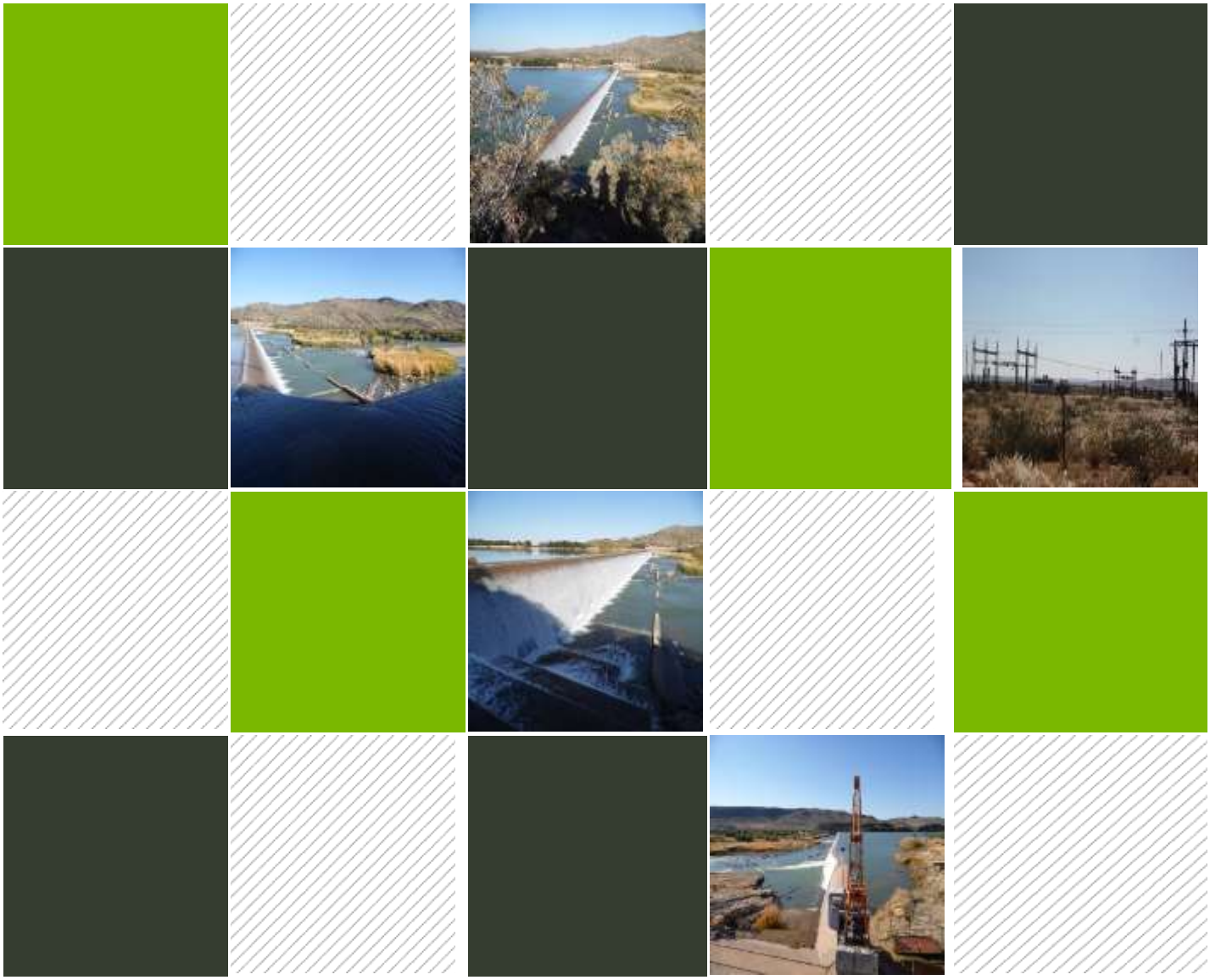

PROPOSED HYDROPOWER STATION AND ASSOCIATED INFRASTRUCTURE AT BOEGOEBERG DAM ON THE ORANGE RIVER, NEAR GROBLERSHOOP, NORTHERN CAPE.

DEA Reference No: 14/12/16/3/3/2/568

NEAS Reference No: DEA/EIA/0001942/2013

DRAFT ENVIRONMENTAL IMPACT REPORT

November 2013

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PROJECT DETAILS

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Proposed hydropower station and associated infrastructure at Boegoeberg Dam on the Orange River, near Groblershoop, Northern Cape

Non-technical summary (English) & Nie-tegniese opsomming (Afrikaans)

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NEMA requirements for Environmental Impact Reports - Guide to this report

The purpose of this section is to provide a guide to how this report has been structured in compliance with Regulation 31 of the National Environmental Management Act (No. 107 of 1998) which specifically pertains to Environmental Impact Reports.

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Regulation	Content as required by NEMA	Page/ Annexure
31(2)(a)	(i) Details of the EAP who prepared the report; and	Page 35 Section 2.3.2
	(ii) Details of the expertise of the EAP to carry out scoping procedures.	Annexure E (EAP CV's)
31(2)(b)	A detailed description of the proposed activity.	Page 37 Section 3.1
31(2)(c)	A description of the property on which the activity is to be undertaken and the location of the activity on the property, or if it is (i) a linear activity, a description of the route of the activity; or	Page 59 Section 3.2.1
31(2)(d)	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.	Page 11 Section 1.1
31(2)(e)	Details of the public participation process conducted in terms of subregulation (1), including –	Page 32 Section 2.2
	(i) Steps undertaken in accordance with the plan of study;	Page 23 Section 1.5
	(ii) a list of persons, organisations and organs of state that were registered as interested and affected parties;	Annexure B (PPP)
	(iii) A summary of comments received from, and a summary of issues raised by registered interested and affected parties, the date of receipt of these comments and the response of the EAP to those comments; and	Annexure B (PPP)
	(iv) copies of any representations and comments received from registered interested and affected parties.	Annexure B (PPP)
31(2)(f)	A description of the need and desirability of the proposed activity.	Page 65 Section 4
31(2)(g)	A description of identified potential alternatives to the proposed 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.	Page 58 Section 3.2
31(2)(h)	An indication of the methodology used in determining the significance of potential environmental impacts.	Annexure F (Methodology)

31(2)(i)	A description and comparative assessment of all alternatives identified during the environmental impact assessment process.	Page 63 Section 3.2.8
31(2)(j)	A summary of the findings and recommendations of any specialist report or report on a specialised process.	Page 153 Section 5.15
31(2)(k)	A description of all environmental issues that were identified during the environmental impact 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 5
31(2)(l)	An assessment of each identified potentially significant impact, including – (i) cumulative impacts;	Section 5
	(ii) the nature of the impact;	Section 5
	(iii) the extend and duration of the impact;	Section 5
	(iv) The probability of the impact occurring;	Section 5
	(v) the degree to which the impact can be reversed;	Section 5
	(vi) the degree to which the impact may cause irreplaceable loss of resources; and	Section 5
	(vii) the degree to which the impact can be mitigated.	Section 5
31(2)(m)	A description of any assumptions, uncertainties and gaps in knowledge.	Page 35 Section 2.3.1
31(2)(n)	A reasoned opinion as to whether the activity should or should not be authorised, and if the opinion is that it should be authorised, any conditions that should be made in respect of that authorisation.	Page 159 Section 6.1.7
31(2)(o)	An environmental impact statement which contains – (i) a summary of the key findings of the environmental impact assessment; and	Page 153 Section 5.15
	(ii) A comparative assessment of the positive and negative implications of the proposed activity and identified alternatives.	Page 159 Section 6.1.6
31(2)(p)	A draft environmental management programme containing the aspects contemplated in regulation 33.	Annexure E
31(2)(q)	Copies of any specialist reports and reports on specialised processes complying with regulation 32.	Annexure D
31(2)(r)	Any specific information that may be required by the competent authority; and	Annexure G
31(2)(s)	Any other matters required in terms of sections 24(4)(a) and (b) of the Act.	Annexure C

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Glossary of Terms

Environment	The surroundings (biophysical, social and economic) within which humans exist and that are made up of i. the land, water and atmosphere of the earth; ii. micro-organisms, plant and animal life; iii. any part or combination of (i) and (ii) and the interrelationships among and between them; and iv. the physical, chemical, aesthetic and cultural properties and conditions of the foregoing that influence human health and wellbeing;
Environmental Impact Assessment (EIA)	A study of the environmental consequences of a proposed course of action.
Environmental Impact Report Assessment (EIR)	A report assessing the potential significant impacts as identified during the Scoping Phase.
Environmental Impact	An environmental change caused by some human act.
Environmental Management Programme (EMP)	A document that provides procedures for mitigating and monitoring environmental impacts, during the construction, operation and decommissioning phases.
Public Participation Process	A process of involving the public in order to identify needs, address concerns, in order to contribute to more informed decision making relating to a proposed project, programme or development.
Scoping	A procedure for determining the extent of and approach to an EIA, used to focus the EIA to ensure that only the significant issues and reasonable alternatives are examined in detail
Scoping Report	A report describing the issues identified.

Abbreviations

ACO	Archaeology Contracts Office
BIA	Biodiversity Impact Assessment
CBA	Critical Biodiversity Area
CRR1	Comments and Response Report 1
CRR2	Comments and Response Report 2
DAFF	Department of Agriculture Forestry and Fisheries
dB	Decibels
DEA	Department of Environmental Affairs (previously Department of Environmental Affairs and Tourism)
DEA&DP	Department of Environmental Affairs and Development Planning
DEANC	Department of Environmental Affairs and Nature Conservation
DEAT	Department of Environmental Affairs and Tourism
DEA: Waste	Department of Environmental Affairs: Waste
DM	District Municipality
DMR	Department of Mineral Resources
DoE	Department of Energy
DSR	Draft Scoping Report
DWA	Department of Water Affairs
EA	Environmental Authorisation
EAP	Environmental Assessment Practitioner
EAPSA	Environmental Assessment Practitioner of South Africa
ECO	Environmental Control Officer
EFR	Environmental Flow Requirements
EIA	Environmental Impact Assessment
EIR	Environmental Impact Assessment Report
EIS	Ecological Importance and Sensitivity
EMF	Environmental Management Framework
EMP	Environmental Management Programme
EP	Equator Principles
EPFI	Equator Principles Financial Institutions
ERA	Electricity Regulation Act (Act No. 4 of 2006)
FROC	Frequency of Occurrence
FSR	Final Scoping Report
GG	Government Gazette
GN	Government Notice
GWh	Gigawatt hour
ha	Hectare
HIA	Heritage Impact Assessment
HV	High Voltage

Hz	Hertz
I&APs	Interested and Affected Parties
IDP	Integrated Development Plan
IEIM	Integrated Environmental Information Management
IEP	Integrated Energy Plan
IFC	International Finance Corporation
IPAP	Industrial Policy Action Plan
IPP	Independent Power Producer
IRP	Integrated Resource Plan
kWh	Kilowatt hour
kV	Kilovolt
LEMP	Life-cycle Environmental Management Programme
LOR	Lower Orange River
LM	Local Municipality
MW	Megawatts
NCNCA	Northern Cape Nature Conservation Act (Act No. 9 of 2009)
NEMA	National Environmental Management Act (Act No. 107 of 1998) (as amended)
NEM:BA	National Environmental Management: Biodiversity Act (Act No. 10 of 2004)
NEM:WA	The National Environmental Management: Waste Act (Act No. 59 of 2008)
NFA	National Forest Act Act 84 of 1998 (as amended)
NHRA	National Heritage Resources Act (Act No. 25 of 1999)
MPRDA	Mineral and Petroleum Resources Development Act (Act No. 28 of 2002)
NWA	National Water Act (Act No. 36 of 1998)
PES	Present Ecological State
PIA	Palaeontological Impact Assessment
PPA	Power Purchase Agreement
PPP	Public Participation Process
SAHRA	South African Heritage Resources Agency
SACNASP	South African Council for Natural Scientific Professions
SDF	Spatial Development Framework
ToR	Terms of Reference
TSP	Total Suspended Particles
WML	Waste Management Licence

1 INTRODUCTION AND BACKGROUND

The purpose of this Chapter is to introduce the project and describe the relevant legal framework within which the project takes place as well as the listed activities in terms of National Environmental Management Act (NEMA) that require authorisation. It further serves to outline the approach to the project and outline the assumptions and limitations for the project.

1.1 INTRODUCTION

Boegoeberg Hydro Electric Power (Pty) Ltd (Boegoeberg Hydro) is proposing to construct a hydropower facility with a capacity of approximately 11 Megawatts (MW) at Boegoeberg Weir. The proposed facility is located approximately 26 kilometre (km) south east of the town of Groblershoop in the Northern Cape and can be accessed via the National Road, N8 (see **Figure 1**). Aurecon South Africa (Pty) Ltd (Aurecon) has been appointed to undertake the requisite environmental process as required in terms of the National Environmental Management Act (No. 107 of 1998) (NEMA), as amended, on behalf of Boegoeberg Hydro.

This Environmental Impact Assessment (EIA) is for the proposed hydropower facility on the farm Zeekoebaart, made up of two portions (Remainder of 306 and Portion 1) and the transmission line corridor to the Fibre substation (see **Table 1-1**).

Table 1-1 List of farms/ erven on which sites are located and the respective landowners

Farm name	Farm/ Erven	Portion	Landowner
Farms/ Erven comprising the plant infrastructure			
Zeekoebaart	1		RSA
Zeekoebaart	306	2+3	Susara Marthina Geldenhuys
Farms/ Erven comprising the transmission line corridor/ servitude			
Zeekoebaart	9	2+ 3	Hendrik Johannes Louis Hanekom
Zeekoebaart		0+ 5	Dirk Jacobus Francois Hanekom-Trustees
Zeekoebaart		1	Dirk Jacobus Francois Greeff
Zeekoebaart	10	0	Smit Jan Willem
Zeekoebaart		1+12	Hendrik Johannes Louis Hanekom
Blinkfontein		19	Smit Jan Willem
Blinkfontein		16	Johnnie Smit Familie trust
Blinkfontein		4	Blaauwputs Trust
Rietfontein	11	2	Wilkot Boerdery Pty Ltd
Rietfontein		5	B J Groenewald Familietrust

The proposed hydropower station would consist of the following components, which are described in detail in **Section 3.1.1**:

- An off-take structure above the existing Boegoeberg weir to facilitate the abstraction of water;
- A temporary upstream and downstream caisson (cofferdam) to exclude water from the construction works;
- Water conveyance infrastructure comprising a combination of either an open canal ,or a tunnel to convey the water to the head pond;
- A head pond;

- Steel (or other suitable pipeline material) penstocks to transfer the water to the power chamber;
- A power chamber to house the turbines and generation equipment;
- Outlet channel (tailrace) to return the abstracted water back into the river; downstream of the power chamber;
- A switchroom and transformer yard;
- A high voltage (HV) distribution line to evacuate the power to a nearby Fibre Substation;
- Sediment basins; and
- Access roads to the site.

Energy generated by the proposed hydropower station would be evacuated from the site transformer yard *via* a proposed transmission line of not more than 132 kilovolt (kV) capacity to a nearby Eskom substation (**Figure 1**). The overhead transmission line would connect the power chamber to Fibre Substation where it would feed into the national grid. Where existing roads do not exist for construction and maintenance purposes, new gravel access roads of 4 metre (m) width would be constructed to follow the transmission servitude.

The transmission line will traverse through a number of farms, described further in **Section 5.1**.

In terms of the NEMA, the proposed project triggers a suite of activities which require authorisation from the competent environmental authority. Since the project is for the generation of energy, and energy projects are dealt with by the national authority, the competent authority is the national Department of Environmental Affairs (DEA). DEA's decision on whether to authorise the project or not will be based on the outcome of this EIA process.

The purpose of this EIA Report (EIR) is to undertake a comparative assessment of the relative significance of the potential environmental impacts for the proposed hydropower station and its alternatives. The EIA process and sequence of documents produced as a result of the process are illustrated in (**Figure 2**). Accordingly, the EIR includes the following:

- A brief overview of the potential environmental impacts and reasonable alternatives identified during the Scoping investigation.
- A summary of the key findings of the various specialist studies as they pertain to the affected environment.
- An overview of the public participation process conducted during the compilation of the EIR.
- A detailed assessment of the significance of the potential environmental impacts for the various project alternatives. This assessment, which would use the methodology outlined in **Section 2**, would be informed by the findings of the specialist studies, and professional judgement of the team members.
- An overview of the full range of mitigation measures, including an indication of how these would influence the significance of any potential environmental impacts, together with a Life-cycle Environmental Management Programme (LEMP). The mitigation measures have been informed by the specialist studies, professional experience and comment received from Interested and Affected Parties (I&APs).
- A set of recommendations regarding the way forward, should any of the proposed alternatives be authorised in terms of NEMA.

1.2 TERMS OF REFERENCE FOR THE EIA

Aurecon was appointed by Boegoeberg Hydro as the independent Environmental Assessment Practitioner (EAP)[1] to undertake the requisite environmental processes as required in terms of the NEMA[2] read with the NEMA 2010 EIA Regulations. The scope of the environmental work entails undertaking an EIA process in terms of the EIA Regulations (Applications for Scoping and EIA) for the proposed construction of the Boegoeberg hydropower station on the Farm Zeekoebaart (Remainder of 306 and Portion 1), and associated infrastructure on the Orange River, near Groblershoop, Northern Cape. This process includes the:

- Completion and submission of the requisite EIA application form to the competent authority (DEA).
- Undertaking of the regulatory processes including:
    - Drafting public information documents;
    - Pro-active consultation with relevant state departments;
    - Undertaking the necessary specialist investigations;
    - Completion and submission of environmental impact reports;
    - Public participation and associated engagement processes; and
    - Draft Life-cycle Environmental Management Programme (LEMP).

This EIA process is aimed at meeting specific requirements of the NEMA EIA Regulations promulgated on 18 June 2010[3]. In addition, the information contained in this report supports the requirements of abovementioned legislation in order for the proposed project to be considered for decision making by the relevant competent authority. Although additional authorisation, licences and permits may be required under the other applicable legislation, it is understood that these cannot be resolved until the NEMA EIA Regulation decision-making has been finalised.

The information collected during this EIA process and the Public Participation Process (PPP) will be utilised to inform the other legal requirements which are in many instances central to statutory process. The details of the public process undertaken to date is summarised in **Section 2.2.**

Note that while it may become apparent at a later stage that additional legislation may be applicable; the Acts most relevant to the project and the environment have all been included in the **Section 1.3** below. Legislation and policies relating to energy generation, specifically renewable energy, have been summarised in Annexure C.

[1] Environmental Assessment Practitioners acting on behalf of Aurecon: Diane Erasmus, Charles Norman, Simon Clark and Andries van der Merwe (See Annexure H for Curricula Vitae of these individuals).
[2] Section 16 of NEMA defines the requirements for Environmental Assessment Practitioners.
[3] GN No. R 543, 544, 545, 546 and 547 in Government Gazette No. 33306 of 18 June 2010.

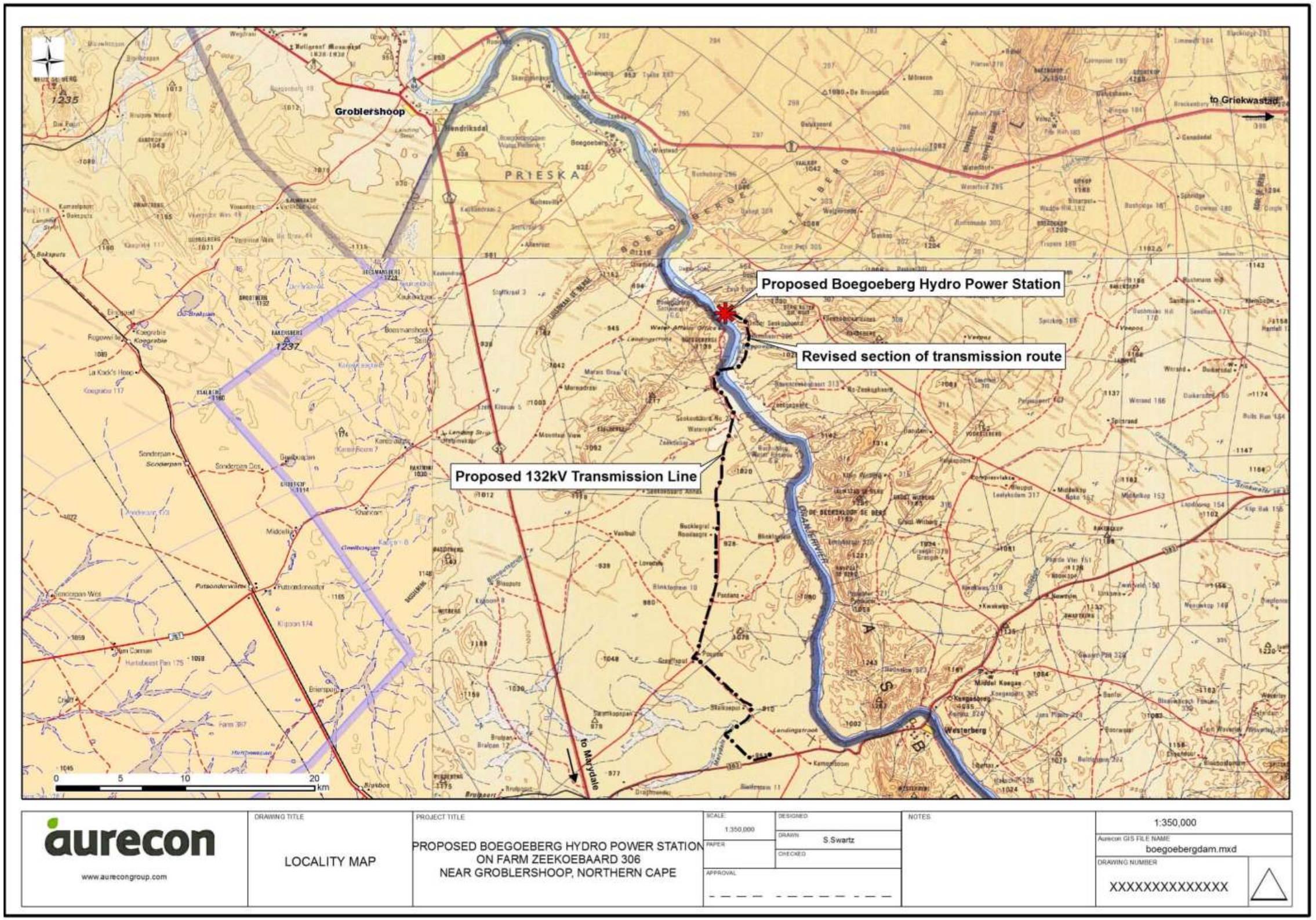


Figure 1 | Locality map of the proposed Boegoeberg hydropower plant and associated transmission line routing (Transmission route partially rerouted 6/11/13)

1.3 LEGAL REQUIREMENTS AND STANDARDS

The legal framework within which this project occurs is complex and includes legislation, policy and principles derived from the Constitution of South Africa, 1996 (No. 108 of 1996), as well as the Promotion of Administrative Justice Act (No. 3 of 2000) and other statutes of general application. Specific pieces of legislation applicable to the proposed project include, *inter alia (*Table 1-2*)*:

Table 1-2 | Legislation and policy considered in preparation of the Environmental Assessment Report

Legal and Policy Requirements		
Title of legislation, policy or guideline	**Applicability to the project**	**Administrating Authority**
The Republic of South Africa Constitution Act ("the Constitution") (Act 108 of 1996)	The environmental right contained in Section 24 of the Constitution provides that everyone is entitled to an environment that is not harmful to his or her well-being.	N/A
National Environmental Management Act, Act No. 107 of 1998 (NEMA)	Several listed activities in terms of NEMA GN No. 544, 545 and 546, 18 June 2010, have been triggered and need to be authorised for the proposed hydropower station (also see 1.4).	DEA
National Water Act, Act No. 36 of 1998 (NWA)	The proposed hydropower station will divert water from the Orange River for the generation of electricity. The location of the hydropower station falls within the D81A quaternary catchment and the Lower Orange Department of Water Affairs (DWA) Water Management Area and requires authorisation from DWA for the following activities as listed in section 21 of the NWA: 21(a) - taking water from a water resource 21 (c) Impeding or diverting flow of water in a watercourse; and 21(i) Altering the bed, banks, course or characteristics of a watercourse.	Department of Water Affairs (DWA)

Legal and Policy Requirements		
Title of legislation, policy or guideline	**Applicability to the project**	**Administrating Authority**
	21(g) – disposing of waste in a manner which may detrimentally impact on a water resource;	
National Heritage Resources Act, Act No. 25 of 1999 (NHRA)	The development will change the character of a site exceeding 5,000m^2 in extent and includes the construction of an access road and transmission line exceeding 300m in length. As such the Act requires that a Heritage Impact Assessment (HIA) is undertaken for the proposed project,	South African Heritage Resources Agency (SAHRA)
National Environmental Management: Biodiversity Act, Act No. 10 of 2004 (NEM:BA)	The hydropower station will be located in a Critical Biodiversity Area (CBA) which contains protected species listed in NEM:BA. Permits will be required for removal of such species should the project receive a positive Environmental Authorisation (EA).	Northern Cape Department of Environmental Affairs and Nature Conservation (DEANC)
National Forest Act, Act No. 84 of 1998 (as amended) (NFA)	Section 12(1)(d) read with s15(1) and s62(2)(c) list protected tree species that may not be cut, destroyed or disturbed without a licence. Should the project be granted a positive EA, the relevant licences will be applied for if any endangered trees, as per those listed in the NFA, are to be cut, destroyed or disturbed.	Department of Agriculture, Forestry and Fisheries (DAFF).
Mineral and Petroleum Resources Development Act, Act No. 28 of 2002 (MPRDA)	Sourcing of material for road construction and foundation purposes (i.e. the use of borrow pits) is regarded as mining and accordingly is subject to the requirements of the Act. In terms of the current project, one section of the Act is particularly relevant As the material would be sourced from two informal borrow pits on the farm, a mining permit would be required from Department of Mineral Resources (DMR).	Department of Mineral Resources (DMR)

Legal and Policy Requirements		
Title of legislation, policy or guideline	**Applicability to the project**	**Administrating Authority**
Northern Cape Nature Conservation Act, Act No. 9 of 2009 (NCNCA)	Numerous sections (specifically Sections 50-51) under NCNCA deal with indigenous and protected plants. A permit in terms of NCNCA will be required if species listed in the Act are located on site and it would be necessary to remove or destroy them.	Northern Cape Department of Environmental Affairs and Nature Conservation (DEANC)
National Environmental Management: Waste Act, Act No. 59 of 2008 (NEM:WA)	Activity number 5, as listed in terms of NEM:WA Category B would be triggered by the storage of spoil and need to be authorised for the proposed hydropower station (also see Section 1.4).	DEA Northern Cape
The National Energy Act, Act No. 34 of 2008	In terms of the New Generation Regulations, the Integrated Resource Plan (IRP) has been developed by the Department of Energy (DoE) and sets out the new generation capacity requirement per technology, taking energy efficiency and the demand-side management projects into account. This required, new generation capacity must be met through the technologies and projects listed in the IRP and all Independent Power Producer (IPP) procurement programmes will be undertaken in accordance with the specified capacities and technologies listed in the IRP .	Department of Energy (DoE)
The National Environmental Management: Waste Act, Act No. 59 of 2008 (NEM:WA)	If no other alternatives are available and spoil is to be left on site, it might trigger the need for a Waste Management Licence (WML). DEA will be consulted in this regard to confirm if a WML will be required.	Department of Environmental Affairs: Waste (DEA: Waste)
The International Finance Corporation (IFC) performance standards	A certain percentage of the funding for the proposed hydropower station would be sourced from the IFC. As such the IFC performance standards would be applicable to the proposed project.	N/A
Equator Principles (EP)	A certain percentage of the funding for the proposed hydropower station would be sourced from the Equator Principles Financial	N/A

Legal and Policy Requirements		
Title of legislation, policy or guideline	**Applicability to the project**	**Administrating Authority**
	Institutions (EPFI's). As such the EP would be applicable to the proposed project.	

1.4 LISTED ACTIVITIES IN TERMS OF NEMA

This is the primary legislation tasked with management of environmental resources and accordingly, identifies activities that require authorisation prior to commencement. The NEMA, as amended, establishes the principles for decision-making on matters affecting the environment. Section 2 sets out the National Environmental Management Principles which apply to the actions of organs of state that may significantly affect the environment. Furthermore, Section 28(1) states that "every person who causes or may cause significant pollution or degradation of the environment must take reasonable measures to prevent such pollution or degradation from occurring, continuing or recurring". If such pollution or degradation cannot be prevented then appropriate measures must be taken to minimise or rectify such pollution or degradation.

Boegoeberg Hydro has the responsibility to ensure that the proposed activities, as well as the EIA process, conform to the principles of the NEMA. In developing the EIA process, Aurecon has been cognisant of this need, and accordingly the EIA process has been undertaken in terms of the NEMA and the EIA Regulations promulgated on 18 June 2010.

In terms of the EIA regulations, certain activities are identified, which require authorisation from the competent environmental authority, in this case DEA, before commencing. Listed activities in Government Notice (GN) No. 545 require Scoping and EIA whilst those in GN No. 544 and 546 require Basic Assessment (unless they are being assessed under an EIA process). The proposed project requires authorisation for activities listed in both GN No. 544, 545 and 546 and therefore a Scoping and EIA process is required. Activities triggered by the proposed project are tabulated in **Table 1-3**.

Table 1-3 | Listed activities in terms of NEMA GN No. 544, 545 and 546, 18 June 2010, to be authorised for the proposed hydropower station and associated infrastructure

NO.	LISTED ACTIVITIES	ASPECT OF PROJECT
GN No. R544, 18 June 2010		
1	The **construction of facilities or infrastructure for the generation of electricity where**:	The proposed hydropower station would have an electricity output of

NO.	LISTED ACTIVITIES	ASPECT OF PROJECT
	i. **the electricity output is more than 10 megawatts but less than 20 megawatts**; or ii. the output is 10 megawatts or less but the total extent of the facility covers an area in excess of 1 hectare	approximately **11MW**.
9	The **construction of facilities or infrastructure exceeding 1000 metres in length for the bulk transportation of water**, sewage or storm water - i. with an internal diameter of 0,36 metres or more; or ii. **with a peak throughput of 120 litres per second or more**, excluding where: a. such facilities or infrastructure are for bulk transportation of water, sewage or storm water or storm water drainage inside a road reserve; or b. where such construction will occur within urban areas but further than 32 metres from a watercourse, measured from the edge of the watercourse.	The project would consist of an off-take structure at the weir and a canal/ tunnel of up to 400m long. However, the capacity of the canal would be approximately **100,000** to **120,000 litres per second**.
10	The **construction of facilities or infrastructure for the transmission and distribution of electricity:** i. **outside urban areas or industrial complexes with a capacity of more than 33 but less than 275 kilovolts**; or ii. inside urban areas or industrial complexes with a capacity of 275 kilovolts or more.	The hydropower plant would connect to the Eskom grid at the Fibre Substation via a **transmission line of not more than 132 kV capacity.**
11	The **construction of**: i. canals; ii. channels; iii. bridges; iv. dams; v. weirs; vi. bulk storm water outlet structures; vii. marinas; viii. jetties exceeding 50 square metres in size; ix. slipways exceeding 50 square metres in size; x. buildings exceeding 50 square metres in size; or **xi. infrastructure or structures covering 50 square metres or more** **where such construction occurs within a watercourse or within 32 metres of a watercourse**, measured from the edge of a watercourse, excluding where such construction will occur behind the	The **footprint** of the proposed hydropower plant, which would be constructed within and **adjacent to the Orange River**, **would exceed 50 square metres**.

NO.	LISTED ACTIVITIES	ASPECT OF PROJECT
	development setback line.	
18	The **infilling or depositing of any material of more than 5 cubic metres into**, or the dredging, excavation, removal or moving of soil, sand, shells, shell grit, pebbles or rock from i. **a watercourse**; ii. the sea; iii. the seashore; iv. the littoral active zone, an estuary or a distance of 100 metres inland of the high-water mark of the sea or an estuary, whichever distance is the greater- but excluding where such infilling, depositing, dredging, excavation, removal or moving i. is for maintenance purposes undertaken in accordance with a management plan agreed to by the relevant environmental authority; or ii. occurs behind the development setback line.	During construction of the proposed hydropower plant **more than 5 cubic metres of material could be removed from the Orange River**. Furthermore **infilling** may be required just upstream of the weir on northern side of the weir pond near the intake structure.
GN No. R545, 18 June 2010		
10	The **construction** of facilities **or infrastructure for the transfer of 50 000 cubic metres or more water per day**, from and to or **between** any combination of the following: (i) water catchments, (ii) water treatment works; or (iii) **impoundments**, i. excluding treatment works where water is to be treated for drinking purposes.	The proposed hydropower station would involve the transfer of **more than 50, 000 m^3 per day**.
GN No. R546, 18 June 2010		
4	**The construction of a road wider than 4 metres** with a reserve less than 13,5 metres. (a) In Eastern Cape, Free State, KwaZulu-Natal, Limpopo, Mpumalanga and Northern Cape provinces: i. In an estuary; ii. **Outside urban areas, in**: (aa) A protected area identified in terms of NEMPAA, excluding conservancies; (bb) National Protected Area Expansion Strategy Focus areas; (cc) **Sensitive areas as identified in an environmental management framework as contemplated in chapter 5 of the Act and as adopted by the competent authority;** (dd) Sites or areas identified in terms of an International Convention;	**Access roads** to the hydropower station **would be approximately 6 m in width**.

NO.	LISTED ACTIVITIES	ASPECT OF PROJECT
	(ee) Critical biodiversity areas as identified in systematic biodiversity plans adopted by the competent authority or in bioregional plans; (ff) Core areas in biosphere reserves; (gg) Areas within 10 kilometres from national parks or world heritage sites or 5 kilometres from any other protected area identified in terms of NEMPAA or from the core areas of a biosphere reserve; (hh) Areas seawards of the development setback line or within 1 kilometre from the high-water mark of the sea if no such development setback line is determined. iii. In urban areas: (aa) Areas zoned for use as public open space; (bb) Areas designated for conservation use in Spatial Development Frameworks adopted by the competent authority or zoned for a conservation purpose; (cc) seawards of the development setback line or within urban protected areas.	
13	The **clearance of an area of 1 hectare or more of vegetation where 75% or more of the vegetative cover constitutes indigenous vegetation**, except where such removal of vegetation is required for: (2) the undertaking of a linear activity falling below the thresholds mentioned in Listing Notice 1 in terms of GN No. 544 of 2010. **Northern Cape** and Western Cape: i. In an estuary; **ii. Outside urban areas, the following**: (aa) A protected area identified in terms of NEMPAA, excluding conservancies; (bb) National Protected Area Expansion Strategy Focus areas; (cc) **Sensitive areas as identified in an environmental management framework as contemplated in chapter 5 of the Act and as adopted by the competent authority;** (dd) Sites or areas identified in terms of an International Convention; (ee) Core areas in biosphere reserves; (ff) Areas within10 kilometres from national parks or world heritage sites or 5 kilometres from any other protected area identified in terms of NEMPAA or from the core area of a biosphere reserve; (gg) Areas seawards of the development setback line or within 1 kilometre from the high-water mark of the sea if no such	The **footprint** of the proposed hydropower station would be greater than **1 hectare (ha) and would be located in CBA**.

NO.	LISTED ACTIVITIES	ASPECT OF PROJECT
	development setback line is determined.	
14	The **clearance of an area of 5 hectares or more of vegetation where 75% or more of the vegetative cover constitutes indigenous vegetation**, except where such removal of vegetation is required for: (a) purposes of agriculture or afforestation inside areas identified in spatial instruments adopted by the competent authority for agriculture or afforestation purposes; (b) the undertaking of a process or activity included in the list of waste management activities published in terms of section 19 of the National Environmental Management: Waste Act, 2008 (Act No. 59 of 2008) in which case the activity is regarded to be excluded from this list; (c) the undertaking of a linear activity falling below the thresholds in Notice 544 of 2010.	The **footprint** of the proposed hydropower station **could be greater than 5 ha and would be located in an area of at least 75 % indigenous vegetation**.
16	The **construction of:** i) jetties exceeding 10 square metres in size; ii) slipways exceeding 10 square metres in size; iii) buildings with a footprint exceeding 10 square metres in size; or **iv) infrastructure covering 10 square metres or more** where such construction occurs within a watercourse or within 32 metres of a watercourse, measured from the edge of a watercourse, excluding where such construction will occur behind the development setback line.	The footprint of the proposed hydropower plant, which would be constructed within and adjacent to the Orange River, would be greater than 10 square metres.

1.5 APPLICABILITY OF NEM:WA TO THE PROPOSED PROJECT

The NEM:WA aims to regulate waste management in order to protect heath and the environment by providing reasonable measures for the prevention of pollution and ecological degradation and for facilitating the ecological sustainability of the development. The Act also defines the institutional arrangements required for the management of waste and provides the norms and standards for regulating the management of waste. The Act makes provision for the licensing of waste management activities as well as compliance and enforcement thereof.

The construction phase of the proposed hydropower facility, in particular the construction of the water conveyance structure and removal of siltation, would generate general waste. Therefore a Waste Management Licence would be required in terms of NEM:WA. The project components requiring authorisation is described below.

Construction of water conveyance structure

The water conveyance infrastructure would be required to transport the water from the river level in the off-take structure. As discussed in **Section 3.1.1** of the report, two alternatives are being assessed namely a canal structure and a tunnel to convey the water. These structures require that materials are excavated and such materials are referred to as spoil materials[4]. The quantities of spoil that would be produced per alternative structure would be:

- *Tunnel (preferred option):* An approximate total of 70,000 m³ spoil materials will be excavated from the weir, tunnel, power chamber, and tailrace. The largest amount of spoil would be generated by the construction of the tunnel.
- *Canal:* An approximate total of 170,000 m³ spoil materials will be excavated from the weir, canal, power chamber, and tailrace. The largest amount of spoil would be generated by the excavation of the canal.

Annexure 1 of the Waste Classification and Management Regulations Gazetted on 23 August 2013 considers *"excavated earth material not containing hazardous waste or hazardous chemicals"* to be General Waste. In light of the above, the construction of the proposed water conveyance structures would trigger Activity 5, listed in Category B of the NEM:WA:

"The disposal of general waste to land covering an area of more than 100 m^2 or 200 m^3 of airspace, including the construction of a facility and associated structures and infrastructure for such disposal".

Therefore both a Waste Management Licence in terms of NEM:WA and an associated EIA in terms of NEMA would need to be undertaken. Since several options have been assessed for the removal and disposal and/or re-use of spoil materials including backfilling of excavated materials, clarification was requested from the DEA with reference to classification of excavated materials that would not be disposed of, but rather reused in the project development phase and rehabilitation activities.

Aurecon's has, while waiting for confirmation from the Department, proceeded according to their interpretation that under the current waste classification the spoil, even if reused, is considered waste and as such would require the relevant Waste Licensing Application to be undertaken. However as this EIA process was already underway when the current legislation was changed, Aurecon has incorporated the required EIA process for the Waste Licence into this EIA process for the whole project. Should the Department request an alternative approach, the EIA process will be amended as required to meet the additional requirements.

[4] Spoil materials can be defined as refuse materials removed from an excavation and can contain rock, sand etc.

Removal of sedimentation/silt (dredging)

In addition to the management of spoil materials excavated during the construction of the water conveyance structures, the removal of silt could also result in the production of spoil materials. Sedimentation of the Boegoeberg Dam is both an historical and on-going problem. Currently DWA scours the dam through one or two of the dam's many sluices. However, the method employed is far from effective but is currently the only option to maintain flows to the irrigation canal. The silt management methods currently employed would have a net negative effect on the projects feasibility as a large portion of the dam's flow is unutilised or lost during scouring.

It is therefore proposed that a sediment extraction program be established to remove sediment from in front of the hydro project off-take structure and from around the irrigation outlet. Sediment would be removed by a dredger in the Boegoeberg weir reservoir. Dredging would only occur around the agricultural irrigation canal and the inlet structure of the hydropower station to allow the required flows to reach each. The sand is dredged by means of equipment housed on a barge which disturbs the sediment either by mechanical means, or by injecting air or water into the sediment to agitate it. A pump housed on the barge draws water containing about 20% solids into a pipe at a rate of about 100 litres per second.

The dredged sediment would be stockpiled in 2 or 3 silt storage basins downstream of the weir to allow the water to drain. The proponent proposes to sell the dry silt to a third party for commercial use. It is estimated that an initial 900 m^3 would be removed from the dam. Initial estimates suggest that up to a maximum of 2,500 m^3 of sediment would be removed every month in order to maintain flows to both the irrigation canal and the hydropower station. The process of obtaining the necessary mining permits from the Department of Mineral Resources (DMR) is currently being undertaken. The quantities of removed silt would exceed the threshold listed in Activity 5 of NEM:WA and therefore the necessary Waste Licence Application in terms of NEM:WA is to be applied for. The potential solution to sell the dredged material has also been communicated with DWA during a meeting on 25 November 2013 to discuss the proposed project in greater detail. DWA is agreeable to the idea of this sediment management program and have indicated their support for the removal of sediment from the Boegoeberg Dam.

1.6 COMPLIANCE OF THIS EIA WITH THE EQUATOR PRINCIPLES

The Equator Principles form a risk management framework which is adopted by financial institutions, for determining, assessing and managing environmental and social risk in projects. The primary goal is to provide a minimum standard for due diligence, allowing for responsible risk decision-making. The principles are listed below.

