

Operational phase impacts anticipated for the three PV facilities

It is expected that noise will be generated from the following operational phase installations and activities:

- Power inverters and electrical substations.
- Corona noise from overhead power lines.
- Maintenance and operation of PV arrays and support structures.
- Traffic.

Whereas the PV arrays' tracking motors will generate some noise during the day, other operations, such as the cleaning of the PV panels may occur during night-time. Transformers typically emit a predominant pure tone of 100 Hertz[18], which is not loud in volume. It is expected that the slight increase in traffic would be immaterial in comparison with current traffic related noise. Given the distant location of sensitive receptors to site the noise impacts are considered to be of very low magnitude, local extent and long term in duration prior to mitigation and therefore of **very (-)** significance, without and with mitigation.

Decommissioning phase impacts anticipated for the three PV facilities

The noise impacts during the decommissioning phase are considered to be of medium magnitude, local extent and during decommissioning phase and therefore of **low (-)** significance, which will be reduced to **very low (-)** significance with mitigation.

6.9.2.1 Cumulative impacts

The potential for cumulative noise impacts exists near major roads. The cumulative noise impacts are considered to be insignificant as there are no major roads close to the proposed facilities and the nearest permanent sensitive receptors are located over 1 km from the sites.

[18] The number of pressure variations per second is referred to as the frequency of sound and is measured in hertz. The hearing of a young, healthy person ranges between 20 hertz and 20 000 hertz.

6.9.2.2 'No-go' impacts

If the *status quo* persists, the noise levels will remain unchanged and the impact is therefore considered to be neutral.

6.9.3 Mitigation Measures

The following mitigation measures are recommended to reduce noise impacts:

- Design electrical buildings to minimise the transmission of noise from inside to the outdoors.
- Insulation particularly noisy operation phase plant and equipment.
- Keep all plant, equipment and vehicles in good repair.
- Ensure project design take into account the maximum allowable equivalent continuous day and night rating levels of the potentially impacted sites outside the project boundary. Where the noise level at such an external site is presently lower than the maximum allowed, the maximum shall not be exceeded.
- Limit noisy maintenance to daylight hours.
- Place construction site yards, workshops, concrete batching plants, and other noisy fixed facilities as far from the identified receptors as possible.
- Encapsulate stationary noisy equipment such as compressors and pumps in acoustic covers, screens or sheds where possible.
- Ensure that all diesel powered equipment is regularly maintained and kept at a high level of maintenance. This must particularly include the regular inspection and, if necessary, replacement of intake and exhaust silencers. Any change in the noise emission characteristics of equipment must serve as trigger for withdrawing it for maintenance.
- Combine noisy operations such as use of diesel mobile equipment, earthworks and concrete batching so that they occur, where possible, at the same time.
- Shut down machines used intermittent in the intervening periods between work or throttle down to a minimum.
- Contain construction activities to reasonable hours during the day. Any construction activities to be undertaken at night must be approved by the resident engineer.
- Do not allow construction on weekends from 14h00 on Saturday afternoons to 06h00 the following Monday morning.
- Ensure that the contractor liaises with local residents and owners on how best to minimise impacts with regard to unavoidable very noisy construction activities in the vicinity of noise sensitive areas. The local population should be kept informed of the nature and duration of intended activities.
- Manufacturers shall be requested to provide details of the sound power level when ordering plant and machinery. Where possible, those with the lowest sound power level (most quiet) should be selected.

6.9.4 Noise Impact Table

Table 43 indicates how the significance ratings of the various noise impacts were derived.

Table 43 | Assessment of noise impacts anticipated at all three PV facilities

Project	Key impacts	Mitigation	Extent	Magnitude	Duration	SIGNIFICANCE	Probability	Confidence	Reversibility
Construction phase	Noise impacts	Without Mitigation	Local	Medium	Construction	Low (-)	Probable	Sure	Reversible
		With mitigation	Local	Low	Construction	Very Low (-)	Probable	Sure	Reversible
Operational phase	Noise impacts	Without Mitigation	Local	Very low	Long term	Very low (-)	Probable	Unsure	Reversible
		With mitigation	Local	Very low	Long term	Very low (-)	Probable	Unsure	Reversible
Decommissioning phase	Noise impacts	Without Mitigation	Local	Medium	Decommission	Low (-)	Probable	Sure	Reversible
		With mitigation	Local	Low	Decommission	Very Low (-)	Probable	Sure	Reversible
	'No-go' alternative	NA	Site specific	Zero	Long term	Neutral	Probable	Unsure	NA

6.9.5 Noise summary

No difference will result from the alternatives being considered and all alternatives could proceed.

6.10 AIR QUALITY OF THE THREE SITES

The construction and operation of the proposed PV projects could result in air quality impacts, through the generation of dust. According to the US-Environmental Protection Agency, electricity generation from solar technologies results in negligible emissions since no fuels are combusted[19]. However, air pollution in the form of dust emissions will occur during the construction phase. Activities associated with dust generation during the construction phase include vegetation removal and land clearing, scraping and grading, and the construction of building and roads. Gaseous emissions would primarily be a result of construction equipment.

These could impact negatively on the health of the surrounding communities if mitigation measures are not implemented. The assessment of air quality impacts were based on a desktop review of available literature and the site visit undertaken by the Aurecon EAPs. The findings and recommendations are provided below.

6.10.1 Description of the Environment

Particulates represent the main pollutant of concern at the construction operations of the proposed PV facilities. Airborne particulate matter comprises a mixture of organic and inorganic substances, ranging in size, shape and density. Total Suspended Particulates is associated with dust fallout.

The main existing sources of particulate emissions in the area of the proposed facilities include the M29 gravel road adjacent to the Hardap substation, C36 gravel road adjacent to the Omburu substation and the tarred M87 road adjacent to the Osona substation as well as agricultural livestock activities. The construction activities currently undertaken at the Gross Barmen resort are also a potential source of particulate emissions at the Osona PV facility.

Gaseous emissions will derive from on-site trucks and heavy construction equipment. Vehicles on the access roads will also contribute to these gaseous emissions but as high levels of traffic are not experienced on these internal roads, the contribution is negligible. No ambient monitoring data or dust fallout data are available for the sites.

6.10.2 Air Quality Impact Assessment

Construction phase impacts anticipated for the three PV facilities
Construction phase impacts might occur as a result of:

- Materials handling.
- Dust from vehicles using paved and unpaved roads onsite.
- Windblown dust from stockpiles.
- Windblown dust from stockpiles.
- Vehicle and equipment emissions.

