Appendix 6B:
Avifauna Assessment

SPECIALIST ASSESSMENT REPORT: AVIFAUNA

PROPOSED 75 MEGAWATT HELENA PHOTOVOLTAIC FACILITY 1 AND ASSOCIATED TRANSMISSION LINE NEAR COPPERTON, NORTHERN CAPE

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DECLARATION OF INDEPENDENCE

I, Chris van Rooyen as duly authorised representative of Chris van Rooyen Consulting, and working under the supervision of and in association with Albert Froneman (SACNASP Zoological Science Registration number 400177/09) as stipulated by the Natural Scientific Professions Act 27 of 2003, hereby confirm my independence (as well as that of Chris van Rooyen Consulting) as a specialist and declare that neither I nor Chris van Rooyen Consulting have any interest, be it business, financial, personal or other, in any proposed activity, application or appeal in respect of which SiVEST was appointed as environmental assessment practitioner in terms of the National Environmental Management Act, 1998 (Act No. 107 of 1998), other than fair remuneration for worked performed, specifically in connection with the Environmental Impact Assessment for the proposed 75 Megawatt Helena Photovoltaic Facility 1 and associated transmission Line near Copperton, Northern Cape.

Full Name: Chris van Rooyen
Title / Position: Director

EXECUTIVE SUMMARY

The proposed project will encompass the installation of a solar PV field and associated components near Copperton in the Northern Cape Province, in order to generate electricity that is to be fed into the Eskom grid at the Kronos Main Transmission Station (MTS). The facility will have a maximum export capacity of 75MW. The proposed development area is approximately 430 ha. The voltage of the connection lines from the solar PV energy facility substation to the grid is likely to be 132kV.

The proposed site is situated approximately 9km south of the town of Copperton, in the Northern Cape Province. The habitat in the broader development area is highly homogenous and consists of extensive sandy and gravel plains with low shrub. The vegetation on the site itself consists mostly of shrubs scattered between bare patches of sand and gravel.

An estimated 121 species could potentially occur in the study area. Of these, 10 are South African Red Data species, 18 are southern African endemics and 29 are near-endemics. This means that 8.2% of the species that could potentially occur in the study area are Red Data species, and 38.8% are southern African endemics of near-endemics. Overall, the study area potentially contains a total of 47 endemics and near-endemics, which is 28% of the 167 southern African endemics and near-endemics (Hockey et al. 2005).

The potential impact on avifauna associated with the proposed development is as follows:

- Temporary displacement due to disturbance associated with the construction of the solar plant and associated infrastructure;
- Collisions with the solar panels;
- Permanent displacement due to habitat transformation; and
- Collisions with the associated power lines resulting in mortality.

The negative impacts of the proposed Helena PV solar facility on local priority avifauna will range from low to high, depending on the type of impact.

In the case of the PV plant and associated infrastructure, the displacement impact due to disturbance during construction is rated as high to start with, and will remain as such after application of mitigation measures. In the case of habitat transformation during operation, the displacement impact is medium – negative and will remain as such after the application of mitigation measures. The impact of direct mortality due to collisions with the solar panels is likely to be low. The displacement impact associated with the construction of the on-site substation will be low, but should not be viewed in isolation, but rather as part of the overall displacement impact associated with the PV plant.

The proposed 132kV circuit grid connection will have a medium negative collision impact on avifauna during operation which should be reduced to low-negative through the application of anti-collision mitigation measures. The impact of displacement caused by the construction of

the power line will be medium negative, but it could be reduced to low if the Martial Eagle nest on the Hydra-Kronos 400kV line next to Kronos MTS could be re-located.

The cumulative impacts of the facility on priority avifauna will range from major to minor on a local scale, and minor to insignificant on a regional scale.

1 INTRODUCTION

The proposed project will encompass the installation of a solar PV field and associated components near Copperton in the Northern Cape Province, in order to generate electricity that is to be fed into the Eskom grid. The facility will have a maximum export capacity of 75MW. The proposed development area is approximately 430 ha, however it is envisaged that the 75MW energy facility layout will only require approximately 250 ha. The voltage of the connection lines from the solar PV energy facility substation to the grid is likely to be 132kV.

1.1 Project Description

This proposed PV energy facility forms one of three PV energy facilities with a 75MW export capacity that BioTherm are proposing to develop on Portion 3 of the farm Klipgats Pan No 117 (Figure 1). In order to accommodate the Department of Energy's (DoE) competitive bidding process for procuring renewable energy from Independent Power Producers in South Africa, each PV energy facility will be developed under a separate Special Purpose Vehicle (SPV) and therefore each requires a separate Environmental Authorisation. However, the possibility to allow shared associated infrastructure will be considered.