Equator Principle	Summary of the Principle	Compliance
Principle 1: Review and Categorisation	When a Project is proposed for financing, an Equator Principle Finance Institution (EPFI) will, as part of its internal environmental and social review and due diligence, categorise it based on the magnitude of its potential environmental and social risks and impacts. Such screening is based on the environmental and social categorisation process of the International Finance Corporation (IFC). Using categorisation, the EPFI's environmental and social due diligence is commensurate with the nature, scale and stage of the Project, and with the level of environmental and social risks and impacts. The categories are:	This project is regarded as a Category B project

	Category A – Projects with potential significant adverse environmental and social risks and/or impacts that are diverse, irreversible or unprecedented; Category B – Projects with potential limited adverse environmental and social risks and/or impacts that are few in number, generally site-specific, largely reversible and readily addressed through mitigation measures; and Category C – Projects with minimal or no adverse environmental and social risks and/or impacts.	
Principle 2: Environmental and Social Assessment	In terms of the EP, Category B Project must undergo an Assessment process to address the relevant environmental and social risks and impacts of the proposed Project. The Assessment Documentation should propose measures to minimise, mitigate, and offset adverse impacts in a manner relevant and appropriate to the nature and scale of the proposed Project.	The EIA has been undertaken to comply with these principles.
Principle 3: Applicable Environmental and Social Standards	The Assessment process must comply with relevant host country laws, regulations and permits that pertain to environmental and social issues.	The EIA has been undertaken in compliance with the relevant legislation in South Africa
Principle 4: Environmental and Social Management System and Equator Principles Action Plan	For all Category A and Category B Projects, the client must develop or maintain an Environmental and Social Management System (ESMS). An Environmental and Social Management Plan must be prepared to address issues raised in the Assessment process and incorporate actions required to comply with the applicable standards.	The ESMS would be a client responsibility outside of this EIA. An Environmental Management Plan has been included as an annexure to the EIR.
Principle 5: Stakeholder Engagement	For all Category A and Category B Projects, Stakeholder Engagement is required as an ongoing process in a structured and culturally appropriate manner with Affected Communities and, where relevant. The consultation process must be tailored to the risks and impacts of the Project; the Project's phase of development; the language preferences of the Affected Communities; their decision-making processes; and the needs of disadvantaged and vulnerable groups. This process should be free from external manipulation, interference, coercion and intimidation.	A consultation process has been undertaken in line with the legal requirements and appropriate to the risk from the project and level of concern raised by the interested and affected parties.
Principle 6: Grievance Mechanism	For all Category A and, as appropriate, Category B Projects, the client, as part of the ESMS, must establish a grievance mechanism designed to receive and facilitate resolution of concerns and grievances about the Project's environmental and social performance. The grievance mechanism is required to be scaled to the risks and impacts of the Project and have Affected Communities as its primary user.	This would need to be developed by the client as part of the ESMS but it not considered essential to this category of project at the EIA stage.
Principle 7: Independent Review	For all Category A and, as appropriate, Category B Projects, an Independent Environmental and Social Consultant, not directly associated with the client, will carry out an Independent Review of the Assessment Documentation including the SMPs, the ESMS, and the Stakeholder Engagement process documentation in order to assess Equator Principles compliance	This is not considered essential to this category of project, based on the fact that the impacts are not considered to have significant risks to the environmental or social environment.

Principle 8: Covenants	Furthermore for all Category A and Category B Projects, the client will covenant the financial documentation: a) to comply with the ESMPs and Equator Principles AP (where applicable) during the construction and operation of the Project in all material respects; and b) to provide periodic reports in a format agreed with the EPFI (with the frequency of these reports proportionate to the severity of impacts, or as required by law, but not less than annually), prepared by in-house staff or third party experts, that i) document compliance with the ESMPs and Equator Principles AP (where applicable), and ii) provide representation of compliance with relevant local, state and host country environmental and social laws, regulations and permits; and c) to decommission the facilities, where applicable and appropriate, in accordance with an agreed decommissioning plan.	This is the client's responsibility for the duration of the construction and operational phases of the project.
Principle 9: Independent Monitoring and Reporting	To assess Project compliance with the Equator Principles and ensure ongoing monitoring and reporting after Financial Close and over the life of the loan, the EPFI will, for all Category A and, as appropriate, Category B Projects, require the appointment of an Independent Environmental and Social Consultant, or require that the client retain qualified and experienced external experts to verify its monitoring information which would be shared with the EPFI.	This is the client's responsibility for the duration of the construction and operational phases of the project.
Principle 10: Reporting and Transparency	The following client reporting requirements are in addition to the disclosure requirements in Principle 5. For all Category A and, as appropriate, Category B Projects, the client will ensure that, at a minimum, a summary of the ESIA is accessible and available Online.	This will be available on the Aurecon website for the duration of the EIA until after the Appeal period has passed.

1.7 COMPLIANCE OF THIS EIA WITH THE INTERNATIONAL FINANCE CORPORATION PERFORMANCE STANDARDS

The IFC Performance Standards are typically applied by financial institutions to manage environmental and social risks and impacts so that development opportunities are enhanced. The IFC has identified eight Performance Standards that establish criteria to be met throughout the life of a project. These are outlined below:

IFC Performance Standard	Description of the Performance Standard	Compliance
Performance Standard 1: Assessment and Management of Environmental and Social Risks and Impacts.	Performance Standard 1 has relevance to the undertaking of the ESIA process specifically, as it deals with the importance of: Integrated assessment to identify the environmental and social impacts, risks, and opportunities of projects; Effective community engagement with local communities; and Management of environmental and social performance throughout the life of the project.	The EIA has been undertaken to comply with these principles.
Performance Standard 2: Labour and Working Conditions.	Performance Standards 2 to 8 deal with management of impacts, emphasising the need to avoid such impacts as far as possible and where these cannot be avoided, to minimise as far as possible. Notwithstanding this objective, it is recognised that residual impacts to workers, affected communities and	This will form part of the conditions of engagement with contractors.
Performance Standard 3:		These principles have been

Resource Efficiency and Pollution Prevention	the environment may remain, which may need to be managed through compensation and/or offsets.	incorporated into the Environmental Management Plan.
Performance Standard 4: Community Health, Safety, and Security.		These principles have been incorporated into the Environmental Management Plan.
Performance Standard 5: Land Acquisition and Involuntary Resettlement		Not applicable to this project
Performance Standard 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources.		These principles have been addressed in the specialist studies and incorporated into the Environmental Management Plan.
Performance Standard 7: Indigenous Peoples.		There are no specific impacts on indigenous people from this project.
Performance Standard 8: Cultural Heritage		This aspect was addressed in the relevant specialist studies.

1.8 SCOPE OF THE EIA

This EIA process identifies and assesses the impacts that might arise should the proposed Boegoeberg Hydropower Station be constructed on the banks of the Orange River near Groblershoop. To assess all the potential impacts, Aurecon appointed the following independent specialists (refer to **Annexure D** for declarations of independence):

- Botanical – Dr D. McDonald (Bergwind Botanical Surveys and Tours cc)
- Aquatic – Mr J. MacKenzie (Mackenzie ecological & developmental services CC)
- Heritage – Dr J. Orton (ACO Associates CC)
- Avifauna – Dr Andrew Jenkins (Avisense CC)
- Palaeontology-- Dr John Almond (Natura Viva)
- Transport-- Dr WR Duff-Riddell (Aurecon)

The specialists have identified and comprehensively assessed the impact for each of the above environmental aspects associated with the proposed project. The findings of these assessments are included in **Section 5** of this report and the full reports are included in **Annexure D**.

This EIA process is informed by the series of national Environmental Guidelines[5] where applicable and relevant:

- Integrated Environmental Information Management (IEIM), Information Series 5: Companion to the NEMA EIA Regulations of 2010 (DEA, 2010);
- Implementation Guidelines: Sector Guidelines for the EIA Regulations (draft) (DEA, 2010);
- IEIM, Information Series 2: Scoping (Department of Environmental Affairs and Tourism (DEAT), 2002);
  IEIM, Information Series 3: Stakeholder Engagement (DEAT, 2002);
- IEIM, Information Series 4: Specialist Studies (DEAT, 2002);
- IEIM, Information Series 11: Criteria for determining Alternatives in EIA (DEAT, 2004);
- IEIM, Information Series 12: Environmental Management Plans (DEAT, 2004);
- Integrated Environmental Management Guideline Series, Guideline 4: Public Participation, in support of the EIA Regulations. Unpublished (DEAT, 2005);
- Integrated Environmental Management Guideline Series, Guideline 7: Detailed Guide to Implementation of the Environmental Impact Assessment Regulations. Unpublished (DEAT, 2007); and
- DEA. Guideline on Need and Desirability (GN 792 of 2012 in Government Gazette (GG) 35746).

[5] Note that these Guidelines have not yet been subjected to the requisite public consultation process as required by Section 74 of R385 of NEMA.

The following guidelines from the Department of Environmental Affairs and Development Planning (Western Cape) (DEA&DP) were also taken into consideration:

- Brownlie. 2005. Guideline for involving biodiversity specialists in EIA process (June 2005),
- Winter & Baumann. 2005. Guideline for involving heritage specialists in the EIR process (June 2005),
- Guideline for Environmental Management Plans (June 2005),
- Guideline for determining the scope of specialist involvement in EIA Processes (June 2005),
- Guideline for the review of specialist input into the EIA Process (June 2005),
- Guideline on Alternatives. EIA Guideline and Information Document Series. (DEA&DP, October 2011),
- Guideline on Need and Desirability. EIA Guideline and Information Document Series. (DEA&DP, October 2011); and
- Guideline on Public Participation. EIA Guideline and Information Document Series. (DEA&DP, October 2011).

2 EIA METHODOLOGY

The purpose of this Chapter is to provide the reader with an overview of the proposed EIA methodology. It describes the proposed Public Participation Process as engagement with the public and stakeholders forms an integral component of the EIA process. The commenting authorities and applicable guidelines are listed. Reference is made to current assumptions and limitations with regards to the proposed hydropower station.

2.1 APPROACH TO THE PROJECT

As outlined in **Figure 2** there are three distinct phases in the EIA process, namely the Initial Application Phase, the Scoping Phase and the EIA Phase. A description of the activities which have been, and will be, undertaken during each phase is provided in the following sections. Note that this report covers the second phase, *viz.* the Scoping Phase.

2.1.1 Initial Application Phase

The Initial Application Phase entailed the submission of an EIA Application Form, submitted on **13 June 2013** to apply for a Basic Assessment process. The application was submitted along with a cover letter requesting clarification on applicability of activity listing 10 of Listing Notice 2 (NEMA) to the proposed project and the NEMA process to be followed. Acknowledgement of receipt of the EIA Application Form was received from DEA on **4 July 2013**. However DEA rejected this initial application citing that activity listing 10 of Listing Notice 2 was applicable and indicating a new application should be made. The updated application form was submitted on the **4 July 2013,** applying for a Scoping and EIA process. Acknowledgements of receipt of the new EIA Application Form were received from DEA on **12 July 2013**. The Application Form and DEA's letter of acknowledgement are included in **Annexure A**. The DEA reference numbers are indicated in **Table 2-1**.

Table 2-1 | DEA assigned reference numbers

DEA Ref Nr	NEAS Ref Nr
14/12/16/3/3/2/568	DEA/EIA/0001942/2013

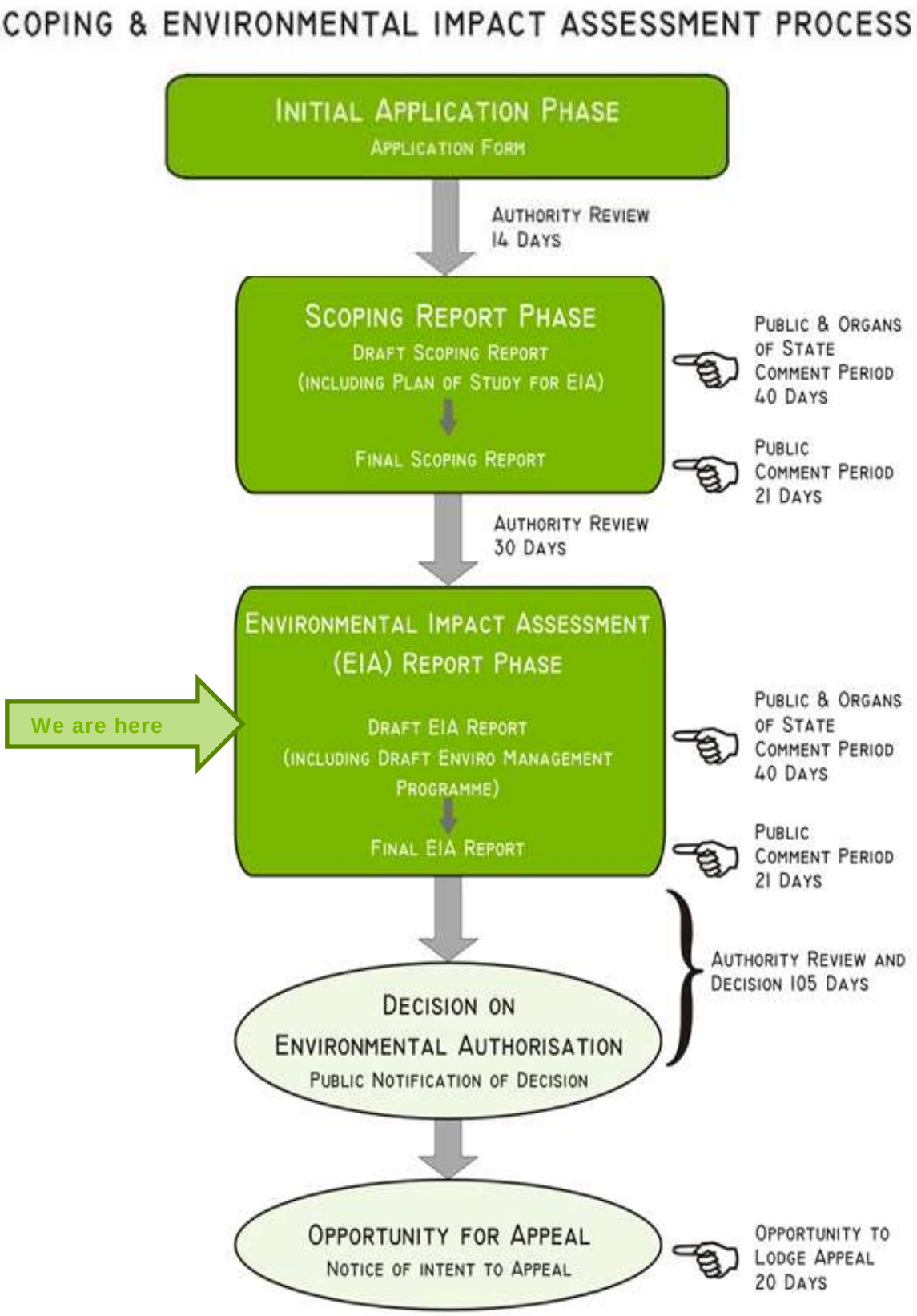
Other tasks undertaken include:

- A Letter of Notification (included in **Annexure A**), in English and Afrikaans, was sent to directly affected landowners to inform them of the proposed project and to invite them to register as Interested and Affected Parties (I&APs) on **12 June 2013**.

2.1.2 The Scoping Phase

Scoping is defined as a procedure for determining the extent of, and approach to, the EIA phase and involves the following key tasks:

- Identification and involvement relevant authorities and I&APs in order to elicit their interest in the project;
- Engagement with relevant authorities and I&APs;
- Identification and selection of feasible alternatives to be taken through to the EIA Phase;
- Identification of significant issues/impacts associated with each feasible alternative to be examined in the EIA Report; and
- Determination of methodology for assessment and specific Terms of Reference (ToR) for any specialist studies required in the EIA Report (Plan of Study for the EIA Report).



The Scoping Phase has involved a desktop review of relevant literature, including a review of previous environmental studies in the area. These included, *inter alia*, the following:

- Proposed hydropower station on the Orange River near Kakamas, Northern Cape: Final BAR (Aurecon, 2011);
- Siyathemba IEMP (African EPA, 2007);
- !Kheis Local Municipality Integrated Development Plan (IDP), 2012 – 2017;
- Siyanda District Municipality Integrated Development Plan (IDP), 2012/2013 – 2017;
- Siyanda District Municipality Environmental Management Framework, 2008;
- Vegetation Map of South Africa (Mucina & Rutherford, 2006);
- Proposed hydropower station on the Orange River in the vicinity of Augrabies, Northern Cape: Draft BAR (Aurecon, 2012).

An inception field trip was held on 21 June 2013 with the Aurecon EIA team, the proponent and the landowners. The purpose of the field trip was to gain an understanding of the key aspects such as:

- Biophysical aspects, including:
    - Terrestrial fauna and flora including avifauna;
    - Surface water resources;
    - Ecologically sensitive areas; and
    - Vegetation types on site.
- Socio-economic aspects, including:
    - Heritage issues;
    - Land use, including agricultural potential;
    - Visual aesthetics including the location of the project in terms of roads, topography and proximity to houses;
    - Location of local communities;
    - Dust;
    - Employment opportunities; and
    - Tourism.

The information gathered during the site visit was used in refining the Plan of Study for the EIA process and ToR for the specialist studies undertaken during the EIA Phase.

The Scoping Phase culminated in the preparation of a Scoping Report which included the information gathered during the desktop study, as well as the previous site visit, and the Plan of Study for the EIA process and ToR for the specialist studies which would commence during the EIA Phase. Following the required public consultation and authority review, the Final Scoping Report was accepted by the DEA on 17 October 2013 allowing the EIA process to proceed. A copy of the acceptance letter is included in **Annexure A**.

2.1.3 The EIA Phase

The Scoping Phase was followed by the EIA Phase. The following specialist investigations were undertaken in accordance with the Plan of Study for EIA as indicated in **Table 2-2**.

Table 2-2 | Specialist studies undertaken per the Plan of Study for the EIA phase

Study	Consultant and Organisation
Archaeological & Heritage Assessment	Mr Jayson Orton (ACO Associates)
Aquatic Ecology Assessment	Mr James MacKenzie (Mackenzie ecological and development services)
Avifauna Assessment	Dr Andrew Jenkins (Avisense)
Botanical Assessment	Dr Dave MacDonald (Bergwind Botanical Surveys)

In response to comments received during the Scoping Phase, it was deemed prudent to evaluate both Palaeontological and Transport impacts as well. Therefore the following assessments were thus also undertaken, as indicated in **Table 2-3.**

Table 2-3 | Additional qualitative assessments undertaken

Study	Consultant and Organisation
Palaeontological Assessment	Dr John Almond (Natura Viva)
Transport Statement	Dr WR Duff-Riddell (Aurecon)

The current EIA phase has culminated in a comprehensive EIA report which documents the outcome of the abovementioned specialist investigations. The findings of the specialist investigations are summarised in **Section 5** and the full reports are included in **Annexure D**.

2.2 THE PUBLIC PARTICIPATION PROCESS

Consultation with the affected stakeholders and the public forms an integral component of this investigation and achieves the following:

- Enables stakeholder groups and I&APs to identify their issues and concerns about the proposed activities, ensuring that these are addressed in the EIA process; and
- Creates a transparent process and ensures that I&APs are well informed about the project.

As much information as was available has been included upfront inform I&APs and afford them numerous opportunities to review and comment on the proposed project. Currently there are **72** I&APs registered on the project database (see **Annexure B** for a list of I&APs). The Public Participation Process is indicated in **Figure 2** as part of the EIA programme.

The objectives of public participation are to provide information to the public, identify key issues and concerns at an early stage, respond to the issues and concerns raised, provide a review opportunity, and to document the process properly. The stakeholder engagement and PPP has been managed to meet these objectives throughout the EIA. The authority and stakeholder engagement and PPP undertaken to date is summarised in **Table 2-4**.

Table 2-4 | Summary of the authority and stakeholder engagement and PPP to date

Task	Details	Date
Stakeholders notification (relevant authorities and I&APs)		
Submission of Applications for Authorisation	The revised application for environmental authorisation was submitted to DEA. Refer to **Annexure A** for proof of submission as well as the Acknowledgment of Receipt from DEA.	**4 July 2013**
Stakeholder identification	The initial database of I&APs included the directly affected landowners, the adjacent landowners, relevant district and local municipal officials, relevant national and provincial government officials, stakeholders, and environmental and other community organisations in the area. This database was augmented via chain referral during the EIA process, and was updated as new I&APs were identified throughout the project life-cycle. The list of I&APs is included in **Annexure B**.	**July 2013**
Site notices	Site notices, in English and Afrikaans were placed at the entrance of the proposed Boegoeberg Hydro Electric Project; the Groblershoop Public Library, and !Kheis Local Municipality offices. Proof of site notices are included in **Annexure B.**	**17 July 2013**
Newspaper Advertisements	Advertisements were placed in the following newspapers (refer to **Annexure B** for copies of the advertisements): • Kalahari Bulletin; • Die Volksblad.	**18 July 2013** **17 July 2013**

Review of Scoping Reports		
I&APs and authorities	All potential I&APs were informed of the availability of the draft and final Scoping Reports by means of post and/ or email. Relevant state departments, as listed in **Annexure B,** were notified of the report and requested to submit comments. Copies of the Scoping Reports were made available for review at the following places: • Groblershoop Public Library, • !Kheis Local Municipality in Groblershoop The reports were also available on the Aurecon website[6] Electronic copies (CD) of the reports were made available on request. Authorities and I&APs were provided with 40-days to review the Draft Scoping Report (DSR) and 21 days to review the Final Scoping Report (FSR) and were invited to submit comments in writing to the Aurecon team.	Comment period for the DSR: **17 July 2013 to 26 August 2013** Comment period for the FSR: **16 September 2013 to 10 October 2013**
Public meeting	I&APs were invited to a public meeting on 7 August 2013 to discuss the findings of the DSR at the Groblershoop Library Hall, 97 Oranjestraat, Groblershoop at 17h00-19h00. I&APs were requested to RSVP by 29 July 2013. However, only one I&AP responded to the invitation (DWA) and the number of RSVP's was insufficient to warrant the meeting. It was thus cancelled and a meeting was held with the DWA directly.	**7 August 2013 (cancelled)**
Addressing comments received	All comments received on the DSR were collated into a Comments and Responses Report 1 (CRR1). The response to these comments from the proponent and the EAP was also provided in the CRR which was included in **Annexure B** of the FSR. All parties that submitted comments were provided with a copy of the CRR.	**17 July 2013 to 26 August 2013**
EIA Phase		
I&APs and authorities	All potential I&APs were informed of the availability of the draft EIA Report by means of post and or email. Relevant state departments, as listed in **Annexure B**, were notified of the report and requested to submit comments. Copies of the report were made available for review at the following places: • Groblershoop Public Library, • !Kheis Local Municipality in Groblershoop The report was also available on the Aurecon website. (CD) of the reports were made available on request. Authorities and I&APs were provided with 40-days to review the draft EIA report and were invited to submit comments in writing to the Aurecon team.	Comment period for the Draft EIA Report: **2 December 2013 to 29 January 2014**
Addressing comments received	All comments received on the Draft EIA Report will be collated into a Comments and Responses Report 3 (CRR3). The response to these comments from the proponent and the EAP will be included in the CRR 3 which will be annexed to the Final EIA report. All parties that submitted comments will be provided with a copy of the CRR.	**January 2014**
Notification of DEA decision-making		
Notification of the Departments Decision	All registered I&APs will be notified of DEA's decision within 12-days from the date of the decision. All registered I&APs will be notified of the Appeal process by means of letters sent by post or e-mail and an advert will be placed in Die Volksblad and the Kalahari Bulletin.	**TBA**

[6] http://www.aurecongroup.com- indicate "Current Location" as "South Africa" and click on the "Public Participation" link.

2.2.1 Issues Raised

All issues raised by I&APs and key stakeholders during the respective comment periods of the DSR and FSR were recorded in CRRs, along with responses from Boegoeberg Hydro and the EAP. The CCR1 and CRR2 includes all comments raised on the DSP and FSR respectively and are included in **Annexure B**.

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

Comments on the DSR:

- Eskom made comment on the transmission lines crossing the river and the impact on avifauna;
- Department of Agriculture, Forestry & Fisheries (DAFF) requested EIA documentation;,
- Neighbouring farmers requested that the study take into account the impacts on their roads due to increased traffic;
- WWF-SA registered as an I&AP but stated that they had no comments at this time,
- SAHRA requested that an opinion on the impacts on palaeontology must be provided,
- DWA requested information about the details of the project, process followed, advertising and approval of infrastructure on DWA land. Subsequent to DWA's request, a meeting with DWA representatives was held on 8 August 2013 where various aspects of the project where discussed, the minutes of which are included in the CRR in Annexure B.

Comments on the FSR:

- David S Fourie of farm 307 & 308 Seekoeibaardsnek noted his concerns on routing of the access road through his farm and requested firming up an agreement with regard to access control, livestock safety, proposed tarred sections for dust suppression and maintenance of the main road with increased traffic.
- Department of Agriculture made comment with respect to Act 43 of 1983 and the project should take cognisance of utilisation and protection of watercourses and flood area and that rezoning would be applicable.

2.2.2 Authority Involvement

Authorities have been involved with this project since the Initial Application Phase. It is anticipated that beyond providing key inputs into the EIA, the continued involvement of authorities will ultimately expedite the process by ensuring that the final documentation satisfies the respective authority requirements and that the authorities are fully informed with respect to the nature and scope of the proposed hydropower facility. The following authorities and parastatals have been requested to comment on the proposed project:

- DEA;
- Siyathemba Local Municipality;
- Siyancuma Local Municipality;
- !Kheis Local Municipality;
- Siyanda District Municipality;
- DWA;
- DEANC;
- Department of Agriculture, Land Reform & Rural Development (Northern Cape);
- SAHRA;
- Northern Cape Provincial Heritage: *Boswa ya Kapa Bokone*;
- Department of Energy (Northern Cape);
- Eskom Holdings Ltd.; and

- DoE.

2.2.3 Decision making

Based on the information gathered during the EIA Phase (including the impact and specialists' assessments) and the public participation process) and the comments submitted by the commenting authorities and I&APs, the competent authority, namely DEA, will make a decision regarding the EIA application. The Environmental Authorisation will either be to authorise the proposed activity (with certain conditions) or reject the application for the proposed activity. In addition the authorities may request further information, should they believe that insufficient information has been provided, on which to base an informed decision.

Once DEA have made their decision on the proposed project, all registered I&APs on the project database will be notified of the outcome of the decision within ten calendar days of the Environmental Authorisation having been issued. As a minimum, the decision would be advertised in the Volksblad and Kalahari Bulletin newspapers used to inform I&APs of the proposed project. Should anyone (a member of public, a registered I&AP, or the Applicant) wish to appeal DEA's decision on the EIA application, a Notice of Intention to Appeal in terms of Section 62 of NEMA must be lodged with the Minister of Water and Environmental Affairs within 10 calendar days of the I&AP being notified.

2.3 ASSUMPTIONS AND LIMITATIONS

2.3.1 Assumptions, Uncertainties and Gaps in Knowledge

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

- The strategic level investigations undertaken by the DoE regarding South Africa's proposed energy mix prior to the commencement of the EIA process are technologically acceptable and robust;
- The information provided by the client is accurate and unbiased; and
- The scope of this investigation is limited to assessing the environmental impacts associated with the proposed hydropower station and connections to the grid. The EIA does not include any infrastructure upgrades which may be required from Eskom to allow capacity in the local grid for the proposed projects.

The gaps in knowledge that were evident during the Scoping Phase include:

- Total spoil amounts and the corresponding amount to be used for the farms revetments.
- Total amount of wearing course required from borrow pits for access roads.

The planning for the proposed projects is at a feasibility level and therefore some of the specific details are not available at this stage of the project. This EIA process forms a part of the suite of feasibility studies, and as other studies progress, more information will become available which may not be available in the EIA process. DEA, and other authorities, will be requested to issue their comments and ultimately their environmental decision to inform the detailed design phase of projects and allow for the type of refinements that typically occur after these feasibility studies. Undertaking the EIA process in parallel with other feasibility studies does have a number of benefits. Such benefits include integrating environmental aspects into the layout and design and therefore ultimately encouraging a more environmentally sensitive and sustainable project.

2.3.2 Independence

The requirement for independence of the environmental consultant is aimed at reducing the potential for bias in the environmental process. Neither Aurecon nor any of its sub-consultants are subsidiaries

of Boegoeberg Hydro, nor is Boegoeberg Hydro a subsidiary to Aurecon. Furthermore, Aurecon does not have any interests in secondary or downstream developments that may arise out of the authorisation of the proposed project.

Aurecon have selected a team of highly experienced specialists and multi-disciplinary practitioners in order to execute these projects as efficiently as possible.

EIA Team
The Project Director, Mr Andries van der Merwe is appropriately qualified and registered with the relevant professional bodies. Mr van der Merwe is a certified Environmental Engineer registered with the Engineering Council of South Africa (PrEng) and holds a B Eng (Civil) degree.
The Project Manager, Mrs Diane Erasmus is registered as a Certified EAP with the Environmental Assessment Practitioners of South Africa (EAPSA). Mrs Erasmus is the designated EAP for the proposed project.
Mr Charles Norman is a senior environmental consultant at Aurecon and has joined the project team as an internal reviewer and to provide guidance where and when it is required.
Mr Simon Clark is an appropriately qualified member of the team with a BA in Environmental Management from the University of South Africa.

Aurecon is bound by the codes of conduct for SACNASP and EAPSA. The CV summaries of the key Aurecon staff are included in **Annexure E**.

3 THE PROPOSED ACTIVITY

The purpose of this Chapter is to description of the proposed activity with specific reference to the construction, operation and decommissioning of the hydropower station and to describe the alternatives that are being considered. Alternatives that are being considered are discussed in terms of location, activity, site layout and technology.

3.1 DESCRIPTION OF THE PROPOSED ACTIVITIES

The proposed station Boegoeberg Hydro Electric Project will be located on the farm Zeekoebaart (*Remainder of Farm no. 306 and Portion 1 of Farm no. 306*) located approximately 26 km south east of the town of Groblershoop in the Northern Cape.

Coordinates of the middle point of the proposed power chamber	
29° 2'19.62"S	**22°12'6.74"E**

The proposed facility would be a run-of-river hydropower scheme capable of producing approximately 11 MW of electricity through two or three Kaplan turbines, each having equal capacity. Run-of-the-river facilities use conventional hydropower technology to produce electricity by using the natural flow and drop in elevation of a river and diverting the flow and passing it through turbines that spin generators. The flowing water spins the turbines, which take the kinetic energy from the flowing water to generate electricity in the same way that a coal-fired power station creates steam to turn turbines and wind turbines are turned by wind. There would be no storage of water off-stream and the power station would thus be subject to seasonal river flows, and would not operate during low flow periods. The process of generation and distribution of electricity through a run-of- the-river hydro plant is illustrated in **Figure 3**. According to Eskom's 2010 financial statements, the average Eskom residential customer uses an approximately 212 kilowatt hours (kWh) per month. Current calculations show approximately 6,300,000 kWh hours of energy would be generated by the plant per month with a load factor of between 50% and 70% (depending on the time of year). It is estimated that the Boegoeberg Hydro Electric Project will generate enough energy to power, on average, 30,000 homes.

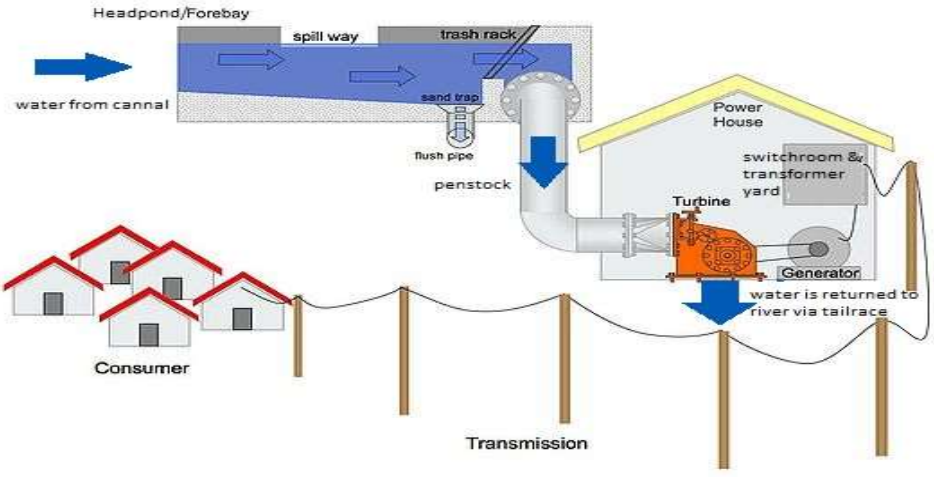


Figure 3 | Illustration of the electricity generation process for a run-of-river hydropower station [Source: https://energypedia.info (Accessed: 28 June 2013)]

3.1.1 Components of the Hydropower Station

This section will in more detail describe each component of the hydropower station.

A run-of-river hydropower station, as proposed, consists of the following main components (refer to **Figure 4** and detailed description below):

- Intake infrastructure:
  - The existing Boegoeberg Weir
  - Off-take Weir (below the normal water surface level) constructed in the Boegoeberg Weir pool to regulate flow into the water conveyance infrastructure and provide a physical ;barrier against the drawdown of water below agreed levels and ensure irrigation flows and environmental flows;
  - Inlet structure, which may contain up to two radial gates that close automatically to stop flow to the power chamber in the event of floods;
- Temporary upstream caisson (coffer dam) will be required in the weir pool to exclude water from the works for the construction phase;
- Water conveyance infrastructure (i.e. canal or tunnel) to direct water from the river to the power chamber;
- Head pond/ forebay to temporarily store water so that flow to the power chamber is regulated, allowing a steady flow to the turbines. The headpond also allows for the extraction of sediment from the water;
- Power station intake structure/ penstock; comprising a sluice, gate or enclosed pipe intake structure which further assists in controlling the transfer of water to the power chamber
- Power chamber to house the turbines and equipment used to generate electricity;
- Sediment basins; and
- Outlet works/ tailrace to return the abstracted water back into the river, downstream of the power chamber.

Ancillary infrastructure includes access roads for use during construction and for maintenance purposes during operation, transmission line(s) for evacuating the energy produced by the hydropower station to the Eskom national grid, a switchroom, and transformer yard.

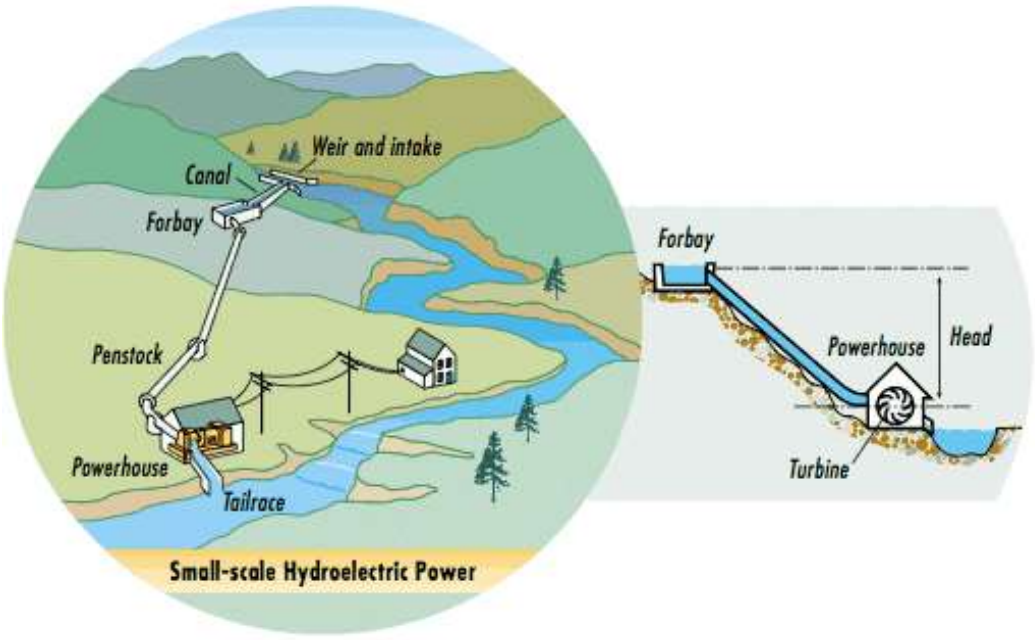


Figure 4 | Illustration of a run-of-river hydropower station [Source: http://enermed.cres.gr (Accessed: 28 June 2013)]

The location of the various components is indicated in **Table 3-1**.

Coffer dams

A coffer dam provides a temporary enclosure used for construction within a body of water by creating a watertight work environment where the works are isolated and water pumped out to allow rivers flow to bypass the foundation works area (**Figure 5**). Coffer dams would be built upstream and downstream of the low weir sites, flow focusing structures and the intake structure. This would divert part of the Orange River by bypassing the footprint of these structures to enable them to be constructed. Controlled blasting would be used to provide a suitable foundation for the weirs before concrete is placed. Any mechanical equipment would be installed after the majority of the civil construction works were completed.

Figure 5 | Example of a coffer dam (Source: Coffer dam http://www.whalingcity.net/picture_hurricane_barrier.html)

Weir and Off-take Structure

The weir (refer to **Figure 7)** regulates flow into the off-take channel. The weir would be designed and constructed to allow the permitted flow volumes to pass the weir and remain within the Orange River and only take water for power generation that is surplus to the irrigation, scour and environmental flow requirements. The Boegoeberg weir is approximately 11 m high (as measured from the river bed). However sediment has filled the reservoir such that the depth of water is estimated to be 6 m upstream of the weir. It is proposed that up to 120 m³/s would be diverted from the river. This diverted flow would then pass through the hydropower plant infrastructure and be returned to the river some 400 m downstream of the off-take weir. A debris boom will be placed upstream of the off-take weir to prevent passage of debris into the hydro power project. The following environmental and technical requirements will be considered as part of the flow diversion required for the hydropower plant:

- An uninterrupted flow equivalent to the demand of the local irrigation scheme, which would pass through the irrigation outlet on the left bank;
- An environmental release in a quantity to be agreed must pass over the weir structure and down the river at all times;
- The hydro scheme requires a flow of up to 120 m^3/s when sufficient river flow is available after environmental releases;
- The project may include a system for flushing sediment that could build up in the water conveyance infrastructure upstream of the power chamber.

Figure 6 | Layout of proposed project components on site (Not to scale)

Figure 7 | Boegoeberg weir, taken from the southern bank. The power station would be situated on the northern bank.

The main criterion for the selection of the proposed site was that there was sufficient elevation between the off-take and release points to allow transport of water to the power station to produce the maximum amount of power based on the physical properties of the site.

The off-take structure (refer to **Figure 13**) would consist of a predominantly concrete structure built into the riverbank 100 m to 250 m upstream of the existing weir wall. The off take weir would be engineered in consultation with the DWA and their requirements in order not to affect the existing weir's structural integrity. Downstream of the off-take weir and channel an inlet structure would be built, which may comprise a trash racks, stoplogs[7] and gates. The trash rack prevents the intake of debris such as branches or trees.

The operable gate would regulate the volume of water which enters the canal or tunnel downstream. The regulation of the volume of water entering the off-take and inlet structure will be necessary, to amongst other things:

a. limit the flow of water to the power station during low flow periods to ensure the obligations to maintain the environmental reserve flow in the Orange River are met; and
b. ensure that only the volume of water required for electricity generation is transferred to the water conveyance infrastructure during peak flows in the Orange River.

Temporary upstream and downstream caissons

A caisson is a watertight structure used to keep water out of a construction area. Caissons are required upstream of the off-take weir and downstream of the tailrace. The caissons to be constructed for the Boegoeberg project could be constructed as two parallel walls, forming a double-walled enclosure with the space between the two parallel walls filled with granular material such as gravel, sand or broken rock so as to form a barrier to the intrusion of water. Once the caisson is constructed water is pumped out so as to permit works to commence. Once construction of the permanent works

[7] A log, plank, or steel or concrete beam that fits into a groove or rack between walls or piers to prevent the flow of water through an opening in a dam, conduit, or other channel.

within the caisson is complete the caisson is removed, allowing water to flow into the off-take structure.

Figure 8 | Example of a similar intake structure with trash racks and cleaner (Source: Entura).

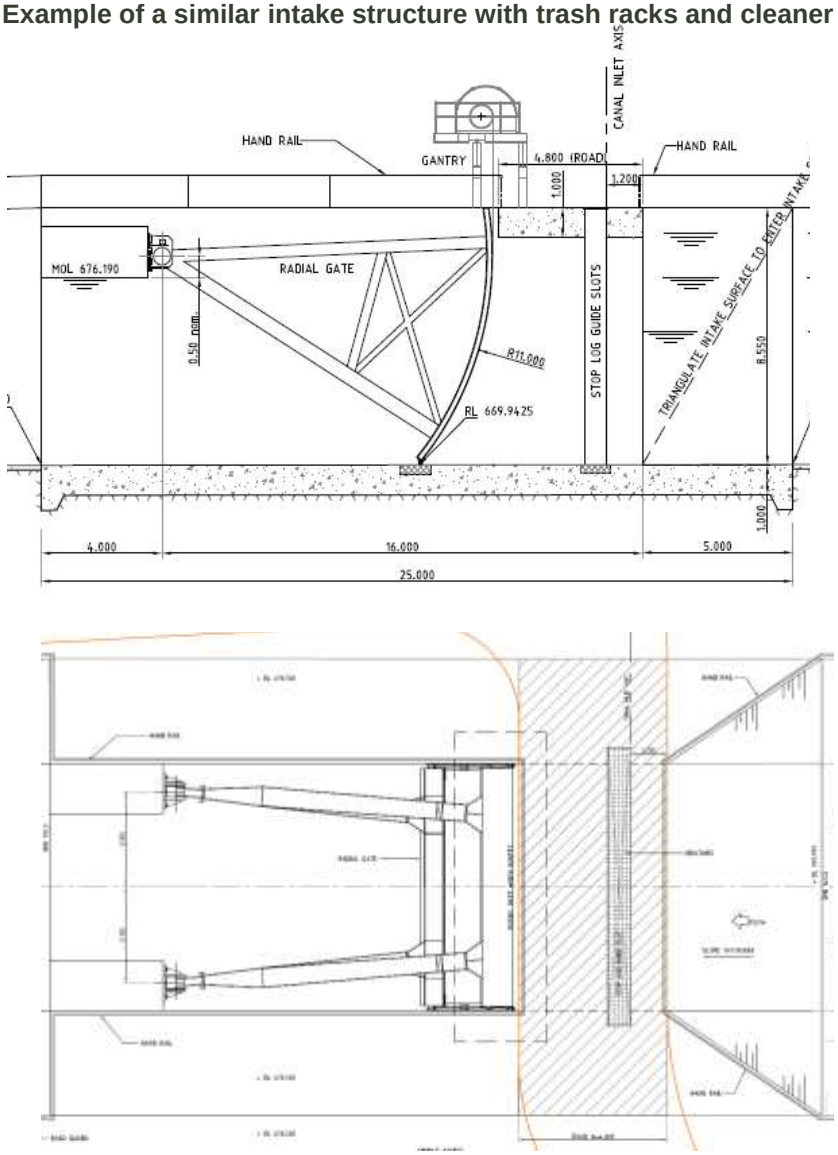


Figure 9 | Section and plan of a similar inlet structure

Water Conveyance Infrastructure

The water conveyance infrastructure transports the water from the river level in the off-take structure, located upstream from the weir, to the power chamber. It will comprise either of an open canal or tunnel to convey the water to the power chamber.