[19] US Environmental Protection Agency. http://www.epa.gov/cleanenergy/energy-and-you/affect/air-emissions.html Accessed on 26 May 2014.

These impacts are described below.

Materials handling

The handling of topsoil and gravel for construction operations could be a potential significant source of dust generation at the various transfer points. The quantity of dust generated depends on various climatic parameters, such as wind speed and precipitation, in addition to non-climatic parameters such as the nature and volume of the material handled. Fine particulates are most readily disaggregated and released to the atmosphere during the material transfer process, as a result of exposure to strong winds. Increases in the moisture content of the material being transferred will decrease the potential for dust emission, since moisture promotes the aggregation and cementation of fines to the surfaces of larger particles.

The number of transfer points, the quantity and moisture content of the material and the hourly wind speed will determine the amount of dust that is given off from the various transfer points. Materials handling operations can be mitigated through chemical dust suppressants that can result in a significant reduction in dust generation.

Dust from vehicles using paved and unpaved roads onsite

Dust emissions from vehicles using paved and unpaved roads are significant, especially where there are high traffic volumes on a road. On unpaved roads in particular, the force of the wheels causes the pulverisation of surface material causing particulates to be lifted and dropped from the rotating wheels, whilst the strong air currents on the road surface cause turbulence which continues after the vehicle has passed. The quantity of dust emissions from unpaved roads increases with the increase of traffic expected on that road.

The level of emissions from paved and unpaved roads depends on the “silt loading” on the road, and to some degree, also the average weight of vehicles using the road. Although a low number of construction trucks are anticipated, it is possible that the traffic on the temporary unpaved roads could be significant sources of dust generation, if uncontrolled. The trucks on paved roads are likely to generate less dust.

Windblown dust from stockpiles

Wind erosion is influenced by atmospheric conditions, soil properties, land-surface characteristics and land-use activities. Windblown dust is generated from natural and anthropogenic sources and requires fairly high wind speeds to exceed a certain threshold to result in erosion. During construction, the proposed topsoil storage piles and cleared land would be the sources of wind-blown dust. A typical wind speed threshold is given as 5.4m/s for storage piles (as applied by the US EPA).

Vehicle and equipment emissions

Gaseous emissions e.g. carbon dioxide, heavy metals, methane, nitrous oxide, would also result from the exhaust fumes of construction vehicles moving in and around the site as well as the use of diesel equipment such as generators on the site. The levels of emissions are considered to be fairly low, in line with general traffic emissions.

The overall air quality impacts are considered to be of medium magnitude, local extent and construction phase in duration prior to mitigation and therefore of **low (-)** significance, without and with mitigation.

Operational phase impacts anticipated for the three PV facilities

Emissions to air associated with the operational phase would arise from maintenance vehicles, both from exhaust fumes and from use of the access roads. The air quality impacts are considered to be of very low magnitude, site specific extent and long term in duration prior to mitigation and therefore of **very low (-)** significance, without or with mitigation. The probability of the impact arising is probable, the confidence in the assessment is considered as unsure and the impact is reversible.

Decommissioning phase impacts anticipated for the three PV facilities

The decommissioning phase will mainly include materials handling activities, wind erosion and to a lesser extent vehicle and equipment movement onsite and on the access road. Smaller dust impacts are anticipated for the decommissioning phase compared to the decommissioning phase and are considered to be of very low magnitude, site specific extent and decommissioning in duration and therefore rated as **very low (-)** with and without mitigation.

6.10.2.1 Cumulative impacts

The potential for cumulative air quality impacts exist near major roads used as haulage routes for other construction or operational activities involving the transport of goods or materials. In terms of the site itself, it is not likely that there are many activities of this scale within the same area of influence as the site and hence no cumulative impacts have been identified. Although a 4.5 MW PV project is proposed approximately 1.5 km from the proposed Osona PV site, this is unlikely to have a cumulative impact on air quality due to the reduced scale of the facility which limits the number of vehicles and the construction period.

6.10.2.1 'No-go' impacts

If the *status quo* persists, the dust levels will remain unchanged and the impact is therefore considered to be neutral.

6.10.3 Mitigation Measures

The following mitigation measures are proposed for all three PV facilities:

- Ensure all reasonable measures are taken to minimise the generation of dust as a result of construction activities. If dust is experienced as a nuisance by nearby residents or businesses, then dust suppression measures shall be implemented onsite. In order to conserve water, dust suppression using water is not recommended, instead chemical dust suppressants such as 'Dustex', may be used provided they are used in the manner prescribed and in areas away from drainage lines.
- Stockpiles shall be located at a suitable distance from any sensitive receptors.
- Ensure all stockpiles that will be exposed to the elements for prolonged periods of time are vegetated or covered by geotextiles or similar erosion protection measures.
- Ensure minimum travel distance between clearing area and topsoil piles as is feasible and as approved by the ECO.
- Ensure exposed areas remain moist through regular dust suppression spraying during dry, windy periods.
- Ensure that vehicles carrying dust susceptible materials have their loads effectively covered/sheeted.

6.10.4 Air Quality Impact Table

Table 44 indicates how the significance ratings of the impacts were derived.

6.10.5 Air quality summary

No difference will result from the alternatives being considered and all could proceed.

6.11 ENERGY PRODUCTION

Historical trends in electricity demand in Namibia have shown a consistent increase in demand. As a result, the generation capacity needs to be increased. The assessment of energy impacts were based on a desktop review of available literature by the Aurecon EIA team. The findings and recommendations are provided below.

6.11.1 Description of the Environment

Namibia has experienced a shortfall in their electricity supply and continues to experience constrained electricity supply[20]. The new high maximum demand is 534 MW and currently the country relies on imports for 60 % of supply and this percentage increases up to 80 % during dry seasons. The installed capacity of energy generating facilities in Namibia is some 498.5 MW– comprising 60% hydro and 40% thermal[21].

Namibia aims to reduce their high reliance on power imports as part of the security of supply plan. NamPower also recognizes the importance of sustainable operations to society. To this end NamPower aim to source at least 10 % of the energy mix from renewables other than hydropower

6.11.2 Energy production Impact Assessment

Construction phase impacts anticipated for the three PV facilities
No impacts are anticipated during the construction phase.

Operational phase impacts anticipated for the three PV facilities
The proposed projects would impact positively on the ability of NamPower to provide electricity, as the 30 MW provided by the proposed facilities represents a 6 % increase of the installed capacity of 498.5 MW.