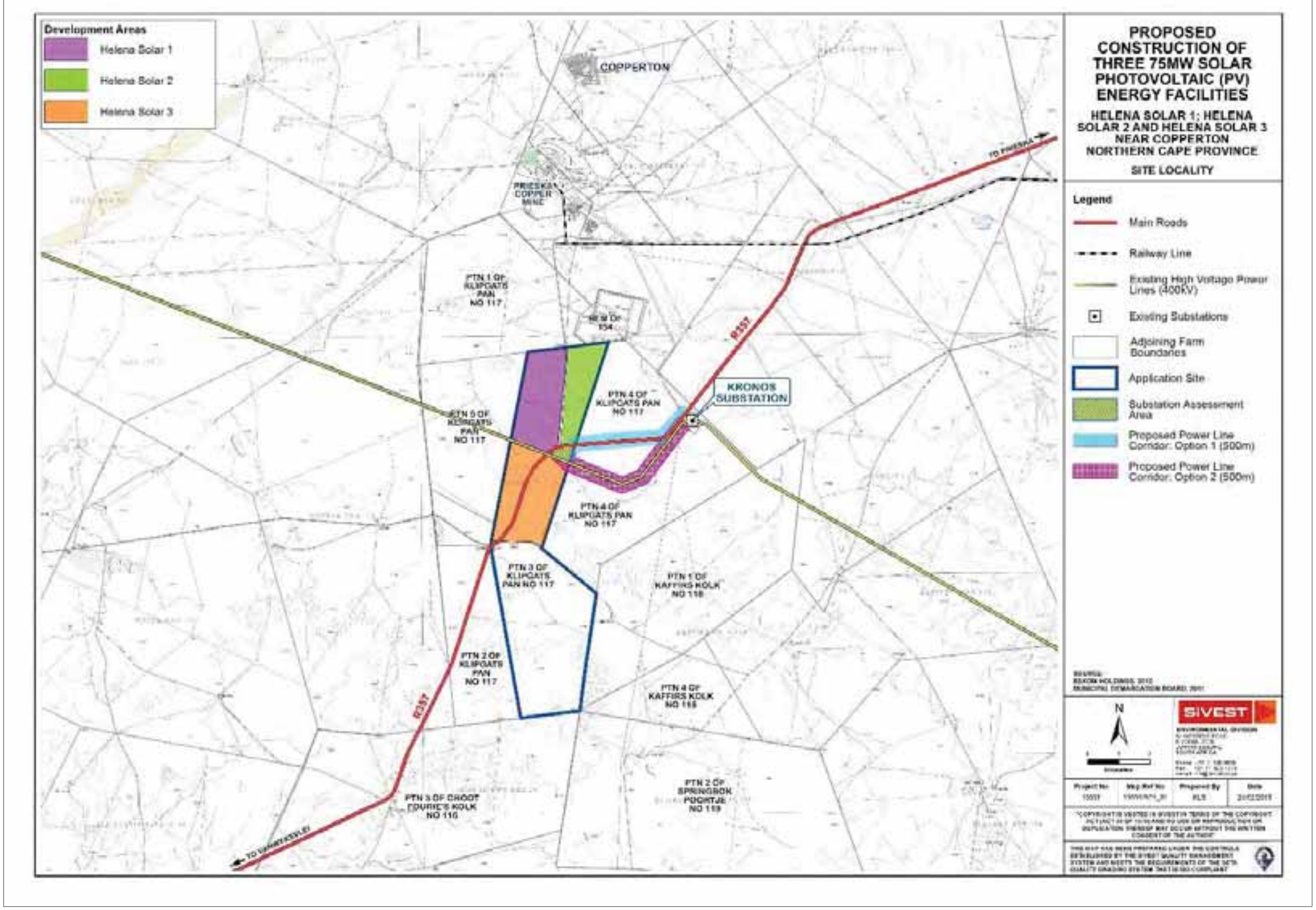

Figure 1: Proposed solar PV energy facility study area (Source: Sivest)

The key technical details and infrastructure required is presented in the table below (**Error! Not a valid bookmark self-reference.**).

Table 1: Helena Solar 1 phase summary

Phase Name	DEA Reference	Farm name and area	Technical details and infrastructure necessary for each phase
Helena Solar 1	14/12/16/3/3/2/765	Portion 3 of Klipgats Pan No 117 (PV site) and Portion 4 of Klipgats Pan No 117 (power lines) PV Site Area: 427.56 ha	▪ Approximately 300 000 **solar PV panels** with a total export capacity of 75MW; ▪ Panels will be either **fixed axis mounting or single axis tracking solutions**, and will be either crystalline silicon or thin film technology; ▪ Onsite **switching station**, with the transformers for voltage step up from medium voltage to high voltage; ▪ The panels will be connected in strings to inverters, approximately **43 inverter stations** will be required throughout the site. Inverter stations will house 2 x 1MW inverters and 1 x 2MVA transformers; ▪ DC power from the panels will be converted into AC power in the inverters and the voltage will be stepped up to 22-33kV (medium voltage) in the transformers. ▪ The **22-33kV cables** will be run underground in the facility to a common point before being fed to the **onsite substation** where the voltage will typically be stepped up to 132kV. ▪ Grid connection is to the Kronos Main Transmission Station (MTS). A **power line** with a voltage of 132kV is proposed and will run from the onsite substation to the Kronos substation. The distance will be about 4km. The final grid connection voltage will be below 275kV. ▪ A **laydown area** for the temporary storage of materials during the construction activities; ▪ **Access roads and internal roads**; ▪ Construction of a **car park and fencing** around the project; and ▪ **Administration, control and warehouse buildings**

1.2 Solar Field

Solar PV panels are usually arranged in rows or 'arrays' consisting of a number of PV panels. The area required for the PV panel arrays will likely need to be entirely cleared or graded. Where tall vegetation is present, this vegetation will be removed from the PV array area.

Approximately 300 000 solar PV panels will be required per project for a total export capacity of 75MW. Support structures will be either fixed axis mounting or single axis tracking solutions and the modules will be either crystalline silicon or thin film technology. The solar PV panels are variable in size, and are affected by advances in technology between project inception and project realisation. The actual size of the PV panels to be used will be determined in the final design stages of the project. The PV panels are mounted onto metal frames which are usually aluminium. Rammed or screw pile foundations are commonly used to support the panel arrays (Figure 2).