Tunnel (Preferred alternative): Preliminary analysis has estimated that the tunnel (**Figure 10**) would be as follows:

a. Two approximately 7.5 m wide by 9.0 m high concrete lined tunnels to convey the required volume of water; and
b. Approximately 300 m in length.

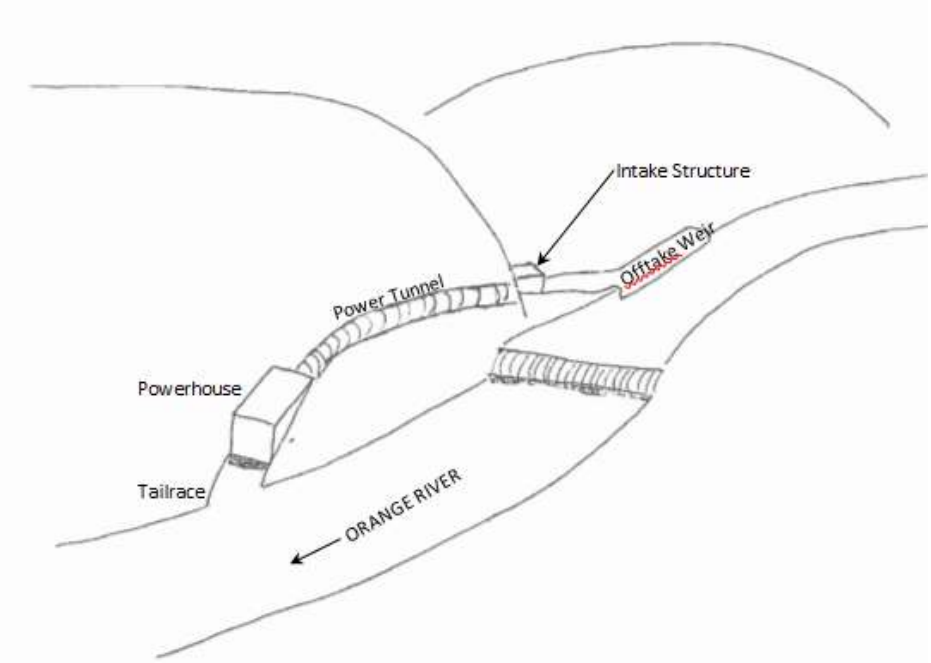


Figure 10 | Sketch of the tunnel alternative at Boegoeberg

Figure 11 | Example of a Tunnel (Source: Entura)

Canal: The option of a canal (**Figure 12**) is a feasible alternative although it is not the preferred as it would require quite extensive blasting and remove a significant portion of the existing koppie. The canal would follow contours as much as possible so as to maintain a constant gradient throughout its length, without losing too much head. The topography will determine the amount of material that needs to be removed for construction of the canal. If the amount of material is found to be too great a tunnel will be considered as an alternative to deliver water to the headpond.

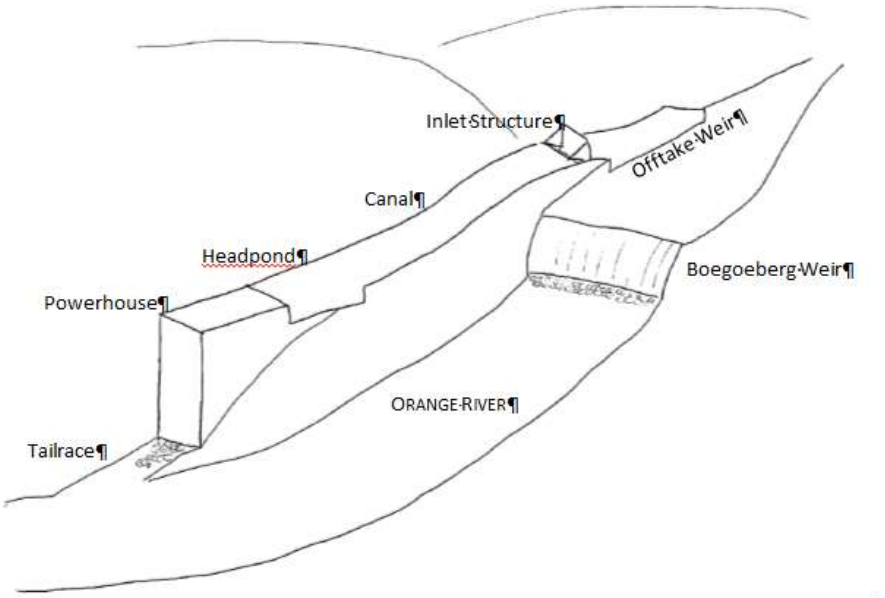


Figure 12 | Sketch of the canal alternative at Boegoeberg

In this case, it is envisaged that an open canal would be possible. The depth of the canal would vary depending upon, amongst other things, the topography of the terrain through which it is passing and the geological conditions of the ground in which it is constructed. Preliminary analysis has estimated that a typical cross-section for the conduit would be in the order of 10 deep and 15 m wide at the floor of the canal.

Figure 13 | Example of an open channel (Source: http://www.hydro.com.au/energy/our-power-stations/derwent (Accessed: 10 September 2013).

The open canal would be fenced in to ensure animals and people cannot fall into the canal, with a bridge built over the canal to allow access to Boegoeberg Weir. A stormwater drain located up-slope of the canal would prevent storm water entering the canal. Stormwater would be diverted around the project infrastructure and returned to the river. The canal would be concrete lined (see **Figure 13**).

Head pond: The headpond is only required for the canal alternative. The purpose of the head pond, also called the forebay, is to accumulate water temporarily and control the rate of the flow into the penstock (**Figure 14**). The head pond's secondary function is to allow for debris (i.e. silt, sediment, etc.) to settle so that it does not enter the facility and damage the turbines. The head pond would be located downstream of the water conveyance infrastructure (canal alternative) and immediately upstream of the power station intake structure. The head pond will be a small concrete structure cut into the hillside with sluices to discharge built up sediment beck to the river. An overflow/ spillway from the head pond may be required in the event of machine shutdown or in the event that the flow of water in the water conveyance infrastructure is otherwise greater than that able to be utilised by the turbines.

Figure 14 | Example of a small head pond. (Source: energypedia.info (Accessed: 28 June 2013)].

This overflow/spillway would have low water velocities (compared to that of the turbine) and would provide a controlled release of water from the head pond into the river downstream. It also assists in the regulation of the volume of water in the head pond.

Power Station Intake Structure (Penstock)

For the canal alternative a concrete intake structure comprising gates at the upstream end of the penstock will transfer water from the head pond to the penstock (**Figure 15** and **Figure 16)**. For the tunnel option, this function is performed by the penstock, an enclosed conduit of approximately 5.0 m wide by 6.0 m high will convey water to the power chamber. The gates would operate in an emergency to shut off flow into the penstock, or to allow maintenance of the penstock to occur.

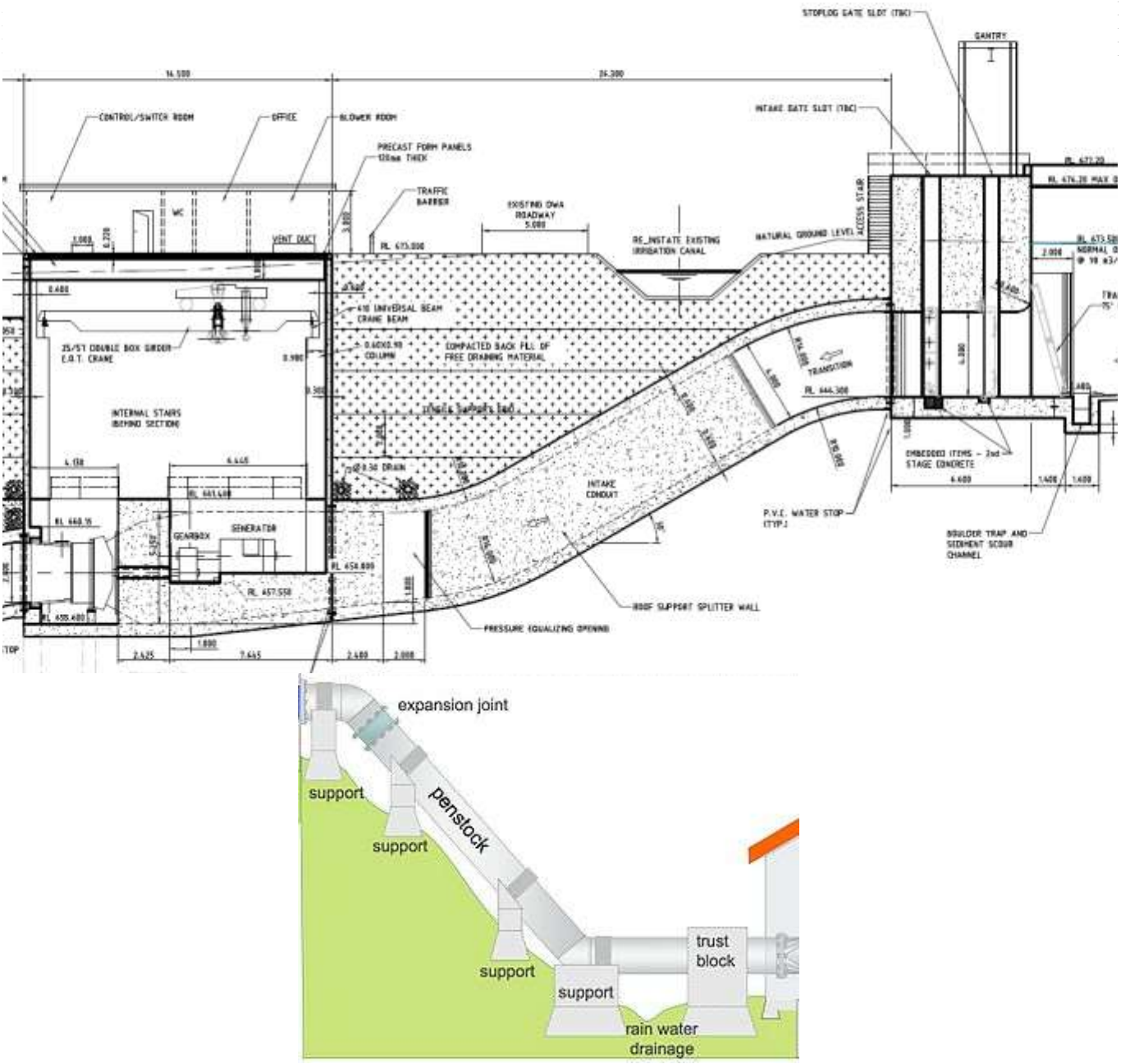


Figure 15 | Illustrated example of a penstock (Source: energypedia.info (Accessed: 28 June 2013)].

Figure 16 | Example of a penstock (source: energypedia.info (Accessed: 28 June 2013)].

Power chamber

The power chamber houses the turbines and generation units within a turbine hall (**Figure 17** and **Figure 18**). The power chamber would be located approximately almost immediately downstream of the intake structure. The power chamber dimensions would be approximately 30 m x 15 m x 20 m (l x b x h). A crane would be positioned within the power chamber for the installation and removal of the turbines and generators as well as for any maintenance required during operation.

Figure 17| Example of a power chamber (Source: http://www.lowimpacthydro.org/Accessed: 28 June 2013).

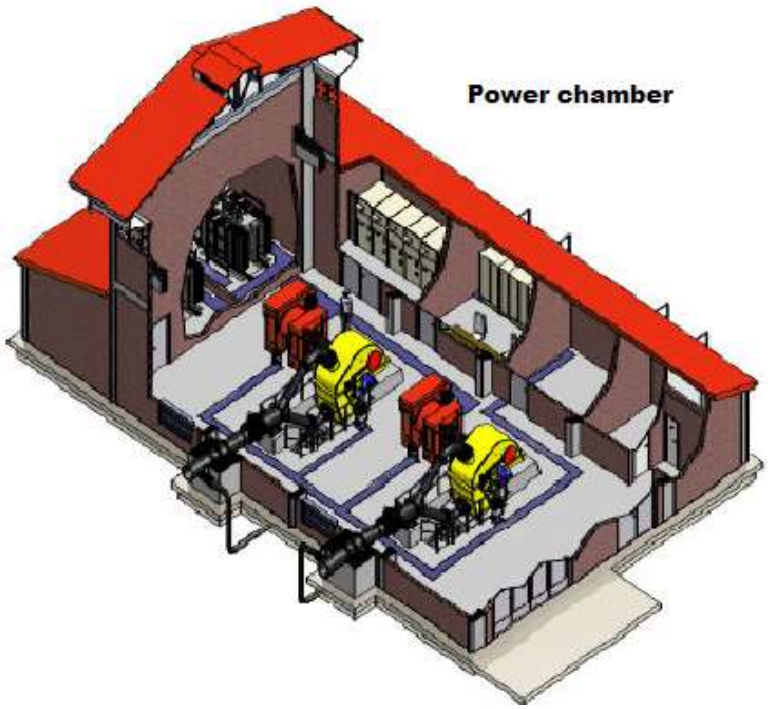


Figure 18 | Illustration of a chamber. (Source: http://www.lcclao.com (Accessed: 28 June 2013)].

Turbines and Generators

Water flows from the elevated head pond or tunnel down the penstock into the connected turbines. The flowing water applies pressure on the turbine blades causing the shaft to rotate which in turn is connected to an electrical generator which converts the motion of the shaft into electrical energy (**Figure 19**).The turbines to be used at the Boegoeberg Hydro Electric Project would be Kaplan type turbines based on the head an flow characteristics of the site.

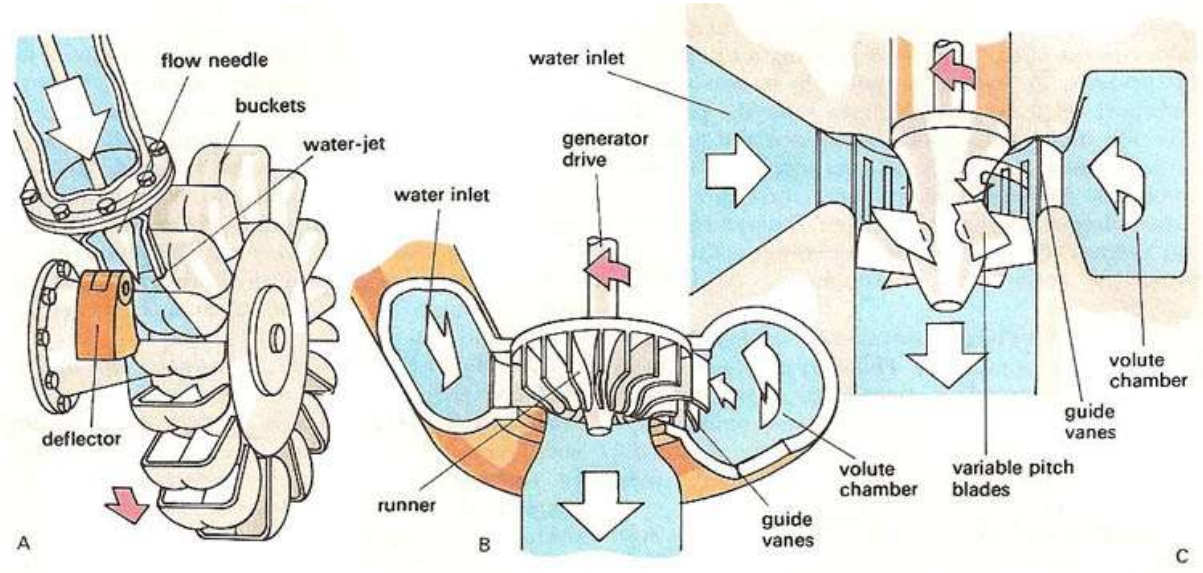


Figure 19 | Illustration of the three main types of water turbines: (A) Pelton wheel; (B) Francis turbine; (C) Kaplan turbine. (Source: The Encyclopaedia of Alternative Energy accessed 8 July 2013)

Outlet Works/ Tailrace

Water would be released from the power chamber, via a draft tube, into a tail race canal (**Figure 20**). This tail race canal/ tunnel terminates in the river where preliminary analysis suggests that the water would be released at a maximum velocity of approximately 2 m/s, but this velocity would vary depending on the volume of water entering the project at any given point in time. The tailrace canal would be approximately 100 m long. The tailrace will have a width of about 20 m and a depth of about 4.0 m and may be concrete lined.

Switchroom

The switchyard would be a small platform approximately the size of a triple bay, garage. It would be located in the vicinity of the power chamber, outside the 1:100 year flood line, and its final location would be informed by the detailed design of the power chamber. An area of approximately 20 m by 20 m would be required for the structure. The switchroom may also be located within the power house.

Transformer yard

Transformers would be located immediately adjacent to the power chamber to transform the electricity produced by the turbines to the transmission line.

Figure 20 | Example of a power chamber and associated infrastructure. (source: http://www.photosensitive.com (Accessed: 28 June 2013)].

High Voltage (HV) Transmission Infrastructure

The HV transmission infrastructure (**Figure 21**) is to be located above ground and would connect into Eskom's 132 kV transmission system via the Fibre Substation some 36 km south of the plant (**Figure 23**). The transmission line was revised based on the botanical specialist's recommendation to route it around a section of the riverine vegetation.

Figure 21 | Example of a 33kV transmission line (Source: www.electrical-contractor.net (Accessed 9 September 2013)

Figure 22 | Eskom's Fibre substation where the transmission line would connect to the national grid

3.1.2 Construction of the proposed hydropower station

The construction of the proposed hydropower station will take approximately 24 months. During the construction period several major tasks will need to be completed, as described below.

Hydropower plant and associated Infrastructure dimensions and construction footprint

The proposed hydropower plant and associated infrastructure dimensions of each facet of the proposed development have been detailed below, in **Table 3-1**.

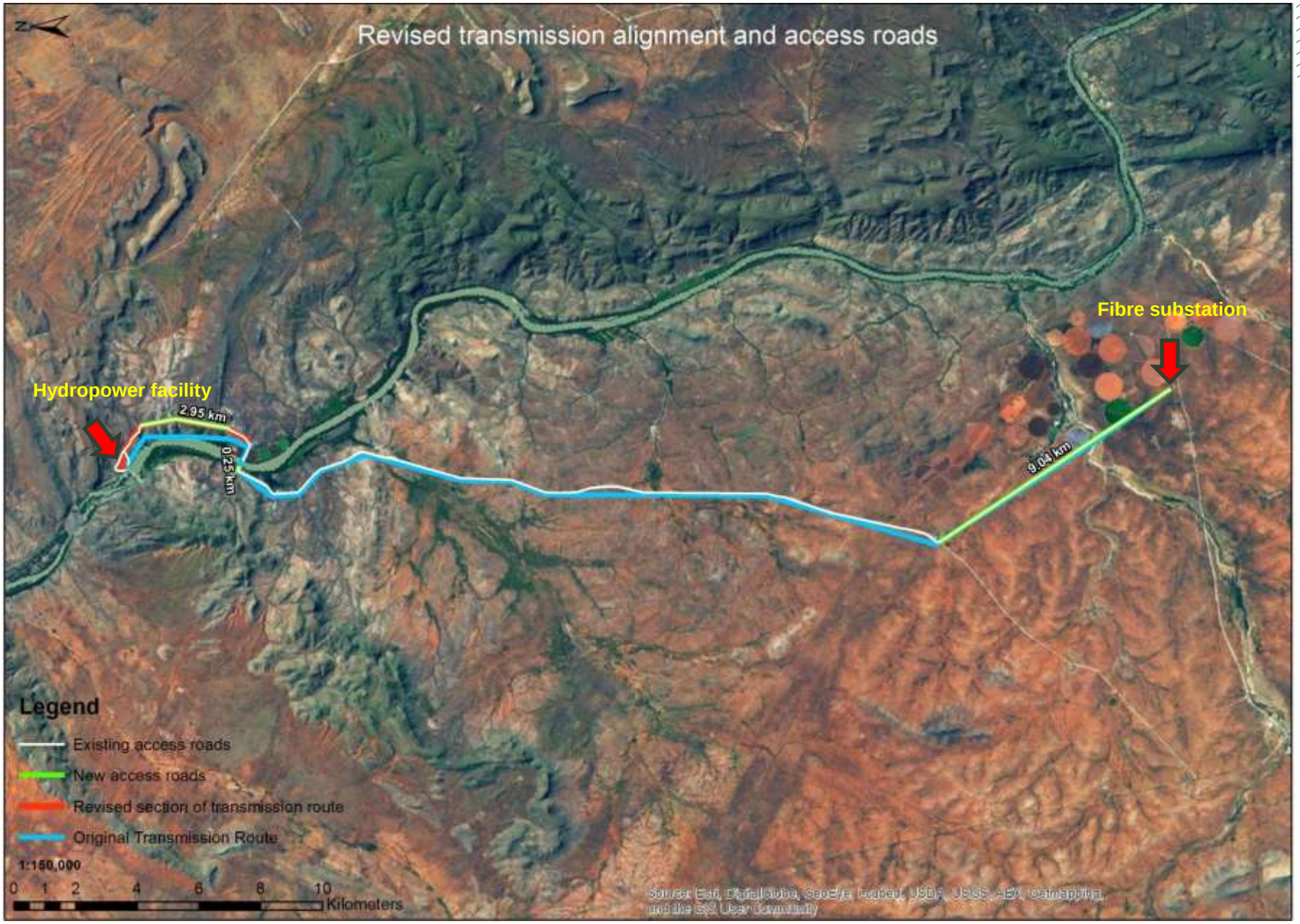


Figure 23 | Revised transmission servitude with cognisance of environmental sensitivities

Table 3-1 | Dimensions, footprint and location for both temporary and permanent plant infrastructure.

Permanent site infrastructure			
Component	**Dimension (WXL)**	**Total footprint (m²)**	**Approximate coordinates**
Off-take infrastructure	20m x 150m	3,000m²	29° 2'28.68"S, 22°12'15.93"E
Water conveyance infrastructure a) canal b) tunnel	35m x 230m 15m x 300m	8,000m² Nil (underground)	29° 2'23.41"S, 22°12'10.53"E
Head pond/ forebay	20m x 20m	400m²	29° 2'20.04"S, 22°12'7.21"E
Power station intake structure/ penstock	15m x 10m	150m²	29° 2'19.88"S, 22°12'7.04"E
Power chamber (i.e. Turbines and generator)	15m x 30m	450m²	29° 2'19.62"S ,22°12'6.74"E
Outlet works/ tailrace	30m x 100m	3,000m²	29° 2'19.29"S, 22°12'4.29"E
Switchroom/ Transformer yard	20m x 20m	400m²	29° 2'19.31"S, 22°12'6.93"E
High Voltage (HV) Transmission Infrastructure	30m x 36,000m (30m for 132kV or 15m for 33kV)	1,080,000m² (however this is the entire servitude each pylon would take up a small percentage of this)	Start 29° 2'19.31"S, 22°12'6.93"E Mid-piont 29°11'21.44"S, 22°11'50.96"E Finnish 29°20'44.58"S, 22°14'2.22"E
Access roads ***Site Access*** a) Existing b) New ***Transmission route*** c) Existing d) New	 ~ 8.5km x 6m - ~ 24.5km x 4m ~12.24km x 4m	 51000 m² - 48960m²	- Start 29° 2'19.31"S, 22°12'6.93"E Mid-piont 29°11'21.44"S, 22°11'50.96"E Finnish 29°20'44.58"S, 22°14'2.22"E
Spoil material		~ 170,000m³.	
Borrowpits ***a)*** Existing farm borrowpits	BP1 Circumference ~250m BP2 Circumference ~200m		29° 3'13.20"S, 22°14'50.38"E
Sediment basins	3 x 30m x 30m	2700m²	Centre basin 1: 29°02'18.13"S, 22°12'08.65" Centre basin 2: 29°02'16.28"S, 22°12'07.37" Centre basin 3: 29°02'14.56"S,

Component	Dimension (WXL)	Total footprint (m²)	Approximate coordinates
			22°12'05.97"
Temporary site infrastructure			
a) Site office b) Construction yard c) Staff accommodation	50m x 75m	3750m²	29° 2'27.23"S, 22°12'24.42"E

Site Access

Access to the site during the construction period would be *via* roads of approximately 6 m in width. The access road would be in part an expansion of the existing Zeekoebaart farm roads, and would be gravel. Where possible these construction access roads would be constructed to a standard suitable for permanent site access for the construction and operational phases of the project. As far as possible existing road alignments will be modified to be approximately 6 m wide to accommodate construction vehicles during the construction period.

Water Conveyance Route

Construction of the water conveyance structures would involve the clearing of vegetation along the alignment as required. The alignment will be cleared for a width of 30 m. A temporary construction corridor of 6 m width would be required adjacent to the alignment in order for the construction machinery to manoeuvre. Once cleared, any soft or intermediate material will be excavated by mechanical means (i.e. excavator). Hard rock will be loosened by means of controlled blasting before it will be excavated. Concrete lining of the canal or tunnel would cast in-situ.

Head pond

Similar to the water conveyance route, the head pond site would be cleared and excavated. An area of 400m² will be cleared. Depending on the geology of the site, controlled blasting might again be required to loosen up hard rock that cannot be excavated mechanically. Any required concrete lining of the head pond would be cast in-situ.

Penstock

The penstocks would be steel or concrete and would be partially buried.

Power chamber

Construction of the power chamber would involve the clearing of vegetation of an area of approximately 450 m^3. Once cleared, any soft or intermediate material will be excavated by mechanical means (i.e. tracked excavator). Hard rock will be loosened by means of controlled blasting before it will be excavated.

Tailrace

Construction of the tailrace would involve the clearing of vegetation of an area of approximately 3000 m². Once cleared, any soft or intermediate material will be excavated by mechanical means (i.e. tracked excavator. Hard rock will be loosened by means of controlled blasting before it will be excavated.

Transmission Line

The overhead transmission line would follow existing access roads where possible. The transmission line would be constructed to Eskom standards appropriate to the rating of the line finally decided upon.

Figure 24 | Access Roads, borrow pits, construction camp, revetments and sediment storage basins for the proposed project

Site Infrastructure

A site office would be located near the site of the construction works. It would house the administrative personnel for the construction works and would have its own services and amenities. The peak construction workforce is estimated to be 150 to 200 people. Accommodation for the workforce would be in temporarily constructed at the farm, close to the site as indicated in **Figure 24**.

Spoil Material

From Tunnel (preferred option)

An approximate total of 70,000 m³ spoil material will be excavated from the weir, tunnel, power chamber, and tailrace. The largest amount of spoil would be generated by the construction of the tunnel.

Canal

An approximate total of 170,000 m³ spoil material will be excavated from the weir, canal, power chamber, and tailrace. The largest amount of spoil would be generated by the excavation of the canal.

Several options have been assessed for the removal and disposal and/or re-use of spoil material. Where possible, backfilling of excavated material will be undertaken to reduce spoil quantities.

Re-use options include:

- Aggregate for concrete production to be used in the construction of the proposed hydropower facility and its associated infrastructure;
- Bunds around the proposed sediment (silt) basins to be constructed.

Additional and alternative uses for spoil materials:

- Access roads to be upgraded and sections of the transmission access roads to be constructed;
- Rehabilitation of existing agricultural revetments on the farm to protect agricultural fields from periodic flooding (as requested by the landowner)

A combination of the above options may be required to ensure the proper management of spoil during the construction phase. However it should be noted all spoil would be reused and not disposed of.

Classification of excavated earth materials as waste:

According to Annexure 1 of the Waste Classification and Management Regulations, *"Excavated earth material not containing hazardous waste or hazardous chemicals"* is considered to be General Waste. Considering the above, it was apparent that the following activity, listed in terms of the Waste Act (NEM:WA), could be potentially triggered:

(Schedule 1: Category B (EIA)):

Activity No. 5. The disposal of general waste to land covering an area of more than 100 m^2 or 200 m^3 of airspace, including the construction of a facility and associated structures and infrastructure for such disposal.

As such excavated materials would exceed Schedule 1's threshold which would require both a Waste License and an associated EIA to be undertaken. Clarification has been requested from the DEA with reference to classification of excavated materials that would not in fact be deposed of, but rather reused in the project development phase and rehabilitation activities.

Aurecon's has, while waiting for confirmation from the Department, proceeded according to their interpretation that under the current waste classification the spoil, even if reused, is considered waste and as such would require the relevant Waste Licensing Application to be undertaken. As this EIA

process was already underway when the current legislation was changed, Aurecon has incorporated the required EIA process for the Waste Licence into this EIA process for the whole project. Should the Department request an alternative approach, the EIA process will be amended as required to meet the additional requirements. Refer to **section 1.3** for further detail on the Waste Licensing Application.

Borrow pits

Material would be needed for upgrading and re-gravelling the existing gravel roads to a maximum width of 6 m. Suitable gravel is not always readily available and may have to be specifically sourced. Two informal borrow pits on the farm have been identified as suitable sources of wearing course as required and are in close proximity to the roads that will require upgrading. At this stage it is not known if material will need to be sourced from the borrow pits and if so, what quantities. This would be determined during the detailed design period. A mining permit would be required from Department of Mineral Resources (DMR) should this option be required, and as such an application for a mining permit will be submitted to DMR.

Sediment removal (dredging)

Sedimentation of the Boegoeberg Dam is an historical and on-going problem. Currently DWA scours the dam through one or two of the dam's many sluices. This is done to ensure the area immediately surrounding the irrigation outlet is kept clear of sediment and it is currently the only option to maintain flows to the agricultural canal running parallel to the southern bank. The sediment management methods currently employed would have a net negative effect on the project's feasibility as a large portion of the dam's flow is unutilised or lost during scouring.

This activity will occur initially as a construction impact (2,000 m^3 will be removed during construction) and then will continue as an operational phase activity. It is proposed that a sediment extraction program be established to remove sediment from in front of the hydro project off-take and from around the irrigation outlet. Sediment would be removed by a dredge in the Boegoeberg weir reservoir. Dredging would only occur around the agricultural irrigation canal and the inlet structure of the hydropower station to allow the required flows to reach each component. The sand is dredged by means of equipment housed on a barge which disturbs the sediment either by mechanical means, or by injecting air or water into the sediment to agitate it. A pump housed on the barge draws slurry, made up of water containing about 20% solids, into a pipe at a rate of about 100 litres per second. It is anticipated that dredging would occur throughout the year for about one week per month on average.

An 8 inch pump will transfer the slurry into an HDPE pipe (350 mm ID Class 6. The pipeline would be suspended by floats while in the water before it passes onto land on the right (eastern) abutment of Boegoeberg weir. The pipe would then traverse around the hillside to the sediment basins located to the north of the power chamber. The total length of the pumping main would be about 700 m. The dredge would deliver about 500 m^3 of sand into the sediment basins per day.

The dredged sediment would be stockpiled in 2 or 3 silt storage basins downstream of the weir (**Figure 26**) to allow the water to drain. The dry sediment would be sold to a third party for commercial use. This potential solution has also been communicated with DWA during a meeting on 25 November 2013 to discuss the proposed project in greater detail. DWA have indicated their support for the removal of silt from the Boegoeberg Dam as proposed in this report.

Figure 25 | Example of a dredger
(Source: http://www.nma.gov.au/online_features/goolwa_toowoomba)

As with the excavated material (spoil), the quantities of silt would exceed Schedule 1's threshold and therefore the necessary waste licence as mentioned above is to be applied for and the EIA process combined with this one.

Figure 26 | Proposed silt storage basins

3.1.3 Operation of the hydropower station

The operational lifespan of the hydropower plant is estimated to be approximately 60 to 80 years. The turbines are designed to operate continuously and with a minimal maintenance intervention throughout the operational lifespan of the facility.

During the operational phase of the project, staff would undertake routine maintenance and the operation of the facility would be done remotely, consequently there would be no need for ancillary buildings to accommodate permanent site personnel.

It is estimated that the operational phase will result in between four to six job opportunities. Vehicles would use the permanent access roads to travel to the power chamber for work. On occasion, maintenance activities would be required on other areas of the project, which may require heavier construction equipment. This equipment would be restricted to the access roads and the work site to minimise its impact on the environment.

On-going dredging will be required to remove sediment loads that accumulate behind the Boegoeberg Dam. The sediment would be monitored and removed via a dredge to a bunded area downstream, as discussed above. It is estimated that removal would happen on a monthly basis depending on the water conditions and seasonality when high sediment yields are mobilised. Approximately 2500 m^3 of silt would be removed every month in order to maintain flows to both the irrigation canal and the hydropower station.

3.1.4 Decommissioning of the proposed hydropower station

As the proposed hydropower station is to be constructed under the Renewable Energy Independent Power Producer Procurement (REIPPP) Program the minimum operational period will be 20 years (which is the duration of the PPA signed between Eskom and the developer). However, as the entire infrastructure, such as roads, transmission, and power chamber, etc. would already be established, and the energy source (water) is a renewable one, the proposed project could potentially continue to be operated beyond this. As such the facility will most likely be upgraded with the latest applicable technology and/or existing infrastructure will be maintained for further use after the expiration of the initial PPA.

Should the facility be decommissioned, which is unlikely, all components will have to be disassembled, removed and recycled as far as possible. Depending on the best available option at the time, any above ground structures must be demolished unless an alternative use is found for them. Decommissioning would have to be undertaken as per the environmental legislation relevant at that time and under the supervision of an independent Environmental Control Officer (ECO).

The rehabilitation of the disturbed areas would form part of any decommissioning phase. The aim would be to restore the land to its original substratum characteristics (or as near as possible). The prescribed restoration activities will be described in the LEMP in the EIR.

3.2 CONSIDERATION OF ALTERNATIVES

3.2.1 Introduction

NEMA requires that alternatives be considered during the EIA process. According to DEAT (2004) "*an alternative can be defined as a possible course of action, in place of another, that would meet the same purpose and need*".

The DEA&DP 2013 guideline for alternatives states that *"every EIA process must identify and investigate alternatives, with feasible and reasonable alternatives to be comparatively assessed. If, however, after having identified and investigated alternatives, no feasible and reasonable alternatives*

were found, no comparative assessment of alternatives, beyond the comparative assessment of the preferred alternative and the option of not proceeding, is required during the assessment phase. What would, however, have to be provided to the Department in this instance is proof that an investigation was undertaken and motivation indicating that no reasonable or feasible alternatives other than the preferred option and the no-go option exist."

"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; and
(f) the option of not implementing the activity ("**No-Go**" alternative).

In addition to the list above, the 2013 Department of Environmental Affairs and Development Planning (DEA&DP) Guidelines on Alternatives also considers the following as alternatives:

(a) **Demand alternative:** Arises when a demand for a certain product or service can be met by some alternative means (e.g. the demand for electricity could be met by supplying more energy or using energy more efficiently by managing demand).
(b) **Input alternative:** Input alternatives are applicable to applications that may use different raw materials or energy sources in their process (e.g. Industry may consider using either high sulphur coal or natural gas as a fuel source).
(c) **Routing alternative:** Consideration of alternative routes generally applies to linear developments such as power line servitudes, transportation and pipeline routes.
(d) **Scheduling and timing alternative:** Where a number of measures might play a part in an overall programme, but the order in which they are scheduled will contribute to the overall effectiveness of the end result.
(e) **Scale and Magnitude alternative:** Activities that can be broken down into smaller units and can be undertaken on different scales (e.g. for a housing development there could be the option 10, 15 or 20 housing units. Each of these alternatives may have different impacts).

The Scoping Phase screened alternatives to derive a list of feasible alternatives assessed in detail in the current EIA Phase. The following types of alternatives were considered to be the most pertinent to the proposed projects:

- Layout alternative dependent on the scale and magnitude alternative;
- Technology alternative;
- Transmission line routing alternative;
- Scale and magnitude alternative; and
- No-Go Alternative.

The above categories of alternatives are most pertinent to this EIA process and are explored in detail below. The purpose of this section of the report is to describe all potential alternatives that were scoped in the Scoping Report and which were carried through to the EIA Phase of the project for further assessment.

3.2.2 Location Alternatives

South Africa is on the verge of increasing the percentage contribution made by renewable energy power generation to the existing energy mix. In response to this opportunity for large scale renewable energy production, Boegoeberg Hydro has identified potential sites across the country and is currently pursuing the best suited locations for hydropower production.

A number of options were considered for the location of the site. The applicant investigated some 12 sites along the Lower Orange River, from Hopetown to Vioolsdrift. All of these opportunities would involve extensive tunnelling (approximately 8 km to 10 km at each site), with an 8 m to 12 m drop in elevation. For these projects to be feasible, a flow rate of some 100 m^3/s would be required for 80% of the time (which is unlikely to occur on the Lower Orange River). Furthermore, they would all require extensive infrastructure to be built and connections to the existing grid were generally 50 km or more away. As such, most of these sites were not considered to be feasible. A few sites were however considered to be feasible.

A project at Neusberg weir near Kakamas is under construction, which has an installed capacity of 12 MW. The Neusberg Hydro Electric Project was selected in the second bid round of the REIPPP program. The applicant has also initiated an EIA for a new site at Riemvasmark near Augrabies for a 40 MW hydropower plant (DEA Ref. No. 14/12/16/3/3/1/681) and at Orange Falls near Onseepkans for a 20 MW hydropower plant (DEA Ref. No. 14/12/16/3/3/2/568).

Furthermore, the applicant also investigated five sites on the Thukela River. These sites would require tunnel lengths ranging from 1 km to 2.5 km, with elevation drops ranging from 13 m to 32 m. Two of these sites with tunnel lengths of 1 km to 1.3 km have received favourable EA's but currently are not feasible as the construction costs are too high. Of the three remaining sites, two are still being investigated for future development.

The Boegoeberg site was selected for the following reasons:

- The suitable hydrology allows for the project to be considered feasible. Most rivers in South Africa do not provide the hydrological condition required for the development of small hydro opportunities. In this regard only the Orange and Thukela rivers present themselves as viable options for smaller hydropower schemes;
- There is a good difference in elevation between abstraction and release points for water (also called head), which therefore requires only a small diversion of water to make the project feasible;
- The site is already developed and there is an existing weir; and
- There is potential for socio-economic development in the !Kheis Local Municipality from the project.

A number of location alternatives were considered in the vicinity of the Boegoeberg weir at the initiation of the project, including options along the northern and southern banks of the river. Due to various reasons such as ownership of land, technical complexity and length of routes these options were discarded in favour of the currently proposed alternative. The proposed project balances the need for a significant difference in elevation in the river with the length of the proposed canal and is considered most suitable from a technical perspective. As such this EIA has only investigated the preferred location alternative.

3.2.3 Activity Alternatives

There are numerous policies and legislation which govern the generation of energy in South Africa. The legal requirements are described in detail in **Annexure C**. The need for additional energy generation in South Africa is well documented, as summarised in **Annexure C** (Forward planning of Energy in South Africa) which covers the following policies and legislation:

- Policies regarding greenhouse gas and carbon emissions;
- White Paper on the Energy Policy of the Republic of South Africa (1998);
- White Paper on Renewable Energy (2003);
- National Energy Act (No. 34 of 2008) and Electricity Regulation Act (ERA) (No. 4 of 2006);
- Integrated Energy Plan for the Republic of South Africa (2003);

- Integrated Resource Plan (2010); and
- Regional Methodology for Wind Energy Site Selection (Department of Environmental Affairs and Development Planning (DEA&DP), 2006 Guideline document).

Furthermore, numerous policies and legislation have been promulgated indicating the mixture of renewable and non-renewable energy which South Africa wishes to pursue. These strategic documents provide the road map for the activity alternatives available to South Africa. Boegoeberg Hydro has identified a number of projects for hydropower generation across South Africa, aimed at meeting these stated goals, hydropower in particular.

The site, situated on the banks of the Orange River near Groblershoop, is suitable for a small hydro given the reasons provided in **Section 3.2.2**.

Boegoeberg Hydro is a company which specialises in hydropower generation. As such, only hydropower generation will be considered for the proposed Boegoeberg site by this company.

3.2.4 Site Layout Alternatives

The current site layout has been compiled based on *inter alia* the following criteria:

- Technical constraints, namely:
  - Construction alongside the Boegoeberg weir;
  - Spatial orientation requirements of project components and associated infrastructure (e.g. roads); and
  - Layout relative to other existing infrastructure, such as power lines.
- Environmental constraints, namely:
  - Hydrology profile of the river;
  - Topographical constraints relative to construction requirements;
  - Botanical and faunal constraints (presence of sensitive or protected plant communities or fauna); and
  - Aesthetics.