Given the need for increased production capacity in Namibia, as well as the targeted renewable energy figure and the contribution of the proposed project in meeting this target, the potential impact of the proposed projects on energy production during the operational phase is considered to be of low magnitude, regional and long term and therefore of **low (+)** significance, without or with mitigation measures.

[20] 2013 Annual Report, NamPower.
21 http://www.engineeringnews.co.za/article/namibia-2013-02-22, accessed 29/05/14 and Engineering*News*

Table 44 | Assessment of potential dust impacts

Project	Key impacts	Mitigation	Extent	Magnitude	Duration	SIGNIFICANCE	Probability	Confidence	Reversibility
Construction phase for all three facilities	Air emissions	Without Mitigation	Local	Medium	Construction	Low (-)	Probable	Unsure	Reversible
		With mitigation	Local	Medium	Construction	Low (-)	Probable	Unsure	Reversible
Operational phase for all three facilities	Air emissions	Without Mitigation	Site specific	Very low	Long term	Very low (-)	Probable	Unsure	Reversible
		With mitigation	Site specific	Very low	Long term	Very low (-)	Probable	Unsure	Reversible
Decommissioning phase for all three facilities	Air emissions	Without Mitigation	Site specific	Very low	Decommission	Very low (-)	Probable	Unsure	Reversible
		With mitigation	Site specific	Very low	Decommission	Very low (-)	Probable	Unsure	Reversible
	'No-go' alternative	NA	Site specific	Zero	Long term	Neutral	Probable	Unsure	NA

Table 45 | Assessment of potential energy production impacts

Project	Key impacts	Mitigation	Extent	Magnitude	Duration	SIGNIFICANCE	Probability	Confidence	Reversibility
Operational Phase	Energy production	Without mitigation	Regional	Medium	Long term	Low (+)	Probable	Sure	Reversible
		NA							

Decommissioning phase impacts anticipated for the three PV facilities

The decommissioning phase would be a reverse of the positive impact as the generation capacity of Namibia would be reduced. Therefore the decommissioning impacts would however be a return to the *status quo* and hence would have no impact.

No difference in significance would result from the proposed alternatives.

6.11.3 Mitigation measures

No mitigation measures are recommended.

6.11.4 Energy production Table

Table 45 above indicates how the significance ratings of the impacts were derived.

6.11.5 Energy production summary

No difference will result from the alternatives being considered and all could proceed.

6.12 TRAFFIC OF THE THREE SITES

A Traffic Statements compiled by Aurecon Namibia provides a professional opinion on the condition of existing roads to accommodate the estimated construction traffic associated with the three proposed PV facilities. The comment also considered the proposed positions of access points from the existing roads. The possible impacts were discussed with the Roads Authority (RA) Divisional Engineer for Maintenance to get a better understanding of current and future maintenance and upgrading plans. As the traffic associated with the proposed developments is low, and the roads are not heavily used by the public, other traffic issues were not considered significant and have not been assessed in detail in this EIA. A brief summary of the findings and recommendations are provided below and the full comment is included in Annexure E6.

6.12.1 Description of the Environment

6.12.1.1 Hardap PV facility

The Hardap site can be accessed via a gravel road MR29 from Mariental as indicated in Figure 64.

Figure 64 | MR29 access road to the proposed Hardap PV site

The proposed alternative access points to the site are approximately 8.3 km and 9.4 km from Mariental. The first 6 km section from Mariental is fairly flat and has no obvious shortcomings in the horizontal and vertical alignments. This section is followed by a section of about 1.3 km with very steep slopes (from bottom to top of plateau), with gradients as high as 12 %. The Hardap site is on top of a plateau as indicated in Figure 65. The gravel road MR29 from Mariental has an average effective width of 9 m. The road is regularly graded, but problems are experienced on very steep sections