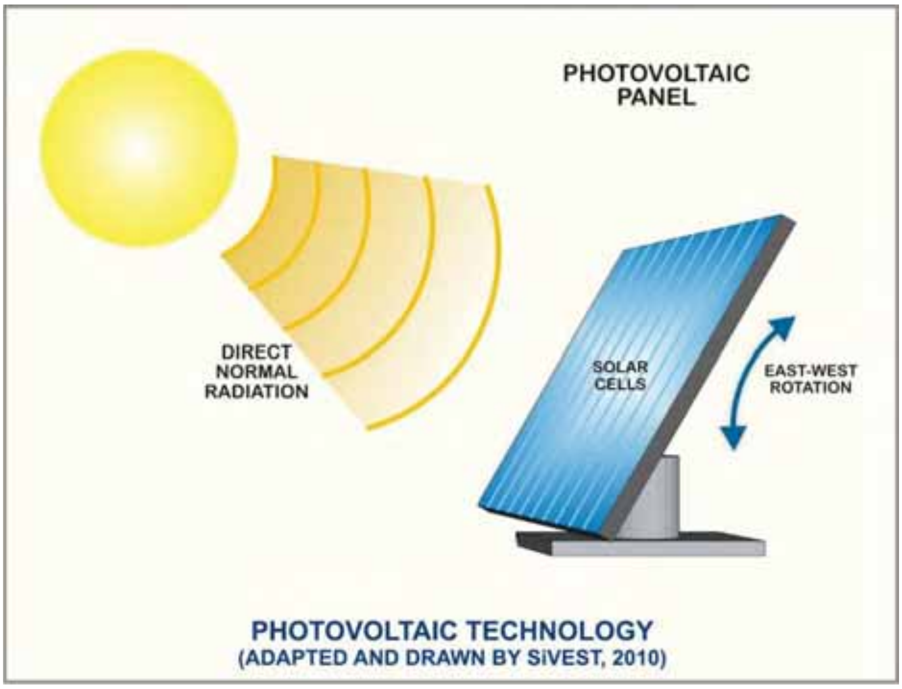

Figure 2: Example of a Photovoltaic Panel with tracking capability.

1.3 Associated Infrastructure

1.3.1 Electrical Infrastructure

The solar PV panel arrays are connected to each other in strings, which are in turn connected to inverters. For a 75MW size facility, typically 2MW inverter stations which are containerised stations housing 2x1MW inverters and 1x2MVA transformers will be used; therefore approximately 43 inverter stations will be required throughout the site for the proposed solar

PV energy facility (Figure 3). DC power from the panels will be converted into AC power in the inverters and the voltage will be stepped up to 22-33kV (medium voltage) in the transformers. The 22-33kV cables will be run underground in the facility to a common point before being fed to the onsite substation and switching station where the voltage will typically be stepped up to 132kV. A Power line with a voltage of up to 132kV will run from the onsite substation to the existing Kronos MTS. The distance will be about 5km.

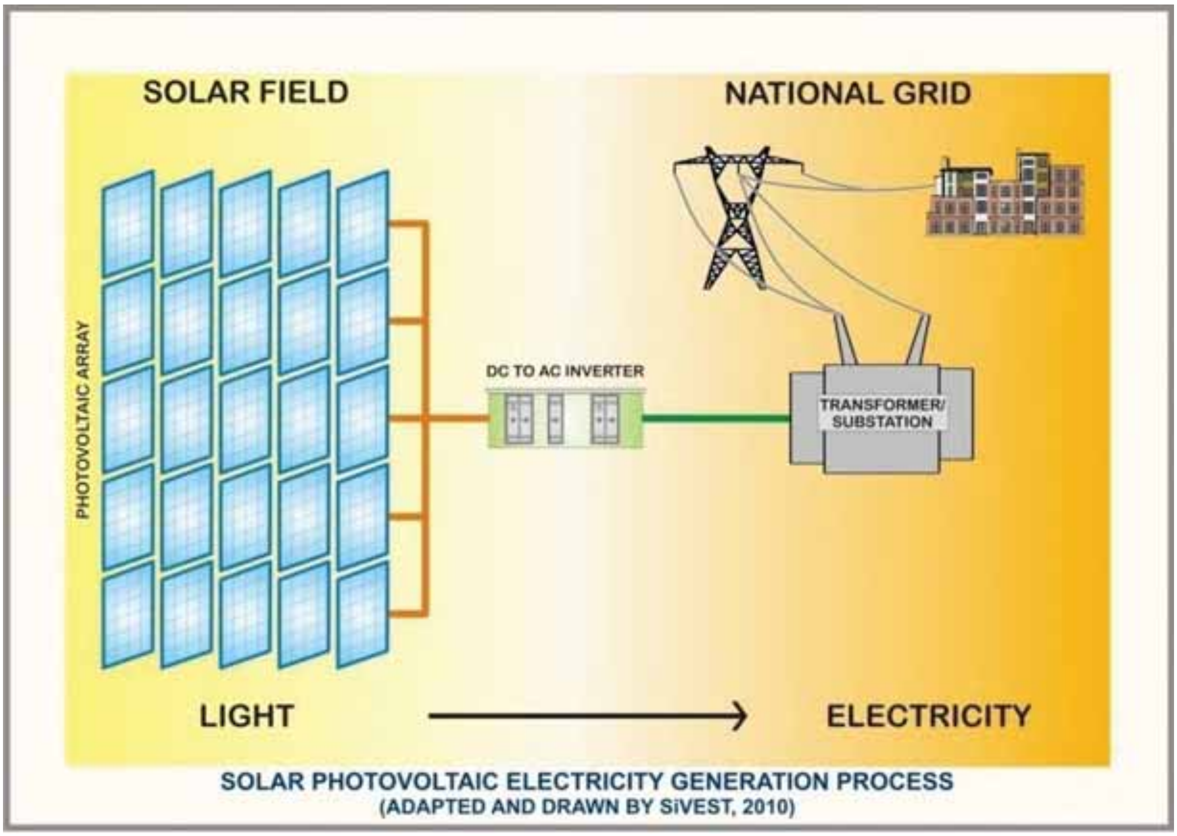

Figure 3: PV process

1.3.2 Buildings

The solar field will require onsite buildings which will be used in the daily operation of the plant and includes an administration building (office). The buildings will likely be single storey buildings which will be required to accommodate the following:

- Control room
- Workshop
- High Voltage (HV) switchgear
- Mess Room
- Toilets
- Warehouse for storage

1.3.3 Construction Lay-down Area

A general construction lay-down area will be required for the construction phase of the proposed solar PV energy facility. The size of this area is yet to be determined, but 3 to 5 hectares is likely.