It should be noted that due to specific hydrology profile and the constraints presented by the rugged terrain, there are limited and very specific locations for the proposed infrastructure that can be considered in order to utilise the energy potential of the hydropower resource effectively. As such this EIA has only investigated alternatives for the water conveyance infrastructure. It was indicated in the Scoping Report that alternatives for the power chamber, headpond and tailrace would be investigated. However given the design requirements and the already limited footprint of the currently proposed infrastructure, it was determined that the structural components have already been optimally designed, with the environmental impact minimised while ensuring plant operation requirements. The only site layout alternatives investigated in the EIR are thus for the water conveyance infrastructure, namely a tunnel (which is preferred) or an excavated canal.

3.2.5 Technology Alternatives

There are two main types of turbines, namely impulse and reaction turbines **(Figure 27)**. The impulse turbine generally uses the velocity of the water stream which hits each bucket on the runner. An impulse turbine is generally suitable for high head, low flow applications. A reaction turbine develops power from the combined action of pressure and moving water which flows over the blades rather than striking each individually.

The type of hydropower turbine selected for a project is based on the following selection criteria:

- "Head" which is the differential in elevation between the water in the forebay and the turbines;
- “Flow”, or volume of water, at the particular site;
- Depth at which the turbine must be set (civil works);

- Turbine efficiency; and
- Turbine cost.

Reaction turbines are generally used for sites with lower head and higher flows than compared with the impulse turbines. The turbines selected based on the head and flow characteristics of the site, are only suitable for the Kaplan turbines (refer to **Figure 28**) as these are well adapted to these characteristics. As such this EIA has only investigated the preferred technology alternative, namely the Kaplan turbine.

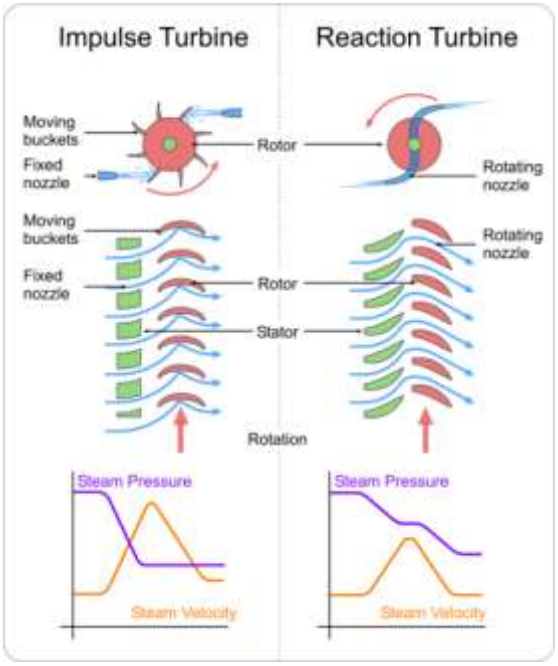


Figure 27 | Impulse and reaction turbines [Source: http://en.wikipedia.org, 5 July 2013)]

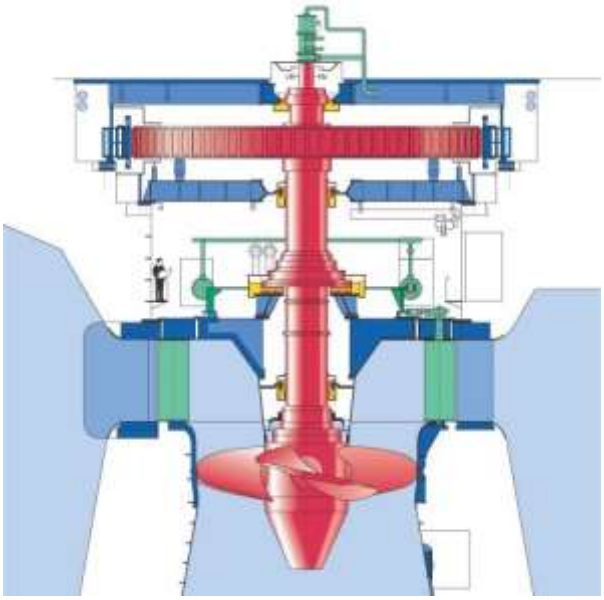


Figure 28 | Kaplan turbine and generator. [source: [source: http://en.wikipedia.org/wiki/File:S_vs_kaplan_schnitt_1_zoom.jpg, 28 November 2013)]

3.2.6 Routing Alternatives

The layout for the transmission line follows the projects alignment as far as possible. Where the transmission line extends beyond the project's alignment it follows the shortest available route towards

the existing Eskom Fibre Substation to the south in order to limit the impact (**Figure 23**). Two transmission line alternatives were originally proposed. Alternative 1, where the transmission line would cross the river below the Boegoeberg Weir is no longer feasible due to the span required and is thus not being pursued. However transmission alternative 2 as proposed has been adapted under advisement of the botanical specialist where it was recommended that the section of the transmission line be moved away from the river based on the sensitive riverine habitat. This recommendation was also endorsed by both the avifaunal and aquatic specialists. The revised alignment is now presented as the preferred alternative.

3.2.7 No-Go alternative

The assessment of alternatives must at all times include the "no-go" option. The "no-go" alternative will be the baseline against which all other alternatives are measured. The "no-go" alternative in this instance is defined as the status quo; i.e. no construction of any kind on the site, and no additional hydropower generation as would be achieved with this project.

3.2.8 Summary of Alternatives

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

- **Location alternatives** – Boegoeberg dam, Farm 306 Zeekoebaart.
    - Only the current location of the proposed hydropower station will be considered.
- **Activity alternatives**
    - Energy generation by means of a hydropower station; and
    - "No-go" alternative to hydropower energy production.
- **Site layout alternatives**
    - Two water conveyance alternatives, tunnel (preferred) or open canal;
- **Routing Alternatives**
    - Transmission line (alternative 2) and road access; and
    - Revised transmission line (alternative 2) and road access alternative to avoid botanical sensitive area.
- **Technology alternatives** – Kaplan hydropower turbines

Only one technology alternative will be considered.

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4 NEED AND DESIRABILITY

The purpose of this Chapter is to describe the need and desirability of the proposed hydropower station as it relates to the local context. To provide a comprehensive analysis, the questions posed in the DEA&DPs Need and Desirability Guidelines (2011) have been addressed. The chapter also gives a brief description on the proposed assessment of sustainability which will form part of the EIA Report.

4.1 MOTIVATION FOR THE PROJECTS

The 2009 DEA&DP Guideline for Need and Desirability highlights the obligation for all proposed activities which trigger the environmental regulations to be considered in light of (amongst others) the National Framework for Sustainable Development, the spatial planning context, broader societal needs, and financial viability. 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.

As noted previously the need for renewable energy is well documented. Hydropower generation is desirable as it:

- Utilising a renewable and natural resource available to South Africa;
- Creates a more sustainable economy by promoting South Africa's energy policy towards energy diversification.
- Provides baseload[8] power, which other renewable energy technologies typically do not, as they are dependent on the vagaries of wind and sunlight. As such hydropower can for instance replace coal-fired power stations as baseload stations, which other renewable technologies cannot do without storage capacity.
- Reduces the demand on scarce resources such as water, as well as non-renewable resources such as coal by promoting energy generating facilities which are less resource intensive[9].
- Assists in meeting nationally appropriate emission targets in line with global climate change commitments, by reducing reliance on coal as an energy source.
- Reduces and where possible eliminates pollution by using cleaner energy generating mechanisms and reducing the demand on carbon based fuels.
- Assists in alleviating energy poverty by providing energy in rural areas to stimulate the local economy.
- Promotes local economic development by creating jobs and promoting skills development.
- Enhances energy security by diversifying generation to reduce reliance on coal as a primary energy source and promoting renewable energy generation.

[8] Baseload is the amount of power required to meet minimum demands based on reasonable expectations of customer requirements. Baseload power stations are devoted to the production of baseload supply and produce energy at a constant rate. Examples of baseload plants using non-renewable fuels include nuclear and coal-fired plants. Among the renewable energy sources, hydroelectric, geothermal, biogas, biomass, solar thermal with storage and ocean thermal energy conversion can provide baseload power (https://en.wikipedia.org/wiki/Base_load_power_plant, accessed 26/06/2013)

[9] A hydropower station only uses water for turning the turbines that generate electricity. Water is not consumed during energy production.

4.1.1 Utilising resources available to South Africa

South Africa currently generates the majority of its required electricity from coal of which there is a ready supply at the local level. However, national government is on the verge of augmenting the existing generation capacity of thermal and nuclear power plants with renewable energy power generation, thus creating the framework that will lead to an increase in the supply of clean energy for the nation.

4.1.2 Meeting nationally appropriate emission targets in line with global climate change commitments

As can be seen by the numerous policies and legislation described in **Section 1.3,** the need for renewable energy is well documented. Due to concerns such as climate change, and the on-going exploitation of non-renewable resources, there is increasing international pressure on countries to increase their share of renewable energy generation. The proposed hydropower facilities are expected to contribute positively towards climate change mitigation.

Renewable energy is recognized internationally as a major contributor in diminishing the effects climate change, as well as providing a wide range of environmental, economic and social benefits that can contribute towards long-term global sustainability.

Hydropower is a source of “green” electricity as for every 1 MWh of “green” electricity used instead of traditional coal powered stations, one can:

- Save water;
- Avoid Sulphur Dioxide (SO2) emissions;
- Avoid Carbon Dioxide (CO2) emissions including transmission losses;
- Avoid ash production; and
- Contribute to social upliftment

4.1.3 Enhancing energy security by diversifying generation

The establishment of the proposed hydropower generation facilities would strengthen the existing electricity grid for the area. Moreover, the projects would contribute towards meeting the national energy target as set by the DoE. Should the proposed hydropower site and development identified by Boegoeberg Hydro be acceptable, it is considered viable that long term benefits for the community and society in Groblershoop would be realised as highlighted above.

The proposed project would also have international significance as they contribute to South Africa being able to meet some of its international obligations by aligning domestic policy with internationally agreed strategies and standards as set by the United Nations Framework Convention on Climate Change (UNFCCC), Kyoto Protocol, Copenhagen Accord and United Nations Convention on Biological Diversity, all of which South Africa is a signatory to.

4.1.4 Creating a more sustainable economy

The Northern Cape has a semi-arid climate, and particularly the Groblershoop area, has large tracts of open land which are sparsely inhabited. The towns are generally small with limited job opportunities. The need to improve the quality of life for all, and especially for the poor, through job creation is critical in South Africa. It is expected that the proposed project would contribute directly to the upliftment of the individuals and the societies in which they live. Skills development, and the transfer thereof, and local community involvement would be two of the priorities. Community involvement would either be through direct employment or indirectly through service industries. This would be enhanced as far as possible. It is anticipated that job opportunities amounting to between 2,400 (100 labourers’ x 24 months) to 3,600 (150 labourers x 24 months) man months would be created per construction phase depending on the procurement method and the primary contractor.

In addition to local skills development and job creation, the following potential benefits could be realised:

- Reducing the demand on scarce resources, such as water as the generation of energy from consume no water unlike coal-fired facilities;
- Reducing pollution as the generation of energy from hydropower facilities produce no pollution unlike coal-fired facilities;
- Local economic development as indicated in **Table 4-2**; and
- Local skills development.

Numerous studies and reports have attempted to quantify the employment creation potential of renewable energy per unit of power installed or generated. AGAMA Energy (2003) established that hydropower has equal creation potential to wind technologies as indicated in **Table 4-1**.

Table 4-1 | Renewable energy employment potential in terms of the gross direct jobs created per GWh for the various technologies (Agama Energy, 2003)

Employment per GWh						
Technology	**Fuel /GWh**	**Manufacture /GWh**	**Installation /GWh**	**O&M /GWh**	**Other /GWh**	**Total /GWh**
Solar thermal	0	3	7	0.4	0	10.4
Solar PV	0	32.9	21.2	4.4	3.5	62
Wind	0	8.4	1.3	2.6	0.3	12.6
Bio-energy	0	3.55	3.55	7.2	0	14.3
Hydro	0	8.4	1.3	2.6	0.3	12.6

Furthermore, the IRP (see **Annexure C**) allows for an additional 20,409 MW of renewable energy in the electricity blend in South Africa by 2030. Of the aforementioned, 130 MW is reserved for small hydro. While there are a number of renewable energy options (including, *inter alia*, wind and solar) being pursued in South Africa, many more renewable energy projects are required to meet the targets set by the IRP. Consequently, based on this requirement for renewable energy, Boegoeberg Hydro is pursuing a number of hydropower projects of which this project is one.

Table 4-2 | The applicability of NEMA Sustainability Principles to the proposed projects

NEMA Sustainable Development Principle	Consideration for these proposed projects and EIA Process
(1) The principles set out in this section apply throughout the Republic to the actions of all organs of state that may significantly affect the environment and – • Shall apply alongside all other appropriate and relevant considerations, including the State's responsibility to respect, protect, promote and fulfil the social and economic rights in Chapter 2 of the Constitution and in particular the basic needs of categories of persons disadvantaged by unfair discriminations; • Serve as the general framework within which environmental management and implementation plans must be formulated; • Serve as guidelines by reference to which any organ of state must exercise any function when taking any decision in terms of this Act; or any statute provision concerning the protection of the environment;	All principles will be considered in the application and consideration for authorisation.

• Serve as principles by reference to which a conciliator appointed under this Act must make recommendations; and • Guide the interpretation, administration and implementation of this Act, and any other law concerned with the protection of management of the environment.	
(2) Environmental management must place people and their needs at the forefront of its concern, and serve their physical, psychological, developmental, cultural and social interests equitably.	This EIA process considered both the natural and socio-economic environment and mitigation measures were provided in response to this principle as included in the LEMP in **Annexure E**.
(3) Development must be socially, environmental and economically sustainable.	The need to improve the quality of life for all, and especially for the poor, through job creation is critical in South Africa. It is expected that the proposed projects would contribute directly to the upliftment of the individuals and the societies in which they live. The proposed project would also include the following benefits that would contribute to environmentally and social sustainability: • Reducing the demand for scarce resources, such as water since the generation of energy from hydropower facilities consume no water unlike coal-fired facilities; • Reducing pollution as the generation of energy from hydropower facilities produces no pollution during operation unlike coal-fired facilities; • Local economic development; • Local skills development; • Construction industry businesses will benefit from an increase in the demand for their goods, materials and services; • Increased business productivity will directly result to improved spending power; and • Increase in the competitiveness of the region in terms of energy generation.
(4) (a) Sustainable development requires the consideration of all relevant factors including the following:	
i. That the disturbance of ecosystems and loss of biological diversity are avoided, or where they cannot be altogether avoided, are minimised and remedied;	Disturbance of the ecosystem and loss of biological diversity would be minimised through design measures and appropriate mitigation measures. The advantage of developing hydropower facilities at Boegoeberg Dam is that this site has already undergone extensive physical alteration with the dam itself and associated infrastructure. Intensive EIA investigations, which identified environmentally sensitive areas and found no fatal flaws which would prevent the development from proceeding. These sensitive areas have thus informed the preliminary design of the proposed hydropower facilities to ensure that sensitive areas are avoided to limit the disturbance of ecosystems. Furthermore, a LEMP was compiled to ensure that mitigation

		measures proposed in this EIA process are implemented during the planning, construction, operational and decommissioning phases.
ii.	That pollution and degradation of the environment are avoided, or, where they cannot be altogether avoided, are minimised and remedied;	A LEMP were compiled to ensure that mitigation measures proposed in this EIA process are implemented during the planning, construction, operational and decommissioning phases.
iii.	That the disturbance of landscapes and sites that constitute the nation's cultural heritage is avoided, or where is cannot be altogether avoided, is minimised and remedied;	A heritage and Palaeontological impact assessment were undertaken during the EIA process. Recommendations of the studies are described in **Section 5**.
iv.	That waste is avoided, or where it cannot be altogether avoided, minimised and re-used or recycled where possible and otherwise disposed of in a responsible manner;	This project shall generate the least amount of waste possible by properly planning material procurement (ordering, transportation and delivery), ensuring proper material handling and storage to reduce the avoidable generation of wastage (i.e. broken and damaged materials) and reusing potential waste materials on site wherever possible. As much of the inevitable waste generated shall be recovered and sorted for donation, reuse elsewhere or stored separately for recycling as economically feasible
v.	That the use and exploitation of non-renewable natural resources is responsible and equitable, and takes into account the consequences of the depletion of the resource;	This project will increase South Africa's generation capacity through renewable energy technologies and would not utilise non-renewable energy. Run-of-river hydropower energy systems have very little impact on the environment, making them one of the cleanest power-generating technologies available today. During operation they produce no air pollution, hazardous waste, or consume water. The more electricity generated from hydropower ultimately decreases our reliance and dependence on fossil fuels and on imported sources of energy. Finally, hydropower can be an effective economic development driver, especially in areas where there is currently little economic impetus. In addition, the following are benefits of hydropower: • Hydropower is a renewable and natural resource. • Hydropower is non-polluting. Unlike coal-fired power stations, they do not emit greenhouse gases or carcinogens into the air during operation. • Water is not consumed and therefor costs nothing. Once you purchase the equipment to capture and convert energy from the river, the operational costs are limited. • Minimal maintenance is required. • Hydropower schemes have some of the longest operational lifespans of any energy generation schemes.
vi.	That the development, use and exploitation of non-renewable resources and the ecosystems of which they are part do not exceed the level beyond which their integrity is jeopardised. and equitable, and takes into account the	The most significant non-renewable resource utilised by most power generation facilities is water. However as the hydropower facility does not consume water in order to generate electricity it does not readily exploit non-renewable resources during both construction and operation comparative to other forms..

	consequences of the depletion of the resource;	The removal of vegetation can also be seen as use of non-renewable resources. This is assessed in **Section 5.1**.
vii.	That a risk-averse and cautious approach is applied which takes into account the limits of current knowledge about the consequences of decisions and actions; and	Limitations and gaps in knowledge have been highlighted and taken into account in the EIA process. The information provided in the EIA will be sufficient for decision-making purposes, and where there is uncertainty with predictions, monitoring will be recommended.
viii.	That negative impacts on the environment and on people's environmental rights be anticipated and prevented, and where they cannot be altogether prevented, are minimised and remedied.	The impacts on the people of Groblershoop were investigated and mitigation measures proposed which aim at reducing negative impacts, were included in the LEMP.
(b) Environmental management must be integrated, acknowledging that all elements of the environment are linked and interrelated, and it must take into account the effects of decisions on all aspects of the environment and all people in the environment by pursuing the selection of the best practicable environmental option.		This EIA was undertaken in accordance with the legal requirements as a fundamental guiding principle.
(c) Environmental justice must be pursued so that adverse environmental impacts shall not distribute in such a manner as to unfairly discriminate against any person, particularly vulnerable and disadvantaged persons.		The EIA process, including the public participation process, outlined the possible impacts on the various groupings of people of Groblershoop and mitigation measures are proposed to reduce negative impacts, including the vulnerable and disadvantaged.
(d) Equitable access to environmental resources, benefits and services to meet basic human needs and ensure human wellbeing must be pursued and special measures may be taken to ensure access thereto by categories of persons disadvantaged by unfair discrimination.		Environmental resources, such as the areas ecology, freshwater ecosystems, and land use, were considered and avoidance or mitigation measures were provided in the LEMP to ensure that none of these resources are compromised thereby limiting access thereto.
(e) Responsibility for the environmental health and safety consequences of a policy, programme, project, product, process, service or activity exists throughout its life-cycle.		The EIA process considered the environmental, health and safety consequences of the development through the construction and operational life of the projects.
(f) The participation of all interested and affected parties in environmental governance must be promoted, and all people must have the opportunity to develop the understanding, skills and capacity necessary for achieving equitable and effective participation by vulnerable and disadvantaged persons must be ensured.		Ample opportunity for public participation were provided to all I&APs throughout the EIA process as described in **Section 2.2**.
(g) Decisions must take into account the interests, needs and values of all interested and affected parties, and this includes recognising all forms of knowledge, including traditional and ordinary knowledge.		The EIA process has taken cognizance of all interests, needs and values adopted by all interested and affected parties.
(h) Community wellbeing and empowerment must be promoted through environmental education, the raising of environmental awareness, the sharing of knowledge and experience and other appropriate means.		The EIA process has taken cognizance of all interests, needs and values espoused by all I&APs. Ample opportunity for public participation were provided to all I&APs throughout the EIA process.
(i) The social, economic and environmental impacts of activities, including disadvantages and benefits, must be considered, assessed and evaluated, and decisions		Please see **Section 5.9** for the socio-economic impact assessment.

must be appropriate in the light of such consideration and assessment.	
(j) The right of workers to refuse work that is harmful to human health or the environment and to be informed of dangers must be respected and protected.	The project area is subject to both the health and safety requirements of the Operational Health and Safety Act.
(k) Decisions must be taken in an open and transparent manner, and access to information must be provided in accordance with the law.	The EIA process has been thoroughly documented and all relevant information known to the EAP, as well as written comments received, have been included in the reporting for consideration by the authorities.
(l) There must be intergovernmental coordination and harmonisation of policies, legislation and actions relating to the environment.	The relevant authorities have been notified of the projects and provided with opportunity to comment. This authority involvement process has been documented in the EIA documentation.
(m) Actual or potential conflicts of interest between organs of state should be resolved through conflict resolution procedures.	There has been no conflict between Departments to date.
(n) Global and international responsibilities relating to the environment must be discharged in the national interest.	The establishment of the proposed Boegoeberg hydropower scheme would strengthen the existing electricity grid for the area. Moreover, the project will contribute towards meeting the national energy target as set by the DoE. Renewable energy is recognized internationally as a major contributor in protecting the climate, nature and the environment, as well as providing a wide range of environmental, economic and social benefits that can contribute towards long-term global sustainability.
(o) The environment is held in public trust for the people, the beneficial use of environmental resources must serve the public interest and the environment must be protected as the people's common heritage.	The impacts are documented in the EIA process to inform decision-makers regarding potential ramifications of the proposed project so that an informed decision can be taken in this regard.
(p) The costs of remedying pollution, environmental degradation and consequent adverse health effects and of preventing, controlling or minimising further pollution, environmental damage, or adverse health effects must be paid for those responsible for harming the environment.	The mitigation measures are recommended in this EIR to minimise negative impacts and enhance positive ones are for implementation and therefore for the cost of the proponent.
(q) The vital role of women and youth in environmental management and development must be recognised and their full participation therein must be promoted.	Public participation of all I&APs has been promoted and opportunities for engagement been provided during the EIA process.
(r) Sensitive, vulnerable, highly dynamic or stressed ecosystems, such as coastal shores, estuaries, wetlands, and similar systems required specific attention in management and planning procedures, especially where they are subject to significant human resource usage and development pressure.	Specialist assessments were undertaken to investigate the biophysical and social impacts that these projects may have. The outcome of the specialist's assessments indicates how significant impacts could be mitigated. Furthermore, the proposed development is not sited within a sensitive, vulnerable, highly dynamic, or stressed ecosystem. Where sensitivities have been identified the project design has been revised to avoid these areas and features.

The questions posed in the DEA&DP's Need and Desirability Guidelines (2011) have been used as a framework to assess the needs and desirability of the proposed project, as required in terms of the NEMA (**Table 4-3**).

Table 4-3 | Discussion related to specific questions in the Needs and Desirability Guideline (DEA&DP, 2011)

Need and Desirability	
Need (Timing)	
Question	Response
1. Is the land use (associated with the activity being applied for) considered within the timeframe intended by the existing approved Spatial Development Framework (SDF) agreed to by the relevant environmental authority i.e. is the proposed development in line with the projects and programmes identified as priorities within the Integrated Development Plan (IDP)?	There is currently no SDF available for the area (p. 14 of the Siyanda District IDP). Although no SDF exists, the IDP (2012 – 2017) identifies two primary development objectives (p.26 of the Siyanda District IDP): • Promoting the growth, diversification and transformation of the provincial economy. • Poverty reduction through social development. The IDP (2012 – 2017) then lists the following macro-level condition for growth (p.26 of the Siyanda District IDP): • Enhancing infrastructure for economic growth and social development. To give effect to the above, one of the high-level development targets set in the Northern Cape is (p.26 of the Siyanda District IDP): • To provide adequate infrastructure for economic growth and development by 2014. The proposed project, which will generate sustainable electricity, will therefore help to promote development and economic growth.
2. Should development, or if applicable, expansion of the town/ area concerned in terms of this land use (associated with the activity being applied for) occur at this point in time?	Yes. As per the response to question 1 above, the proposed project would contribute to the provision of adequate infrastructure for economic growth and social development by 2014, as per the high-level targets set in the Siyanda District IDP (p.26 of the Siyanda District IDP). Furthermore, South Africa is actively pursuing renewable energy projects.
3. Does the community/ area need the activity and the associated land use concerned (is it a societal priority)?	Yes. The stated mission of !Kheis Municipality is as follows: • 'To promote economic development to the advantage of the communities within the boundaries of the !Kheis Municipality. This will be done by the establishment and maintenance of an effective administration and a safe environment in order to attract tourists and investors to the area' • To create an environment in which to empower the Community through capacity building and skills development, as well as for economic growth in order to reduce unemployment and poverty with at least 5%, by June 2014 (!Kheis Local Municipality IDP, 2012 - 2017). The proposed hydropower station would not only create job opportunities for the local community as the construction of the facilities require a wide range of skill levels which the District can, to a degree, supply, but will also be a source of income to the landowners. Secondary economic impacts may include an increase in service amenities through an increase in contractors and associated demand for accommodation.
4. Are there necessary services with appropriate capacity currently available (at	Yes. The proposed project would feed into the national Eskom grid through at the Fibre Substation. The connection to the substation would be

Need and Desirability	
Need (Timing)	
Question	Response
the time of application), or must additional capacity be created to cater for the development?	constructed as part of the proposed project.
5. Is this development provided for in the infrastructure planning of the municipality, and if not, what will the implication be on the infrastructure planning of the municipality (priority and placements of services)?	*No.* It should be noted that once the proposed project are operational, there would be a very limited requirement for municipal services.
6. Is this project part of a national programme to address an issue of national concern or importance?	*Yes.* The establishment of the proposed facilities would strengthen the existing electricity grid for the area. Moreover, the project would contribute towards meeting the national energy target as set by the DoE, of a 30% share of all new power generation being derived from IPPs. The Industrial Policy Action Plan (IPAP2, 2010) recommends a sector focussed approach identifying key sectors with potential to be developed. The sectors identified in the IPAP2 document renewable energies**.** The proposed hydropower project, although not specifically mentioned, will further facilitate the realisation of this development objective. The Integrated Resource Plan (IRP 2010) developed by the DoE for the 2010 to 2030 period aims to achieve a "*balance between an affordable electricity price to support a globally competitive economy, a more sustainable and efficient economy, the creation of local jobs, the demand on scarce resources such as water and the need to meet nationally appropriate emission targets in line with global commitments*". The final IRP provides for an additional 20,409MW of renewable energy in the electricity mix in South Africa by 2030.
Desirability (Placing)	
Question	Response
1. Is the development the best practicable environmental option (BPEO) for this land/ site?	*Yes.* !Kheis LM is a very arid region of the Northern Cape where agricultural potential is for irrigated agriculture. Irrigation activities are mainly situated along the Orange River and include crops such as lucerne, grapes and wheat, with subsidiary crops of vegetables, deciduous fruits and maize. The site for the facilities does not fall within a cultivated area and has a low agricultural potential. The hydropower plant small scale is very unlikely to have any effect on the status quo farming activities.
2. Would the approval of this application compromise the integrity of the existing approved Municipal IDP and SDF as agreed to by the relevant authorities?	*No.* The project is in line with the Siyanda DM IDP (2012-2017) which stated vision is to "enhance economic development for the benefit of the community of the Siyanda District area. We do this by creating and maintaining an effective administration and a safe environment to attract tourists and investors". The Siyanda District IDP is informed by a Regional Development Strategy that puts additional emphasis on specific aspects and strategic priority areas, notably that of infrastructure maintenance and

Need and Desirability	
Need (Timing)	
Question	Response
	economic development. There is currently no SDF available for the Siyanda DM or !Kheis LM.
3. Would the approval of this application compromise the integrity of the existing environmental management priorities for the area (e.g. as defined in Environmental Management Frameworks (EMFs)), and if so, can it be justified from in terms of sustainability considerations?	*No.* The Siyanda DM EMF (2008) has prioritised the protection of Alluvial Thicket along the Orange River. However the Siyanda DM EMF (2008) also states that "By adopting a policy that only rocky outcrops within the river system should be considered for development provided that they can be reached without causing significant environmental impacts and that they are not sensitive in terms of their aesthetic value." Tithe proposed construction footprint is dominated by a rocky outcrop and would be in line with this recommendation. Furthermore, the EIA process would ensure that the proposed facilities would be environmentally sustainable. Although the site falls within a CBA the site layout will respond to this through the specialist recommendations. Comment will also be sought from the relevant authorities to ensure that the application does not comprise the Siyanda EMF.
4. Do location factors favour this land use (associated with the activity applied for) at this place?	*Yes.* The site were selected based on the following criteria: • The site has an existing weir. • Hydrologically suitable characteristics such as head (drop in elevation); • Existing database to inform engineering decisions - flow rate annual measurements collected for Boegoeberg and Neus DWA stations. • Suitable topography and accessibility for construction. • Favourable land ownership. • Feasibility of project design to accommodate environmental sensitivities and various financial and technical considerations. • Relatively easy grid connectivity and proximity to grid access via Fibre Substation.
5. How will the activity or the land use associated with the activity applied for, impact on sensitive natural and cultural areas (built and rural/ natural environment)?	Potential impacts associated with the proposed upgrade will be assessed and discussed during the EIA Phase. Refer to the Plan of Study for EIA in Chapter 5.
6. How will the development impact on people's health and wellbeing (e.g. in terms of noise, odours, visual character and sense of place, etc.)?	Potential impacts associated with the proposed upgrade will be discussed and assessed during the EIA Phase. Refer to the Plan of Study for EIA in Chapter 5.
7. Will the proposed activity or the land use associated with the activity applied for, result in unacceptable opportunity costs?	The socio-economic impacts will be assessed and discussed in the EIA Phase. Refer to the Plan of Study for EIA in Chapter 5.
8. Will the proposed land use result in unacceptable cumulative impacts?	Potential cumulative impacts associated with the proposed upgrade will be discussed and assessed during the EIA Phase. Refer to the Plan of Study for EIA in Chapter 5.

5 BIOPHYSICAL AND SOCIO-ECONOMIC IMPACT ASSESSMENT

This section forms the focus of this EIA process. It contains a detailed assessment of the construction, operations and decommissioning impacts associated with the proposed project on the affected biophysical and socio-economic environment, using standard Aurecon assessment methodology. Mitigation measures to enhance positive impacts and reduce negative impacts are described.

As mentioned in **Section 1.5**, the Scoping Phase identified various impacts on the biophysical and socio-economic environment are anticipated to occur throughout the construction and operational phases. These impacts are described in the sections below in the following order:

- Disturbance of flora and fauna;
- Disturbance of avifauna;
- Sedimentation and erosion of water ways;
- Impact on local economy (employment) and social conditions;
- Impact on heritage resources (including palaeontology);
- Impact on agricultural land
- Visual impact;
- Traffic Impact ;
- Noise impacts (including blasting);
- Impacts related to spoil; and
- Dust impact.
- Impact of storage of hazardous substances on site;

These impacts on the biophysical and socio-economic environment were assessed in terms of the methodology outlined in the Plan of Study for EIA (for ease of reference the methodology is included in **Annexure F**). For each impact assessed, mitigation measures have been proposed to reduce and/or avoid negative impacts and enhance positive impacts. These mitigation measures are also incorporated into the LEMP to ensure that they are implemented during the planning, construction, operational and decommissioning phases. The LEMP forms part of the EIR, as such its implementation will become a binding requirement should this project be authorised.

5.1 IMPACT ON FLORA

The Boegoeberg Dam area and the surrounding properties over which the transmission lines would extend are all located within the Nama Karoo Biome, Bushmanland Bioregion (Rutherford & Westfall, 1994; Rutherford, Mucina & Powrie, 2006; Mucina et al., 2006). Potential issues relevant to the botany of the study area include impacts on endemic and 'Red Data' species, sensitive habitats, and cumulative impacts of all the components of the project.

Dr David J. McDonald of Bergwind Botanical Surveys & Tours CC was appointed to undertake a Botanical Impact Assessment (BIA). The study considered a range of potential botanical impacts. A field assessment was undertaken on 1 and 2 October 2013. The BIA is included in **Annexure D** and the findings and recommendations of the study are summarised below.

5.1.1 Description of the Environment

Three vegetation types are found, namely Lower Gariep Alluvial Vegetation, Lower Gariep Broken Veld and Bushmanland Arid Grassland. The Boegoeberge are named after the mid-high shrub *Croton gratissimus* (boegoe; lavender fever-berry) which occurs on the rocky hills.

- *Red List plant species, protected plants and trees of the study area*

Neither Lower Gariep Broken Veld nor Bushmanland Arid Grassland is listed in the National List of Threatened Ecosystems (Government Gazette, 2011) but Lower Gariep Alluvial Vegetation is listed as Endangered A1 (the A1 criterion means there is irretrievable loss of natural habitat with the remaining natural habitat of this type ≤ biodiversity target +15%). However, the Lower Gariep Alluvial Vegetation will not be greatly affected by the proposed project.

However, particular emphasis is to be placed on minimising loss or damage of *Boscia albitrunca* (Shepherds' Tree), a nationally protected plant species. Application for permission to the DAFF to remove trees from the construction zone of the hydro-power plant would be required. No Red List Species (Raimondo et al. 2009) were found in the survey and the chances of the project affecting such species are **low (-)** to **very low (-)**.

- *Ecology sensitivity assessment*

The sensitivity assessment identifies those parts of the study area that have high conservation value or that may be sensitive to disturbance. Riparian vegetation areas of "**medium**" sensitivity are shown in **Figure 29**. The majority of the site was deemed to be of "**low - medium**" sensitivity.

The impacts are assessed below. The assessments for the proposed layout below have been separated in order to assess the facility layout and the ancillary infrastructure separately as the impacts would be different.

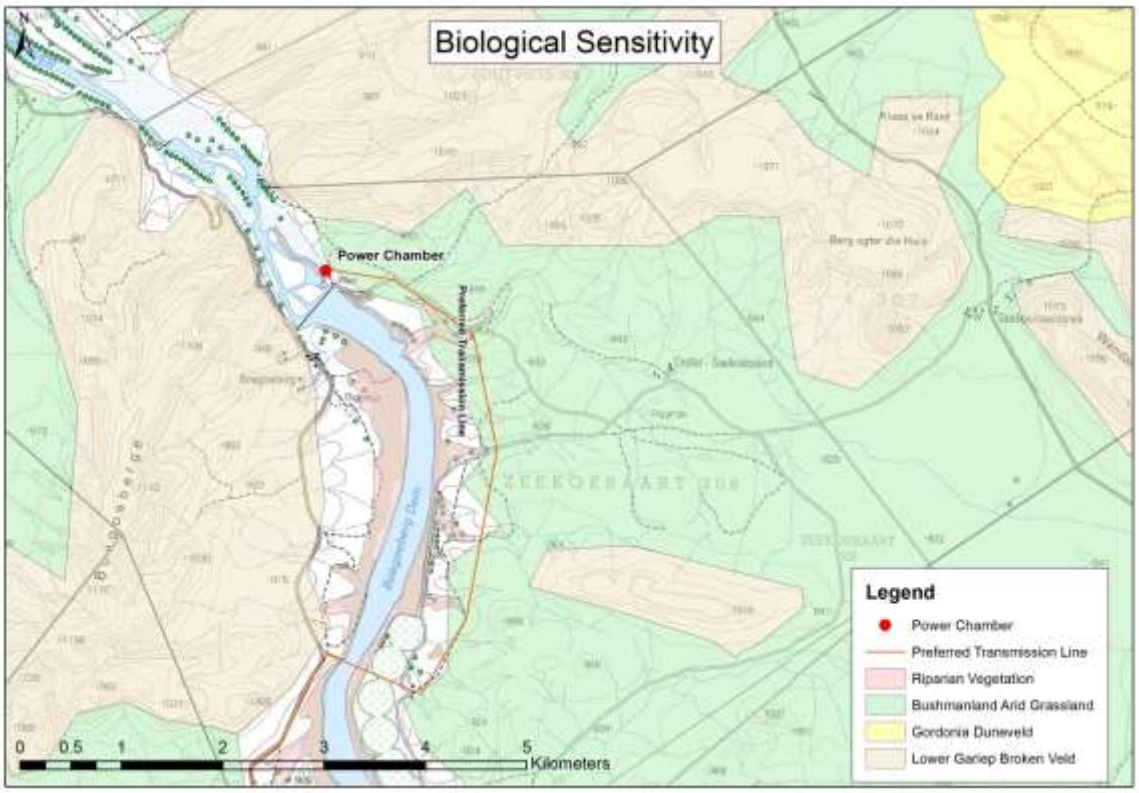

Figure 29 | Botanical sensitivity map

5.1.2 Impact Assessment

The impacts of the respective elements of the Boegoeberg hydro power project as they pertain to vegetation and flora are given below.

5.1.2.1 Construction phase

Off-take structure

The Lower Gariep Alluvial Vegetation is represented by only *Searsia pendulina* in the area of the 'off-take' to the hydro power plant (**Figure 30**). *S. pendulina* is a common species with low botanical sensitivity. No other species with high conservation value such as *Euclea pseudebenus* (Cape ebony) or *Vachellia erioloba* (camel thorn tree) were found in the area.

Figure 30 | *Searsia pendulina* lining the east bank of Boegoeberg Dam where the off-take structure would be located (Source: D.McDonald 2013).

Access roads

Along the access road to the site numerous trees of *S. pendulina* and *Ziziphus mucronata* (blinkblaar wag-'n-bietjie) trees would have to be cut and trimmed to provide access for vehicles and equipment. The access road to the construction site would follow an existing farm road which would require widening but this would not adversely affect any vegetation.

Roads to access both the construction site for the hydropower plant, construction camp and transmission lines are well-established. Apart from the need for widening and upgrading in some places, there would be little further impact on vegetation and therefore this element of the project would have **low (-)** impacts a before and after mitigation.

Conveyance infrastructure

Alternative 1 –Tunnel (preferred)

Construction of the off-take canal the side of the hill or koppie adjacent to the east side of the Boegoeberg weir would be excavated. The tunnel option would only require an entry and exit point into the koppie itself. The footprint in terms of vegetation destruction is limited and this option is thus preferred from a botanical perspective, based on the reduced removal of vegetation overall.

Alternative 2 - Canal

To allow for construction of the off-take canal, the entire side of the hill or koppie adjacent to the east side of the Boegoeberg weir would be excavated. The vegetation on the west part of the koppie would be lost. While most of the vegetation is not sensitive, a number of *Boscia albitrunca* (Shepherd's tree; Witgatboom) trees (a protected species) (Alias, Milton, Herrmann & Seymour, 2003) would be lost. It is

estimated that in the order of eight (8) *B. albitrunca* trees would need to be removed, and a permit would be required from the DAFF for this.

Figure 31 | The Boegoeberg weir with DWA access track and koppie on the east side. The small green tree amongst the rocks is *Boscia albitrunca* (Source: D.McDonald 2013).

Tailrace

For construction of the tailrace, an area of 3,000 m² would be cleared. The vegetation in the area is not dense or sensitive, consisting mostly of reed-beds and *Searsia pendulina* trees.

Construction Camp

A construction camp with site office, crusher and such equipment, as well as temporary accommodation for personnel would be required. Establishment of the construction camp, although in an already disturbed area, would be likely to have **medium (-)** impacts as personnel may move out of such areas into more sensitive vegetation and may strip vegetation for firewood or use the areas for informal ablutions. These impacts could be mitigated and limited by strict adherence to 'No Go' zones outside the construction camp. This could lower the impact to l**ow (-)**.

Figure 32 | The proposed site for the construction camp which is already impacted by disturbance from agricultural activities (Source: D.McDonald 2013).

Transmission

Alternative 1 transmission line route would extend from the Boegoeberg Hydro-power transformer yard and switching station across the Orange River below the Boegoeberg weir to the west side. From there it would follow the gravel for a distance of 27.5 km to the entrance to Greeffsput, after which it

would be aligned along farm roads for a distance of 12.8 km via Skalksput to the Fibre Substation. The first section i.e. where the transmission line would cross the river below the Boegoeberg Weir is not feasible thus is not being pursued.

Alternative 2 transmission line route, would give greater management flexibility, would extend from the Boegoeberg Hydro-power transformer yard and switching station along the farms roads of Zeekoebaart 306 on the east side of the hills flanking the Orange River to the Rugbreek Boerdery Farmstead. From this point it would extend over the Orange River to meet the Alternative 1 route at approximately 3.5 km along its length. From that point to the Fibre Sub-station the Alternative 1 and Alternative 2 routes would be the same.

Revised Alternative 2 transmission line route, would align the transmission route outside of riverine habitat and would use the existing road network and the would extend over the Orange River to meet the Alternative 1.

Silt basins

Two silt basins for the deposition of dredged silt are proposed on the alluvial plain to the north-east of the Boegoeberg Weir and north of the proposed hydro-plant. These silt basins would receive silt dredged from behind the Boegoeberg Weir which would be necessary to ensure continuous adequate flow of water through the hydro-plant. The silt basins would be constructed to allow the escape of water to dehydrate the silt which would then be commercially used.

Borrow pits

The two borrow pits envisaged would be extensions of the borrow pits on the farm Zeekoebaart 306. These borrow pits are located in Bushmanland Arid Grassland and the vegetation has low sensitivity. However, they are in close proximity to watercourses so measure would have to be taken to prevent disturbance of the watercourses either through impeding water flow or increasing silt-load in the watercourse in runoff water from the borrow pits.