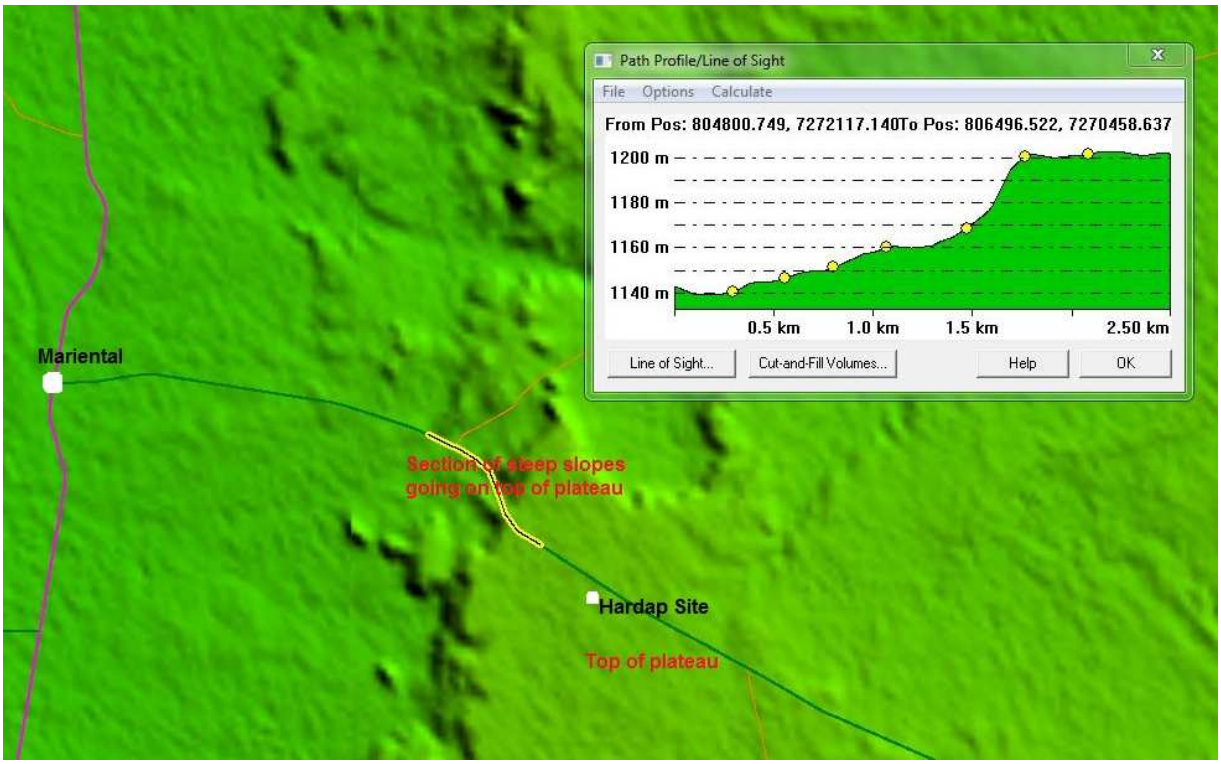


Figure 65 | Illustration of steep slopes to the Hardap Site

6.12.1.2 Omburu PV facility

The Omburu site can be accessed via a gravel road MR80 which runs from bitumen road TR2/3 (Karibib to Omaruru) to bitumen road TR7/1 (Karibib to Okahandja). A feasibility study is at present being conducted by the Roads Authority for the rehabilitation of TR2/3, whilst TR7/1 was rehabilitated in 2011. The gravel road MR80 route traverses relatively flat terrain with no obvious shortcomings in the horizontal and vertical alignments. The average effective width of the road is 9 m and the surface condition is in a relatively fair state but needs re-graveling. The road experiences isolated wash-outs during rainy seasons as it crosses a number of small streams as indicated in Figure 66, but remains passable as drainage structures are provided.

6.12.1.1Osona PV facility

The Osona site can be accessed via a bitumen road MR87 from Okahandja. The proposed alternative access points to the site are approximately 20.9 km and 22 km along MR87 from Okahandja.

The condition of MR87 is a bitumen surfaced road constructed to high engineering standards as indicated in Figure 67. The road is in good condition and was resealed in 2013 to improve its surfacing condition.

Figure 66 | MR80 access road to the proposed Omburu PV site

Figure 67 | MR87 access road to the proposed Osona PV site

6.12.2 Traffic Statement

The potential impacts of additional traffic on surrounding roads are discussed below.

It is estimated that heavy traffic during construction would amount to 60 truckloads, transporting in total 120 40-foot containers per 10 MW PV facility. The truckloads would be spaced out over the 12 to 18 construction months. An average of 60 truckloads per PV facility distributed over a period 12 to 18 month period is an acceptable loading especially considering that there will be no abnormal truckloads. The RA indicated that they will inform their affected maintenance regions of the possible PV developments and resultant increase in heavy traffic, should the facilities be approved. No abnormal truckloads are anticipated. Traffic during the operational and maintenance stage of the proposed facilities is expected to be insignificant.

Based on the above, the following conclusions are made:

Hardap PV facility

Although the gravel road MR29 is generally in good condition, it is anticipated that the section with steep slopes may cause problems to heavy vehicles en route to the Hardap site. Fully loaded

heavy vehicles will travel slowly when going uphill and this may be a safety risk to fast travelling motor vehicles particularly during dusty conditions. During rain storms the steep slopes are prone to wash-outs and will also be very slippery.

On top of the plateau the proposed access points from MR29 are on straight and flat sections and therefore no sight distance problems are foreseen.

Constructing new intersections at access points will be part of the new development and the intersections will need to be approved by the RA during the detail design stage.

Omburu PV facility

The proposed access point on MR80 to the site is approximately 5.7 km from TR2/3 and 62 km from TR7/1. Although TR2/3 shows signs of severe distress with rutting and potholes, it is still expected that both bitumen roads (TR2/3 and TR7/1), will be able to carry the expected truckloads and that the additional trucks would not deteriorate the roads significantly. The gravel road MR80 is currently in an acceptable condition to provide access to Omburu. The position of the access point from MR80 to the preferred site is on a straight and flat section and no sight distance problems are foreseen. Permission will need to be obtained from the RA during the detail design stage for the proposed new access point on MR80 to the preferred PV site. Construction of the new access will be part of the new development.

Osona PV facility

No problems are foreseen with access to Osona site since it is accessed via a bitumen road and the access points are on relatively straight and flat sections MR87 constructed to high engineering standards. Also no sight distance problems are foreseen at the proposed access points from MR87 to the preferred site. Permission will need to be obtained from the RA during the detail design stage to construct a new access onto MR87 or to upgrade the existing access. This work will be done as part of the contract to build the new PV facility at the Osona site.

6.12.3 Mitigation Measures

The RA is responsible for the maintenance of trunk and main roads providing access to the respective PV sites. The roads are in a good to fair condition during the dry season. While stormwater erosion may occur on gravel roads during the rainy season, the roads will remain passible, but should be used with care. The proposed project and PV sites have been discussed with the RA and the maintenance division undertook to do regular grading of the roads during the construction period.

Access from the district road to the respective site will be provided by the contractor (s) appointed to construct the PV facilities.

The following mitigation measures are also recommended:

- Enter and exit roadways and construction areas shall be demarcated at the entrances.
- Erect signage to warn motorists about construction activities and heavy vehicle movement where appropriate.
- Implement traffic control measures where necessary.
- Vehicles associated with the project shall remain on designated routes.
- Vehicles carrying materials shall have their loads effectively covered/sheeted.

- Dirt/Spoil deposits on public roads arising from construction traffic shall be cleared on a daily basis or as required.
- The holder of the ECC shall inform the RA well in advance when actual construction at each PV site will commence when this information is available.
- The intersection of each respective access road to the PV site needs to be designed by a professional engineer and submitted to the RA for approval.

6.12.4 Traffic statement summary

No difference will result from the alternatives being considered and all could proceed.

6.13 HAZARDOUS SUBSTANCES ONSITE OF THE THREE SITES

6.13.1 Description of the Environment

As at any construction site, small volumes (less than 5 m^3) of various hazardous substances are likely to be used and stored onsite. These substances may include amongst other things, diesel, curing compounds, shutter oil and cement. Utilisation of such substances in close proximity to aquatic environments such as drainage lines are of greater concern than when used in a terrestrial environment.

6.13.2 Hazardous substances Impact assessment

The volumes that would be stored onsite are considered to be insignificant, however the significance of spillages of hazardous substances is considered to be of medium magnitude, local extent and long term and therefore of **medium (-)** significance. However, with the implementation of mitigation measures this impact is considered to be negligible.

6.13.3 Mitigation measures

The necessary precaution measures have been included in the EMP and include, amongst others storage of the material in a bunded area, with a volume of 110 % of the largest single storage container or 25 % of the total storage containers whichever is greater, refuelling of vehicles in designated areas that have a protective surface covering and utilisation of drip trays for stationary plant.

6.13.4 Hazardous substances Impact Table

Table 44 indicates how the significance ratings of the impacts were derived.