1.3.4 Other Associated Infrastructure

Other associated infrastructure includes the following:

- Access roads and internal roads;
- A car park; and
- Fencing around the project.

1.4 Alternatives

Due to the limited space available as well as the constraints of the sensitive areas, no alternative PV panel layouts were identified. It was felt that it would be environmentally preferable to assess one viable panel layout rather than two panel layouts that are not technically or environmentally viable. Other design or layout alternatives have been identified. Two alternative site locations for the substation were also proposed, as well as two alternative route corridors for the proposed power line. Additionally, two road and cabling layout alternatives were identified. Based on the scoping phase specialist findings the substation assessment area was eliminated as an appropriate area for the proposed substation as most of this site was found to be potentially sensitive by the specialists. As such, two alternative substation sites that cover an area of 3 ha each were proposed to be assessed in the EIA phase. Should the other two PV projects that are being proposed by BioTherm on the same farm also be granted EAs and be awarded preferred bidder status by the DoE the possibility of sharing the substation site to reduce the environmental impact will be considered.

The layout for the proposed Helena Solar 1 PV facility is presented in 4.

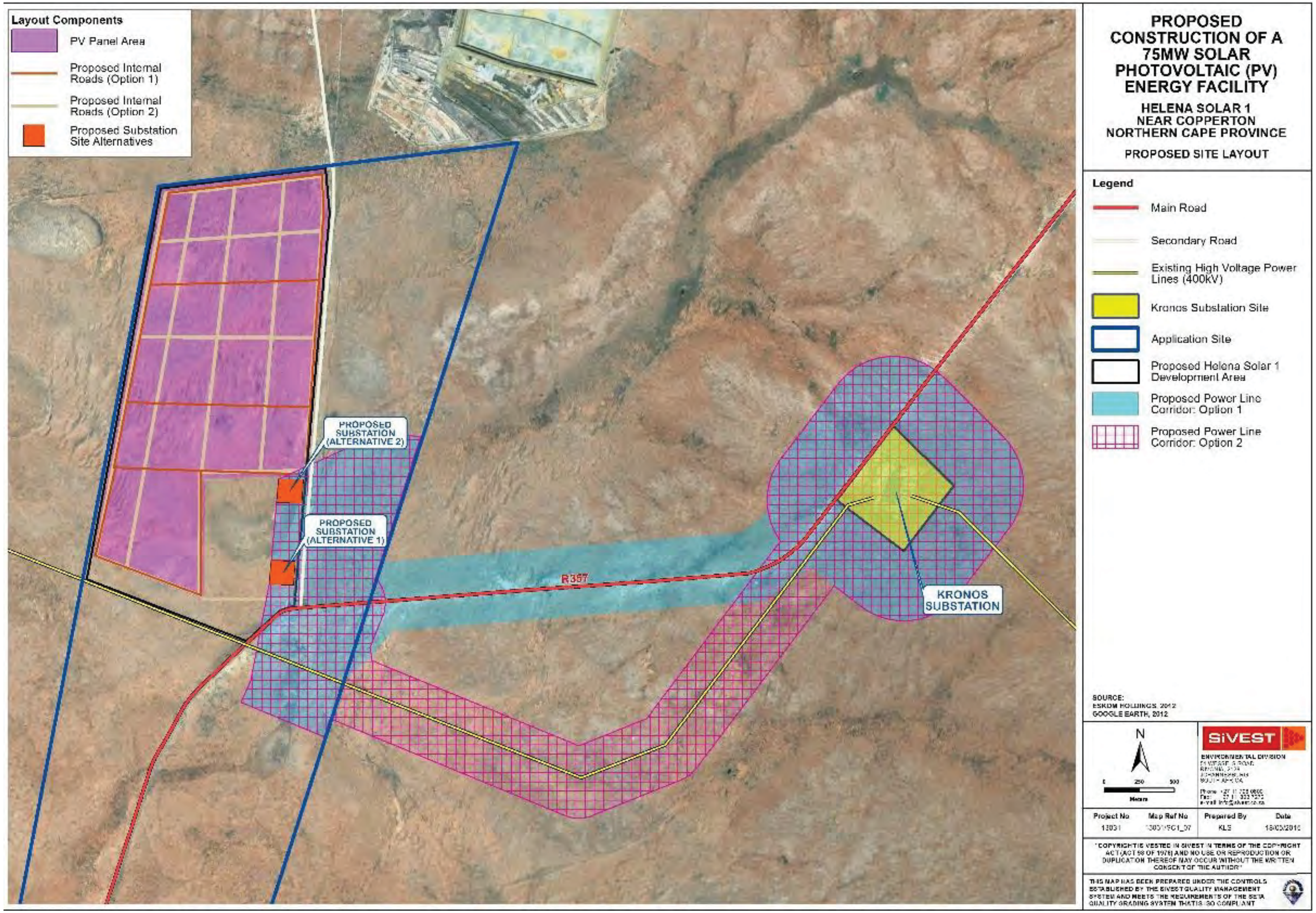

Figure 4: **Proposed Layout Alternatives** (Source: **SiVEST)**

1.5 Terms of Reference

The terms of reference for this impact assessment report are as follows:

- Describe the affected environment from an avifaunal perspective;
- Discuss gaps in baseline data and other limitations;
- List and describe the expected impacts associated with the PV facility and associated infrastructure;
- List and describe the expected impacts associated with the proposed transmission line;
- Assess and evaluate the potential impacts; and
- Recommend mitigation measures to reduce the impact of the expected impacts.