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5.1.2.2 Construction impact

Boegoeberg hydropower Plant Layout 1

- Off-take weir and open canal.
- Hydropower house, head-pond, tailrace.

The potential impact on botany from the plant is considered to be of medium magnitude, local extent and is anticipated to continue throughout the construction period. It is therefore predicted to be of **high (-)** significance without mitigation. The significance of this impact could be reduced to **medium (-)** with mitigation.

Boegoeberg hydropower Plant Layout 2 (preferred)

- Off-take weir and tunnel.
- Hydropower house, head-pond, tailrace

The potential impact on botany is considered to be of low-medium magnitude, local extent and anticipated to continue throughout the construction period and are therefore of **medium (-)** significance without mitigation. The significance of this impact could be reduced to **low (-)** with mitigation.

Transmission route 1

The potential impact on botany is considered to be of medium magnitude, regional extent and anticipated to continue throughout the construction period and are therefore of **medium (-)** significance without mitigation. The significance of this impact could be reduced to **low (-)** with mitigation.

Transmission route 2

The potential impact on botany is considered to be of medium magnitude, regional extent and anticipated to continue throughout the construction period and are therefore of **medium (-)** significance without mitigation. The significance of this impact could be reduced to **low (-)** with mitigation.

Revised Transmission route 2 (preferred)

The potential impact on botany is considered to be of medium magnitude, regional extent and anticipated to continue throughout the construction period and are therefore of **medium (-)** significance without mitigation. The significance of this impact could be reduced to **low (-)** with mitigation. Although the overall significance remains the same for this alternative, impact on riverine habitat will be greatly reduced and is thus the preferred option from a botanical perspective.

Access roads

Roads to access both the construction site for the hydro-power plant, construction camp and transmission lines are well-established. Apart from the need for widening and upgrading in some places, there would be little further impact on vegetation the potential impact on botany is considered to be of low magnitude, local extent and anticipated to continue throughout the construction period and are therefore of **low (-)** significance with or without mitigation.

Construction camp

Establishment of the construction camp, although in an already disturbed area, would medium magnitude, local extent and anticipated to continue throughout the construction period and are therefore of **medium (-)** significance without mitigation. The significance of this impact could be reduced to **low (-)** with mitigation.

Borrow pits

The two borrow pits envisaged would be extensions of the borrow pits on the farm Zeekoebaart 306. The potential impact on botany is considered to be of low magnitude, local extent and anticipated to continue throughout the construction period and are therefore of **low (-)** significance with or without mitigation.

5.1.2.3 Operational impact

Boegoeberg hydropower Plant Layout 2 (preferred)

- Off-take weir and tunnel.
- Hydropower house, head-pond, tailrace

The potential impact on botany is considered to be of low magnitude, local extent and anticipated to continue throughout the operational period and are therefore of **low (-)** significance with or without mitigation.

Transmission route 1 & Transmission route 2 (preferred)

The potential impact on botany is considered to be of low magnitude, regional extent and anticipated to continue throughout the operational period and are therefore of **low (-)** significance with or without mitigation.

Access roads

The potential impact on botany is considered to be of low magnitude, local extent and anticipated to continue throughout the operational period and are therefore of **low (-)** significance with or without mitigation.

Construction camp

The potential impact on botany is considered to be of low magnitude, local extent and anticipated to continue throughout the operational period and are therefore of **low (-)** significance with or without mitigation.

Silt Basin

The potential impact on botany is considered to be of low magnitude, local extent and anticipated to continue throughout the operational period and are therefore of **low (-)** significance with or without mitigation.

5.1.2.4 Decommissioning impact

Layout and all ancillary infrastructure

The potential impact on botany is considered to be of low magnitude, local extent and anticipated to continue throughout the decommissioning period and are therefore of **low (-)** significance with or without mitigation.

5.1.2.5 Cumulative impacts

Negative impacts resulting from all phases of this proposed development would be amplified by the construction and operation of multiple projects along this stretch of the Orange River the area, despite the restricted footprint of the power station which would ensures that the direct impacts are localised. Thus, when considering the impact of the power stations in conjunction with other developments including agriculture, along the river banks, the cumulative impacts can be significant in terms of destruction and alternation of vegetation.

5.1.2.6 No-Go alternative

The No-Go Alternative would have a neutral impact as the status quo would remain.

5.1.3 Mitigation Measures

No provincially protected plant species which are likely to be damaged or removed were noted in the study. However, as a precautionary measure it is recommended that the Department of Environment Affairs and Nature Conservation, Northern Cape should be given the opportunity to inspect the hydro power site at an early stage prior to construction to ensure that if any permits are required they can be timeously obtained.

5.1.3.1 Preconstruction mitigation

- Application for removal of *B. albitrunca* (Shepherds' Tree) would be required prior to the start of construction.
- Topsoil should be removed from the construction area and stockpiled for future rehabilitation use.
- Cleared vegetation should be chipped, bagged and stored for application as mulch in rehabilitation work.

5.1.3.2 Construction mitigation

An ECO should be appointed to be on site for the duration of the construction period (24 months). The ECO should, inter alia, be responsible for the following:

- The ECO should ensure that no unnecessary damage is caused to any vegetation despite the vegetation being generally of low sensitivity.
- The ECO should ensure that areas outside the site construction area and construction camp designated as 'No Go' areas are observed.
- The ECO should monitor the use of roads to ensure that no driving off roads into surrounding veld occurs. Any such activity should result in fines and appropriate remedial action to repair any damage.

- The ECO should monitor roads for run-off and erosion into the adjacent veld in the event of heavy rain. Any negative impact such as erosion should be reported and remedial action taken.
- The ECO should identify and take action to remove and destroy any alien plants such as *Prosopis glandulosus* (mesquite) that could be stimulated by disturbance.

5.1.3.3 Post-construction phase

In the post-construction phase, the ECO would be responsible for ensuring that the construction zone of the hydropower plant and construction camp are left in a state that would permit the natural vegetation to re-colonise naturally. Tasks would include the following:

- Soil should be flattened and graded, i.e. no heaps of soil or piles of rock to be left.
- No deep ruts or channels should remain.
- Any temporary access roads and the construction zone alongside the canal should be scarified to alleviate compaction by heavy vehicles and to aerate the soil to permit re-colonization by local flora.
- Attend to all recommended mitigation measures concerning vegetation and vegetation rehabilitation in the LEMP.

5.1.3.4 Post-construction rehabilitation

- Flatten or mould disturbed areas to form uniform surfaces.
- Scarify the disturbed areas to break up any compaction due to vehicles.
- Restoration work should take in late summer to ensure that all rehabilitation areas are prepared before the end of February. The intention would be to benefit from the autumn rains (highest rainfall is in March).
- Replace topsoil from stockpile to depth of at least 100 mm on the surface of disturbed areas.
- Spread chipped organic material over the topsoil as a mulch to enhance water-holding capacity of the soil.
- The areas being rehabilitated should be watered areas twice a week for two to three months to supplement rainfall and to encourage vegetative cover before the following winter.
- Trees such as *Searsia pendulina* and *Ziziphus mucronata* should be planted in strategic places e.g. at the construction camp site and in the vicinity of the tail-race to re-create groves of trees. These trees should be actively watered for at least three months after planting to promote establishment.
- No hydro-seeding using exotic or grasses non-native to the area should be permitted. The natural grass species have the capacity to quickly and successfully recolonize disturbed sites and this should be encouraged by watering as noted above.
- The mitigation measures outline above should be carefully observed to ensure that disturbance caused by the project is ameliorated as far as possible in the post-construction phase. It is extremely important that post-construction 'clean-up' is meticulously carried out to return all areas to as near-natural as possible

5.1.3.5 Monitoring of re-vegetation

- The progress of vegetation rehabilitation should be monitored by the ECO and reported on a monthly basis for four to six months post-construction. Measurable targets should be determined by a restoration practitioner give the characteristic of the local environment.
- Any alien invasive vegetation such as *P. glandulosa* (mesquite) that appears in disturbed areas or near the hydropower site, particularly along the banks of the Orange River, should be removed and destroyed by the developer.

Table 5-1 | Botanical Impact Table

	Project	Key impacts	Extent	Magnitude	Duration	SIGNIFICANCE (Without mitigation)	SIGNIFICANCE (With Mitigation)	Probability	Confidence	Reversibility
Construction phase	Boegoeberg Hydropower Plant Layout 1 (preferred)	1. .Off-take weir and canal. 2. Hydropower chamber, head-pond, tailrace.	Local	High	Long-term	High negative	Medium negative	Definite	Certain	Irreversible
	Boegoeberg Hydropower Plant Layout 2	1. Off-take weir and tunnel. 2. Hydropower chamber, head-pond, tailrace	Local	Medium	Long term	Medium negative	Low negative	Definite	Certain	Irreversible
	Roads	Widening and upgrading	Local	Low	Long term	Low negative	Low negative	Definite	Certain	Irreversible
	Construction camp	Establishment of construction camp and crusher	Local	Medium	Short term	Medium negative	Low negative	Definite	Certain	Reversible
	Transmission Route 2	Construction of lines	Regional	Medium	Long term	Medium negative	Low negative	Definite	Certain	Reversible
	Borrow Pit 1	Removal of gravel	Local	Low	Short-term	Low negative	Low negative	Definite	Certain	Irreversible
	Borrow Pit 2	Removal of gravel	Local	Low	Short-term	Low negative	Low negative	Definite	Certain	Irreversible
	Silt depot 1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Silt depot 2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Boegoeberg Hydropower Plant Layout 1 (preferred)	1. Off-take weir and canal Hydropower chamber, head-pond, tailrace.	Local	Low	Long term	Low negative	Low negative	Definite	Certain	Irreversible
Operational phase	Boegoeberg Hydropower Plant Layout 2	1. Off-take weir and tunnel. 2. Hydropower chamber , head-pond, tailrace	Local	Low	Long term	Low negative	Low negative	Definite	Certain	Irreversible
	Roads	Widening and upgrading	Local	Low	Long term	Low negative	Low negative	Definite		Irreversible
	Construction camp	Use of construction camp and crusher	Local	Low	Short term	Low negative	Low negative			Irreversible
	Transmission	Maintenance of lines	Regional	Low	Long term	Low negative	Low negative	Definite	Certain	Reversible

	Project	Key impacts	Extent	Magnitude	Duration	SIGNIFICANCE (Without mitigation)	SIGNIFICANCE (With Mitigation)	Probability	Confidence	Reversibility
	Route 2									
	Borrow Pit 1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Borrow Pit 2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Silt basin 1	Deposition of silt	Local	Low	Long-term	Low negative	Low negative	Definite	Certain	Reversible
	Silt basin 2	Deposition of silt	Local	Low	Long-term	Low negative	Low negative	Definite	Certain	Reversible
	Boegoeberg Hydropower Plant Layout 1 (preferred)	1. Off-take weir and canal 2. Hydropower chamber, head-pond, tailrace.	Local	Low	Long term	Low negative	Low negative	Definite	Certain	Irreversible
	Boegoeberg Hydropower Plant Layout 2	1. Off-take weir and tunnel. 2. Hydropower chamber, head-pond, tailrace1. Off-take weir and canal 2. Hydropower chamber, head-pond, tailrace.	Local	Low	Long term	Low negative	Low negative	Definite	Certain	Irreversible
Decommissioning phase	Construction camp	Removal of construction camp and crusher.	Local	Low	Short term	Low negative	Low negative	Definite	Definite	Reversible
	Roads	Closure of certain roads which will not be required	Local	Low	Short term	Low negative	Low negative	Definite	Certain	Irreversible
	Transmission Route 1	Removal of lines	Regional	Low	Long term	Low negative	Low negative	Definite	Certain	Reversible
	Transmission Route 2	Removal of lines	Regional	Low	Long term	Low negative	Low negative	Definite	Certain	Reversible
	Borrow Pit 1	Restoration of vegetation	Local	Low	Long-term	Low negative	Low negative	Definite	Certain	N/A
	Borrow Pit 2	Restoration of vegetation	Local	Low	Long-term	Low negative	Low negative	Definite	Certain	N/A
	Silt basin 1	Removal of silt basin	Local	Low	Long-term	Low negative	Low negative	Definite	Certain	N/A
	Silt basin 2	Removal of silt basin	Local	Low	Long-term	Low negative	Low negative	Definite	Certain	N/A
No Go	No construction of Hydropower plant	N/A	Regional	Low	Long-term	Low negative	Low negative	Definite	Definite	N/A
	No construction of Hydropower plant	N/A	Regional	Low	Long-term	Low negative	Low negative	Definite	Definite	N/A

Table 5-2 | Cummulative botanical impacts

	Extent	Magnitude	Duration	SIGNIFICANCE	Probability	Confidence	Reversibility
Without Mitigation	Regional	Very low	Long term	Low (negative)	Probable	Sure	Irreversible
With Mitigation	Regional	Very low	Long term	Low (negative)	Probable	Sure	Irreversible

5.1.4 Botanical Conclusions

Overall impact will be **Medium (-)** to **Low (-).** The largest impact will be at the hydro-power site with the transmission lines likely to have a **Low (-)** impact. Mitigation measures should be carefully applied, particularly in the post-construction phase. Such measures would reduce the **Medium (-)** impact of the hydropower plant from **Medium (-)** to **Low (-)**.

5.2 IMPACT ON AVIFAUNA

The birds of greatest potential relevance and importance in terms of the possible impacts of the hydropower plant are likely to be the following:

- Wetland birds foraging, roosting and/or nesting in the immediate area;
- Cliff-nesting birds resident on the rock faces overlooking the site; and
- Endemic passerines and large terrestrial species and raptors located in the area affected by the power line routing.

Dr Andrew Jenkins of Avisense Consulting was appointed to undertake an avifauna impact assessment. The assessment included a desktop review of relevant literature and a two day site visit (conducted on 23-24 August, 2013) to determine the avian habitats present at the site and within the surrounding environment. The avifaunal study is included in **Annexure D.** The findings and recommendations of the avifauna study are summarised below.

The anticipated impacts of the hydropower facility and associated infrastructures on avifauna include:

- Habitat destruction;
- Disturbance by construction and maintenance activities and possibly by the operation of the facility;
- Possible displacement or disturbance of sensitive species; and
- Mortality caused by collision with the associated power line network and electrocution of avifauna.

Based on the avifauna observed during the site visit and documented avifaunal information on the general area, 11 priority species are recognised as key in the assessment of avian impacts of the proposed Boegoeberg hydropower station. These are mostly nationally and/or globally threatened species which are known to occur, or could occur, in relatively high numbers in the development area and which are likely to be, or could be, negatively affected by the proposed development (**Table 5-3**).

Table 5-3 | Priority bird species considered central to the avian impact assessment process for the proposed hydropower station).

Common name	Scientific name	SA conservation status/ (Global conservation status)	Risk posed by		
			Collision	Electro-cution	Disturbance / habitat loss
Cape Eagle-Owl	*Bubo capensis*	-	Moderate	High	Moderate
Ludwig's Bustard	*Neotis ludwigii*	Vulnerable (Endangered)	High	-	Moderate
Kori Bustard	*Ardeotis kori*	Vulnerable	High	-	Moderate
African Fish-Eagle	*Haliaetus vocifer*	-	High	High	Moderate
Martial Eagle	*Polemaetus bellicosus*	Vulnerable (Near-threatened)	High	High	Moderate
Verreaux's Eagle	*Aquila verreauxii*	-	High	High	Moderate
Secretarybird	*Sagittarius serpentarius*	Near-threatened (Vulnerable)	High	-	Moderate

Peregrine Falcon	*Falco peregrinus*	Near-threatened	High	Moderate	-
Lanner Falcon	*Falco biarmicus*	Near-threatened	High	Moderate	-
Goliath Heron	*Ardea goliath*	-	High	Moderate	Moderate
Black Stork	*Ciconia nigra*	Near-threatened	High	Moderate	Moderate

5.2.1 Description of the Avifaunal Environment

The impact zone of the proposed hydropower facility largely comprises areas of dry, grassy Karoo veld around the broader periphery of the development area. This is overlaid on the hilly, rocky terrain of the Boegoeberge, with small areas of exposed, vertical rock presenting habitat for cliff-nesting birds. At least 217 bird species are considered likely to occur with some regularity within the anticipated impact zone of the proposed hydropower development, including 65 endemic or near-endemic species, 10 red-listed species, and three species – Ludwig's Bustard *Neotis ludwigii*, Blue Crane *Anthropoides paradiseus* and Sclater's Lark *Spizocorys sclateri* – which are endemic and red-listed (Barnes 1998, 2000)

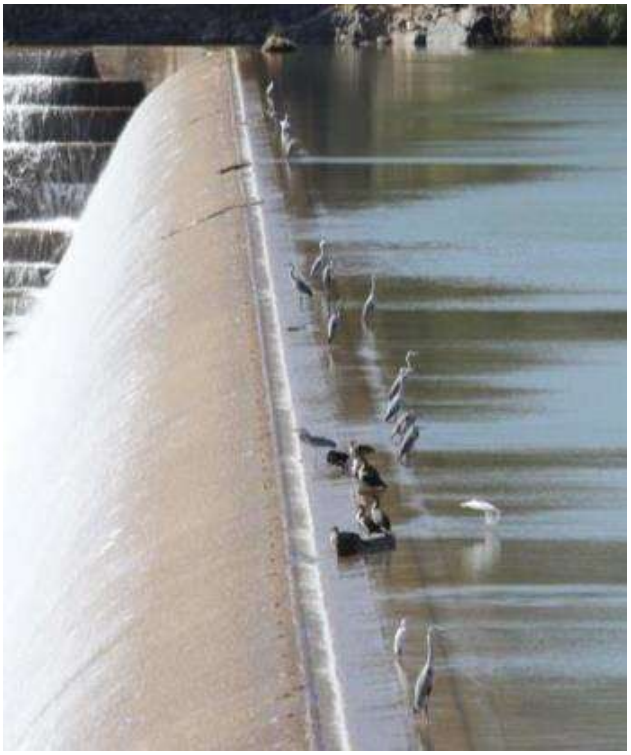

Figure 33 | Large piscivorous birds (herons, egrets and cormorants) resting on and hunting from the inner edge of the Boegoeberg weir.

5.2.2 Avifauna Impact Assessment

Specific impacts of the proposed site are most likely to be manifested in the following ways:

- Habitat loss/change/degradation and disturbance impacts on the waterbird (e.g. herons, cormorants, egrets, storks and African Fish-Eagle) and cliff-nesting communities (e.g. Verreaux's Eagle, other montane raptors, storks), and to a lesser extent on populations of woodland and regionally endemic Karoo passerines, associated with construction and decommissioning activities on the development site, as well as with maintenance and operation of the plant itself.

- Habitat loss/degradation and disturbance impacts on large terrestrial birds (e.g. bustards, korhaans, Secretary bird) and savannah raptors (e.g. Martial Eagle), and to a lesser extent on populations of woodland and regionally endemic Karoo passerines, associated with construction and maintenance of the power line servicing the power station.
- Mortality of waterbirds, raptors and large terrestrials in collisions with and/or electrocution on the power line servicing the power station.

In addition, some waterbird species may benefit from the imposed changes on river flow or water quality, and species such as Martial Eagle, a suite of smaller raptors, corvids and Sociable Weaver may colonise and roost and/or breed in the various utility structures making up the development.

The impacts are assessed below. The assessments for the proposed layout below have been separated in order to assess the layout and the transmission corridor separately as the impacts would be different.

5.2.2.1 Construction phase impact

Construction activities would result in a negative direct impact on the avifauna in the area caused by the loss of vegetation, habitat, disturbance and collision ().

Table 5-4 | Potential avifaunal impacts during the construction phase.

Common name	Scientific name	SA conservation status/ (Global conservation status)	Risk posed by		
			Collision	Electro-cution	Disturbance / habitat loss
Cape Eagle-Owl	*Bubo capensis*	-	Moderate	High	Moderate
Ludwig's Bustard	*Neotis ludwigii*	Vulnerable (Endangered)	High	-	Moderate
Kori Bustard	*Ardeotis kori*	Vulnerable	High	-	Moderate
African Fish-Eagle	*Haliaetus vocifer*	-	High	High	Moderate
Martial Eagle	*Polemaetus bellicosus*	Vulnerable (Near-threatened)	High	High	Moderate
Verreaux's Eagle	*Aquila verreauxii*	-	High	High	Moderate
Secretarybird	*Sagittarius serpentarius*	Near-threatened (Vulnerable)	High	-	Moderate
Peregrine Falcon	*Falco peregrinus*	Near-threatened	High	Moderate	-
Lanner Falcon	*Falco biarmicus*	Near-threatened	High	Moderate	-
Goliath Heron	*Ardea goliath*	-	High	Moderate	Moderate
Black Stork	*Ciconia nigra*	Near-threatened	High	Moderate	Moderate

Table 5-5 | Construction phase activities, associated impact and anticipated avifaunal receptors

Project Aspect/ activity	Receptors Affected
• Disturbance/displacement associated with noise and movement of construction equipment and personnel. • Loss or degradation of avian habitat through site clearance, road upgrade and establishment of the camp, lay-down and assembly areas.	• All birds on site; key species – wetland bird community (herons, cormorants, African Fish-Eagle), cliff-nesting raptors (Verreaux's Eagle), endemic passerines. • All birds on site; key species – wetland bird community (herons, cormorants, African Fish-Eagle), cliff-nesting raptors

	(Verreaux's Eagle), endemic passerines.

Layout (preferred)

The potential impact on birds as a result of disturbance, displacement, loss or degradation of habitat is considered to be of low-medium magnitude, local extent and anticipated to continue throughout the construction period and are therefore of **low-medium (-)** significance without mitigation. The significance of this impact could be reduced to **low (-)** with mitigation.

Transmission route 1 & Transmission route 2 (preferred)

The potential impact on birds for both transmission alternatives as a result of disturbance, displacement, loss or degradation of habitat is considered to be of low-medium magnitude, local extent and anticipated to continue throughout the construction period and are therefore of **low (-)** significance without mitigation. The significance of this impact could be reduced to **very low (-)** with mitigation.

5.2.2.2 Operational phase impact

Operational impacts on avifauna include habitat loss, disturbance and displacement of sensitive species by maintenance activities and operation of the hydropower facility, and mortality caused by collision with the associated transmission lines and electrocution of avifauna. **Table 5-6** details potential avifaunal impacts during the operational phase.

Table 5-6 | Operational phase activities, associated impact and anticipated avifaunal receptors

Project Aspect/ activity	Receptors Affected
• Loss of habitat to space occupied by hydropower station and associated infrastructure, and disturbance / displacement associated with routine maintenance work. • Interruption of regular water flow, changes in water turbidity and/or downstream pollution of river. • Mortality in collisions with power lines, or by electrocution on new power infrastructure.	• All birds on site; key species – wetland bird community (herons, cormorants, African Fish-Eagle), cliff-nesting raptors (Verreaux's Eagle), endemic passerines. • Wetland bird community. • Wetland bird community, cliff-nesting raptors, large terrestrial species

Layout (preferred)

The potential impact on birds as a result of disturbance, displacement, loss or degradation of habitat is considered to be of low-medium magnitude, local extent and anticipated to continue throughout the operational period and are therefore of **low-medium (-)** significance without mitigation. The significance of this impact could be reduced to **low (-)** with mitigation.

Transmission route 1 & Transmission route 2 (preferred)

The potential impact for both transmission alternatives on birds as a result of mortality is considered to be of medium magnitude, regional extent and anticipated to continue throughout the operational period and are therefore of **high (-)** significance without mitigation. The significance of this impact could be reduced to **low-medium (-)** with mitigation.

5.2.2.3 Decommissioning phase impact

All decommissioning activities would result in a negative direct impact on the avifauna of the hydropower site through disturbance associated with noise and movement of decommissioning equipment and personnel. **Table 5-7** details potential avifaunal impacts during the decommissioning phase.

Table 5-7 | Decommissioning phase activities, associated impacts and anticipated avifaunal receptors

Project Aspect/ activity	Receptors Affected
• Disturbance/displacement associated with noise and movement of decommissioning equipment and	• All birds on site; key species – wetland bird community (herons, cormorants, African Fish-Eagle), cliff-nesting raptors

personnel.	(Verreaux's Eagle), endemic passerines.

Layout (preferred)

The potential impact on birds as a result of disturbance is considered to be of low-medium magnitude, local extent and anticipated to continue throughout the decommissioning period and are therefore of **low (-)** significance without mitigation. The significance of this impact could be reduced to **very low (-)** with mitigation.

Transmission route 1 & Transmission route 2 (preferred)

The potential impact for both transmission alternatives on birds as a result of disturbance is considered to be of medium magnitude, local extent and anticipated to continue throughout the decommissioning period and are therefore of **low (-)** significance without mitigation. The significance of this impact could be reduced to **very low (-)** with mitigation.

5.2.2.4 Cumulative impacts

Negative impacts resulting from all phases of this proposed development would be amplified by the development of other industrial and agricultural projects planned for along this stretch of the Orange River the area.

5.2.2.5 No-Go impacts

The No-Go Alternative would have a neutral impact as the *status quo* would remain.

5.2.3 Mitigation Measures

The following mitigation measures apply to all alternatives and are recommended to mitigate all potential impacts to avifauna:

- Minimise the total construction footprint of the development area.
- Restrict construction time to a reasonable minimum.
- Minimise noise and disturbance associated with construction activities. Ideally, the bulk of the construction work should be done outside of the Verreaux's Eagle breeding season (approximately April/May to September/October).
- Minimise noise and disturbance associated with maintenance activities at the plant once it becomes operational.
- Route the power line away from the immediate vicinity of the Orange River as it evacuates power from the plant and avoid the riparian vegetation along the bank of the river (Alternative 1).
- Minimise the length of any new power lines installed and bury lines wherever possible. Where lines cannot be buried, ensure that all new lines are marked with bird flight diverters (Jenkins *et al.* 2010) along their entire length and that all new power line infrastructure is adequately insulated and bird friendly in configuration (Lehman *et al.* 2007).
- In addition to bird flight diverters, use industry standard aviation balls to mark the power line where it crosses the Orange River, to ensure that the line is maximally visible to birds using the river course as a flyway.
- In the interests of understanding the longer-term and cumulative impacts of run-of-river hydro developments in South Africa, and with a view guiding impact assessment for future developments of this kind, it would be ideal to institute a control modulated before:after monitoring programme. This should be particularly aimed at quantifying and comparing waterbird numbers on the affected length of river. The results of such a programme could also inform any additional impact mitigation that might be required. However, this recommendation cannot be a condition of authorisation.

5.2.4 Avifauna Impact Table

Table 5-8 and **Table 5-9** indicate how the significance ratings of the various impacts were derived.

Table 5-8 | Impact rating of avifauna impacts

	Project component	Key impacts	Extent	Magnitude	Duration	SIGNIFICANCE (Without mitigation)	SIGNIFICANCE (With Mitigation)	Probability	Confidence	Reversibility
Construction	Layout (preferred)	Disturbance	Local	Low - Medium	Short	Low-Medium	Low	Definite	Certain	Reversible
		Habitat loss / degradation	Local	Low	Short	Low	Very Low	Definite	Certain	Reversible
	Roads	Disturbance	Local	Low - Medium	Short	Low-Medium	Low	Definite	Certain	Reversible
		Habitat loss / degradation	Local	Low	Short	Low	Very Low	Definite	Certain	Reversible
	Transmission Route 1	Disturbance	Local	Low	Short	Low	Very Low	Definite	Certain	Reversible
		Habitat loss / degradation	Local	Low	Short	Low	Very Low	Definite	Certain	Reversible
	Transmission Route 2	Disturbance	Local	Low	Short	Low	Very Low	Definite	Certain	Reversible
		Habitat loss / degradation	Local	Low	Short	Low	Very Low	Definite	Certain	Reversible
Operation	Layout (preferred)	Habitat loss & disturbance	Local	Low - Medium	Long	Low-Medium	Low	Definite	Certain	Irreversible
		Changes in river quality	Local	Low - Medium	Long	Low-Medium	Low	Probable	Sure	Reversible
	Roads	Habitat loss & disturbance	Local	Low	Long	Low-Medium	Low	Definite	Certain	Irreversible
	Transmission Route 1	Habitat loss & disturbance	Local	Low	Long	Low	Very Low	Definite	Certain	Irreversible
		Mortality	Regional	Medium	Long	High	Low-Medium	Probable	Sure	Irreversible
	Transmission Route 2	Habitat loss & disturbance	Local	Low	Long	Low-Medium	Low	Definite	Certain	Irreversible
		Mortality	Regional	Medium	Long	High	Low-Medium	Probable	Sure	Irreversible
Decommissioning	Layout (preferred)	Disturbance	Local	Low	Short	Low-Medium	Low	Definite	Certain	Reversible
	Roads	Disturbance	Local	Low	Short	Low-Medium	Low	Definite	Certain	Reversible
	Transmission Route 1	Disturbance	Local	Low	Short	Low	Very Low	Definite	Certain	Reversible
	Transmission Route 2	Disturbance	Local	Low	Short	Low	Very Low	Definite	Certain	Reversible

*Mitigation measures are described in detail in Section 5.2.3.

Table 5-9 | Cumulative avifauna impacts

Mitigation	Magnitude	Duration	SIGNIFICANCE	Probability	Confidence	Reversibility
Without Mitigation	Medium	Permanent	Medium	Definite	Certain	Irreversible
With Mitigation	Low	Permanent	Low	Definite	Certain	Irreversible

5.2.5 Avifauna conclusion

Overall, the proposed hydropower development is likely to have relatively little significant, long-term impact on the avifauna of the area. Careful and responsible implementation of the required mitigation measures – including minimising the size of the construction footprint and the severity of disturbance arising from construction, maintenance and operational activities, and ensuring that the attendant power line is engineered to minimize avian mortality risk - should easily reduce impacts to tolerable and sustainable levels throughout the life of the development.

5.3 IMPACT ON FAUNA

According to a number of biodiversity databases (SABIS:SABIF, IUCN) consulted a number of faunal species (reptile, amphibian and mammal) are known to occur in the greater study area.

5.3.1 Description of the environment

There are a number of smaller mammals endemic to the Northern Cape in the study area, such as carnivores including bat-eared fox, Cape fox, slender mongoose, yellow mongoose, suricate, caracal, striped polecat and black-backed jackal and a number of smaller antelope species such as springbok, klipspringer and duiker. The fauna in the area is dependent on the quality and type of habitats provided by the flora.

5.3.2 Faunal Impact Assessment

The proposed project may potentially disturb resident fauna through noise and physical barriers created by the proposed project, and may cause animals to leave the area. The potential impacts are assessed below.

The impacts are assessed below. The assessments for the proposed layout below have been separated in order to assess the facility layout and the ancillary infrastructure separately as the impacts would be different.

5.3.2.1 Construction phase

All infrastructure and alternatives
Affected fauna would generally be largely mobile and would relocate during the construction phase and are likely to recolonise the area, once the construction phase has been completed and the disturbed areas rehabilitated. Small insects and reptiles may not be as mobile and habitat destruction would have significant impacts on the immediate populations. However, these are not likely to be localised to this area only and should be well represented in the larger area.

Based on the above the potential impact on fauna during construction due to disturbance, habit loss and displacement is considered to be of low to medium magnitude, local extent and short term and therefore **low (-)** significance without mitigation. With the implementation of mitigation measures this is anticipated to reduce to **very low (-)** significance. There would be no difference in significance as a result of the proposed alternatives.

5.3.2.2 Operational phase

All infrastructure and alternatives
Operation and maintenance of the proposed project would entail very few on-site activities and as such disturbance of animals and / or habitats are likely to be limited. Existing human activities in the area are likely to have habituated larger animals to the presence of humans and as such it is

anticipated that any disturbance would result in animals leaving an area for a short period, if at all, and returning once the disturbance has passed. As such the potential impact of the proposed project on fauna is considered to be of low magnitude, local extent and long term and therefore of **low (-)** significance, with or without mitigation for all alternatives.

5.3.2.3 Decommissioning

All infrastructure and alternatives

Any affected fauna would generally be largely mobile and would relocate during the decommissioning phase and are likely to recolonise the area, once the decommissioning phase has been completed and the disturbed areas rehabilitated.

Based on the above the potential impact on fauna during decommissioning due to disturbance, habit loss and displacement is considered to be of low to low magnitude, local extent and short term and therefore **low (-)** significance without mitigation. With the implementation of mitigation measures this is anticipated to reduce to **very low (-)** significance. There would be no difference in significance as a result of the proposed alternatives.

5.3.2.4 Cumulative impacts

Although a number of developments are proposed for the area, these are widely spaced apart and are unlikely to result in significant cumulative impacts on fauna.

5.3.3 Mitigation measures

The following mitigation measures are recommended for the construction phase for all project alternatives:

- In all cases construction of access roads must be designed for minimal impact eg – use existing access roads; restrict new roads to shortest distance through non-sensitive areas as identified in the botanical report. All construction must take place within the footprint of the proposed hydropower facility and associated construction site.
- Ensure that the vegetation rehabilitation plan is implemented. The construction phase must be closely monitored by an ECO who needs to identify any areas that would require rehabilitation in the post-construction phase. The restoration of those areas must follow the construction phase as quickly as possible (Refer to **Annexure E**)
- The site must be cleared in sections as required for construction and not all at once.
- Open canal (should this option occur) acting as a barrier to movement, and also as a drowning risk for local fauna. The canal should be fenced but crossing areas for fauna should be allowed – this would require specialist input into the detailed design phase.

5.3.4 Fauna Impact Table

Table 5-10 and **Table 5-11** indicate the various impacts and how their significance ratings were determined.

Table 5-10 | Impact rating of faunal impacts

Project	Mitigation	Extent	Magnitude	Duration	SIGNIFICANCE	Probability	Confidence	Reversibility
Layout (all project alternatives) Construction phase	Without mitigation	Local	Low-Medium	Short term	Low (-)	Probable	Unsure	Irreversible
	With mitigation	Local	Low	Short term	Very-low (-)	Probable	Unsure	Reversible
Layout (all project alternatives) Operational phase	Without mitigation	Local	Low	Long term	Low (-)	Probable	Sure	Irreversible
	With mitigation	Local	Low	Long term	Low (-)	Probable	Sure	Irreversible
Layout (all project alternatives) Decommissioning phase	Without mitigation	Local	Low- medium	Short term	Low (-)	Probable	Sure	Irreversible
	With mitigation	Local	Very Low	Long term	Very Low (-)	Probable	Sure	Reversible

*Mitigation measures are described in detail in Section 5.3.3.

Table 5-11 | Cumulative fauna impacts

Key impacts	Mitigation	Extent	Magnitude	Duration	SIGNIFICANCE	Probability	Confidence	Reversibility
Cumulative fauna impacts	Without mitigation	Local	Low	Long term	Low (-)	Probable	Unsure	Reversible
	With mitigation	Local	Low	Long term	Low (-)	Probable	Unsure	Reversible

5.3.5 Fauna Conclusion

The affected faunal species are largely mobile and the impact of construction of the various project components is not anticipated to have significant impact on animals. Small less mobile species will be more affected by the destruction of localised habitats but are well represented in the area and the impact is thus not considered significant. There are no threatened, near threatened or protected species of potential concern that are likely to occur on site

5.4 IMPACT ON AQUATIC ECOLOGY

The study area occurs within the D73B quaternary catchment of the Lower Orange DWA water management area in the Northern Cape. James Mackenzie was appointed to undertake an Aquatic Ecology Assessment study to determine the potential impacts that the proposed hydropower facility may have on aquatic ecology of the study area. Aquatic Ecosystem and Health assessments were also undertaken to provide information on the ecological condition and ecological importance and sensitivity of the aquatic resources. The site was visited in October 2013 where the characterisation, mapping and integrity assessments of the freshwater features were undertaken. The detailed aquatic ecology assessment report is included in **Annexure D**. Findings and recommendations from the assessment study are provided below.

5.4.1 Description of the Environment

The assessed area occurs directly downstream of the Boegoeberg Dam wall and is a mere 5km upstream of Environmental Flow Requirements (EFR) site 2[10]. All areas described below are referenced in **Figure 34**, as well as in **Figure 35** to **Figure 42**. The Boegoeberg Dam wall does not have a fish ladder, so the existing infrastructure is an existing barrier to fish movement. Below the wall, there are varied and complex hydraulic habitats ranging from rapids and runs to deeper slow pools. The main channel comprises several mid-channel bars with smaller channels in-between, but the site can be generally be described by 3 main sub-channels (labelled 1 through 3). The left and centre channels (labelled 1 and 2) are bedrock dominated with fast flowing, rocky habitats, while the right channel (labelled 3) is characterised by slower deeper flows and mainly alluvial in nature, other than at the dam wall where rapids occur. The proposed hydro scheme development is like to increase water delivery to the right alluvial channel and decrease flow in the bedrock channels. This is likely to scour the right channel. The riparian vegetation in dominated by reeds and woody vegetation (labelled r and w respectively, where w1 is high density woody vegetation and w2 low density) and is characterised as Lower Gariep Alluvial Vegetation (Mucina & Rutherford, 2006), which is considered to be an endangered unit. Features described above are photographically shown spatially in **Figure 35**.

Table 5-12 | Present Ecological State (PES) and Ecological Importance and Sensitivity (EIS)

Boegoeberg

EIS: HIGH (quaternaries / delineations (reach in this instance) that are considered to be unique on a national scale due to biodiversity (habitat diversity, species diversity, unique species, rare and endangered species). These rivers (in terms of biota and habitat) may be sensitive to flow modifications but in some cases, may have a substantial capacity for use).

- Highest scoring metrics are instream and riparian rare /endangered biota, unique riparian biota, flow intolerant instream biota, taxon richness of riparian biota, diversity of riparian habitat types, critical riparian habitat, refugia, migration corridor.

PES: Category C (the system is moderately modified i.e loss and change of natural habitat and biota have occurred, but the basic ecosystem functions are still predominantly unchanged).

- Loss of frequency of large floods, agricultural return flows, higher low flows than natural in the dry season, drought and dry periods, decreased low flows at other times, release of sediment, presence of alien fish species and barrier effects of dams.

Driver Components	PES	TREND	REC	AEC↓
IHI HYDROLOGY	E			
WATER QUALITY	C		C	D
GEOMORPHOLOGY	C	0	C	C
INSTREAM IHI	C/D			
RIPARIAN IHI	B/C			
Response Components	**PES**	**TREND**	**REC**	**AEC↓**
FISH	C	0	C	D
MACRO INVERTEBRATES	C	0	C	D
INSTREAM	C	0	C	D
RIPARIAN VEGETATION	B	0	A/B	B/C
RIVERINE FAUNA	C	0	B	C
ECOSTATUS	C	0	B/C	C
EIS	HIGH			

[10] The site that was used for the Reserve determination conducted in 2010 (Louw & Koekemoer (eds), 2010). All data and information from the site are relevant to this project.

Figure 34 | Aerial view of the site to be impacted by the proposed development, showing 3 channels that comprise the main Orange River downstream of the dam wall, and the proposed alignment of the hydro scheme (dark blue line).

 Channel 1	 Channel 2
 Channel 3	 Reed banks (r)
 Dense woody riparian vegetation (w1)	 Sparce woody vegetation and sandy banks / bars (w2)
 Rapid and fast deep instream habitats downstream of dam wall	 Slow deep habitats in channel 3

Figure 35 | Photographs representing locations according to Figure 31 showing instream and riparian habitats downstream of the Boegoeberg Dam wall

The Present Ecological State (PES) and Ecological Importance and Sensitivity (EIS) are summarised below for various components of the riverine environment, as well as an integrated Ecological Status (Ecostatus) for the reach downstream of the Boegoeberg Dam. Potential impacts of the proposed activity have two main components. Those pertaining to the aquatic or instream environment are

mainly flow related, while those pertaining to the riparian / wetland environment are mainly non-flow related.

The river below the dam wall was divided into three channels during the survey, as detailed above:

- A right-hand channel which consisted mostly of slow deep and shallow habitat with sandy bottom substrate; and
- A middle and left-hand channel with rocky rapid and riffle habitat.

The right-hand and middle channels are of less importance in terms of fish as the habitat diversity is low with minimal cover. The left-hand channel is of higher importance due to various flow depth classes being present as well as ample cover in terms of rocks and water column.

Figure 36 indicates the habitat in the left-hand channel downstream from the dam wall which will be affected by the proposed development. This habitat will be dry during low flow season.

Figure 36 | Downstream view of dominant habitat of left-hand channel at and below the site.

Figure 37 shows the right-hand channel of the river below the dam wall consisting of slow shallow and slow deep sandy habitat. Very little cover is present at these habitats.

Figure 37 | Dominant habitat of right-hand channel at site.

Figure 38 and **Figure 39** show the habitat directly below the dam wall on left of the main river channel that will be affected and laid dry during low flows.

Figure 38 | Main habitat section below dam expected to be dry or lost during low flow periods.

Figure 39 | Main section of habitat on left-hand of river below dam expected to be dry or lost.

The flow was measured to be 42 m^3/s further downstream from the site at the time of the survey. There are, however, two channels within the reach between the Boegoeberg Weir and the gauging station, which supplement the flow in the Orange River from an irrigation channel that flows parallel to the river on the left bank. One of these channels (upper channel) delivers approximately 5 m^3/s to the river. The outlet of this channel falls within the lower reaches of the affected area, which means that this additional inflow will help mitigate the effects of the proposed water abstraction. This channel should maintain fish and fish habitats in this area within the deeper sections of the main river and its deeper pools during low flow periods.

Both the channels from the irrigation channel have adequate and even fast flow with ample habitat and cover in terms of water column and rocky substrate. Overhanging vegetation is also abundant. These two channels are, therefore, of importance as they provide additional habitat for fish and flow to the main river.