6.13.5 Hazardous substances summary

No difference will result from the alternatives being considered and all could proceed.

Table 46 | Assessment of hazardous substances impacts

Project	Key impacts	Mitigation	Extent	Magnitude	Duration	SIGNIFICANCE	Probability	Confidence	Reversibility
Construction phase	Spillage of hazardous substances	Without Mitigation	Local	Medium	Construction	Medium (-)	Probable	Sure	Reversible
		With mitigation	Local	Zero	Long term	Negligible	Probable	Sure	Reversible
Operational phase	Spillage of hazardous substances	Without Mitigation	Local	Medium	Long term	Medium (-)	Probable	Sure	Reversible
		With mitigation	Local	Zero	Operation	Negligible	Probable	Sure	Reversible
Decommissioning phase	Spillage of hazardous substances	Without Mitigation	Local	Medium	Decommission	Medium (-)	Probable	Sure	Reversible
		With mitigation	Local	Zero	Decommission	Negligible	Probable	Sure	Reversible
Cumulative impacts	Low quantities to be stored so no cumulative impacts anticipated.								

6.14 IMPACT ON CLIMATE CHANGE

The establishment of PV facilities would reduce Namibia's future reliance on energy from coal-fired power stations which could in turn reduce the future volume of greenhouse gases emitted to the atmosphere, reducing the greenhouse effect on a regional, national and international scale.

6.14.1 Description of the Environment

Gases that contribute to the greenhouse effect are known to include carbon dioxide (CO_2), methane, water vapour, nitrous oxide, chloroflurocarbons, halons and peroxyacylnitrate. All of these gases are transparent to shortwave radiation reaching the earth's surface, but trap long-wave radiation leaving the earth's surface, acting like a greenhouse. This action leads to a warming of the earth's lower atmosphere, with changes in the global and regional climates, rising sea levels and extended desertification. This in turn is expected to have severe ecological consequences and a suite of implications for humans.

The *Namibian Greenhouse Gas Inventory for Year 2000* has been prepared for the MET. The results for CO_2-equivalent emissions and removals clearly indicate that the agriculture and energy sectors are most important with respect to emissions, and the land-use change and forestry sector is most important with respect to sequestration (absorbing of emissions). Namibia produces no fossil fuels of its own, nor refines/ processes any fuels (MET, 2008). 0.38 metric tons of carbon per capita was generated in Namibia during 2010 as indicated in Figure 68, in comparison to South Africa who generated 2.5 metric tons of carbon per capita[22]

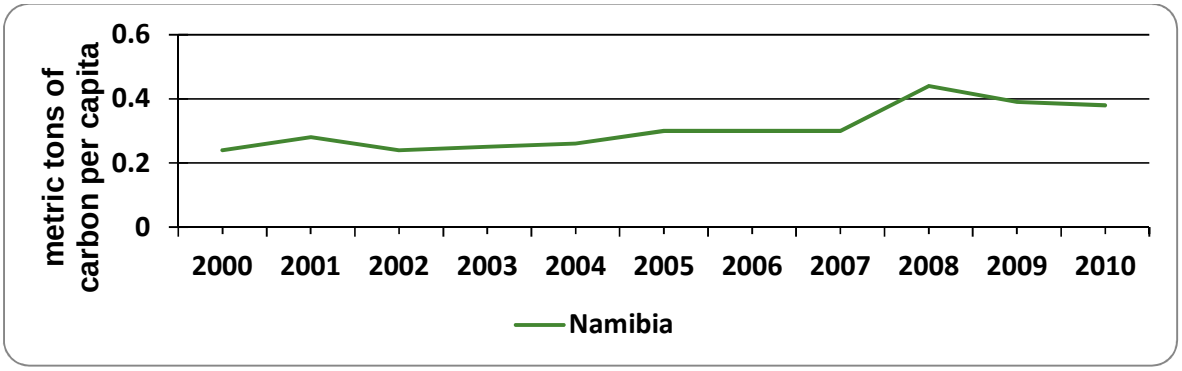


Figure 68 | Per capita CO_2 emissions (metric tons of carbon) for Namibia

6.14.2 Climate Change Impact Assessment

Construction phase impacts for all three PV facilities

Greenhouse gases released from a new coal-fired power station are primarily CO_2 with minor amounts of nitrous oxide. The Medupi Power Station, currently under construction near Lephalale in South Africa, will have a capacity of 4 788MW and is expected to produce 29.9 million metric tons of CO_2 per annum. This would be a significant increase in greenhouse gas emissions, and given the aims of the Kyoto Protocol, which are to reduce overall emission levels, the increase in greenhouse gas emissions must be viewed in light of global trends to reduce these emissions.

[22] Knoema, 2014. http://knoema.com/CDIACGNCO2E2013/fossil-fuel-co2-emissions-by-nation-2013?regionId=NA. Accessed on 26 May 2014.

Environmental impacts associated with renewables, as opposed to fossil fuels such as coal, are significantly less over the entire life-cycle.

Operational phase impacts for all three PV facilities

No greenhouse gases are produced by PV facilities during operation, as PV facilities use solar energy to generate electricity. Although PV facilities would not completely replace coal-fired power stations within Namibia, they would reduce reliance on them. This would assist in reducing future volumes of greenhouse gas emissions. While the proposed PV facilities would not provide an equivalent amount of energy to a typical new coal-fired power station due to lower efficiencies, when considered with regards to climate change and given the spirit of the Kyoto Protocol and that of the Copenhagen Accord, the impact is deemed to be of regional extent, low magnitude and long term and therefore of **medium (+)** significance, without mitigation.

6.14.2.1 Cumulative impacts

Namibia could house many more PV facilities which would have the potential for reduction in future greenhouse gas emissions through a reduce reliance on coal-fired power stations.

6.14.3 Mitigation measures

No mitigation measures are recommended.

6.14.4 Climate change summary

No difference will result from the alternatives being considered and all could proceed.

7 RECOMMENDATIONS AND CONCLUSION

This section concludes the report and provides information on the way forward.

7.1 CONCLUSIONS

The proposed project consists of three proposed 10 MW PV facilities at the Hardap substation near Mariental, Omburu substation near Omaruru and Osona substation near Okahandja. As required by EMA, alternatives were investigated as listed below.

Hardap 10 MW PV facility

- Location alternative: Hardap1.
- **Technology**: Fixed tilt PV and Single-axis tracking.
- **Access and haulage routing**: Hardap Road 1 and Hardap Road 2.
- 'No–go' alternative.