1.6 Outline of Methodology and Information Reviewed

The following information sources were consulted in order to conduct this study:

- Bird distribution data of the South African Bird Atlas 2 (SABAP 2) was obtained from the Animal Demography Unit of the University of Cape Town, as a means to ascertain which species occurs within the broader area i.e. within a block consisting of nine pentad grid cells within which the proposed solar facilities are situated. The nine pentad grid cells are the following: 2955_2210, 2955_2215, 2955_2220, 3000_2210, 3000_2215, 3000_2220, 3005_2210, 3005_2215 and 3005_2220 (see Figure 5). A pentad grid cell covers 5 minutes of latitude by 5 minutes of longitude (5'× 5'). Each pentad is approximately 8 × 7.6 km. From 2007 to date, a total of 26 full protocol cards (i.e. 26 surveys lasting a minimum of two hours each) have been completed for this area.
- The national threatened status of all priority species was determined with the use of the most recent edition of the Red Data Book of Birds of South Africa (Taylor 2014), and the latest authoritative summary of southern African bird biology (Hockey *et al.* 2005).
- The global threatened status of all priority species was determined by consulting the latest (2014.3) IUCN Red List of Threatened Species (http://www.iucnredlist.org/).
- A classification of the vegetation types in the study area was obtained from the Atlas of Southern African Birds 1 (SABAP1) and the National Vegetation Map compiled by the South African National Biodiversity Institute (Mucina & Rutherford 2006).
- The Important Bird Areas of Southern Africa (Barnes 1998; http://www.birdlife.org.za/conservation/important-bird-areas) was consulted for information on relevant Important Bird Areas (IBAs).
- Satellite imagery from Google Earth was used in order to view the broader development area on a landscape level and to help identify bird habitat on the ground.
- Mr. Gerrie Rudolph, landowner at the development site, was interviewed with regard to birds occurring on the property as well as agricultural practices in the district.

- Information on the micro habitat level was obtained through a site visit by the author from 13 – 17 July 2015 (in the dry season), which included field surveys and bird counts. The survey area included the proposed PV locations and associated infrastructure, transmission lines and access roads (see Appendix 1).
- The results of surveys conducted in similar habitat approximately 12km from the site in the period 26 – 30 January 2015 were also consulted to give an indication of the species diversity in the wet season.
- An intensive internet search was conducted to source information on the impacts of solar facilities on avifauna.

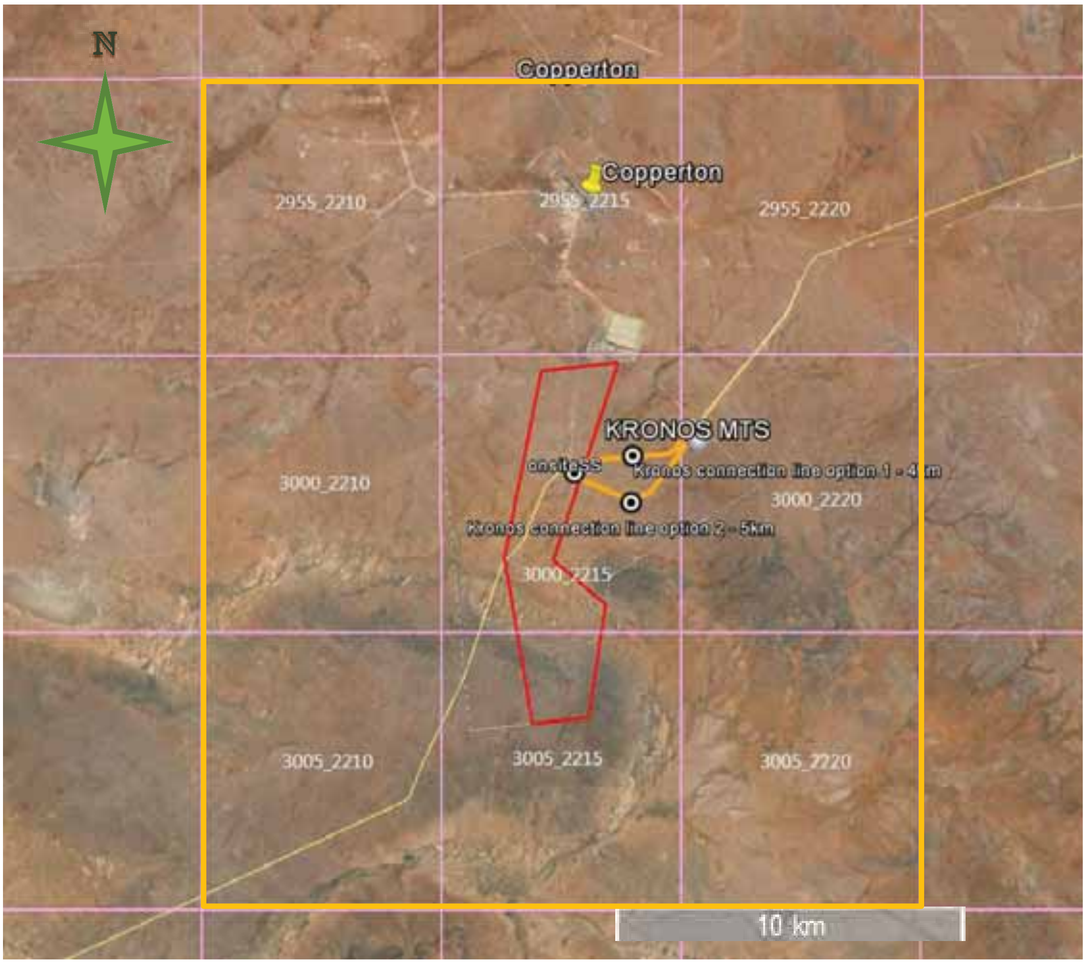

Figure 5: The nine pentads within which the proposed PV facility and associated infrastructure is located.

1.7 Assumptions and Limitations

This study made the basic assumption that the sources of information used are reliable. However, the following must be noted:

- The focus of the study is primarily on the potential impacts on Red Data species, endemics and near-endemics (hereafter called priority species).