When the above is taken into account it can be reasoned that the flow over the Boegoeberg Dam wall was approximately 30 m^3/s at the time of the survey. If this flow is spread between the three channels identified within the main channel below the weir, it can be estimated that there was a flow of approximately 10 m^3/s per channel. It was observed during the survey that half of the observed flow should be adequate to maintain the river during low flows. This calculates to 5 m^3/s per channel (i.e. 15 m^3/s for the three channels combined within the main stream). The flow of the upper supplementing channel from the irrigation channel falling within the affected reach will, therefore, be of high importance to the site as it will provide flow to the left-hand channel which was identified as the most important section of the river within the development area.

Figure 40 indicates the upper channel falling within the development area. The channel has a fast deep flowing stream with ample cover for fish (water column, rocks, and vegetation overhang). These channels are important as they provide additional habitat for fish.

Figure 40 | Fast flow from the upper irrigation canal to the main river in impacted area of site.

Figure 41 | General habitat characteristics of the stream channels fed from the irrigation channel feeding into the Orange River.

Figure 41 shows the general habitat of the lower channel flowing from the irrigation canal into the Orange River. Rocky substrate (rocks, cobbles, and gravel) seems to be dominant (**Figure 42**), and is also the preferred habitat of the more sensitive species. The additional habitat created by these side channels from the irrigation canal are important and will help with the mitigation of the upstream impacts from the proposed development.

Figure 42 | Substrate in the side channels in area and downstream of site.

5.4.2 Aquatic Ecology Impact Assessment

Potential impacts of the proposed activity have two main components. Those pertaining to the aquatic or instream environment are mainly flow related, while those pertaining to the riparian / wetland environment are mainly non-flow related.

The main impact to the instream environment is the potential loss of spawning habitats characterised by bedrock substrates and fast flowing water which are important to rheophilic fish species such as yellowfish. Other fish such as the Orange River mudfish, and the rock catfish also utilise these habitats for spawning. Maintenance of these habitats requires certain minimum flows as well as the correct frequency and timing of small floods. The diversion of water from Boegoeberg Dam before it spills has the potential to reduce flows that are required for habitat maintenance directly downstream of the dam wall. Mitigation potential of this impact is high and outlined in detail as specific flows required for each month of the year. These flows were determined as part of the Reserve determination study conducted in 2010 (Louw & Koekemoer (eds)).

The main impacts to the riparian environment are the removal and disturbance of indigenous riparian vegetation and the promotion of invasion of disturbed sites by alien perennial species such as *Prosopis glandulosa*. The current riparian zone is characterised as Lower Gariep Alluvial Vegetation (Mucina & Rutherford, 2006), which is considered to be an endangered unit. While it is unlikely that removal will be avoidable for the off-take and outflow structures, the routing of the power transmission lines so as to not be within the riparian zone (except where direct crossing is unavoidable) will mitigate this impact significantly. Where direct crossing of riparian zones or drainage channels is required, mitigation would be to not (as far as is possible) place pylons within these areas, but to span them. Mitigation for invasion by alien vegetation species would require physical removal on site after construction and for the first few years of operation.

The impact of the proposed hydropower station will only be local, and the river should again attain its current integrity downstream of the tailrace of the plant. It is, however, important to protect rare spawning areas and ensure its functioning in order to ensure the survival of our already scarce and endangered fish species such as the largemouth yellowfish and the rock catfish.

The impacts are assessed below. The assessments for the proposed layout below have been separated in order to assess the facility layout and the ancillary infrastructure separately as the impacts would be different.

5.4.2.1 Construction phase impacts

Due to the intensive nature of the construction activities for the hydropower facility which would occur both within and on the banks of the river, potential impacts on significant aquatic features is anticipated within the proposed development area. These impacts include the following:

- Sediment input into the river channel/s (deterioration of bottom substrate habitats for biota), elevated turbidity;
- Water quality deterioration (increased turbidity, accidental spills, sanitation, erosion from stored aggregates), especially disturbance of fine sediments in the weir;
- Increased invasion by alien plant species, especially perennial aggressive species such as *Prosopis glandulosa* and *Sesbanea punicea*;
- Bank destabilisation and erosion, especially given the alluvial nature of the majority of banks;
- Noise and visual (increased activity of people and construction equipment) disturbance to riparian fauna;
- Physical disturbance such as excavations and clearing, which may include blasting, in or near the river;

- Waste reticulation and removal;
- Cutting into rock and rock faces at site with resultant loss of natural rock features and deterioration of aesthetic value of area; as the area has recreational value with resorts around dam;
- Decreased overhanging vegetation for cover for fish results in decreased Frequency of Occurrence (FROC) of species with preference for these habitats;
- Loss of habitat (cover) from removal of riverine vegetation also results in increased exposure to predators;
- Decreased abundance, and therefore FROC related to over utilisation of fish for human consumption (especially during construction when foreign workers enter an area with good fishing potential);
- Poaching and over-fishing of fish using nets (gill and seine nets, often home-made); and
- Reduced spawning success resulting in decreased FROC of many species, due to erosion and siltation.

Layout (preferred)

The potential impact on aquatic ecology as a result of construction is considered to be of low-medium magnitude, local extent and anticipated to continue throughout the construction period and are therefore of **low-medium (-)** significance without mitigation. The significance of this impact could be reduced to **low-very low (-)** with mitigation.

Transmission route 1

The potential impact for transmission route 1 on aquatic ecology as a result of construction is considered to be of medium magnitude, local extent and anticipated to continue throughout the construction period and are therefore of **medium-high(-)** significance without mitigation. The significance of this impact could be reduced to **low-very low (-)** with mitigation.

Transmission route 2 (preferred)

The potential impact for transmission route 2 on aquatic ecology as a result of construction is considered to be of medium magnitude, local extent and anticipated to continue throughout the construction period and are therefore of **medium(-)** significance without mitigation. The significance of this impact could be reduced to **low-very low (-)** with mitigation.

5.4.2.2 Operational phase impacts

Operational impacts anticipated as follows:

- Potential erosion / bank destabilisation at the outlet point;
- Decreased wet season flows in river section between the intake and outlet, especially in the bedrock habitats in channels 1 and 2 (**Figure 43**) i.e. left and central channels;
- Lack of capacity / commitment to manage operations in terms of environmental flow requirements;
- Maintenance / clearing of riparian vegetation in power line servitudes along the river bank;
- Open canal (should this option occur) acting as a barrier to faunal movement, and also as a drowning risk.
- Release of pulsed flows in-between the intake and outflow if turbines are switched off frequently due to technicalities rather than flows becoming too low.
- Loss in abundance and diversity of especially fast instream habitats, as result of decreased base flows;
- Decrease in FROC and abundance of fish species with preference for fast habitats;
- Reduced spawning success resulting in decreased FROC of many species;
- Flow modification resulting in absence of spring flushes resulting in reduced habitat suitability and stimulation from modified flow patterns that can disrupt the normal breeding cycle; and
- Increased turbidity and disturbed bottom substrates, reduced bottom substrate quality and water quality for indigenous fish (especially breeding habitats) due to bank destabilisation,

vegetation removal and storm water run-off, as well as flow regulation that changes the existing flow patterns.

Impact of no flow on fish directly below Boegoeberg Dam

The project would consist of an off-take structure at the weir and a canal/ tunnel of up to 400 m long. The hydro scheme requires a flow of up to 120 m^3/s when sufficient river flow is available after environmental releases[11]. The off-take structure would consist of a predominantly concrete structure built into the riverbank 120 m to 250 m upstream of the existing weir wall. The tailrace canal would be approximately 100 m long.

The impact of water abstraction for the proposed hydro-power station at Boegoeberg will therefore be experienced over a distance of 400 m, reaching from above the weir to below, with the tailrace and impacted area downstream of the weir expected to be 100 m to 150 m long.

The hydro scheme will require an operational flow in excess of the current flows experienced during low flow season, implicating that the river channel directly below the weir will be dry during low flow seasons for a distance of 100 m to 150 m.

Unnatural zero flow conditions are generally undesirable for rivers this negatively affects the biotic integrity of the system. The biotic integrity of the area or site at Boegoeberg Weir is, however, already compromised due to the presence of the weir. The main impacts of large weirs such as the one at Boegoeberg are mainly flow regulation, upstream inundation, in-stream habitat loss, and the loss of migration of fish further upstream. The most important habitat which will be impacted below the weir is the rapid and riffle habitat with rocky substrate.

The rapids below the dam wall are not unique to the reach and rapids and cobble beds also occur further downstream. However, the loss of spawning habitat below the dam will have a negative impact on the spawning success of the fish in this reach, and these types of habitats need to be protected as they become less and less due to the impact of dams (inundation) and water abstraction from our rivers. The area directly below the weir is therefore mainly of importance in terms of spawning for fish and habitat for stream loving aquatic species including fish species such as yellowfish. However, the loss of flow in the rapids directly below the dam wall will only be of high significance for the immediate site (i.e. at the dam wall), but of lower significance to the reach.

Other habitats that occur below the dam wall such as the slow deep channels with marginal vegetation in the mid- and right-hand sections of the river will also be affected, but is of lesser importance as it is utilised to a lesser extent by fish. These habitats are also more abundant throughout the system (Kotze and Koekemoer, 2010). The main criterion for fish at the site is that there should be enough flow during high flow season over the weir to facilitate spawning in the rapid and rocky habitat below the weir (see **Figure 43** below for comparison of flow scenarios).

The impact of no flow at the site is considered to be low as a relatively short length of river (100-150 m) will be affected, during low flow seasons/periods.

[11] This is the specific quantity, timing, and quality of water flow in a system required to sustain ecosystems and the human livelihoods and well-being that depend on these ecosystems, as determined scientifically for a specific body of water.

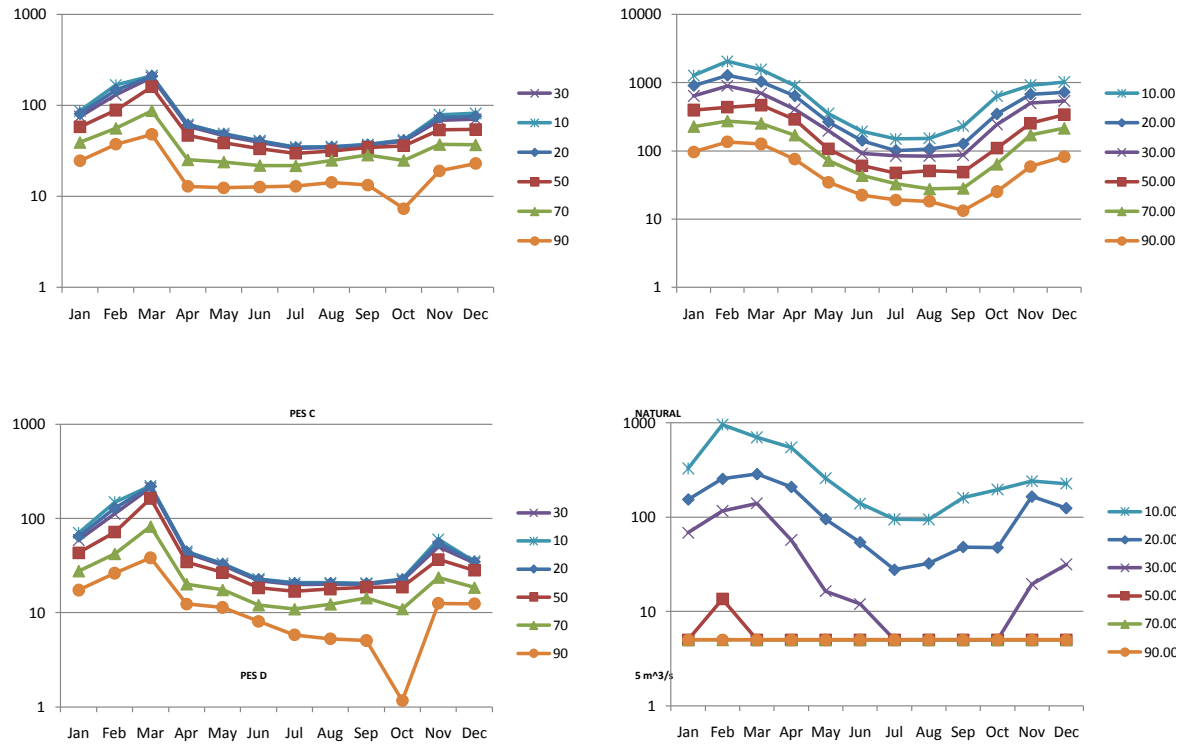

Figure 43 | Comparison of flow scenarios: top left – PES C; top right – Natural; bottom left – PES D; bottom right – 5m^3/s.

Impact of dredging in Boegoeberg Dam

As discussed above, the area above the dam is historically dredged to manage the problem of siltation in the dam. The proposed dredging as part of the project is not predicted to have a significant impact on the area downstream of the dam but a more detailed discussion of potential impacts associated with the dredging will be provided in the Final EIR.

Layout (preferred)

The potential impact on aquatic ecology as a result of operation is considered to be of low-medium magnitude, local extent and anticipated to continue throughout the construction period and are therefore of **low-medium (-)** significance without mitigation. The significance of this impact could be reduced to **low-very low (-)** with mitigation.

Transmission route 1 & Transmission route 2 (preferred)

The potential impact for both transmission alternatives on aquatic ecology during operation is considered to be of medium magnitude, local extent and anticipated to continue throughout the construction period and are therefore of **low (-)** significance without mitigation, should the pylons be places within aquatic habitats. The significance of this impact could be reduced to **very low (-)** with mitigation (i.e. location of pylons outside of such habitats).

5.4.2.3 Decommissioning phase impacts

Layout (preferred)

The potential impact on aquatic ecology as a result of decommissioning is considered to be of low-magnitude, local extent and anticipated to continue throughout the decommissioning period and are therefore of **low-medium (-)** significance without mitigation. The significance of this impact could be reduced to **low-very low (-)** with mitigation.

Transmission route 1 & Transmission route 2 (preferred)
The potential impact for both transmission alternatives on aquatic ecology during decommissioning is considered to be of low magnitude, local extent and anticipated to continue throughout the decommissioning period and are therefore of **low (-)** significance without mitigation. The significance of this impact could be reduced to **very low (-)** with mitigation.

5.4.2.4 Cumulative impacts

Based on the limited opportunities to pursue feasible hydropower on the Orange River, the relatively far distances between currently proposed projects, and the minimal footprint, the overall cumulative impact from hydropower station should be limited and of a low significance. Furthermore provided the construction and operation activities of the project remain contained within the allocated areas and any disturbed areas within the aquatic features rehabilitated, the significance would further reduce.

5.4.2.5 No-Go alternative

The No-Go Alternative would have a neutral impact as the *status quo* would remain form an aquatic ecology perspective.

5.4.3 Mitigation Measures

5.4.3.1 Construction phase mitigation measures

The following mitigation measures are proposed for the construction phase for all project alternatives:

- Minimise footprint by demarcation of impact zone (such as fencing / markers to limit access elsewhere);
- Minimise removal or disturbance of adult trees especially *A. erioloba* and *Searsia pendulina* specimens;
- Ensure construction camps are fenced and set back at least 32 m from any watercourse;
- The collection of firewood from riverine areas by construction workers should be prohibited;
- Relocation of a portion of the transmission line from the riparian zone along the Orange Riverto traverse the terrestrial zone;.
- Use of erosion control measures to minimise erosion at excavation sites or aggregate storage sites. Construction activities to take place in dry season as far as possible.
- Ensure aggregate storage outside of riparian zones / drainage channels.
- Employ recognised best practices with respect to machinery washing and maintenance; procedures for discarding unused concrete; storage of hazardous materials; provision of sanitation facilities, erosion prevention, etc.
- Removal of perennial alien species such as *Prosopis glandulosa* and *Sesbanea punicea* at sites disturbed or cleared by construction activities. Care should be taken not to introduce additional seed or propagules of alien species that may be present in aggregates brought to site.
- Vegetate areas that are not meant to stay barren as soon as possible after construction with a local indigenous species.
- Employ best practice for design and prevention of bank erosion, especially since alluvium is fine on the right bank. Minimised vegetation removal on banks will help with stabilisation
- Restrict unnecessary movement of people and plant in the riparian zone or drainage channels.
- Prevent unnecessary disturbance of substrates, fauna or flora.
- Employ recognised best practice to prevent spillage of pollutants of any kind into the river, either directly or via soak aways.
- Make use of natural materials such as rock from site in the construction process of plant wherever possible.
- Rehabilitate marginal and riparian vegetation after construction where necessary.
- Prohibit fishing from start. Ban the use of all fishing techniques. Apply regulations firmly.
- Minimise bank destabilisation, vegetation removal and erosion.

5.4.3.2 Operational Phase mitigation measures

The following mitigation measures are proposed for the operational phase for all project alternatives:

- Correct design and reinforcing to prevent bank cutting, especially at high flows.
- Conservation of as much vegetation cover as possible during construction will also mitigate in the longer term.
- Ensure rehabilitation of vegetation after construction.
- Ensure environmental flows occur before intake comes into operation. Allow small and moderate flood requirements to pass over the dam wall in keeping with final flow requirements.
- Provide effective training to ensure capacity exists to ensure environmental flow requirements are not compromised.
- Monitor flows through the turbines at sub-daily resolution, and ensure adequate maintenance of turbines to promote consistency in operation as and when flows enter the intake.

5.4.3.3 Decommissioning phase mitigation measures

The relevant mitigation measures proposed for the construction phase should be applied during the decommissioning phase for all project infrastructure and activities.

5.4.4 Aquatic Impact Table

Table 5-13, **Table 5-14, Table 5-15** and **Table 5-16** indicate how the significance ratings of the various impacts were derived.

Table 5-13 | Construction impact rating of aquatic ecology impacts

Project Component	Key impacts	Extent	Magnitude	Duration	SIGNIFICANCE (Without mitigation)	SIGNIFICANCE (With Mitigation)	Probability	Confidence	Reversibility
Hydropower Layout (preferred)	Riparian vegetation removal / clearing	Local	Low	Long Term	Low	Low	Definite	Certain	Irreversible
Roads		Regional	Medium	Long Term	Medium	Low	Probable	Certain	Irreversible
Transmission Route 1&2		Regional	Medium	Long Term	Medium	Low	Probable	Certain	Irreversible
Hydropower Layout (preferred)	Sediment input into the river channel/s	Local	Medium	Short term	Medium	Low	Probable	Certain	Reversible
Roads		Local	Low	Short term	Low	Very Low	Probable	Certain	Reversible
Transmission Route 1&2		Local	Low	Short term	Low	Very Low	Probable	Certain	Reversible
Hydropower Layout (preferred)	Water quality deterioration	Local	Medium	Short term	Medium	Low	Probable	Certain	Reversible
Roads		Local	Low	Short term	Low	Very Low	Probable	Certain	Reversible
Transmission Route 1&2		Local	Low	Short term	Low	Very Low	Probable	Certain	Reversible
Hydropower Layout (preferred)	Increased invasion by alien plant species	Local	Medium	Long Term	Medium	Low	Probable	Certain	Reversible
Roads		Regional	Medium	Long Term	High	Low	Probable	Certain	Reversible
Transmission Route 1&2		Regional	Medium	Long Term	High	Low	Probable	Certain	Reversible
Hydropower Layout (preferred)	Bank destabilisation and erosion	Local	Medium	Short term	Medium	Low	Probable	Certain	Reversible
Roads		Local	Low	Short term	Low	Very Low	Probable	Certain	Reversible
Transmission Route 1&2		Local	Low	Short term	Low	Very Low	Probable	Certain	Reversible
Hydropower Layout (preferred)	Noise and visual disturbance to riparian fauna.	Local	Medium	Short term	Low	Low	Probable	Certain	Reversible
Roads		Local	Medium	Short term	Low	Low	Probable	Certain	Reversible
Transmission Route 1&2		Local	Medium	Short term	Low	Low	Probable	Certain	Reversible
Hydropower Layout (preferred)	Physical disturbance such as excavations and clearing, which may	Local	Medium	Short term	Medium	Medium	Probable	Certain	Reversible
Roads		Local	Medium	Short term	Medium	Low	Probable	Certain	Reversible

Project Component	Key impacts	Extent	Magnitude	Duration	SIGNIFICANCE (Without mitigation)	SIGNIFICANCE (With Mitigation)	Probability	Confidence	Reversibility
Transmission Route 1&2	include blasting, in or near the river.	Local	Medium	Short term	Medium	Low	Probable	Certain	Reversible
Hydropower Layout (preferred)	Waste reticulation and removal	Local	Low	Short term	Low	Very Low	Probable	Sure	Reversible
Roads		Local	Low	Short term	Very Low	Neutral	Probable	Sure	Reversible
Transmission Route 1&2		Local	Low	Short term	Very Low	Neutral	Probable	Sure	Reversible
Hydropower Layout (preferred)	Cutting into rock and rock faces at site –	Local	Low	Short term	Low	Low	Probable	Sure	Reversible
Hydropower Layout (preferred)	Decreased overhanging vegetation for cover for fish predators.	Local	Low	Short term	Low	Low	Probable	Sure	Reversible
Hydropower Layout (preferred)	Decreased abundance, related to over utilization of fish for human consumption.	Local	High	Short term	Medium	Low	Probable	Certain	Reversible
Hydropower Layout (preferred)	Reduced spawning success, due to erosion and siltation	Local	Medium	Short term	Medium	Low	Probable	Certain	Reversible

*Mitigation measures are described in detail in **Section 5.4.3**.

Table 5-14 | Operation impact rating of aquatic ecology impacts

Project Component	Key impacts	Extent	Magnitude	Duration	SIGNIFICANCE (Without mitigation)	SIGNIFICANCE (With Mitigation)	Probability	Confidence	Reversibility
Hydropower Layout (preferred)	Potential erosion / bank destabilization at the outlet point.	Local	Low	Short Term	Low	Low	Probable	Sure	Irreversible
Hydropower Layout (preferred)	Decreased wet season flows in river section between the intake and outlet	Local	Medium	Long term	Medium	Low	Probable	Sure	Irreversible

Project Component	Key impacts	Extent	Magnitude	Duration	SIGNIFICANCE (Without mitigation)	SIGNIFICANCE (With Mitigation)	Probability	Confidence	Reversibility
Hydropower Layout (preferred)	Lack of capacity / commitment to manage operations in terms of environmental flow requirements.	Local	Medium	Long term	Medium	Low	Probable	Unsure	Reversible
Hydropower Layout (preferred)	Birds colliding with overhead power lines, which cut across riparian corridors.	Local	Low	Long Term	Low	Very Low	Probable	Certain	Reversible
Roads		Local	Low	Long Term	Low	Very Low	Probable	Certain	Reversible
Transmission Route 1&2		Local	Low	Long Term	Low	Very Low	Probable	Certain	Reversible
Transmission Route 1&2	Maintenance / clearing of vegetation in power line servitudes.	Local	Medium	Long term	Medium	Low	Definite	Certain	Irreversible
Hydropower Layout (preferred)	Open canal (should this option occur) acting as a barrier to faunal movement, and also as a drowning risk.	Local	Low	Long term	Low	Very Low	Probable	Certain	Reversible
Hydropower Layout (preferred)	Pulsed flows in the section of river between intake and outflow if turbines switched off frequently	Local	Low	Long term	Low	Low	Probable	Sure	Reversible
Hydropower Layout (preferred)	Loss in abundance and diversity of especially fast instream habitats as result of decreased base flows.	Local	Medium	Long term and/or Intermittent during operation	Medium	Low	Probable	Sure	Reversible
Hydropower Layout (preferred)	Decrease in FROC and abundance of fish species with preference for fast habitats.	Local	Medium	Long term and/or Intermittent during operation	Medium	Low	Probable	Sure	Reversible
Hydropower Layout (preferred)	Reduced spawning success resulting in decreased FROC of	Local	Medium	Long term and/or Intermittent	Medium	Low	Probable	Sure	Reversible

Project Component	Key impacts	Extent	Magnitude	Duration	SIGNIFICANCE (Without mitigation)	SIGNIFICANCE (With Mitigation)	Probability	Confidence	Reversibility
	many species.			during operation					
Hydropower Layout (preferred)	Flow modification: Absence of spring flushes, reduced habitat suitability and stimuli, flow pattern disrupts normal breeding cycle.	Local	Medium	Long term and/or Intermittent during operation	Medium	Low	Probable	Sure	Reversible
Hydropower Layout (preferred)	Increased turbidity and disturbed bottom substrates, reduced bottom substrate quality and water quality for indigenous fish	Local	Medium	Long term and/or Intermittent during operation	Medium	Low	Probable	Sure	Reversible

Table 5-15 | Decommissioning impact rating of aquatic ecology impacts

Project Component	Key impacts	Extent	Magnitude	Duration	SIGNIFICANCE (Without mitigation)	SIGNIFICANCE (With Mitigation)	Probability	Confidence	Reversibility
Hydropower Layout (preferred)	Rubble generation and removal	Local	Low	Long Term	Medium	Low	Definite	Certain	Irreversible
Roads		Regional	Low	Long Term	Low	Very Low	Probable	Certain	Irreversible
Transmission Route 1&2		Regional	Low	Long Term	Low	Very Low	Probable	Certain	Irreversible

Table 5-16 | Cumulative aquatic ecology impacts

Key impacts	Mitigation	Extent	Magnitude	Duration	SIGNIFICANCE	Probability	Confidence	Reversibility
Impact to surface water ecosystem	No mitigation	Regional	Medium/ Low	Longer term	Low (-)	Probable	Sure	Reversible
Impact to surface water ecosystem	Mitigation	Regional	Low	Longer term	Very Low (-)	Improbable	Sure	Reversible

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5.4.5 Aquatic Ecology Conclusions

The impact of the proposed hydropower station will only be local, and the river should again attain its current integrity downstream of the tailrace of the plant. It is, however, important to protect rare spawning areas and ensure its functioning in order to ensure the survival of our already scarce and endangered fish species such as the largemouth yellowfish and the rock catfish. The significance of the transmission alternative 2 is likely to be more significant as it avoids riparian habitat.

The area below the Boegoeberg Weir is mainly important in terms of spawning for fish. It is, however, expected that there would be enough flow over the weir during floods (high flow season) to facilitate spawning. The supplementing flows (two channels observed) from the irrigation canal will help mitigate effects (no flow) from the proposed development. These channels also provide the preferred habitat for the more sensitive species. It will be preferable (and recommended) if the flows from the side channels from the irrigation canal can be maintained.

The affected reach (100 m) is relatively short if the extent of the development and the size of the Orange River are taken into account. The impact can, therefore, be seen as low for the reach.

The advantages of the development seem to outweigh the disadvantages to the system, but it is important to note that from a conservation point of view the development and the effect of total loss of flow still remain undesirable to the natural area and ecosystem. It is still recommended that some flow, if possible, is released to help maintain the area below the weir especially the left-hand channel in the mainstream.

The tailrace from the hydro power scheme may also provide new habitat for fish as it will most probably flush sand and sediment from the right-hand channel creating new rocky substrate for fish. In addition constructed cobble beds will provide additional fish habitat and serve to mitigate other losses.

It is highly likely that there will be reed encroachment is the impacted section.

5.5 IMPACT ON AGRICULTURE

In South Africa there is a scarcity of high potential agricultural land, with less than 14% of the total area being suitable for dry land crop production. Consequently areas which could sustainably accommodate any production need to be protected from non-agricultural land uses.

5.5.1 Description of the Environment

Groblershoop agricultural production is made up of stock farming and wine production and the area is currently a main source of export for table grapes and sultanas. A modern abattoir with approximately 130 employees processes livestock from surrounding farms, while the local wine cellars have an annual intake of ~12,000 tons of grapes (http://www.groblershoop.co.za/). The Boegoeberg Dam supplies an agricultural canal with water for irrigation for farms downstream of the dam. It should be noted that the agreed agricultural flow to the canal as would be maintained before any water for the proposed project could be used. Thus in periods of low flow, water to the agricultural canal would be prioritised.

Agricultural activities on the farm on which the project is located, Zeekoebaart, currently consist of a mix of stock farming and irrigated land used primarily in the production of maize.

5.5.2 Agricultural Impact Assessment

The proposed hydropower station and ancillary infrastructure is to be located next to the Boegoeberg Dam on the banks of the Orange River. Given both the location and associated topography of the area surrounding the hydropower station the land offers very little in the way of agricultural opportunity.

Furthermore the limited footprint of the hydropower station would have little to no impact on current or future agricultural production. Potential impact on agricultural resources could occur with the access roads to the hydropower plants which would require to be widened to 6 m, but would not require any new roads. This impact is predicted to be extremely limited. The transmission route would follow existing road alignments and only three sections totalling ~12.24 km would need to be developed for construction and maintenance of the line (**Figure 23**). However these sections would not pass through agriculturally productive areas.

Water would only be diverted for 250 m and returned to the Orange River again. Therefore, no water would be lost and the project will not impact on irrigation of farmers downstream.

The impacts are assessed below. The assessments for the proposed layout below have been separated in order to assess the facility layout and the ancillary infrastructure separately as the impacts would be different.

5.5.2.1 Construction phase impact

Layout (preferred)
The potential impact on agriculture is considered to be of low magnitude, local extent and anticipated to continue throughout the construction period and are therefore of **very low (-)** significance with or without mitigation.

Transmission route 1 & Transmission route 2 (preferred)
The potential impact on agriculture is considered to be of low magnitude, local extent and anticipated to continue throughout the construction period and are therefore of **low (-)** significance with or without mitigation.

5.5.2.2 Operational phase impact

Layout (preferred)
The potential impact on agriculture is considered to be of low magnitude, local extent and anticipated to continue throughout the operational period and are therefore of **very low (-)** significance with or without mitigation.

Transmission route 1 & Transmission route 2 (preferred)
The potential impact on agriculture is considered to be of low magnitude, local extent and anticipated to continue throughout the operational period and are therefore of **low (-)** significance with or without mitigation.

5.5.2.3 Decommissioning phase impact

Layout (preferred)
The potential impact on agriculture is considered to be of low magnitude, local extent and anticipated to continue throughout the decommissioning period and are therefore of **very low (-)** significance with or without mitigation.

Transmission route 1 & Transmission route 2 (preferred)

The potential impact on agriculture is considered to be of low magnitude, local extent and anticipated to continue throughout the decommissioning period and are therefore of **low (-)** significance with or without mitigation.

5.5.2.4 Cumulative impacts

The inherently low agricultural potential of the region and that nominal footprint would have a **low (-)** overall cumulative impact on agricultural production of the area.

5.5.2.5 No-Go impact

The No-Go Alternative would have a neutral impact as the status quo would remain.

5.5.3 Mitigation Measures

The proposed mitigation measures would reduce the potential impacts on current agricultural production and soil resources even further.

5.5.3.1 Construction phase mitigation measures

The following mitigation measures are required during the construction phase to mitigate the loss of agricultural land and degradation of soil resources for all alternatives:

- A planned phased approach must be adopted.
- All normal agricultural activities should continue in unaffected areas.
- Land rehabilitation and re-vegetation must be initiated as soon as possible after disturbance.
- Erosion control:
    - The soil erosion plan and associated recommendations should be employed (**Annexure E**).
    - Clearing activities should be kept to a minimum.
    - Should heavy rains be predicted, land-clearing activities should be put on hold to reduce the risk of erosion.
    - If additional earthworks are required, any steep or large embankments that may be exposed during the wetter months should be armoured with fascine like structures (a fascine structure usually consists of a natural wood material and is used for the strengthening of earthen structures or embankments).
    - If earth works are required, then storm water control and wind screening should be undertaken to prevent soil erosion.

5.5.3.2 Operational phase mitigation measures

The following mitigation measures are required during the operational phase to mitigate the loss of agricultural land and degradation of soil resources for all alternatives:

- Initiate land rehabilitation and re-vegetation as soon as possible and continue to visually monitor land for early detection of degradation.
- Allow normal agricultural activities to continue in unaffected areas.

5.5.3.3 Soil Erosion Management Plan

Soil erosion management plan mitigation measures:

- Soil erosion would need to be monitored visually by the appointed ECO. It is recommended that areas around roads, stockpiles and hydropower are visually monitored during audits. A photographic record of the on-site conditions would also aid in the identification of erosion

problems. A quarterly (3 month) photographic frequency is recommended. Signs of rill and gully erosion should be remediated as soon as possible.

- Clearing activities should be kept to a minimum and must only be undertaken during agreed working times, as well as permitted weather conditions.
- If heavy rains are predicted clearing activities should be put on hold. In this regard, the contractor must be aware of weather forecasts.
- The unnecessary removal of groundcover vegetation from slopes must be prevented, especially on steep slopes.
- Following the clearing of an area, the surfaces of all exposed slopes must be roughened to retain water and increase infiltration (especially important during the wet season).
- Any steep or large embankments that are expected to be exposed during the 'rainy' months should either be armoured with fascine[12] like structures or vegetated. If a cleared area is not going to be built on immediately, the top layer (150 mm) of soil should be removed and stockpiled in a designated area approved by the ECO.
- Vegetation shall be stripped in a sequential manner as the work proceeds to reduce the time that stripped areas are exposed to the elements.
- Top-soiling and re-vegetation shall start immediately after the completion of an activity and at an agreed distance behind any particular work front.
- It is highly recommended that existing farm roads are used as much as possible, while the additional creation of access roads should be kept to a minimum.
- Storm water control and wind screening should be undertaken to prevent soil loss from the site.
- All embankments shall be protected by a cut off drain to prevent water from running down the face of the embankment, resulting in soil erosion. Typical erosion control measures such as the installation of silt fences, hay bales, EcoLogsTM and Bio JuteTM are recommended if erosion problems are noted during construction and operation phases and pegged hay bale wall used to reduce runoff velocities.

5.5.4 Agriculture Impact Table

Table 5-17 and **Table 5-18** indicate the various impacts and how their significance ratings were determined.

[12] A fascine structure usually consists of natural wood material and is used for the strengthening earthen structures or embankments.

Table 5-17 | Impact rating of agricultural impacts

	Project	Mitigation	Extent	Magnitude	Duration	SIGNIFICANCE	Probability	Confidence	Reversibility
Construction phase	Layout (all alternatives)	Without mitigation	Site specific	Low	Construction	Low (-)	Definite	Sure	Irreversible
		With mitigation	Site specific	Low	Construction	Very Low (-)	Definite	Sure	Reversible
	Transmission lines (all alternatives)	Without mitigation	Site specific	Low	Construction	Low (-)	Definite	Sure	Irreversible
		With mitigation	Site specific	Low	Construction	Low (-)	Definite	Sure	Reversible
Operational phase	Layout (all alternatives)	Without mitigation	Site specific	Very Low	Long term	Very Low (-)	Definite	Sure	Irreversible
		With mitigation	Site specific	Very Low	Long term	Very Low (-)	Definite	Sure	Reversible
	Transmission lines (all alternatives)	Without mitigation	Site specific	Very Low	Long term	Very Low (-)	Definite	Certain	Reversible
		With mitigation	Site specific	Very Low	Long term	Very Low (-)	Definite	Certain	Reversible
Decommissioning phase	Layout (all alternatives)	Without mitigation	Site specific	Very Low	Decommissioning Period	Very Low (-)	Definite	Sure	Reversible
	Transmission lines (all alternatives)	With mitigation	Site specific	Very Low	Decommissioning Period	Very Low (-)	Definite	Sure	Reversible

*Mitigation measures are described in detail in **Section 5.4.3**.

Table 5-18 | Cumulative agricultural impacts

Key impacts	Extent	Magnitude	Duration	SIGNIFICANCE	Probability	Confidence	Reversibility
Cumulative loss of agricultural production / grazing land (without mitigation)	Regional	Low	Long term	Low (-)	Probable	Unsure	Reversible
Cumulative loss of agricultural production / grazing land (with mitigation)	Regional	Low	Long term	Very Low (-)	Probable	Unsure	Reversible

5.5.5 Agriculture Conclusion

The location of the proposed site is not agriculturally productive and the small scale of the infrastructure would not impede or limit current or future agricultural production.

5.6 IMPACT ON HERITAGE

The National Heritage Resources Act (NHRA) No. 25 of 1999 protects a variety of heritage resources including palaeontological, prehistoric and historical material (including ruins) more than 100 years old (Section 35), human remains older than 60 years and located outside of a formal cemetery administered by a local authority (Section 36) and non-ruined structures older than 60 years (Section 34). Landscapes with cultural significance are also protected under the definition of the National Estate (Section 3 (3.2d)). Section 38 (2a) states that if there is reason to believe that heritage resources will be affected then an impact assessment report must be submitted.

In order to assess any potential impacts of the hydropower plant on heritage resources in the project area, a Heritage Impact Assessment (HIA) was undertaken by Mr Jayson Orton of ACO Associates cc (ACO). The HIA was informed by a literature survey and a field survey which was conducted on 9 September 2013 to examine specific locations considered to be of heritage interest and also to conduct random examination of other areas. The HIA is included in **Annexure D**.

5.6.1 Description of the Heritage Environment

Due to the length of the power line, the affected area was variable in character. At the Boegoeberg Dam the Orange River is about 500 m wide and islands of silt and reeds occur immediately downstream of the weir. The power station and associated pipelines and/ or canals would be placed at the foot of a small cliff at the north-eastern end of the weir. The very limited floodplain upstream (to the southeast) is grassed and used as a campsite, while that downstream is sandy with riverine vegetation.

The power line would run along the river for the first part, encountering similar environments, but then it would cross the river and follow a local road moving away from the river and through the arid far eastern Bushmanland. In these areas the substrate is generally rocky and vegetation cover very limited.

5.6.1.1 Archaeology

Few archaeological resources were found. Above the cliff at the Boegoeberg Weir an extensive scatter of stone artefacts was recorded. Most are likely to be Middle Stone Age (MSA) (**Figure 44**) but a few grindstones (**Figure 45**) and other isolated flaked artefacts are probably Late Stone Age (LSA). There is no obvious occupation site but the position offers an excellent view over the valley and was no doubt repeatedly used for short periods.

On the sandy floodplain just downstream of the weir was a small and very ephemeral archaeological site. It consists of a scatter of rocks that may well have been used to anchor a hut. Just two artefacts and one fragment of ostrich eggshell were associated with the stones. No other signs of occupation were seen anywhere else on the sandy floodplain.

The most interesting archaeological site was a cluster of low stone walls on the south side of the river and on the mountain slope close to the power line crossing point. A total of twelve features were recorded at the site. The features included straight walls, semi-circles, L-shapes and small mounds of rocks (**Figure 46**). Only one flaked stone artefact was found associated and this was within the semi-circle. It was a banded ironstone flake. These stone walls are fairly typical of pre-colonial walling from

the Karoo (Hart 1989; Sampson 1984, 1985) and some may have been hunting blinds – that they face down towards the river valley offers further support for this.

Figure 44 | Banded ironstone artefacts and a typical MSA blade found.

Figure 45 | Two quartzite lower grindstones.

Figure 46 | Interesting clusters of low stone walls

Another archaeological aspect is rock art. Although none was seen during the survey, there is said to be a rock art site in the mountains near the start of the access road to the farm. This was not located during the survey.

5.6.1.2 Graves

One informal graveyard and two isolated graves/probable graves were located (**Figure 47**). The graveyard lies alongside the access road to Zeekoebaart and one grave is within about one metre of the edge of the road. There are at least eight graves all placed in a single row. In the sandy floodplain just downstream of the cliff where the weir two possible graves where found. One is a cement

headstone seemingly propped up in the sand. Its caption reads: “Rus in vrede Gert Peters oorlede die 10 April 1953, 62 jaar, die seun van die mens.” According to the land owner that the person had drowned upstream but had been buried on the spot where his body washed up. It is possible that this headstone is out of position and might even have been moved downstream from another location. Nearby, some 50m to the northwest, is a stone cairn that seems very much like a burial cairn. Whether the cement headstone in fact belongs with this cairn is unknown, but it is possible that two graves are represented. Many people died during construction of the Boegoeberg Weir but it is not known where they were buried.

Figure 47 | Headstone and a Stone Cairn

5.6.1.3 Built environment

No built environment of heritage significance will be directly affected by the proposed project but a few farm buildings are located in close proximity to the project. At the Boegoeberg Dam there is a modern building at the campsite which has no heritage significance. During construction of the weir a school and hospital were apparently built but the whereabouts of these is not known. However, on the road leading to the farm there is a house dating to the late 19th or early 20th century has high heritage significance. It is a very good example of vernacular architecture which was found to be generally rare in the study area. It is about 15 m from the access road so will not be impacted. The transmission line would also pass close to a small stone kraal (**Figure 48**)

Figure 48 | Vernacular house and small stone kraal

The Boegoeberg Weir itself is a heritage structure since it was built between 1929 and 1933 and the dam has a long history.

The weir was proposed in the late 1920s as a job creation project for poor Afrikaaners in the region. The idea of a weir and irrigation canal was, however, being considered as early as 1872. The first plan put together was only in 1895 but it was considered too costly and was shelved. The idea was frequently discussed in parliament until in 1906 the scheme was revived but in a different and cheaper

configuration. Work began in 1906 using black labour but stopped in 1907 as the costs were deemed to be too high.

Then, in 1929 with the Great Depression and a severe drought South Africa, the government ordered construction of the Boegoeberg Weir to provide labour for poor whites. Although built by the Department of Irrigation, the funding was supplied by the Department of Labour. The weir and canal were treated as separate developments and the construction camp for the weir was on Zeekoebaart (the location of this camp is not known and there are no such remains obviously evident close to the power station area). Coffer dams were made from sandbags and all work on these and the main weir was carried out by hand. Although people of colour were not allowed to work on the project, white children as young as nine years old were at times employed. As stated above, a school and hospital were also built. Approximately 50 people (including 38 children) are said to have died during the project.

Although the weir had proceeded far enough to begin supplying the irrigation canal with water by 1932, it was only in 1934 that the 121 km long irrigation canal was completed. **Figure 49** shows the dam under construction.

Figure 49 | Boegoeberg Weir during construction in 1930. Source: www.boegoebergecoroute.co.za.