Omburu 10 MW PV facility

- Location alternative: Omburu3.
- **Technology**: Fixed tilt PV and Single-axis tracking.
- **Access and haulage routing**: Omburu Road 1.
- 'No–go' alternative.

Osona 10 MW PV facility

- Location alternative: Osona1.
- **Technology**: Fixed tilt PV and Single-axis tracking.
- **Access and haulage routing**: Osona Road 1 and Osona Road 2.
- 'No–go' alternative.

This Scoping Report provides a comprehensive assessment of the environmental issues associated with each of the abovementioned alternatives of the proposed project. The environmental and social impacts and alternatives were derived in response to inputs from consultation with I&APs, provincial and local authorities, and the EIA project team. Table 47, Table 48 and Table 49 provide summaries of the significance of the environmental impacts at each site associated with this proposed project.

Table 47 | Summary of significance of the potential impacts associated with the proposed Hardap PV facility

IMPACTS- HARDAP		Construction		Operation		Decommissioning	
		No Mitigation	With Mitigation	No Mitigation	With Mitigation	No Mitigation	With Mitigation
Impact on ecology (flora and fauna)	Destruction of vertebrate fauna (e.g. road kills; fence and pylon mortalities)	Low (-)	Very low (-)	Medium (-)	Low (-)	-	-
	Loss of unique flora and special habitats as a result of access road alternatives and transmission corridors	Low (-)	Very low (-)			-	-
	Provide ideal habitat for alien vegetation to establish	-	-	-	-	Very low (-)	Very low (-)
	Access road alternatives and transmission corridor	-	-	-	-	Low (-)	Very low (-)
	Avifauna Impacts	High (-)	Medium (-)	High (-)	Medium (-)	High (-)	Medium (-)
	'No–go'	Neutral		Neutral		Neutral	
Impact on agriculture	Hardap PV site	Low (-)	Very low (-)	-	-	Very low (-)	Very low (-)
	'No–go'	Neutral		Neutral		Neutral	
Impact on surface water	Hardap PV site	Very low (-)	Very low (-)	Very low (-)	Very low (-)	Low (-)	Very low (-)
	'No–go'	Neutral		Neutral		Neutral	
Groundwater impacts	Hardap PV site	Low to medium (-)	Very low (-)	Low (-)	Very low (-)	-	-
	'No–go'	Neutral		Neutral		Neutral	
Impact on archaeology	Hardap PV site	Medium (-)	Low (-)	Medium (-)	Low (-)	-	-
	'No–go'	Neutral		Neutral		Neutral	
Visual impacts	Alternative 1: Conventional PV 5m	Very low (-)	Very low (-)	Low (-)	Low (-)	Very low (-)	Very low (-)
	Alternative 2: Tracking PV 15m	Low (-)	Low (-)	Medium (-)	Medium (-)	Low (-)	Low (-)
	Road Access 1	Low (-)	Very low (-)	Low (-)	Very Low (-)	Low (-)	Low (-)
	Road Access 2	Very Low (-)	Very Low (-)	Very Low (-)	Very Low (-)	Very low (-)	Very low (-)
	'No–go'	Neutral		Neutral		Neutral	
Socio-economic	Employment creation during construction	Low (+)	Medium (+)	Medium (+)	Medium (+)	Medium (-)	Low (-)
	Presence of construction workers	Medium (-)	Low (-)	-	-	-	-
	Displacement of land uses	Medium (-)	Medium (-)	-	-	Low (+)	Low (+)

IMPACTS- HARDAP		Construction		Operation		Decommissioning	
		No Mitigation	With Mitigation	No Mitigation	With Mitigation	No Mitigation	With Mitigation
	Physical intrusion impacts	Low (-)	Very low (-)	-	-	-	-
	'No–go'						
Noise impact	Hardap PV site	Low (-)	Very low (-)	Very low (-)	Very low (-)	Low (-)	Very low (-)
	'No–go'	Neutral		Neutral		Neutral	
Dust impacts	Air Emissions	Low (-)	Low (-)	Very Low (-)	Very low (-)	Very low (-)	Very low (-)
	'No–go'	Neutral		Neutral		Neutral	
Hazardous substances	Spillage of hazardous substances	Medium (-)	Negligible	Medium (-)	Negligible	Medium (-)	Negligible

Table 48 | Summary of significance of the potential impacts associated with the proposed Omburu PV facility

IMPACTS- OMBURU		Construction		Operation		Decommissioning	
		No Mitigation	With Mitigation	No Mitigation	With Mitigation	No Mitigation	With Mitigation
Impact on ecology (flora and fauna)	Destruction of vertebrate fauna (e.g. road kills; fence and pylon mortalities)	Low (-)	Very low (-)	Medium (-)	Low (-)	-	-
	Loss of unique flora and special habitats as a result of access road alternatives and transmission corridors	Low (-)	Very low (-)			-	-
	Provide ideal habitat for alien vegetation to establish	-	-	-	-	Very low (-)	Very low (-)
	Access road alternatives and transmission corridor	-	-	-	-	Low (-)	Very low (-)
	Avifauna Impacts	High (-)	Medium (-)	High (-)	Medium (-)	High (-)	Medium (-)
	'No–go'	Neutral		Neutral		Neutral	
Impact on Agriculture	Omburu PV site	Low (-)	Very low (-)	-	-	Very low (-)	Very low (-)
	'No–go'						
Impact on Surface Water	Omburu PV site	Very low (-)	Very low (-)	Very low (-)	Very low (-)	Low (-)	Very low (-)
	'No–go'						
Groundwater impacts	Omburu PV site	Low to medium (-)	Very low (-)	Low (-)	Very low (-)	-	-