- The impact of solar installations on avifauna is a new field of study, with only one scientific study published to date (McCrary *et al*. 1986). Strong reliance was therefore placed on expert opinion and data from existing monitoring programmes at solar facilities in the USA which have recently (2013 - 2015) commenced with avifaunal monitoring. The pre-cautionary principle was applied throughout as the full extent of impacts on avifauna at solar facilities is not presently known.
- The assessment of impacts is based on the baseline environment as it currently exists in the study area. Future changes in the baseline environment are not taken into account. This aspect is dealt with under the section dealing with cumulative impacts.

2 LEGISLATIVE CONTEXT

There is no specific legislation pertaining specifically to the impact of solar facilities on avifauna. There are best practice guidelines available which were compiled by Birdlife South Africa in 2012 (Smit 2012), which was followed in the compilation of this report. Efforts are currently (August 2015) underway to comprehensively revise these guidelines, however these new guidelines are still in draft form and have not been released as yet.

3 BASELINE ASSESSMENT

3.1 Helena Solar 1 and associated infrastructure[1]

The proposed site is situated approximately 9km south of the town of Copperton, in the Northern Cape Province. The habitat in the broader development area is highly homogenous and consists of extensive sandy and gravel plains with low shrub. The vegetation on the site itself consists mostly of shrubs scattered between bare patches of sand and gravel. The dominant vegetation type is Bushmanland Basin Shrubland. Bushmanland This vegetation type consists of dwarf shrubland dominated by a mixture of low, sturdy and spiny (and sometimes also succulent) shrubs (*Rhigozum sp., Salsola sp., Pentzia sp.,* and *Eriocephalus sp.*), 'white' grasses (*Stipagrostis sp.*) and in years of high rainfall also abundant annual flowering plants such as species of *Gazania sp.* and *Leysera sp*. (Mucina & Rutherford 2006). The closest Important Bird Area (IBA), the Platberg Karoo Conservancy, is located approximately 160km to the east (Birdlife 2014) and falls outside the zone of influence of this development.

SABAP1 recognises six primary vegetation divisions within South Africa, namely (1) Fynbos (2) Succulent Karoo (3) Nama Karoo (4) Grassland (5) Savanna and (6) Forest (Harrison *et al.* 1997). The criteria used by the authors to amalgamate botanically defined vegetation units, or to keep them separate were (1) the existence of clear differences in vegetation structure, likely to be relevant to birds, and (2) the results of published community studies on bird/vegetation associations. It is important to note that no new vegetation unit boundaries were created, with use being made only of previously published data. Using this classification system, the natural vegetation in the study area is classified as Nama Karoo.

[1] Associated infrastructure includes buildings, electrical infrastructure, access roads, a car park, fencing and administrative buildings (see Table 1).

Nama Karoo as dominated by low shrubs and grasses; peak rainfall occurs in summer from December to May. Average daily temperatures range between 35°C in January and 18°C in July (http://www.worldweatheronline.com/Copperton-weather-averages/Northern-Cape/ZA.aspx). Trees, e.g. *Acacia karroo* are mainly restricted to ephemeral watercourses, but in the proposed development area, due to the extreme aridity (average annual precipitation of only 147mm in 12 years from 2000 – 2012 - http://www.worldweatheronline.com) the ephemeral watercourses are devoid of trees. In comparison with the Succulent Karoo, the Nama Karoo has higher proportions of grass and tree cover. The two Karoo vegetation types support a particularly high diversity of bird species endemic to Southern Africa, particularly in the family *Alaudidae* (Larks). Its avifauna typically comprises ground-dwelling species of open habitats. Because rainfall in the Nama Karoo falls mainly in summer, while peak rainfall in the Succulent Karoo occurs mainly in winter, it provides opportunities for birds to migrate between the Succulent and Nama Karoo, to exploit the enhanced conditions associated with rainfall. Many typical karroid species are nomads, able to use resources that are patchy in time and space (Barnes 1998).

Figure 6 below is a sample of the typical habitat at the Helena Solar 1 site.

Figure 6: Bushmanland Basin Shrubland, the dominant habitat at the proposed Helena Solar 1 site.

The existing Aries-Kronos 400kV transmission line runs in an east-west direction directly to the south of the development area, which acts as an important perching substrate for raptors (see Figure 7). The site also contains a borehole with surface water in the form of a water reservoir and a water trough (see Figure 8), which could potentially attract a variety of avifauna which uses it for bathing and drinking.

Figure 7: The existing Aries-Kronos 400kV transmission line which runs just south of the proposed development site.

Figure 8: A borehole and water reservoir at the development site

3.2 Proposed Powerline Corridor Option 1

The habitat within the proposed transmission line corridor is also Bushmanland Basin Shrubland (see habitat description under 3.1 above). The proposed alignment runs in an easterly direction from the PV site along the R357 dirt road to Kronos MTS, for a total length of approximately 4.5km. In general, the corridor does not contain any distinguishing features from an avifaunal perspective, except a two borrow pits that may attract waterbirds and raptors sporadically when filled with water. The one distinguishing feature of the corridor is a Martial Eagle nest site on the Hydra-Kronos 400 kV line that was initially recorded in the early 2000s in surveys of large raptors nesting on Eskom's transmission network in the Karoo (Jenkins *et al.* 2013). The presence of the nest was re-confirmed in 2013, with a pair of adults in attendance at a nest on tower 519 (30º 01.579 S, 22º 20.675 E) in May 2013, and feeding a small chick in August of the same year. This chick was successfully fledged by November, and at least one adult was present in the area, with the nest showing signs of preparation for the upcoming breeding season, in March 2014 (Jenkins & Du Plessis 2014). The nest was inspected during the site visit in June 2015, but the birds were not observed, which is an indication that the nest may not be active this year. At the time of the site visit, there was extensive activity at the Kronos MTS with continuous movements of trucks and pedestrians, which may account for the absence of the eagles at this specific nest site.