5.6.1.4 Cultural landscapes and scenic routes

There are no significant cultural landscapes in the study area. It is generally remote and the gravel roads through the study area receive little traffic. None of the roads within proximity of the site can be regarded as a scenic route. There is a campsite close to the dam on the southern banks and the dam itself provides a scenic environment as part of the recreational resource.

5.6.1.5 Living heritage

A song entitled “Boegoeberg se dam” was written but no further information on this could be found. The song has been produced by various artists over the years so it is part of Afrikaner heritage. Eve Boswell (mid-20th century) and Die Van Wyk Broers (2004) both sang the song. It is possible that the song was written during construction of the weir, as implied by a post on the website www.boerevryheid.co.za (2007), although the veracity of this claim cannot be ascertained.

5.6.2 Heritage Impact Assessment

In general very little heritage will be impacted by the proposed project. The only impacts of any significance are those related to archaeological artefacts and graves and impact to these would be a high negative. Although other aspects of heritage do occur in the vicinity, these will not be directly affected and can be avoided during the development. Note that all impacts would take place at the construction phase and (assuming that the graves continue to be avoided) no new impacts would occur during operation and decommissioning.

The impacts are assessed below. The assessments for the proposed layout below have been separated in order to assess the facility layout and the ancillary infrastructure separately as the impacts would be different.

5.6.2.1 Construction phase impact

Layout
Damage and/or destruction of archaeological resources through both canal and road construction, while limited at the power station area, is likely to be of higher magnitude than along the transmission line route.

Transmission line corridor
While mitigation will be required above the cliff area to reduce impacts, there is little of concern along the transmission line where only small holes would be excavated and the general disturbance footprint is substantially smaller.

5.6.2.2 Operational- and decommissioning phase impact

Impacts to archaeological heritage resources would occur at the construction phase and thereafter remain unchanged through the operational and decommissioning phases. This is because once they are destroyed they cannot be recreated.

5.6.2.3 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.

5.6.2.4 Cumulative impacts

Cumulative impacts are not very easy to assess, since archaeological resources, in particular, are point-specific. Each is unique and, while the general locations of archaeological sites could 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. A review of reports conducted for other renewable energy projects in the area suggests that the MSA and LSA sites found surrounding Boegoeberg Dam are fairly typical of the wider area and that the significance of any cumulative impacts would be **very low (-)**.

5.6.3 Mitigation Measures

As described above, historical archaeological material was rather limited, however some parts of the main study area remain important and require mitigation through avoidance.

The following mitigation measures are recommended for the project components as mentioned in Section 4.7.2:

The suggested archaeological mitigation will involve establishing a sampling grid over the flat area at the top of the cliff and excavating/collecting artefacts from various areas. It should be borne in mind that the scatter is likely to extend well beyond the area inspected during this survey. The site should also be carefully examined to determine if any spatial patterning is evident. It can be very easily mapped using a hand-held GPS. This area is particularly vulnerable since it is likely that much machinery would be brought in here and that work on blasting the cliff for the canal would largely occur from this point.

For graves, mitigation will involve temporary fencing and complete avoidance of all known and possible graves. Since the small graveyard is in such a vulnerable position immediately alongside a gravel access road, a permanent fence and gate could be considered there.

It is recommended that the project be allowed to proceed. The following recommendations should be adhered to (and should be included in the EMP for the project):

- The gravestone (ZKB2013/003) and stone cairn (ZKB2013/002) immediately downstream of the power station site should be temporarily cordoned off and carefully avoided throughout construction work;
- Excavation in the silts immediately below the weir should be carefully monitored just in case there are other burials, or the cement headstone has been washed downstream from another location during floods;
- If the road passing the graveyard at ZKB2013/004 is to be used for access to the transmission route then the graves must be cordoned off and avoided during and after development (due to its generally sensitive location, erection of a permanent fence around this graveyard could be considered);
- Archaeological mitigation should be carried out at site ZKB2013/001 on the platform at the top of the cliff prior to construction; and
- The stone structures at BDW2013/001, specifically the one near the road, should be avoided during and after construction. Careful placement of pylons will be required to ensure that these structures are spanned but care should be taken to avoid damage to them during construction.

Table 5-19 | Co-ordinates of important heritage sites

Site Name	Co-ordinates	
ZKB2013/001	S29 02 22.5 E22 12 15.9	S29 02 23.4 E22 12 11.8
	S29 02 23.4 E22 12 14.4	
ZKB2013/002	S29 02 17.3 E22 12 05.4	
ZKB2013/003	S29 02 18.8 E22 12 06.5	
ZKB2013/004	S29 03 23.0 E22 12 55.1	
ZKB2013/005	S29 03 59.0 E22 12 52.4	
BDW2013/001	S29 04 26.8 E22 12 04.5	S29 04 23.2 E22 12 06.5
	S29 04 26.3 E22 12 04.4	S29 04 23.0 E22 12 06.8
	S29 04 26.0 E22 12 04.3	S29 04 23.7 E22 12 06.3
	S29 04 25.4 E22 12 04.8	S29 04 23.9 E22 12 06.4
	S29 04 23.1 E22 12 05.9	S29 04 27.1 E22 12 05.3
	S29 04 23.2 E22 12 06.1	S29 04 26.8 E22 12 06.8

5.6.4 Heritage Impact Table

Table 5-20 and **Table 5-21** indicate how the significance ratings of the various impacts were derived.

Table 5-20 | Impact rating of heritage impacts

	Project	Key impacts	Extent	Magnitude	Duration	SIGNIFICANCE (Without mitigation)	SIGNIFICANCE (With Mitigation)	Probability	Confidence	Reversibility
Construction phase	Layout (preferred)	Destruction of archaeological stone artefact scatters on the cliff above the weir.	Local	Medium	Long term	Medium	Low	Definite	Certain	Irreversible
	Roads		Local	Medium	Long term	Medium	Low	Definite	Certain	Irreversible
	Transmission Route		Local	Low	Long term	Low	Low	Probable	Certain	Irreversible
No-Go Option		Disturbance of archaeological artefacts through natural erosion.	Local	Very low	Long term	Very low	Very low	Probable	Certain	Irreversible
Construction phase	Layout (preferred)	Disturbance or destruction of graves below the weir and/or along the access road.	Local	High	Long term	High	Low	Unlikely	Certain	Irreversible
	Roads		Local	High	Long term	High	Low	Probable	Certain	Irreversible
	Transmission Route		Local	Low	Long term	Low	Low	Unlikely	Certain	Irreversible
No-Go Option		Disturbance of graves through natural erosion.	Local	Very low	Long term	Very low	Very low	Probable	Certain	Irreversible

*Mitigation measures are described in detail in **Section 5.6.3**.

Table 5-21 | Cumulative heritage impacts

Key impacts	Mitigation	Extent	Magnitude	Duration	SIGNIFICANCE	Probability	Confidence	Reversibility
Heritage	No mitigation	Site specific	Low	Permanent	Low (-)	Definite	Sure	Irreversible
	Mitigation	Site specific	Very low	Permanent	Very low (-)	Definite	Sure	Irreversible

5.6.5 Heritage Conclusion

This assessment has shown that impacts to heritage resources are likely to be of medium significance and that these could be reduced to low significance through mitigation. It is thus deemed appropriate that the project should continue as planned.

5.7 IMPACT ON PALAEONTOLOGY

The extent of the proposed development (over 5,000 m^2) falls within the requirements for a Heritage Impact Assessment (HIA) in terms of Section 38 (Heritage Resources Management) of the NHRA. The various categories of heritage resources recognised as part of the National Estate in Section 3 of the NHRA include, among others:

- Geological sites of scientific or cultural importance;
- Palaeontological sites; and
- Palaeontological objects and material, meteorites and rare geological specimens.

The South African Heritage Resources Agency (SAHRA) requested during the Scoping Phase that a palaeontological study be undertaken to assess whether or not the development will impact upon palaeontological resources. The minimum requirement was a letter from a palaeontologist to indicate that this is unnecessary if a full study was unnecessary. As such Dr J.E. Almond of Natura Viva was appointed to undertake a desktop Palaeontological Impact Assessment (PIA) which has been informed by a review of relevant scientific literature and geological maps relevant to the study area. The PIA is included in **Annexure D**.

5.7.1 Description of the Environment

The Boegoeberg hydropower project study area lies within the Lower Vaal and Orange Rivers geomorphic province (Partridge et al. 2010). The development footprint of the proposed Boegoeberg Hydropower Station and associated 132 kV transmission line overlie areas of the Northern Cape Province that are underlain by potentially fossilifous sedimentary rocks of Precambrian, and younger, Tertiary or Quaternary age.

The northern and central portions of the region are largely underlain by Precambrian (Late Archaean to Middle Proterozoic) sediments, metasediments and volcanic rocks along the western margin of the ancient Kaapvaal Craton.

Three major Precambrian rock successions were mapped in the area:

- Late Archaean (c. 2.7 Ga = billion years old) volcanics of the Ventersdorp Supergroup (Zeekoebaart Formation, Rz) comprise andesitic lavas and tuffs (ashes) with minor interbeds of marble.
- The Ventersdorp rocks are overlain with an unconformable or faulted contact by marine carbonates of the Campbell Rand Subgroup (Ghaap Group, Transvaal Supergroup Vgd) that were deposited on the western edge of the Kaapvaal Craton (Griqualand West Basin) in Late Archaean times, some 2.56 billion years ago (Erikkson et al. 2006).
- During early Proterozoic times (c. 1.9 Ga) the varied succession of shallow marine shelf to fluvial continental sediments of the Olifantshoek Supergroup were deposited unconformably on the older Precambrian basement rocks. Some 100 million years or so later, the Olifantshoek sedimentary rocks were deformed and thrust south-eastwards onto the edge of the Kaapvaal Craton as a result of continental collision events (probably between the Congo and Kaapvaal Cratons) to form part of the Ubendian Belt (Kheis Orogeny; Moen 2006, McCarthy & Rubidge 2005). Olifantshoek Supergroup sediments dominate the terrain around and immediately to the south of the Boegoeberg Dam area, to the southeast of the major Dabep Fault that defined the contact with the Namaqua-Natal basement rocks to the west (Moen 2006, see also structural study of the study region by Altermann & Hälbich 1990).

The southern portion of the study region is underlain by granitoid rocks of the ancient Archaean basement, mapped as the Skalkseput Granite. These last rocks form part of the Marydale – Prieska

granite-greenstone terane on the southwestern edge of the Kaapvaal Craton and have been dated to between 3 and 2.7 Ga (Robb et al. 2006). Since they are entirely unfossiliferous, they are not regarded as significant in terms of palaeontological resources and are not discussed further.

The Precambrian bedrocks are mantled in many areas by a range of much younger superficial deposits. These include most notably Quaternary aeolian sands of the Gordonia Formation (Qg, Kalahari Group) as well as various alluvial sediments (gravels, sands, silts) associated with the major drainage systems such as the Orange and Marydale Rivers plus smaller ephemeral stream beds. Relict patches of older terrace or pediment gravels ("High Level Gravels") are not mapped along this stretch of the Orange River, however. Other (unmapped) superficial deposits that are indeed present include rocky colluvium (scree), sheetwash and downwasted surface gravels, and residual soils on the valley slopes and mountainous areas. Most of these younger deposits are probably Quaternary to Recent in age.

5.7.2 Impact Assessment

Once constructed, the operational and decommissioning phases of the hydropower facilities would not involve further adverse impacts on palaeontological heritage as described below.

The impacts are assessed below. The assessments for the proposed layout below have been separated in order to assess the facility layout and the ancillary infrastructure separately as the impacts would be different.

5.7.2.1 Construction phase impact

The construction phase of the development will entail surface clearance and substantial excavations into the superficial sediment cover as well as locally into the underlying bedrock, notably for tunnels, turbine chamber, as well as transmission line pylon installations. In addition, sizeable areas of bedrock may be sealed-in or sterilised by infrastructure such as construction camps as well as new gravel roads. All these developments may adversely affect fossil heritage preserved at or beneath the surface of the ground within the study area. These resources may be destroyed, disturbed or result in fossils that are permanently sealed-in and no longer available for scientific research or other public good.

No areas or sites of exceptional fossil heritage sensitivity or significance have been identified within the Boegoeberg hydropower project study area. The footprint of the hydropower station itself, where substantial excavations are anticipated, is underlain by tectonically deformed Precambrian sedimentary bedrocks of the Olifantshoek Supergroup that are not known to contain fossil remains. It is also noted that potentially fossiliferous ancient river gravels are *not* mapped along this section of the Orange River.

The majority of the transmission line corridor from the Boegoeberg Dam site to the Fibre Substation traverses bedrocks of very low to zero palaeontological sensitivity - mainly Ventersdorp Group lavas, basement granites, Kalahari sands. Campbell Rand Subgroup marine carbonates crossed by the transmission line some seven kilometres south of the dam site might contain fossil stromatolites (microbial mounds) but these rocks are probably tectonically deformed and only a small outcrop area is concerned here.

The overall impact significance of the construction phase of the proposed hydropower plant and associated powerline is assessed as **low (-)** with regard to palaeontological heritage resources. This is due to:

- The general scarcity of fossil remains within the bedrocks and superficial deposits represented;

- The moderately high levels of bedrock deformation;
- The comparatively small development footprint; and
- The extensive superficial sediment cover mapped within the study area.

This assessment applies equally to all site layout and transmission line route alternatives under consideration since the impacts in all cases will be very similar.

5.7.2.2 Operational and decommissioning phase

Once constructed, the operational and decommissioning phases of the hydropower facilities would not involve further adverse impacts on palaeontological heritage.

5.7.2.3 No-Go Alternative

The "no-go" option (i.e. no hydropower station and transmission line development) will have a neutral impact on fossil heritage resources. The operational and decommissioning phases of the hydropower plant facilities will not involve significant adverse or other impacts on palaeontological heritage.

5.7.2.4 Cumulative impacts

Provided that the recommended mitigation measures are carried through, it is likely that any potentially negative impacts of the proposed hydropower facilities on local fossil resources would be substantially reduced and, furthermore, they would partially offset by the *positive* impact represented by increased understanding of the palaeontological heritage of the Northern Cape.

5.7.3 Mitigation Measures

During the construction phase all substantial bedrock excavations should be generally monitored for fossil remains by the responsible ECO. In particular, the ECO should be alerted to the possibility of fluvial gravels containing transported, disarticulated bones and teeth of fossil mammals. Should significant fossil remains such as vertebrate bones and teeth, shells, plant-rich fossil lenses or dense fossil burrow assemblages be exposed during construction, the ECO should safeguard these, preferably *in situ*, and alert SAHRA[13] as soon as possible so that appropriate action can be taken by a professional palaeontologist at the developer's expense. Mitigation would normally involve the scientific recording and judicious sampling or collection of fossil material as well as associated geological data (e.g. stratigraphy, sedimentology, taphonomy).

In addition, the following mitigation measures needs to be included in the LEMP (for all project developments):

- All South African fossil heritage is protected by law (NHRA) and fossils cannot be collected, damaged or disturbed without a permit from SAHRA or the relevant Provincial Heritage Resources Agency;
- The palaeontologist concerned with mitigation work would need a valid fossil collection permit from SAHRA and any material collected would have to be curated in an approved depository (e.g. museum or university collection); and
- All palaeontological specialist work would have to conform to international best practice for palaeontological fieldwork and the study (e.g. data recording fossil collection and curation, final report) should adhere as far as possible to the minimum standards for Phase 2 palaeontological studies recently developed by SAHRA (2013).

5.7.4 Palaeontology Impact Tables

Table 5-22 and **Table 5-23** indicate how the significance ratings of the various impacts were derived

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Table 5-22 | Impact rating of palaeonotogical impacts

Project	Key impacts	Mitigation	Extent	Magnitude	Duration	SIGNIFICANCE	Probability	Confidence	Reversibility
All alternatives	Disturbance, damage or destruction of fossils preserved at or below the ground surface during the construction phase	No mitigation	Site specific	Very low	Long term	Low (-)	Probable	Unsure	Irreversible
		Mitigation	Site specific	Very low	Long term	Low (-)	Probable	Unsure	Irreversible

*Mitigation measures are described in detail in **Section 5.7.3**.

Table 5-23 | Cumulative palaeontological impacts

Key impacts	Mitigation	Extent	Magnitude	Duration	SIGNIFICANCE	Probability	Confidence	Reversibility
Disturbance, damage or destruction of fossils preserved at or below the ground surface	No mitigation	Site specific	Low to Very low	Long term	Low (-)	Probable	Unsure	Irreversible
	Mitigation	Site specific	Low to Very low	Long term	Low (-)	Probable	Unsure	Irreversible

5.7.1 Palaeontology Conclusion

The overall impact significance of the construction phase of the proposed hydropower plant and associated powerline is assessed as **low (-)** with regard to palaeontological heritage resources. This applies equally to all site layout and transmission line route alternatives under consideration since the anticipated impacts in all cases will be very similar. The impacts on this aspect are limited to the construction phase.

5.8 VISUAL IMPACTS

5.8.1 Description of the Environment

The location of the proposed project is at the site of the existing Boegoeberg weir, which is a dominant feature in the landscape. There is infrastructure and equipment for the weir on the southern banks upstream of the weir as well as an established campsite for visitors to the dam. The northern banks of the river above the weir are wooded, with a house and campsite within this tree area. There is a koppie with indigenous vegetation immediately upstream of the proposed power chamber, through which the canal will be tunnelled. Below the weir, the site is less disturbed, although an irrigation channel runs parallel to the southern banks.

While the area is disturbed visually, the Boegoeberg Dam area is nonetheless a highly scenic area on the Orange River. The predominant landuse in the area is agricultural and recreational, although the equipment associated with the dam wall provides some form of industrial type activity (cranes).

The area is not densely populated and not many people would be visually affected by the proposed activity. The exception is when the camp site is used during holiday periods and weekends. However, the campsite is someway upstream of the weir and once the construction period is over, the larger components such as the power chamber would not be visible from the dam or the campsite, although it will be visible from the weir itself and from areas downstream of the dam.

Figure 50 to **Figure 51** illustrate the site and surrounds.

Figure 50 | View of the weir, the Boegoeberg Dam and the downstream area from the koppies to the north of the river bank.

Figure 51 | View of the weir and area downstream of the weir close to where the canal and power chamber are proposed.

Figure 52 | View of the site where the power chamber is proposed. The weir can be seen in to the right of the photo. The canal would be tunnelled through the koppies.

Figure 53 | View of the northern bank from the southern bank. The power station would be located on the northern bank close to the koppies.

Figure 54 | View of the area downstream of the weir, with equipment for operation of the weir visible in the foreground, and the irrigation canal evident to the left of the photo.

The construction period would last approximately 24 months and the majority of construction would be screened by the weir itself, and trees upstream of the weir, with limited receptors near to the site. However, with fairly intensive construction activity taking place for a large percentage of this period, there will be an increase in the number of people and vehicles travelling through the area

5.8.2 Visual Impact Assessment

Visual and scenic resources include abstract qualities and connotations that are by their nature difficult to assess or quantify as they often have cultural or symbolic meaning. It is necessary therefore to consider quantitative criteria (such as viewing distances), and qualitative criteria (such as sense of place), in visual assessments. An assessment therefore relies on the evaluating both objective and subjective aspects, including the context of the proposed project within the surrounding area.

The methodology to determine the level of visual impact of the planned infrastructure involves a consideration of the existing visual environment. This comprises understanding the existing landscape setting and how the planned infrastructure is seen from various viewing locations. In this way the visual character of the landscape, as well as visual sensitivity of the various viewing locations can be determined. The visual modification of the planned infrastructure is determined by considering the visual characteristics of the planned infrastructure in the context of the landscape within which it is

seen. A combined consideration of both visual sensitivity and visual modification determines impact and gives some direction on mitigation strategies.

Oberholzer (2005) developed a system to allow for assessment in terms of the visual sensitivity of the site in relation to the intensity of the type of development, as shown in **Table 5-24**. The proposed development is deemed to be a Category 2 development, according to his scale; i.e. small-scale infrastructure, while the type of environment is considered to be of medium scenic, cultural or historical significance. As such, the predicted visual impact is minimal.

Table 5-24 | Key categories of development

Type of environment	Level of intensity				
	Category 1 development	**Category 2 development**	**Category 3 development**	**Category 4 development**	**Category 5 development**
Protected/wild areas of international, national, or regional significance	Moderate visual impact expected	High visual impact expected	High visual impact expected	Very high visual impact expected	Very high visual impact expected
Areas or routes of high scenic, cultural, historical significance	Minimal visual impact expected	Moderate visual impact expected	High visual impact expected	High visual impact expected	Very high visual impact expected
Areas or routes of medium scenic, cultural or historical significance	Little or no visual impact expected	**Minimal visual impact expected**	Moderate visual impact expected	High visual impact expected	High visual impact expected
Areas or routes of low scenic, cultural, historical significance / disturbed	Little or no visual impact expected. Possible benefits	Little or no visual impact expected	Minimal visual impact expected	Moderate visual impact expected	High visual impact expected
Disturbed or degraded sites / run-down urban areas / wasteland	Little or no visual impact expected. Possible benefits	Little or no visual impact expected. Possible benefits	Little or no visual impact expected	Minimal visual impact expected	Moderate visual impact expected

The visual impacts were also considered in terms of the standard methodology provided for assessment of all impacts in this EIA. The greatest impact will be during the construction phase.

The impacts are assessed below. The assessments for the proposed layout below have been separated in order to assess the facility layout and the ancillary infrastructure separately as the impacts would be different.

5.8.2.1 Construction phase impact

Layout

The visual impact of the proposed hydropower facility and associated infrastructure is considered to be high intensity, short term and site specific and therefore of **low (-)** significance, without mitigation.

Transmission line corridor

The visual impact of the proposed transmission line is considered to be high intensity, short term and local and therefore of **low (-)** significance, without mitigation.

5.8.2.3 Operational- and decommissioning phase impact

Layout

The visual impact during the operational period is considered to be low intensity, long term but site specific and therefore of **low (-)** significance.

Transmission line corridor

The visual impact from the transmission line during the operational period, being visually linked to existing similar type infrastructure is considered to be low intensity, long term but site specific and therefore of **low (-)** significance.

5.8.2.4 No-Go Alternative

The No-Go alternative would result in maintenance of the *status quo*. Impacts to visual resources would continue at a very limited scale.

5.8.2.5 Cumulative impacts

It is unlikely that potentially negative impacts on visual resources of the proposed hydropower facilities coupled with other visual impacts already existing and proposed would have any higher significance than what is currently assessed as (**low (-)**).

5.8.3 Mitigation measures

The following recommendations should be adhered to (and should be included in the LEMP for the project):

- Construction yards should be restricted in extent as far as possible and should be screened by visually impermeable material;
- Trees that screen the inlet works must be retained to reduce the visual impact on the recreational users on the dam:
- The power chamber should be screened with trees indigenous to the area, as occur naturally on the river bank,
- The power chamber building should be as low as possible and painted in muted colours to blend in with the colours of the natural environment, thereby reducing the levels of contrast.

5.8.4 Visual Impact Table

Table 5-25 and **Table 5-26** indicate how the significance ratings of the various impacts were derived.

Table 5-25 | Impact rating of visual impacts

	Project	Key impacts	Extent	Magnitude	Duration	SIGNIFICANCE (Without mitigation)	SIGNIFICANCE (With Mitigation)	Probability	Confidence	Reversibility
Construction phase	Layout (preferred)	Impact on Visual and scenic resources	Site specific	High	Long term	Low	Low	Definite	Certain	Irreversible
	Transmission Route (1&2)		Local	Low	Long term	Low	Low	Probable	Certain	Irreversible
Operational phase	Layout (preferred)	Impact on Visual and scenic resources	Site specific	High	Long term	Low	Low	Unlikely	Certain	Irreversible
	Transmission Route(1&2)		Local	Low	Long term	Low	Low	Unlikely	Certain	Irreversible
No-Go Option		Impact on Visual and scenic resources	Site specific	Very low	Long term	Very low	Very low	Probable	Certain	Irreversible

*Mitigation measures are described in detail in **Section 5.8.3.**

Table 5-26 | Cumulative visual impacts

Key impacts	Mitigation	Extent	Magnitude	Duration	SIGNIFICANCE	Probability	Confidence	Reversibility
Impact on Visual and scenic resources	No mitigation	Site specific	Low	Permanent	Low (-)	Definite	Sure	Irreversible
	Mitigation	Site specific	Very low	Permanent	Low (-)	Definite	Sure	Irreversible

5.8.5 Visual Conclusion

Given the location of the site, limited number of visual receptors and the current transformed visual landscape the recommendation from a visual perspective is that project should proceed.

5.9 SOCIAL IMPACTS INCLUDING IMPACT ON LOCAL ECONOMY AND EMPLOYMENT

5.9.1 Description of the environment

5.9.1.1 Demographics

The project is located near Groblershoop which falls within the !Kheis Local Municipality (LM) within the ZF Mgcawu District Municipality District Municipality (DM) (known before 1 July 2013 as Siyanda). This areas falls within the north western quadrant of the Northern Cape Province, the largest province in South Africa. The LM covers 11,107 km^2 and the DM is 102,524 km^2 in extent. The LM is home to 16,637 people and the DM has a total population of 236,783 (Census, 2011). The area is very sparsely populated as evident from the low population density measured in person per square kilometre which is 1.5 for the LM, 2.3 for the DM and 3.1 for the province. As a comparison the national average is 42 people per square kilometre (Census, 2011). The LM had a growth rate of 0.06% between 2001 and 2011 which is lower than the province, which is at 1.4%.

The majority of the LM is coloured (85.3%), with a smaller representation of black people (6.9%) and white people (5.4%) with very few Asians (1%) (**Table 5-27**). The demographic composition by age reflects a higher number of children (age 0-14 years) at 5823, with of youth (15 to 35 years) slightly lower at 5374 of the population, adults between 36 and 64 years at 4657, and the elderly, 64 years and above, at 784.

Table 5-27 | Demographic composition

Group	Percentage
Black African	6,9%
Coloured	85,4%
Indian/Asian	1%
White	5,4%
Other	1,4%

The average household size in the LM is 3.9 people, similar to the DM and the province at 3.7 (Census, 2011). More than a third of households are headed by females (33.6%) which is slightly less favourable than the DM (35.7%) and the province (39%) (Census, 2011).

5.9.1.2 Service Provision

In terms of services in the LM, 16.7% of households have access to piped water inside their dwelling or yard. Less than 1% of the population has no access with the remainder having access to piped water further than 200m. This is significantly less than the provincial average of 97% and the national average of 91%. The ZF Mgcawu DM (previously Siyanda DM) Integrated Development Plan (IDP) (2013-2014) highlights the importance of water provision and availability as a constraint to economic activity in many of the towns.

With respect to sanitation, 43.8% of households in the LM have flush toilets, 20.83% have pit toilets, 20.74% have no toilets, 1.98% have bucket toilets with the remainder having chemical toilets or other. This is lower than the provincial average which is 66% and the national average of 57% in terms flushed toilets.

In terms of energy source for lighting, 64.02% of households have access to electricity, with 30.36% only having candles, less than 2.72% having solar, and the remainder having either paraffin, gas, other or no energy for lighting. This is far less than the DM at 86.6% and national average of 85%.

The access to refuse removal in the LM is less favourable than the province as a whole with 50.53% of households having refuse removed by the council, compared to the provincial average (73.31%) and the national average (64%).

Overall the service provision in the LM is extremely poor, with a lot of potential for improvement. The IDP notes that growth in population often exceeds the growth of service provision thereby increasing backlogs. (Siyanda DM, 2013-14).

Hospitals are located in Kakamas (Kai! Garib),Keimoes (Kai! Garib), Upington and Gordonia (//Khara Hais) and Postmasburg (Tsantsabane). There are five hospitals in the DM. There are only two Community Health Facilities in the DM and Kecoolnhardt (Kai! Garib) and Rietfontein (Mier) are the only settlements that have these facilities. The clinics are generally located in settlements along the main routes through the municipality, namely the N14 and the N10 in the case of Kai !Garib and !Kheis. There are 52 clinics in the DM. Kai !Garib has the most clinics, 18, followed by //Khara Hais that has 14 clinics (Siyanda DM, 2013-14). In terms of education facilities, Groblershoop has two primary schools, and one secondary school (Siyanda DM, 2013-14). There is a library and a community hall and some recreational facilities.

5.9.1.3 Education

A critical factor affecting quality of life is the standard of education within a community. According to Census (2011), the population of the LM has a low level of education. As many as 13.5% of the population aged 20 and older have no schooling, 14% have a matric and only 4.5% have a higher education.

5.9.1.4 Welfare

In this region the greatest social problems are illiteracy and poverty. According to the last socioeconomic survey in 2000, approximately 60% of the inhabitants have a monthly household income of between R0 – R800.

As a result of the above-mentioned factors there is a close correlation between poverty and health. Generally speaking the poorer people are, the worse is their health. This includes malnutrition of children as a result of a lack of money to buy enough and/ or nutritious food. The person receiving it must fully informed. This is directly affected by literacy and education. Malnutrition is the result of illiterate mothers. The education of people is one of the single most important factors in the health of individuals. Adult literacy is also below standard (Siyanda DM, 2013-14).

5.9.1.5 Employment and Earnings

Lack of employment opportunities has been identified as a challenge within the DM. There is a high rate of unemployment in the LM which is 28%. This is slightly lower than the DM unemployment rate at 34.4%, the rate in the province 28.1% and the national rate of 39% (Census, 2011).

5.9.1.6 Economy

According to the Siyanda DM, 2013-14 agriculture is the major economic contributor and compromises of grape production, which is mainly exported to Europe, owing to specific grapes types that are ripe and ready for export before the grapes of other countries can reach these markers. Agriculture also includes livestock and game farming. Agriculture has undergone extensive restructuring since the opening up of the South African economy and substantial growth took place between 1998 and 2002.

This growth was however been impacted on by mounting pressures from market competition and legislative changes.

Agricultural Enterprises

The Orange River area delivers a major part of South Africa's table grape production. The Orange River Producers Alliance is a table grape industry that is renowned as supplier of fresh table grapes to Europe with an output of more than 20 million cartons (OABS, 2012)

More than 90% of Africa's total dried vine fruit arm production is produced through 1250 sultana grape growers in the Northern Cape, who produced more than 50,000 tons in 2010. The sultanas produced here comprise more than 80% of that which is exported primarily to Europe and other eastern countries (OABS, 2012).

SAD Vine Fruit Pty (Ltd) is located in Upington and owns the largest dried vine fruit processing and packaging plant in South Africa, employing more than 350 persons. It has intakes at Groblershoop, Mylpaal, Louisvaleweg, Keimoes, Kakamas and Vredendal (OABS, 2012)

The Orange River Wine Cellars Co-op, also based in Upington, is the second largest winemaking cooperative in the world and has wine cellars are at Groblershoop, Grootdrink, Upington, Keimoes and Kakamas. This co-op has more than 740 members who produce wine grapes and 445 farmers who produce grape juice (OABS, 2012)

Livestock Farming

According to the Siyanda IDP, 2013-14, livestock farming occurs mainly on large farms where farming is extensive. The large majority of these farms are privately owned. In the jurisdiction of the Siyanda District Municipality there are approximately 1,600 farm land units, which belong to 890 owners. Because of the difference in the carrying capacity of the field, there are fairly large differences in the sizes of the farms. The carrying capacity of the field in this area can differ considerably between (for instance) a 10ha stock unit and 65 ha stock unit further westwards. The central parts of the region consist mainly of semi-desert areas and are therefore, with a few exceptions, mainly suitable for extensive livestock farming.

Lastly, it should be mentioned that a large variety of game can be found on both private and conservation areas in the region, forming an important base for the well-established game industry in the region. More than 1,000 game farmers have been registered with the Department of Environmental Affairs and Nature Conservation which is also an indication of the extent of the industry in the region.

Irrigation Farming

According to the Siyanda IDP, 2013-14, although the largest part of the Siyanda District Municipal Area is taken up by extensive livestock farming, there is also limited intensive irrigation farming in the surroundings of Byna-Bo and Schuitdrift (Southern Farms). The area referred to above is known worldwide for its table grapes, which are usually the first to reach the markets in Europe and other international countries. This is a very intensive industry and it contributes greatly to the economy of the region. Agriculture is still the major industry in the district, contributing to job creation and economic growth.

Tourism & Heritage in the district

The tourism industry plays a key role in the South African economy, both from its contribution to GDP and from its contribution to employment. Tourism is dependent on both domestic and foreign visitors both in the sense of domestic to the DM and Northern Cape and also in the sense of national as well as international visitors. Tourism is one of the most important economic sectors in the Northern Cape as well as within the Siyanda District Municipal boundaries. The industry is noted as the fastest growing component of the economy by the SDM IDP (2007 – 2011).

Boegoeberg Dam itself is especially popular for fishing, camping and water sport enthusiasts (!Kheis IDP 2012-2017).

5.9.2 Socio-economic Impact Assessment

5.9.2.1 Construction phase impacts

Throughout the construction phase, various impacts are anticipated for all project alternatives as described below.

Direct Employment and Skills Development
The construction of the proposed hydropower facilities would require a workforce which would translate into direct employment. Employment opportunities created by the construction phase would equate to approximately 150 to 200 people over a period of 24 months. 75% of the jobs created would be filled from the local community. 80% would be allocated to South African citizens and 75% specifically for black citizens (HydroSA 2013, pers comm, 28 Nov). 58% of the opportunities would require skilled employees of which 20% would be black.

Statistics set out in **Section 5.9.1.3** indicate that in terms of education, the population has a low level of education with only 14% having completed matric. This is linked to a limited skills base coupled with a high level of unemployment. Of the skills required onsite, there would be potential opportunities for low skilled security staff and construction workers. Should these staff require training the developer is committed to providing training onsite.

The positions created that will require more highly skilled staff from outside the local area or region would have a positive impact on the wider economy. However this impact is less significant at the regional level due to the relatively small number of jobs created in comparison with the size of the regional labour force and is therefore considered in the assessment of cumulative impacts.

For all alternatives the potential impact of the hydropower facility is considered to be of low magnitude, local and regional extent and limited to the construction phase and therefore of **low (+)** significance which can be increased to **low-medium (+)** with mitigation

Economic Multiplier Effects
Economic multiplier effects are the positive ripple effects in the economy as a result of direct expenditure through a development such as the proposed hydropower facility. Apart from direct job creation (considered above), multiplier effects could also include 'indirect effects' such as additional jobs and economic activity generated through the supply of goods and services to the development. 'Induced effects' includes employment and other economic activity generated by the re-spending of wages earned by those directly and indirectly employed in the industry; jobs created by the construction workers spending their wages in local shops as an example (United States Department of Energy, 1997).

The turbines will be sourced abroad and therefore imported. However the rest of the ancillary components required will be from South Africa, with the majority from the Northern Cape and will benefit for the local economy.

At a LM and DM level, there are likely to be economic multiplier effects from the use of local goods and services which includes, but is not limited to, construction materials and equipment and workforce essentials such as food, clothing, safety equipment, and other goods. The percentage of the workforce that would be employed from the local area would most likely spend their entire salaries within the local area or region. Although it is likely that onsite accommodation would be provided, it is likely that

the non-local staff would also visit Groblershoop during their free time and this additional spend would provide an indirect boost to the local economy. However, the extent to which these benefits can be achieved would also depend on the location of the contractor and the subcontractors and their preferred suppliers and the behaviour of the staff.

For all alternatives the potential impact of each hydropower facility is considered to be of low magnitude, local and regional extent and limited to the construction phase and therefore of **low (+)** significance which can be increased to **low-medium (+)** with mitigation.

Indirect effects of additional workers on site

Additional workers on the site during construction may have indirect effects, such as increased security issues for neighbouring farms and damage to property, the risk of veld fire, poaching and stock theft. It is estimated that 150 to 200 workers would be required. Of these 90-120 will require overnight accommodation either onsite or in the community. It is possible that the site may accommodate as many as 60% of the workforce, which would indicate a potential risk. Services would be provided and agreements with the municipality would ensure the environmental impacts on the property are limited.

For both Layout Alternatives 1 and 2, the potential impact of each hydropower facility is considered to be of low magnitude, local extent and limited to the construction phase and therefore of **medium (-)** significance which can be reduced to **low (-)** with mitigation.

Impacts of a non-local workforce on society

The introduction of a non-local workforce has the potential to result in social disruption both physical and emotional, during construction. Such disruption could result in an increased demand on social infrastructure such as accommodation, health facilities, transport facilities and so forth. Social ills including the spread of diseases such as HIV/AIDS, crime and social conflict are also a potential risk.

However, the degree to which society is disrupted largely depends on the level of local employment achievable and in the case of this project, 70% of the workforce is expected to be sourced locally and the outsiders would be accommodated temporarily onsite or in Groblershoop.

Being a smaller but prominent node in the District, the infrastructure within Groblershoop is likely to have the capacity to absorb the additional people. In terms of social ills, however, there is an existing substance and alcohol abuse problem in the area which is often linked to crime and this has the potential to be exacerbated by newcomers. There is also the likelihood that many of the community members are unemployed and seeking alternative opportunities to subsist. There is potential for conflict with unemployed residents that feel resentment towards outsiders being selected for jobs they feel entitled to.

The potential impact for all layout alternatives and the hydropower facility is considered to be of low magnitude, local extent and limited to the construction phase and therefore of **low (-)** significance which could be reduced to **very low (-)** with mitigation.

Disruption or damage to adjacent properties

As a result of the construction activities described in **Section 3**, disruption or damage to adjacent properties (including access arrangements) is a potential issue and may include a temporary increase in noise and dust, or the wear and tear on private farm roads for access to the site.

The potential impact for both layout alternatives is considered to be of low magnitude, local extent and limited to the construction phase and therefore of **low (-)** significance which could be reduced to **very low (-)** with mitigation.

Safety issues
While the power station would be located on private property, construction activities could pose a safety risk for people in the area, especially children. This may a particular issue during holiday seasons when the dam is used for recreation. Fencing off these components and ensuring security on site to keep people out of the danger area would reduce the safety risks.

5.9.2.2 Operational phase Impacts

Operational impacts anticipated for all project alternatives are described below.

Direct Employment and Skills Development
Maintenance would be carried out throughout the lifetime of the hydropower facility. Activities include technical maintenance, clearing of debris and fault finding if necessary. The operation of the project would require a workforce, which would however be smaller than the workforce required for the construction phase, and therefore limited direct employment would be generated. Operational employment has been calculated as 5 to 6 people for the design life of 20 years. Of these opportunities, 80 would be allocated to South African citizens and 75% specifically for black citizens (HydroSA, 2013).

In terms of skills, the project would create job opportunities for a wide range of skills, 58% would be skilled employees and 20% would be black skilled employees. In addition, 75% of the jobs created would be from the local community and the developer is committed to providing onsite training for people from the local labours (HydroSA, 2013).

For all alternatives, the potential impact is considered to be of low magnitude, local and regional extent and long term and therefore of **low (+)** significance which would remain **low (+)** with mitigation.

Economic Multiplier Effects
Economic multiplier effects generated from the supply of local goods and services to the project during operation would include maintenance tools, supplies and equipment which may be technology specific and therefore not necessarily available within the region or district.

Furthermore the operational wage for the hydropower facility for highly-skilled employees, skilled individuals and non-skilled employees will be received over a period of 20 years. This could benefit the local economy through money spent on items such as basic essentials, namely food, clothing, and other goods. Leakage is the loss of income generated from the project to other economies. There is a lower potential for leakage from the local economy if employees are sourced locally as most of their salaries would be spent locally within the district or region.

Regardless of the layout alternative, the potential impact is considered to be of low magnitude, local and regional extent and long term and therefore of **low (+)** significance which would remain **low (+)** with mitigation.

Landowner revenue
The project would increase the profitability of the land leased from farmers and will provide an additional income for the landowner of Zeekoebaart Farm. Although this direct financial benefit is fairly limited, as it will only profit the one landowner in question, this income could be used to reinvest in agricultural activities on this farm with benefits for the local economy, or it could enter the local economy through other investments or through additional spend.

For both layout alternatives the potential impact is considered to be of low magnitude, local extent and long term and therefore of **low (+)** significance without mitigation. No mitigation is recommended.

Diversification of the local economy

Increasing the contribution of the renewable energy sector to the local economy could assist with diversification and provide greater stability. The economy of the ZF Mgcawu DM is founded on community services, agriculture, transport and tourism, with the service sector supporting a large proportion of the labour force within !Kheis LM. It is recognised that diversification of the district economy is one of the key challenges that needs to be addressed in order to facilitate economic growth (Siyanda IDP, 2013-2014).

The growth in the renewable energy sector could therefore contribute towards diversification and stability of the economy, reducing the employment vulnerability with positive impacts for the local economy and communities. Therefore the potential impact is considered to be of low magnitude, local extent and long term and therefore of **low (+)** significance without mitigation regardless of the layout alternatives. No mitigation is recommended.

The cumulative impact for all Alternatives would be the same and is considered to be of medium magnitude, local, regional and national in extent and long term to permanent and therefore of **medium (+)** significance. No mitigation is recommended.

Safety issues

While the power station would be located on private property, there are a number of components, especially the canal if open, the tunnel (if constructed) and the forebay that could pose a safety risk for people in the area, especially children. This may a particular issue during holiday seasons when the dam is used for recreation. Fencing off these components would reduce the safety risks.

5.9.2.3 Decommissioning phase impacts

Decommissioning and restoration activities are likely to have similar impacts as those identified for the construction phase. There are likely to be fewer skills and training opportunities available because at the end of the projected IPP contract of 20 years, skills would already be established.

The impact from decommissioning for both Layout Alternative 1 and 2 would be the same and the impact on the local economy is considered to be of **low (+)** significance and the other general impacts on society in general as being of **very low (-)** significance.

5.9.2.4 Cumulative Impacts

Construction phase

The sudden spate of renewable energy development proposals within the Northern Cape, and South Africa in general, has been driven by the National Government. The abundant renewable resources in the Northern Cape led to a high concentration of renewable energy facility proposals with associated concerns regarding the potential cumulative impact on the environment. However, very few facilities have been proposed in the immediate area.