IMPACTS- OMBURU		Construction		Operation		Decommissioning	
		No Mitigation	With Mitigation	No Mitigation	With Mitigation	No Mitigation	With Mitigation
	'No–go'						
Impact on archaeology	Omburu PV site	Medium (-)	Low (-)	Medium (-)	Low (-)	-	-
	'No–go'	Neutral		Neutral		Neutral	
Visual impacts	Alternative 1: Conventional PV 5m	Very low (-)	Very low (-)	Low (-)	Very low (-)	Very low (-)	Very low (-)
	Alternative 2: Tracking PV 15m	Medium (-)	Medium (-) or Low (-)[23]	High (-)	Medium (-) or Low (-)[24]	Very low (-)	Very low (-)
	Road Access	Very low (-)	Very low (-)	Low (-)	Low (-)	Very low (-)	Very low (-)
	'No–go'	Neutral		Neutral		Neutral	
Socio-economic	Employment creation during construction	Low (+)	Medium (+)	Medium +)	Medium (+)	Medium (-)	Low (-)
	Presence of construction workers	Medium (-)	Low (-)	-	-	-	-
	Displacement of land uses	Medium (-)	Medium (-)	-	-	Low (+)	Low (+)
	Physical intrusion impacts	Low (-)	Very low (-)	-	-	-	-
	'No–go'						
Noise impact	Omburu PV site	Low (-)	Very low (-)	Very low (-)	Very low (-)	Low (-)	Very low (-)
	'No–go'	Neutral		Neutral		Neutral	
Dust impacts	Air Emissions	Low (-)	Low (-)	Very low (-)	Very low (-)	Very low (-)	Very low (-)
		Neutral		Neutral		Neutral	
Hazardous substances	Spillage of hazardous substances	Medium (-)	Negligible	Medium (-)	Negligible	Medium (-)	Negligible

Table 49 | Summary of significance of the potential impacts associated with the proposed Osona PV facility

IMPACTS- OSONA	Construction		Operation		Decommissioning	
	No Mitigation	With Mitigation	No Mitigation	With Mitigation	No Mitigation	With Mitigation

IMPACTS- OSONA		Construction		Operation		Decommissioning	
		No Mitigation	With Mitigation	No Mitigation	With Mitigation	No Mitigation	With Mitigation
Impact on ecology (flora and fauna)	Destruction of vertebrate fauna (e.g. road kills; fence and pylon mortalities)	Low (-)	Very low (-)	Medium (-)	Low (-)	-	-
	Loss of unique flora and special habitats as a result of access road alternatives and transmission corridors	Low (-)	Very low (-)			-	-
	Provide ideal habitat for alien vegetation to establish	-		-		Very low (-)	Very low (-)
	Access road alternatives and transmission corridor	-		-		Low (-)	Very low (-)
	Avifauna Impacts	High (-)	Medium (-)	High (-)	Medium (-)	High (-)	Medium (-)
	'No–go'	Neutral		Neutral		Neutral	
Impact on Agriculture	Osana PV site	Low (-)	Very low (-)	-	-	Very low (-)	Very low (-)
	'No–go'						
Impact on Surface Water	Osana PV site	Very low (-)	Very low (-)	Very low (-)	Very Low (-)	Low (-)	Very low (-)
	'No–go'						
Groundwater impacts	Osana PV site	Low to medium (-)	Very low (-)	Low (-)	Very low (-)	-	-
	'No–go'						
Impact on archaeology	Osana PV site	Medium (-)	Low (-)	Medium (-)	Low (-)	-	-
	'No–go'	Neutral		Neutral		Neutral	
Visual impacts	Alternative 1: Conventional PV 5m	Very low (-)	Very low (-)	Low (-)	Very low (-)	Very low (-)	Very low (-)
	Alternative 2: Tracking PV 15m	Medium (-)	Medium (-) or Low (-)[25]	High (-)	Medium (-) or Low (-)[26]	Very low (-)	Very low (-)
	Road Access 1	Low (-)	Very low (-)	Medium (-)	Very low (-)	Low (-)	Very low (-)
	Road Access 2	Very low (-)	Very low (-)	Very low (-)	Very low (-)	Low (-)	Very low (-)
	'No–go'	Neutral		Neutral		Neutral	
Socio-economic	Employment creation during construction	Low (+)	Medium (+)	Medium (+)	Medium (+)	Medium (-)	Low (-)

[25] With the implementation of a 7 m height limit.
[26] With the implementation of a 7 m height limit.

IMPACTS- OSONA		Construction		Operation		Decommissioning	
		No Mitigation	With Mitigation	No Mitigation	With Mitigation	No Mitigation	With Mitigation
	Presence of construction workers	Medium (-)	Low (-)	-	-	-	-
	Displacement of land uses	Medium (-)	Medium (-)	-	-	Low (+)	Low (+)
	Physical intrusion impacts	Low (-)	Very low (-)	-	-	-	-
	'No–go'						
Noise impact	Osana PV site	Low (-)	Very low (-)	Very low (-)	Very low (-)	Low (-)	Very low (-)
	'No–go'	Neutral		Neutral		Neutral	
Dust impacts	Air Emissions	Low (-)	Low (-)	Very low (-)	Very low (-)	Very low (-)	Very low (-)
		Neutral		Neutral		Neutral	
Hazardous substances	Spillage of hazardous substances	Medium (-)	Negligible	Medium (-)	Negligible	Medium (-)	Negligible

Key:

M-H	Medium to High Significance
M	Medium Significance
L-M	Low to Medium Significance
L	Low Significance
VL-L	Very Low to Low Significance
N	Neutral Significance
L-M+	Medium positive significance
L+	Low positive significance

7.1.1 Construction Impacts

7.1.1.1 Hardap PV facility

With reference to Table 47, the most significant negative construction phase impact to the biophysical and socio-economic environment, without mitigation was impact on avifauna due to an increase in pylon collisions. This was rated as **high (-)** but would reduce to **medium (-)** with the implementation of the proposed mitigation measures. **Medium (-)** significance is considered to be acceptable as the transmission lines would be relatively short in comparison to existing transmission lines and no critical issues are foreseen.

It should be noted that potential positive socio-economic impacts such as employment creation and energy production would result during construction and these would mostly be of between **medium (+)** and **low (+)** significance, without and with mitigation measures.

7.1.1.1 Omburu PV facility

With reference to Table 48, the most significant negative construction phase impacts to the biophysical and socio-economic environment, without mitigation were impact on avifauna due to an increase in pylon collisions and the visual impact associated with the single axis tracking system, being 15 m above the natural ground level. These were rated as **high (-)** and **medium (-)**, respectively. With the implementation of the proposed mitigation measures, the avifauna impact significance would be reduced to **medium (-)**. **Medium (-)** significance is considered to be acceptable as the transmission lines would be relatively short in comparison to existing transmission lines and no critical issues are foreseen. By limiting the height of the single axis tracking PV to 8 m, it could reduce the significance to **low (-)**. If single axis tracking structures exceeding 8 m in height are used, then the significance of the visual impact would remain **medium (-)**.
It should be noted that potential positive socio-economic impacts such as employment creation and energy production would result during construction and these would mostly be of between **medium (+)** and **low (+)** significance, without and with mitigation measures.