3.3 Proposed Powerline Corridor Option 2

The habitat within the proposed transmission line corridor is also Bushmanland Basin Shrubland (see habitat description under 3.1 above). The proposed alignment runs in an easterly direction to Kronos MTS, adjacent to the existing Aries-Kronos 400kV transmission line (see Figure 7), for approximately 5km. The existing transmission line was inspected for any potential large eagle nesting activity from the development site to the Kronos MTS, but no indications of any nesting activity was recorded. The closest recorded Martial Eagle nest site on the Aries – Kronos 400kV line is situated at tower 392 (Jenkins *et. al* 2013), which is approximately 15km to the west and outside the immediate impact zone of this development footprint. The presence of a Martial Eagle nest site on the Hydra-Kronos 400 kV at Kronos MTS has already been discussed under 3.2 above and is also relevant to this corridor option.

4 AVIFAUNA IN THE STUDY AREA

An estimated 121 species could potentially occur in the study area. Of these, 10 are South African Red Data species, 18 are southern African endemics and 29 are near-endemics. This means that 8.2% of the species that could potentially occur in the study area are Red Data species, and 38.8% are southern African endemics of near-endemics. Southern Africa contains 13 avifaunal endemic regions, namely Western Arid, Woodland, Evergreen Forest, Grassland, Montane, Rocky slopes and cliffs, Fynbos, Marine and Inland Waters (MacLean 1999). Of these regions, Western Arid, where the study area is located, contains the highest number of endemics. Overall, the study area potentially contains a total of 47 endemics and near-endemics, which is 28% of the 167 southern African endemics and near-endemics (Hockey *et al.* 2005).

See Appendix 2 for a list of species potentially occurring in the study area. The SABAP2 reporting rate refers to the combined reporting rate in the 9 pentads surrounding and including the development site.

Potential impacts on priority species are listed in Table 1 below.

Table 1: Priority species potentially occurring in the study area

EN = Endangered
VU = Vulnerable
NT = Near-threatened
LC = Least concern
End = Southern African Endemic
N-End = Southern African near endemic

Name	Scientific name	National Red Data Status	Global status	Collisions with associated power line	Collisions with PV panels	Displacement through disturbance	Displacement through habitat transformation*
Ant-eating Chat	*Myrmecocichla formicivora*	End	LC		x	x	x
Ashy Tit	*Parus cinerascens*	N-end	LC		x	x	x
Black-chested Prinia	*Prinia flavicans*	N-end	LC		x	x	x
Black-eared Sparrowlark	*Eremopterix australis*	End	LC		x	x	x
Black-headed Canary	*Serinus alario*	End	LC		x	x	x
Bokmakierie	*Telophorus zeylonus*	N-end	LC		x	x	x
Cape Bunting	*Emberiza capensis*	N-end	LC		x	x	x
Cape Penduline – Tit	*Anthoscopus minutus*	N-end	LC		x	x	x
Cape Sparrow	*Passer melanurus*	N-end	LC		x	x	x
Chat Flycatcher	*Bradornis infuscatus*	N-end	LC		x	x	x
Chertnut-vented Tit-babbler	*Parisoma subcaeruleum*	N-end	LC		x	x	x
Double-banded Courser	*Rhinoptilus africanus*	NT	LC		x	x	x
Dusky Sunbird	*Cinnyris fuscus*	N-end	LC		x	x	x
Eastern Clapper-Lark	*Mirafra fasciolata*	N-end	LC		x	x	x
European Roller	*Coracias garrulus*	NT	NT		x	x	x
Fairy Flyctacher	*Stenostira scita*	End	LC		x	x	x
Grey-backed Cisticola	*Cisticola subruficapilla*	N-end	LC		x	x	x

Name	Scientific name	National Red Data Status	Global status	Collisions with associated power line	Collisions with PV panels	Displacement through disturbance	Displacement through habitat transformation*
Grey-backed Sparrowlark	*Eremopterix verticalis*	N-end	LC		x	x	x
Jackal Buzzard	*Buteo rufofuscus*	End	LC	x		x	x
Kalahari-Scrub-Robin	*Cercotrichas paena*	N-end	LC		x	x	x
Karoo Chat	*Cercomela schlegelii*	N-end	LC		x	x	x
Karoo Eremomela	*Eremomela gregalis*	End	LC		x	x	x
Karoo Korhaan	*Eupodotis vigorsii*	NT, End	LC	x	x	x	x
Karoo Long-billed Lark	*Certhilauda subcoronata*	End	LC		x	x	x
Karoo Prinia	*Prinia maculosa*	End	LC		x	x	x
Karoo Scrub-Robin	*Cercotrichas coryphoeus*	End	LC		x	x	x
Kori Bustard	*Ardeotis kori*	NT	NT	x		x	x
Lanner Falcon	*Falco biarmicus*	VU	LC			x	x
Large-billed Lark	*Galerida magnirostris*	End	LC		x	x	x
Lark-like Bunting	*Emberiza impetuani*	N-end	LC		x	x	x
Layard's Tit-babbler	*Parisoma layardi*	End	LC		x	x	x
Ludwig's Bustard	*Neotos ludwigii*	EN, N-end	EN	x		x	x
Martial Eagle	*Polemaetus bellicosus*	EN	VU	x		x	x
Mountain Wheat-ear	*Oenanthe monticola*	N-end	LC		x	x	x
Namaqua Sandgrouse	*Pterocles namaqua*	N-end	LC	x	x	x	x
Northern Black Korhaan	*Afrotis afraoides*	End	LC	x	x	x	x
Orange River White-eye	*Zosterops pallidus*	End	LC		x	x	x
Pale-winged Starling	*Onychognathus nabouroup*	N-end	LC		x	x	x
Pririt Batis	*Batis pririt*	N-end	LC		x	x	x
Red-headed Finch	*Amadina erythrocephala*	N-end	LC		x	x	x
Rufous-eared Warbler	*Malcorus pectoralis*	End	LC		x	x	x