The cumulative impact for all Alternatives would be the same and is considered to be of medium magnitude, local and regional in extent and for the duration of the construction phase and therefore of **medium (+)** significance.

5.9.3 Mitigation Measures

5.9.3.1 Construction Mitigation

The following mitigation measures are proposed to be implemented during the construction phase for all alternatives:

- It is recommended that the local employment policy, as stated by the proponent, be implemented, audited and accompanied by a training programme. The policy must be based on a 'local's first' policy, specifically for low skilled jobs and should aim to recruit at least 20% of the jobs from the local community. This should also apply to all contracting firms.
- A local procurement policy should be adopted by the applicant to maximise the benefit to the local economy.
- Implement a policy of "no employment at the gate" to prevent loitering.
- The site should be secured to reduce safety risks.
- A comprehensive employee induction programme would cover land access protocols and fire management. This was addressed in the LEMP.
- A comprehensive employee induction programme would address issues such as HIV/ AIDS and Tuberculosis, as well as alcohol and substance abuse. The induction should also address a code of behaviour for employees that would align with community values.
- The LEMP also addressed noise and dust control. A 24 hour system for receiving and addressing complaints should be established before the commencement of the construction phase. Local farmers and residents should be informed of the contact number.
- Housing has to be restricted to the approved laydown areas.

5.9.3.2 Operational Mitigation

The following operational mitigation measures are proposed for all project alternatives:

- It is recommended that the local employment policy as stated by the proponent is implemented, audited and accompanied by a training programme. The policy must be based on a 'local's first' policy, specifically for low skilled jobs and should aim to recruit at least 20% of the jobs from the local community. This should also apply to all contracting firms.
- It is recommended that the developer adopts a local procurement policy which would maximise the benefit to the local economy and minimise leakage.
- Components of the development that may pose a safety risk to the public must be fenced securely to prevent unauthorised access.

5.9.4 Socio-economic Impact Table

Table 5-28 and **Table 5-29** indicate how the significance ratings of the various impacts were derived.

Table 5-28 | Construction socio-economic impacts

Project	Key impacts	Mitigation	Extent	Magnitude	Duration	SIGNIFICANCE	Probability	Confidence	Reversibility
All Alt	Direct employment and skills development	Without mitigation	Local and Regional	Low	Construction	Low (+)	Probable	High	Reversible
		With mitigation	Local and Regional	Low-Medium (+)	Construction	Low-Medium (+)	Probable	High	Reversible
All Alt	Economic Multiplier Effects	Without mitigation	Local and Regional	Low	Construction	Low (+)	Probable	Low	Reversible
		With mitigation	Local and Regional	Low-Medium (+)	Construction	Low-Medium (+)	Probable	Low	Reversible
All Alt	Indirect effects of additional workers on site	Without mitigation	Local	Low	Construction	Low (-)	Probable	Medium	Irreversible
		With mitigation	Local	Very Low (-)	Construction	Very Low (-)	Probable	Medium	Irreversible
All Alt	Impacts of a non-local workforce on society	Without mitigation	Local	Low	Construction	Low (-)	Improbable	Medium	Irreversible
		With mitigation	Local	Very Low (-)	Construction	Very Low (-)	Improbable	Medium	Irreversible
All Alt	Disruption or damage to adjacent properties	Without mitigation	Local	Low	Construction	Low (-)	Probable	Medium	Irreversible
		With mitigation	Local	Very Low (-)	Construction	Very Low (-)	Probable	Medium	Irreversible
	Potential negative or positive cumulative effects	Without mitigation	Local and Regional	Medium	Construction	Medium (-)	Probable	Medium	Irreversible
		With mitigation	Local and Regional	Medium	Construction	Medium (-)	Probable	Medium	Irreversible

Table 5-29 | Operational socio-economic impacts

Project	Key impacts	Mitigation	Extent	Magnitude	Duration	SIGNIFICANCE	Probability	Confidence	Reversibility
All Alt	Direct Employment and Skills Development	Without mitigation	Local and Regional	Low	Long term	Low (+)	Probable	High	Reversible
		With mitigation	Local and Regional	Low	Long term	Low (+)	Probable	High	Reversible

Project	Key impacts	Mitigation	Extent	Magnitude	Duration	SIGNIFICANCE	Probability	Confidence	Reversibility
All Alt	Economic Multiplier Effects	Without mitigation	Local and Regional	Low	Long term	Low (+)	Probable	Low	Reversible
		With mitigation	Local and Regional	Low	Long term	Low (+)	Probable	Low	Reversible
All Alt	Landowner revenue	Without mitigation	Local and Regional	Low	Long term	Low (+)	Probable	Low	Reversible
		With mitigation	Local and Regional	Low	Long term	Low (+)	Probable	Low	Reversible
All Alt	Diversification of the local economy	Without mitigation	Local and Regional	Low	Long term	Low (+)	Probable	Low	Reversible
		With mitigation	Local and Regional	Low	Long term	Low (+)	Probable	Low	Reversible
All Alt	Potential negative or positive cumulative effects	Without mitigation	Local, Regional and National	Medium	Long term / Permanent	Medium (+)	Probable	Medium	Reversible
		With mitigation	Local, Regional and National	Medium-High (+)	Long term / Permanent	Medium (+)	Probable	Medium	Reversible

*Mitigation measures are described in detail in **Section 5.9.3.1 & 5.9.3.2**

5.9.5 Social Conclusions

From a social point of view, any proposed alternatives can proceed as the impacts would be of equal magnitude and significance.

5.10 IMPACT ON ENERGY PRODUCTION

As noted in Section 4.1.3, South Africa aims to procure 6,925MW of capacity of renewable energy. The proposed project could therefore contribute positively towards this goal.

5.10.1.1 Description of the Environment

Historical trends in electricity demand in South Africa have shown a consistent increase in demand. There have been some years where the demand levels off or decreases, but over the long term there has been an increasing trend on electricity demand. 130MW has been allowed for hydropower and this project would contribute 15MW towards this target. The reserve margin remains extremely low and the supply capacity is still limited. The proposed hydropower facility would be able to provide power to assist in meeting the energy demand within South Africa.

5.10.1.2 Energy Impact Assessment

Since hydropower is a clean source of energy and given the need for increased production capacity in South Africa, the potential impact of the proposed project on energy production is considered to be of low magnitude, regional and long term and therefore of **low (+)** significance, without or with mitigation measures. No difference in significance would result from the proposed alternatives.

5.10.1.3 Mitigation Measures

No mitigation measures are recommended.

5.10.1.4 Energy Impact Table

Table 5-30 indicates how the significance rating for energy was determined.

Table 5-30 | Energy impact table

	Project	Key impacts	Mitigation	Extent	Magnitude	Duration	SIGNIFICANCE	Probability	Confidence	Reversibility
Construction phase	All Alt	Increased dust	Without mitigation	Regional	Low	Long term	Low (+)	Definite	Certain	Reversible
			With mitigation	Regional	Low	Long term	Low (+)	Definite	Certain	Reversible

*No mitigation measures are proposed.

5.11 IMPACT ON TRAFFIC

Construction vehicles are likely to make use of the existing roads, including the N10, N8 and DR3040, to transport equipment and material to the construction site. The anticipated traffic to and from the site is indicated in **Figure 55**. These truckloads would be distributed throughout the construction period (24 months).

Mr David S Fourie of Farms 307 & 308 Seekoeibaardsnek raised concern with regard to increased traffic during the construction period on both the DR3040 and the access road over his farm. In order to assess any potential impacts a transportion specialist was consulted. It was decided that, based on the relevant information provided, a Traffic Impact Statement would be sufficient to address the impact. A desktop Traffic Impact Statement was undertaken by Dr Wayne Duff-Riddell of Aurecon to examine specific aspects considered to be of concern. The Traffic Impact Statement is included in **Annexure D**.

5.11.1 Description of the Environment

It is anticipated the route from Cape Town via Upington to the site would utilise the N10, N8, DR3040 road networks. Zeekoesbaart's private access roads would be used to transport the various components for construction of the proposed plant (**Figure 55**).

Figure 55 | Affected road networks

The anticipated traffic to and from the site as a result of the proposed project is indicated in **Figure 55**.

Table 5-31 | Daily and irregular anticipated traffic to and from the site

Activity	Anticipated trips	Average trips
Daily		
Site Management	3 x 2 trips to and from site by Light Duty Vehicle (LDV) per day	6 LDV trips per day
Site staff	3 x 2 trips to and from site by taxis per day	6 taxi trips per day
Site visitors	2 trips to and from site per week	0.4 LDV trips per day

Sub-contractors	60% of the above items per day	7.45 trips per day
Irregularly		
Cement Trucks	21 trips over 24 months	< 1 trip per month
Reinforcing	13.33 trips	< 0.5 trip per month
Turbines & generators	6 Trips to site	6 Trips to site
Operation and Management (O&M)		
O&M	5 Trips a week	5 Trips a week

5.11.2 Traffic Impact Assessment

5.11.2.1 Construction phase

On average 6.4 Light Duty Vehicles (LDVs), 6 Taxis and would access the site daily (excluding weekends). The additional vehicles on the roads could potentially result in more accidents and or traffic congestion. However the potential impact of the project on traffic during the construction phase is considered to be of **low** magnitude, regional extent with duration limited to the construction phase and therefore of **low (-)** significance, without mitigation. Through the implementation of mitigation measures the significance could be reduced to **very low (-)**. No difference in significance would result from the proposed alternatives.

5.11.2.2 Operational phase and decommissioning phase

The potential impact of the project on traffic during the operational phase is considered to be very low since additional traffic would be very limited to and from the site. It is therefore expected to be of very low magnitude, local extent with a long term duration and therefore of **very low (-)** significance, with and without mitigation. No difference in significance would result from the proposed alternatives.

The removal of structures during the decommissioning phase would result in a negative impact. It is expected to be of very low magnitude, local extent with a similar duration as the construction phase and therefore of **very low (-)** significance, with and without mitigation.

5.11.2.3 Cumulative impacts

The cumulative potential impact of renewable energy projects on transport is considered to be of medium magnitude, regional extent and short term and therefore of **medium (-)** significance, with or without mitigation. No difference in impact significance would result from the proposed alternatives.

5.11.3 Mitigation Measures

The following mitigation measures are recommended:

- Ensure that road junctions have good sightlines;
- Transport the materials in the least amount of trips as possible;
- Adhere to the speed limit;
- Implement traffic control measures where necessary;
- Transport components overnight as far as possible on the National and Provisional roads network; and
- Proponent to reach an agreement on the routing of the road close to the farmer's house on the farm 307 & 308 Seekoeibaardsnek.

5.11.4 Traffic Impact Table

Table 5-32 anticipated traffic impacts.

Table 5-32 | Traffic impact table

	Project	Key impacts	Mitigation	Extent	Magnitude	Duration	SIGNIFICANCE	Probability	Confidence	Reversibility
Construction phase	All Alt	Accidents and or traffic congestion	Without mitigation	Regional	Medium	Construction phase	Low (-)	Probable	Sure	Reversible
			With mitigation	Regional	Low	Construction phase	Very Low (-)	Probable	Sure	Reversible
Operational and Decommissioning Phase	All Alt	Accidents and or traffic congestion	Without mitigation	Local	Very low	Long term	Very Low (-)	Probable	Sure	Reversible
			With mitigation	Local	Very low	Long term	Very Low (-)	Probable	Sure	Reversible
Cumulative	All Alt	Accidents and or traffic congestion	Without mitigation	Regional	Medium	Short term	Medium (-)	Probable	Unsure	Reversible
			With mitigation	Regional	Medium	Short term	Medium (-)	Probable	Unsure	Reversible

*Mitigation measures are described in detail in **Section 5.11.3**

The following impacts associated with the proposed project have been accessed as having a potentially low to negligible impact and therefore do not have accompanying impact tables.

5.12 NOISE IMPACTS

Noise is generally defined as unwanted sound transmitted through a compressible medium such as air. Noise is reported in decibels (dB). Sound in turn, is defined as any pressure variation that the ear can detect. The number of pressure variations per second is referred to as the frequency of sound and is measured in hertz (Hz).Human response to noise is complex and highly variable as it is subjective rather than objective. The hearing of a young, healthy person ranges between 20 Hz and 20,000 Hz.

In terms of sound pressure level, audible sound ranges from the threshold of hearing at 0 dB to the pain threshold of 13 0dB and above. Even though an increase in sound pressure level of 6 dB represents a doubling in sound pressure, an increase of 8dB to 10dB is required before the sound subjectively appears to be significantly louder. Similarly, the smallest perceptible change is about 1dB.

Many factors affect the propagation of noise from source to receiver. The most important of these are:

- The type of source and its sound power;
- The distance between the source and the receiver;
- The extent of atmospheric absorption (attenuation);
- Wind speed and direction;
- Temperature and temperature gradient;
- Obstacles such as barriers or buildings between the source and receiver;
- Ground absorption;
- Reflections;
- Humidity; and
- Precipitation

5.12.1 Description of the Environment

Noise sensitive community members include residences on surrounding farms. The closest of these are residences directly opposite the Boegoeberg Dam on the southern bank of the river at 1.2 km from the inlet works and 1.9 km for the power chamber. The campsite on the southern bank upstream of the weir is occupied during weekends and specifically over the December holiday period and this site would be the closest public sensitive receptor area.

Baseline noise levels within the project area are considered ‘rural’ where average day and night-time noise levels of between 45 dBA and 35 dBA, respectively.

5.12.2 Noise Impact Assessment

Noise will be generated during the construction, operation and decommissioning phases of the proposed projects. Construction and decommissioning activities are often similar. Potential sources of noise during the construction phase are increased traffic, operation of heavy machinery during the construction period and additional people in the area.

5.12.2.1 Construction phase impacts

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.

The construction phase is expected to have the most notable impact on environmental noise levels and may result in levels above the South African National Standards (SANS) guideline at the site boundaries. With mitigation in place, these impacts could be brought into compliance.

5.12.2.2 Operational phase impacts

The site is located in a rural setting with both agricultural and recreational activities surrounding the area of Boegoeberg Dam. Generally there is very little disturbance to the ambient noise levels. The construction of the proposed hydropower station could potential introduce increased noise levels.

Noise levels generated by the proposed turbines are considered to be generally low and it is often the other auxiliaries that create a higher noise. However on occasion there may be a certain level of a low frequency “rumble” from the turbines. The turbines will generate noise consistently during the plants operation. Noises and vibrations within small hydroelectric plants come from the generator, gearbox, turbine and transformers. Other than the transformers, these components will be encased in the power chamber which would reduce noise levels during operation. It is anticipated that operating equipment would have sounds levels of approximately 80 dBA inside the turbine hall. No noise would be generated by the off-take or tunnel It is expected that the slight increase in traffic would be immaterial in comparison with current traffic related noise.

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

- Inlet works, tunnel, headpond and power chamber with tailrace;
- Switchyard with transformers;
- Construction and Corona noise from overhead power lines;
- Ancillary works; and
- Traffic.

The turbines will generate noise consistently during the plants operation. However the turbines will be encased in the power chamber which would further reduce noise levels during operation. Turbines typically emit a predominant pure tone which, although not loud in volume, has the potential to induce vibrations in nearby structures. It is expected that the slight increase in traffic would be immaterial in comparison with current traffic related noise.

5.12.2.3 Decommissioning phase impacts

It is expected that noise will be generated from the decommissioning phase activities will be similar but not as intense or long terms as the construction phase noise levels.

5.12.2.4 Cumulative impacts

The potential for cumulative noise impacts exist near major roads such as the N8. Other industrial type noise sources are distant enough from the sensitive receptors that cumulative impacts are unlikely.

5.12.3 Mitigation Measures

5.12.3.1 Construction phase

The noise mitigation measures to be considered during the construction phase are as follows (for all alternatives):

- Construction site yards, workshops, concrete batching plants, and other noisy fixed facilities should be located well away from noise sensitive areas.
- Stationary noisy equipment such as compressors and pumps should be encapsulated in acoustic covers, screens or sheds where possible. Portable acoustic shields should be used in the case where noisy equipment is not stationary (i.e. angle grinders, chipping hammers).
- Vehicles should avoid unnecessary use of the reverse gear to minimise annoyance caused by reverse sirens. Consideration of alternative safety measures may be necessary when taking such a measure.
- All diesel powered equipment must be 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.
- Truck traffic should be routed away from noise sensitive areas, where possible.
- Noisy operations should be combined so that they occur where possible at the same time.
- Instruction of employees on low-noise work methods, for example, the handling of structural steel and the use radiotelephony rather than shouting for communication.
- Machines in intermittent use should be shut down in the intervening periods between work or throttled down to a minimum.
- Construction activities are to be contained to reasonable hours during the day and early evening.
- Night-time activities near noise sensitive areas should not be allowed. No construction should be allowed on weekends from 14h00 on Saturday afternoons to 06h00 the following Monday morning. Careful consideration must be given as to how to manage construction activities during the holiday periods.
- With regard to unavoidable very noisy construction activities in the vicinity of noise sensitive areas, the contractor should liaise with local residents and owners on how best to minimise impact, and the local population should be kept informed of the nature and duration of intended activities.

5.12.3.2 Operational phase

The noise mitigation measures to be considered during the construction phase are as follows (for all alternatives):

- The design of all major plant components should incorporate all the necessary acoustic design aspects required to ensure that the generated noise level from the project does not exceed the SANS 10103 maximum equivalent continuous day/night rating level (LRdn) of 70 dBA for industrial areas at the project boundary.
- The design should also to 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. Where the noise level at the external site is presently at or exceeds the maximum, the existing level shall not be increased by more than what is considered as acceptable in SANS 10103.
- The latest technology incorporating maximum noise mitigation measures for components of the project should be designed into the system. The sound power level of each piece of equipment should be such that the sound pressure level (LP – i.e. the noise level) measured at 1m from the surface of the given plant/equipment should not exceed 85dBA. When ordering plant and machinery, manufacturers should be requested to provide details of the sound power level. Where possible, those with the lowest sound power level (most quiet) should be selected.
- The design process is to consider, inter alia, the following aspects:
    - The position and orientation of buildings on the site.

- The design of the buildings to minimise the transmission of noise from the inside to the outdoors.
- The insulation of particularly noisy plant and equipment.
- All plant, equipment and vehicles are to be kept in good repair.
- Where possible, very noisy activities should not take place at night.

5.12.4 Noise Conclusions

All the alternatives would have very similar noise impacts and would likely be of equal magnitude and significant and with the introduction of appropriate mitigation would be reduced to acceptable levels.

5.13 DUST IMPACTS

Hydropower technology results in no direct air emissions during operation as no fossil or other fuels are combusted. However, air pollution in the form of dust emissions will occur during the construction phase.

5.13.1 Description of the Environment

Meteorological mechanisms govern the dispersion, transformation, and eventual removal of pollutants from the atmosphere. Air temperature is an important parameter for the development of the mixing and inversion layers. It also determines the rate of dissipation of pollutants before it reaches ground level. Incoming solar radiation determines the rate of development and dissipation of the mixing layer. Relative humidity is an inverse function of ambient air temperature, increasing as ambient air temperature decreases. On average, temperatures in the area range between 19°C in June to 33°C in January.

Precipitation represents an effective removal mechanism of atmospheric pollutants and is therefore frequently considered during air pollution studies. Evaporation is a function of ambient temperature, wind and the saturation deficit of the air. Evaporation rates have important implications for the design and implementation of effective dust control programmes. The area falls within a summer rainfall belt with the annual mean rainfall recorded in the Northern Cape Province reported as 527 mm, with the maximum value of 2,031 mm and minimum value of 200 mm (Schulze, 1997).

Particulates represent the main pollutant of concern at the construction operations of the hydropower facilities. Airborne particulate matter comprises a mixture of organic and inorganic substances, ranging in size, shape and density.

5.13.2 Dust Impact Assessment

It is anticipated that the following activities would result in dust generation.

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 of material, the moisture content of the material and the hourly wind speed will determine the amount of Total Suspended Particles (TSP), emissions deriving from the various transfer points. The construction operations are assumed to be a 12-hour, five day a

week operation for the 24 month period. Materials handling operations can be mitigated through water sprays that can result in a 50% reduction in dust generation.

Windblown dust from stockpiles

Wind erosion is a complex process, including three different phases of particle entrainment, transport and deposition. It is primarily influenced by atmospheric conditions (e.g. wind, precipitation and temperature), soil properties (e.g. soil texture, composition and aggregation), land-surface characteristics (e.g. topography, moisture, aerodynamic roughness length, vegetation and non-erodible elements) and land-use practice (e.g. farming, grazing and mining).

Moisture will act as a binding agent and reduce wind erosion emission by around 50%, depending on the amount of water applied. Alternatives include vegetation of exposed surfaces that will not be constructed on.

The main findings from the qualitative assessment are as follows for all project alternatives:

5.13.2.1 Construction phase

It is unlikely that site dust fallout impacts during construction will be significant due to the limited construction footprint and minimal construction loads anticipated on the access roads. With mitigation in place, primarily comprising of water sprays, these impacts could be further reduced.

5.13.2.2 Operational phase

Emissions to air associated with the operational phase would only result from maintenance vehicles and the trucks off-loading fuel. These are regarded as insignificant.

5.13.2.3 Decommissioning phase

The decommissioning phase will mainly include materials handling activities, wind erosion and to a lesser extent vehicle and equipment movement on-site and on the access road.

5.13.3 Mitigation Measures

Generic management objectives are provided to address potential dust generation from the proposed hydropower facility and associated infrastructures (all alternatives), throughout the project life-cycle.

- Water sprays to be applied at the area to be cleared should significant amounts of dust be generated. Moist topsoil will reduce the potential for dust generation when tipped onto stockpiles.
- Ensure travel distance between clearing area and topsoil piles to be at a minimum.
- Ensure exposed areas remain moist through regular water spraying during dry, windy periods.
- Reshape all disturbed areas to their natural contours.
- Cover disturbed areas with previously collected topsoil and replant native species.

5.13.4 Dust Conclusions

The temporary nature of the construction activities, and the likelihood that these activities will be localised and on small areas at any given time, would reduce the potential for significant off-site impacts. All of the proposed alternatives would have similar magnitude and significance.

5.14 STORAGE OF HAZARDOUS SUBSTANCES ON SITE

Hazardous substances would be stored on site during the operational phase. These substances may include amongst other things, hydrocarbons (i.e. fuel), curing compounds, shutter oil, and cement. The use of hazardous substances at a site is controlled by various pieces of legislation. Approximately 500 litres of fuel and 50 litres of lubrication oil would be stored on site. This volume falls well below the

triggers as listed activity in terms of NEMA. However, the necessary precaution measures would be in place and have been included in the LEMP (**Annexure E**).

5.14.1 Impact Assessment

The volume to be stored onsite falls well below the triggers of listed activity in terms of NEMA. Therefore the impacts were not assessed using the assessment methodology provided in Annexure F. However, the necessary precaution measures would be in place and have been included in the LEMP.

5.14.2 Mitigation Measures

The management and protection of the environment would be achieved through the implementation of the LEMP, which *inter alia* specify the storage details of hazardous compounds and the emergency procedures to follow in the event of a spillage.

Typical mitigation measures include 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.

5.15 SUMMARY OF POTENTIAL IMPACTS

A summary of all the potential impacts from the proposed project assessed above is included in **Section 6.1.**

5.16 BOEGOEBERG HYDRO COMMITMENTS

Boegoeberg Hydro recognises that by constructing the hydropower facility near Groblershoop, it constitutes a change in the predominant land-use and would result in impacts (both positive and negative) to the biophysical and social environment. Furthermore, as this is a long-term project Boegoeberg Hydro takes cognisance of the need to create a sustainable environment within the community. Part of the IPP bid application requirements to construct a renewable project requires a strict, comprehensive Economic Development Plan to be submitted. This plan would detail the various job creation, socio economic development, skills development, local content and ownership.

In order to create a sustainable environment, Boegoeberg Hydro proposes to:

- Create a local community trust which has an equity share in the project life to benefit historically disadvantaged communities;
- Initiate a training strategy to facilitate employment from the local community;
- Give preference to local suppliers of components for the construction of the facility;
- Put in place a maintenance plan to ensure that broken components or materials are recycled or are disposed of in an environmentally responsible manner;
- Recycle the facilities components should the facility be decommissioned; and

Rehabilitate the site to its original state prior to the construction of the hydropower facility, as far as possible

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6 RECOMMENDATIONS AND CONCLUSION

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

6.1 CONCLUSIONS

The proposed project consists of a 15 MW hydropower facility comprising of associated support infrastructure and ancillary infrastructure.

As per the requirements of NEMA, this EIA investigation has contemplated and assessed the array of potential environmental impacts associated the following range of project alternatives:

- **Location alternatives** – Boegoeberg dam, Farm 306 Zeekoebaart.
  - Only the current location of the proposed hydropower station will be considered.
- **Activity alternatives**
  - Energy generation by means of a hydropower station; and
  - "No-go" alternative to hydropower energy production.
- **Site layout alternatives**
  - Two water conveyance alternatives, tunnel (preferred) or open canal;
- **Routing Alternatives**
  - Two Transmission line and road access alternatives (alternative 2 and the revised alternative 2 (preferred);
- **Technology alternatives** – Kaplan hydropower turbines
  - Only one technology alternative will be considered.

This Draft EIA 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 5-33** provides a summary of the significance of the environmental impacts associated with this proposed project.

Table 5-33 | Summary impact table

IMPACTS	PROJECT ASPECT	Construction		Operation		Decommissioning	
		No Mitigation	With Mitigation	No Mitigation	With Mitigation	No Mitigation	With Mitigation
Impact on flora	Layout (canal)	High (-)	Medium (-)	Low (-)	Low (-)	Low (-)	Low (-)
	Layout (tunnel)	Medium (-)	Low (-)	Low (-)	Low (-)	Low (-)	Low (-)
	Access Road	Low (-)	Low (-)	Low (-)	Low (-)	Low (-)	Low (-)
	Transmission lines (both alt)	Medium (-)	Low (-)	Low (-)	Low (-)	Low (-)	Low (-)
	Construction site	Medium (-)	Low (-)	Low (-)	Low (-)	Low (-)	Low (-)
	No- Go	Low (-)	-	Low (-)	-	Low (-)	-
Impact on avifauna	Layout Alts	Low - Medium (-)	Low (-)	Low - Medium (-)	Low (-)	Low - Medium (-)	Low (-)
	Transmission 1 and 2 habitat loss and disturbance	Low (-)	Very Low (-)	Low - Medium (-)	Low (-)	Medium (-)	Medium-Low (-)
	Transmission 1 and 2 Mortality			High (-)	Low - Medium (-)		
Impact on fauna	Layout & Transmission (all alternatives)	Low (-)	Very low (-)	Low (-)	Low (-)	Low (-)	Very low (-)
Impact on Agriculture	Layout Alt	Low (-)	Very Low (-)	Very low (-)	Very low (-)	Very Low (-)	Very Low (-)
	Transmission lines & Access roads	Low (-)	Low (-)	Very low (-)	Very low (-)		
Aquatic Ecology	Layout (all alternatives)	Medium (-)	Low (-)	Medium (-)	Low (-)	Low (-)	Very low (-)
	Transmission corridors, roads	Low (-)	Very low (-)			Very low (-)	Very low (-)
Palaeontology	Layout Alt.1 and 2	Low (-)	Low (-)				
	Transmission lines	Low (-)	Low (-)				
Impact on heritage	Layout archaeology	Medium (-)	Low (-)				
	Layout graves	High (-)	Low (-)				
	Transmission archaeology	Low (-)	Low (-)				
	Transmission graves	Low (-)	Low (-)				
	Roads archaeology	Medium (-)	Low (-)				
	Roads graves	High (-)	Low (-)				

IMPACTS	PROJECT ASPECT	Construction		Operation		Decommissioning	
		No Mitigation	With Mitigation	No Mitigation	With Mitigation	No Mitigation	With Mitigation
	No- Go	Very low (-)	Very low (-)				
Visual impacts	Layout (All Alt)	Low (-)	Low (-)	Low (-)	Low (-)	Low (-)	Low (-)
	Transmission (All alt)	Low (-)	Low (-)	Low (-)	Low (-)	Low (-)	Low (-)
Social impacts	Layout All alternatives Direct employment and skills development; Economic Multiplier Effects	Low (+)	Low (+)	Low (+)	Low (+)		
	Layout All alternatives Additional workers on site	Low (-)	Very Low (-)				
	Layout All alternatives Landowner revenue Diversification of the local economy			Low (+)	Low (+)		
Impact on Energy production	Layout Alt.1 and 2			Low (+)	Low (+)		
Impact on traffic	Layout Alt.1 and 2	Low (-)	Very Low (-)	Very Low (-)	Very Low (-)	Low (-)	Very Low (-)

6.1.1 Level of confidence in assessment

With reference to the information available at this stage of the proposed projects 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 EAP believes that the information contained within the FSR and this EIA Report is adequate to inform DEA to be able to determine the environmental acceptability of the proposed alternatives.

It is acknowledged that the projects details will evolve during the detailed design and construction phases to a limited extent and that there are certain aspects that will be addressed in greater detail in the Final EIR. However, these are unlikely to change the overall environmental acceptability of the proposed projects and any significant deviation from what was assessed in this EIR should be subject to further assessment. If this was to occur, an amendment to the EA may be required in which case the prescribed process would be followed.

6.1.2 Construction phase impacts

With reference to **Table 5-33**, there are two impact of high significance that were identified, namely Flora and Heritage. With the implementation of mitigation measures, this **high (-)** heritage impact (specifically the impact on graves) can be mitigated to a **low (-)** significance. **High (-)** for the botanical impact would be mitigated to **medium (-)**. However it should be noted that the preferred alternative would have a **low (-)** significance after mitigation. The most significant (**medium (-)**) construction phase impacts to the biophysical and social environment, without mitigation, were on flora and aquatic ecology. With the implementation of the proposed mitigation measures, the impact ratings could be reduced to **low (-) or very-low (-)**.

It should be noted that a potential positive impacts on the local economy (employment) and social conditions would result and these would be of **low (+)** significance, with and without mitigation measures for all alternatives. Direct employment and skills development and economic multiplier effects can be enhanced to a **low (+)** significance, with mitigation measures for all alternatives.

6.1.3 Operational phase impacts

The operational impacts were assessed and the potential avifaunal impacts was rated as having a **high (-)** significance without mitigation. The high significance rating given to the avifaunal impacts is associated with both the transmission lines (all alternatives) and this level of significance would reduce to **low – medium (-)** with mitigation.

It should be noted that two potential positive impacts on local economy (employment) and energy production would be of **low (+)** significance, with and without mitigation measures for all alternatives.

6.1.4 Decommissioning phase

The decommissioning phase impacts were assessed and the potential avifauna impacts were rated to be of **medium (-)** significance, without mitigation measures for all alternatives, which could be reduced to **medium-low (-)** respectively with the implementation of the LEMP.

6.1.5 Recommendations

Section 4 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 in the LEMP (**Annexure E**) for all alternatives and all projects. Where appropriate, the mitigation measures, and any others, identified by DEA could be enforced as Conditions of Approval in the EA, should DEA issue a positive EA.

6.1.6 Considerations in identification of preferred alternatives

In order to identify the preferred alternative, the EAP evaluated all the recommendations and impact assessments determined by the respective specialists. Based on the specialist findings, it was evident that layout alternative (1) was preferred, with the tunnel ultimately having a smaller footprint which also takes environmentally sensitive areas into consideration. Therefore, based on the ratings provided by the specialists, the project could be authorised since the impacts are of an acceptable level. As for the routing alternative for the transmission line and the associated access roads which were assessed, and the preferred route (1) was deemed acceptable by all specialists since it avoids identified sensitive riverine areas and could therefore be authorised

6.1.7 EAP's opinion with respect to authorisation

Regulation 32(2)(m) of the EIA Regulations requires that the EAP include an opinion as to whether the activity should be authorised or not.

Based on the outcome of this EIA, we are of the opinion that the proposed hydropower project should be authorised as the incremental local and regional benefits outweigh negative impacts and the proposed projects substantially meet the NEMA principles (**Table 4-2**) as well as the Need and Desirability criteria (**Table 4-3**). The significance of negative impacts can be reduced with effective and appropriate mitigation. If authorised, the implementation of an LEMP should be included as a Condition of Approval.

Based on the outcome of this EIA, we are of the opinion that the following project alternatives are preferred and should be authorised:

- **Location alternatives**
  - Boegoeberg dam, Farm 306 Zeekoebaart.
- **Activity alternatives**
  - Energy generation by means of a hydropower station
- **Site layout alternatives**
  - Water conveyance by way of tunnel (preferred).
- **Routing Alternatives**
  - Transmission Route 2 (preferred route).
- **Technology alternatives**
  - Kaplan hydropower turbines.

6.2 WAY FORWARD

The current phase of the PPP commenced on **2 December 2013** and I&APs were afforded 40-days to provide comments on this Draft EIA Report, until **29 January 2013**. The Draft EIA Report was lodged in the Groblershoop Public Library, Municipal buildings and on the Aurecon website and potential 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 EIR. Where appropriate, the report will be updated.

Once the Final EIR has been completed, including the CRR, it will be submitted to the DEA for review. DEA must, within 60 days, do one of the following:

- Accept the report;
- Notify the applicant that the report has been referred for specialist review;
- Request amendments to the report; or

- Reject the report if it does not materially comply with regulations.

If the report is accepted, DEA must within 45 days:

(a) Grant authorisation in respect of all or part of the activity applied for; or

(b) Refuse authorisation in respect of all or part of the activity.

Once DEA issues their decision on the proposed project, all registered I&APs on the project database will be notified of the outcome of the decision within 12 calendar days of the date of the decision. I&APs will also be informed of the Appeal procedure.

7 REFERENCES

Alias, D., Milton, S., Herrmann, E. & Seymour C. 2003. A collation and overview of research information on Boscia albitrunca (Shepherd's Tree) and identification of relevant research gaps to inform protection of the species. Report for Department of Water Affairs and Forestry, Contract No. 2003/089.

Altermann, W. & Hälbich, I.W. 1990. Thrusting, folding and stratigraphy of the Ghaap Group along the southwestern margin of the Kaapval Craton. South African Journal of Geology 93, 553-566.

Aurecon. 2012. Proposed Hydropower Station on the Orange River, in the vicinity of Augrabies, Northern Cape. Draft BAR. Report No. 7021/ 108361

Aurecon, 2011. Proposed hydropower station on the Orange River near Kakamas, Northern Cape: Final BAR.

Barnes, K.N. (ed.) 1998. The Important Bird Areas of southern Africa. BirdLife South Africa, Johannesburg.

Barnes, K.N. (ed.) 2000. The Eskom Red Data Book of Birds of South Africa, Lesotho and Swaziland. BirdLife South Africa, Johannesburg.

Eriksson, P.G., Altermann, W. & Hartzer, F.J. 2006. The Transvaal Supergroup and its precursors. In: Johnson, M.R., Anhaeusser, C.R. & Thomas, R.J. (Eds.) The geology of South Africa, pp. 237-260. Geological Society of South Africa, Marshalltown.

Jenkins, A.R., Smallie, J.J. & Diamond, M. 2010. South African perspectives on a global search for ways to prevent avian collisions with overhead lines. Bird Conservation International 20: 263-278.

Kotze, P. and Koekemoer, J.H. (2010) Orange River Study, Fish Specialist Component: Lower Orange River Fish Survey, May 2010, Draft Report for Rivers for Africa, Cleanstream Biological Services, Report Number - RFA/B/2010.

!Kheis Local Municipality Integrated Development Plan (IDP), 2012 – 2017

Lehman, R.N., Kennedy, P.L. & Savidge, J.A. 2007. The state of the art in raptor electrocution research: a global review. Biological Conservation 136: 159-174.

Lower Orange River Management Plan (DWA LORMP, Draft October 2008)

Louw MD and S Koekemoer (Eds.) (2010); Deliverable 12: Volume 1: Environmental Flow Requirements Produced for WRP as part of Support to Phase II ORASECOM Basin Wide Integrated Water Resources Management Plan.

McCarthy, T. & Rubidge, B. 2005. The story of Earth and life: a southern African perspective on a 4.6-billion-year journey. 334pp. Struik, Cape Town.

Moen, H.F.G. 2006. The Olifantshoek Supergroup. In: Johnson, M.R., Anhaeusser, C.R. & Thomas, R.J. (Eds.) The geology of South Africa, pp. 319-324. Geological Society of South Africa, Marshalltown.

Mucina, L. and Rutherford, M.C.(eds). 2006. The Vegetation of South Africa, Lesotho and Swaziland. Strelitzia 19. South African National Biodiversity Institute, Pretoria.

Partridge, T.C., Dollar, E.S.J., Moolman, J. & Dollar, L.H. 2010. The geomorphic provinces of South Africa, Lesotho and Swaziland: a physiographic subdivision for earth and environmental scientists. Transactions of the Royal Society of South Africa 65, 1-47.

Raimondo, D., Von Staden, L., Foden, W., Victor, J.E., Helme, N.A., Turner, R.C., Kamundi, D.A. & Manyama, P.A. (eds) 2009. Red List of South African plants 2009. Strelitzia 25. South African National Biodiversity Institute, Pretoria.

Robb, L.J., Brandl, G., Anhaeusser, C.R. & Poujol, M. 2006. Archaean granitoid intrusions. In: Johnson, M.R., Anhaeusser, C.R. & Thomas, R.J. (Eds.) The geology of South Africa, pp. 57-94. Geological Society of South Africa, Marshalltown.

Rutherford, M.C & Westfall, R.H. 1994. Biomes of southern Africa – and objective categorization, edn. 2. Mem. Bot. Surv. S. Afr. No. 63: 1 – 94

Schulze RE 1997. South African Atlas of Agrohydrology and -climatlogy. Water Research Commission, Pretoria Report TT82/96

Siyanda District Municipality Integrated Development Plan (IDP), 2012/2013 - 2017
Siyathemba Intergrated Environmental Management Plan (African EPA, 2007).
Siyanda Environmental Management Framework – EMF Report (DEAT, NCDTEC & SDM 2008).
Statistics South Africa, 2011. Census 2011, Northern Cape Municipal Report, http://www.statssa.gov.za/Census2011/Products/NC_Municipal_Report.pdf, Accessed 28 October 2013.

Guidelines

Guideline for determining the scope of specialist involvement in EIA Processes (Münster, June 2005).
Guideline for Environmental Management Plans (Lochner, June 2005).
Guideline for involving biodiversity specialists in EIA process (Brownlie, June 2005).
Guideline for involving heritage specialists in the EIR process (Winter & Baumann, June 2005).
Guideline for involving visual and aesthetic specialists in the EIA process (Oberholzer, June 2005).
Guideline for the review of specialist input into the EIA Process (Keatimilwe & Ashton, June 2005).
Guideline on Alternatives, EIA Guideline and Information Document Series. (DEA&DP, October 2011).
Guideline on Need and Desirability, EIA Guideline and Information Document Series. (DEA&DP, October 2011).
Guideline on Public Participation, EIA Guideline and Information Document Series. (DEA&DP, October 2011).
IEIM, Information Series 2: Scoping (Department of Environmental Affairs and Tourism (DEAT), 2002).
IEIM, Information Series 3: Stakeholder Engagement (DEAT, 2002).
IEIM, Information Series 4: Specialist Studies (DEAT, 2002).
IEIM, Information Series 11: Criteria for determining Alternatives in EIA (DEAT, 2004).
IEIM, Information Series 12: Environmental Management Plans (DEAT, 2004).
Implementation Guidelines: Sector Guidelines for the EIA Regulations (draft) (DEA, 2010).
Integrated Environmental Information Management (IEIM), Information Series 5: Companion to the NEMA EIA Regulations of 2010 (DEA, 2010).
Integrated Environmental Management Guideline Series, Guideline 4: Public Participation, in support of the EIA Regulations. Unpublished (DEAT, 2005).
Integrated Environmental Management Guideline Series, Guideline 7: Detailed Guide to Implementation of the Environmental Impact Assessment Regulations. Unpublished (DEAT, 2007).

Electronic

http://bgis.sanbi.org
http://www.boegoebergecoroute.co.za
www.boerevryheid.co.za
http://www.bptargetneutral.com
https://energypedia.info
http://enermed.cres.gr
www.daviddarling.info/encyclopedia
http://www.geoscience.org.za
http://www.lowimpacthydro.org
http://www.lcclao.com
http://www.photosensitive.com
http://www.electrical-contractor.net/
http://www.statssa.gov.za
http://en.wikipedia.org
http://www.dwaf.gov.za/Orange/Low_Orange/boegoebe.aspx
www.worldweatheronline.com

http://www.hydro.com.au/energy/our-power-stations/derwent
http://www.groblershoop.co.za/).

Legislation

Electricity Regulation Act, Act No. 4 of 2006
Equator Principles
Industrial Policy Action, 2010
Integrated Energy Plan for the Republic of South Africa (2003)Integrated Resource Plan (2010)
International Finance Corporation Performance Standards
Mineral and Petroleum Resources Development Act, Act No. 28 of 2002
National Environmental Management Act, Act No. 107 of 1998
National Environmental Management: Biodiversity Act, Act No. 10 of 2004
National Forest Act, Act 84 of 1998 (as amended)
National Heritage Resources Act, Act No. 25 of 1999
National Water Act, Act No. 36 of 1998
Northern Cape Nature Conservation Act, Act No. 9 of 2009
The Integrated Resource Plan, 2010
The National Energy Act, Act No. 34 of 2008
The National Environmental Management: Waste Act, Act 59 of 2008
Regional Methodology for Wind Energy Site Selection (Department of Environmental Affairs and Development Planning (DEA&DP), 2006 Guideline document)
The Republic of South Africa Constitution Act ("the Constitution"), Act 108 of 1996
White Paper on the Energy Policy of the Republic of South Africa (1998
White Paper on Renewable Energy (2003)

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