7.1.1.2 Osona PV facility

With reference to Table 49, the most significant negative construction phase impacts to the biophysical and socio-economic environment, without mitigation were impact on avifauna due to an increase in pylon collisions and the visual impact associated with the single axis tracking system, being 15 m above the natural ground level. These were rated as **high (-)** and **medium (-)**, respectively. With the implementation of the proposed mitigation measures, the avifauna impact significance would be reduced to **medium (-)**. **Medium (-)** significance is considered to be acceptable as the transmission lines would be relatively short in comparison to existing transmission lines and no critical issues are foreseen. By limiting the height of the single axis tracking to 7 m, it could reduce the significance to **low (-)**. If single axis tracking PV structures exceeding 7 m in height are used, then the significance of the visual impact would remain **medium (-)**.

It should be noted that potential positive socio-economic impacts such as employment creation and energy production would result during construction and these would mostly be of between **medium (+)** and **low (+)** significance, without and with mitigation measures.

7.1.2 Operation Phase Impacts

7.1.2.1 Hardap PV facility

With reference to Table 47, the most significant negative operational phase impact (avifaunal impacts) to the biophysical and socio-economic environment, without mitigation was rated as **high (-)**. With the implementation of the proposed mitigation measures, the impact significance would be reduced to **medium (-)**.

The creation of employment during operation, positive impact on climate change and energy production is considered to be **medium (+)**, with and without mitigation.

7.1.2.1 Omburu PV facility

With reference to Table 48, the most significant negative operational phase impacts (avifaunal impacts and visual impacts of the single axis tracking PV at 15 m in height) to the biophysical and socio-economic environment, without mitigation were rated as **high (-)**. With the implementation of the proposed mitigation measures, the impact significance would be reduced to **medium (-)** for avifaunal and **medium (-)** for visual impacts. By limiting the height of the single axis tracking PV to 8 m, it could further reduce the significance to **low (-)**.

The creation of employment during operation, positive impact on climate change and energy production is considered to be **medium (+)**, with and without mitigation.

7.1.2.2 Osona PV facility

With reference to Table 49, the most significant negative operational phase impacts (avifaunal impacts and visual impacts of the single axis tracking PV) to the biophysical and socio-economic environment, without mitigation were rated as **high (-)**. With the implementation of the proposed mitigation measures, the impact significance for both these impacts would be reduced to **medium (-)**. By limiting the height of the single axis tracking PV to 7 m, it could further reduce the significance to **low (-)**.

The creation of employment during operation, positive impact on climate change and energy production is considered to be **medium (+)**, with and without mitigation.

7.1.3 Cumulative impacts

Cumulative impacts have been assessed by considering the impact of the development in combination with other broader biophysical, social and economic considerations, which typically cannot be addressed at the project level. It was found that the impacts on the environment were all acceptable, except for the cumulative impacts associated with the single axis PV technology, which is part of the reason why the fixed tilt PV alternative is preferred.

7.1.4 Level of confidence in assessment

With reference to the information available at this stage of the proposed project planning cycles, the confidence in the environmental assessment undertaken is regarded as being acceptable for decision-making, specifically in terms of the environmental impacts and risks. The EAPs believe that the information contained within the Scoping Report is adequate to inform MET: DEA to be able to determine the environmental acceptability of the proposed alternatives.

It is acknowledged that the project details will evolve during the detailed design and construction phases to a limited extent. However, these are unlikely to change the overall environmental acceptability of the proposed facilities and any significant deviation from what was assessed in this Scoping Report should be subject to further assessment.

7.2 RECOMMENDATIONS

Section 6 outlines the mitigation measures which, if implemented, could significantly reduce the negative impacts and enhance positive impacts associated with the projects. These mitigation measures have also been incorporated into the EMP (Annexure D). Where appropriate, the mitigation measures, and any others, identified by MET:DEA could be enforced as Conditions of Approval in the ECC, should MET:DEA approve the project.

7.2.1 Considerations in identification of preferred alternatives

Based on the findings of the study, it was evident that the following was the preferred alternatives:

Hardap 10 MW PV facility

- Location alternative: Hardap1.
- **Technology**: Fixed tilt PV or Single axis tracking.
- **Access and haulage routing**: Hardap Road 2 following the existing farm road is preferred however Hardap Road 1 is also environmentally acceptable.

Omburu 10 MW PV facility

- Location alternative: Omburu3.
- **Technology**: Fixed tilt PV or single axis tracking PV not exceeding 8 m in height.
- **Access and haulage routing**: Omburu Road 1 following the existing transmission service road.

Osona 10 MW PV facility

- Location alternative: Osona1.
- **Technology**: Fixed tilt PV or single axis tracking PV not exceeding 7 m in height.
- **Access and haulage routing**: Osona Road 2 which will follow the existing substation access road is preferred however Osona Road 1 is also environmentally acceptable.

7.2.2 EAP's opinion with respect to authorisation

Based on the outcome of this impact assessment, Aurecon is of the opinion that the three proposed PV facilities should be authorised as the incremental local and regional benefits outweigh negative impacts and the proposed project has a sound motivation demonstrating the need and desirability therefore. The significance of negative impacts can be reduced with effective and appropriate mitigation. If authorised, the implementation of an EMP should be included as a Condition of Approval.

Based on the outcome of this Scoping Assessment, **we are of the opinion that the project is preferred over the 'No–go' alternative, and the project alternatives as discussed in Section 4.5, should be approved as all impacts are considered acceptable.**

7.3 WAY FORWARD

This Draft Scoping Report is available for a comment period between **18 June 2014 and 8 July 2014.** The Draft Scoping Report has been made available in the Aurecon Windhoek office, the Mariental, Omaruru and Okahandja Municipalities as well as on the Aurecon and NamPower websites. Registered I&AP's were notified of the availability of the report.

Cognisance will be taken of all comments in compiling the final report, and the comments, together with the project team and proponent's responses thereto, will be included in the Final Scoping Report. Where appropriate, the report will be updated.

The Final Scoping Report will be submitted to the MET: DEA for consideration and decision-making. The MET: DEA has 30 working days to review the report and issue a decision. Following this, all I&APs will be notified of the decision and an appeal period will follow.

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9 REPORT TRANSMITTAL NOTE

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ANNEXURE A

LETTER TO MET: DEA

ANNEXURE B

CURRICULUM VITAE OF EAPS

ANNEXURE C

C1- List of potential Interested and Affected Parties

C2- Copy of adverts

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ANNEXURE C1

LIST OF POTENTIAL INTERESTED AND AFFECTED PARTIES

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