Name	Scientific name	National Red Data Status	Global status	Collisions with associated power line	Collisions with PV panels	Displacement through disturbance	Displacement through habitat transformation*
Sabota Lark	*Calendulauda sabota*	N-end	LC		x	x	x
Scaly-feathered Finch	*Sporopipes squamifrons*	N-end	LC		x	x	x
Sclater's Lark	*Spizocorys sclateri*	NT, End	NT		x	x	x
Secretarybird	*Sagittarius serpentarius*	VU	VU	x		x	x
Sickle-winged Chat	*Cercomela sinuata*	End	LC		x	x	x
Sociable Weaver	*Philetairus socius*	End	LC		x	x	x
South African Shelduck	*Tadorna cana*	End	LC	x	x	x	x
Southern Pale Chanting Goshawk	*Melierax canorus*	N-end	LC	x	x	x	x
Spike-heeled Lark	*Chersomanes albofasciata*	N-end	LC		x	x	x
Stark's Lark	*Spizocorys starki*	N-end	LC		x	x	x
Tratrac Chat	*Cercomela tractrac*	N-end	LC		x	x	x
Verreaux's Eagle	*Aquila verreauxii*	VU	LC	x		x	x
White-throated Canary	*Crithagra albogularis*	N-end	LC		x	x	x
Yellow Canary	*Crithagra flaviventris*	N-end	LC		x	x	x

With smaller species this impact might result in partial but not total exclusion from the site, depending on the level of vegetation transformation

5 IMPACT ASSESSMENT

5.1 Impacts of solar facilities and associated infrastructure on avifauna

A literature review reveals a scarcity of published, scientifically vetted information regarding large-scale solar plants and birds. To date, only one published scientific study has been conducted on the direct impacts of solar facilities on avifauna, namely "*Avian mortality at a solar energy power plant*" by McCrary, McKernan, Schreiber, Wagner & Sciarrotta 1986. This describes the results of monitoring at the experimental Solar One solar power plant in southern California (now de-commissioned), which was a 10 megawatt, central receiver solar power plant consisting of a 32-ha field of 1 818, 6.9 x 6.9m mirrors (heliostats) which concentrates sunlight on a centrally located, tower-mounted boiler, 86m in height. Since then, several much larger plants have been constructed in the Desert Southwest of the USA namely the 250MW, 1 300ha California Valley Solar Ranch PV plant (completed in 2013), the 377 MW, 1 600ha Ivanpah central receiver CSP plant (completed in 2014), the 550MW, 1 600ha Desert Sunlight PV plant (completed in 2015) and the 250MW, 1 880ha Genesis Solar Energy parabolic trough Concentrated Solar Power plant (completed in 2014). The full spectrum of impacts of solar facilities on birds is only now starting to emerge from compliance reports at these solar facilities. These can be summarised as follows:

- Temporary displacement due to disturbance associated with the construction of the solar plant and associated infrastructure;
- Collisions with the heliostats or solar panels;
- Burning due to solar flux (only relevant to CSP plants, not relevant for PV plants);
- Permanent displacement due to habitat transformation; and
- Collisions with the associated power lines resulting in mortality.

5.1.1 Collisions with solar infrastructure

There are currently two known types of direct solar-related bird fatalities (McCrary *et al*. 1986; Hernandez *et al*. 2014; Kagan *et al*. 2014):

- Collision-related fatality—fatality resulting from the direct contact of the bird with a project structure(s). This type of fatality has been documented at solar projects of all technology types.
- Solar-flux-related fatality—fatality resulting from the burning/singeing effects of exposure to concentrated sunlight. Passing through the area of solar flux may result in: (a) direct fatality; (b) singeing of flight feathers that cause loss of flight ability, leading to impact with other objects; or (c) impairment of flight capability to reduce the ability to forage or avoid predators, resulting in starvation or predation of the individual (Kagan *et al.* 2014). Solar-flux-related fatality has been observed only at facilities employing power tower technologies.

McCrary *et al*. (1986) searched for dead birds amongst the heliostat mirrors and around the central receiver tower, and they estimated a bird fatality rate caused by bird collisions with heliostat mirrors and the tower, and by heat encountered when birds flew through the concentrated sunlight reflected toward the tower. Their forty visits (one week apart) to the facility over a two year period revealed 70 bird carcasses involving 26 species. It was estimated that between 10% and 30% of carcasses were removed by scavengers in between visits, so the actual mortality figure may have been slightly higher. **They estimated that 57 (81%) of these birds died through collision with infrastructure, mostly the heliostats**. Species killed in this manner included waterbirds, small raptors, gulls, doves, sparrows and warblers. Thirteen (19%) of the birds died through burning in the standby points. Species killed in this manner were mostly swallows and swifts. However, they appeared to have under-appreciated the magnitude of the impacts caused by Solar One, likely because they did not know as much as scientists know today about scavenger removal rates and searcher detection error (Smallwood 2014). Their search pattern was not fixed, so it was not as rigorous as modern searches at wind energy projects and other energy generation and transmission facilities. They placed 19 bird carcasses to estimate the proportion remaining over the average time span between their visits to the project site, though they provided few details about their scavenger removal trial. It is known today that the results of removal trials can vary substantially for many reasons, including the species used, time since death, and the number of carcasses placed in one place at one time, etc. (Smallwood 2007). They also performed no searcher detection trials, because they concluded that the ground was sufficiently exposed that all available bird carcasses would have been found. This conclusion would not be accepted today, based on modern fatality search protocols. Smallwood (2014) recalculated the estimated fatality rate at Solar One, but this time using US national averages to represent scavenger removal rates and searcher detection rates (see Smallwood 2007, 2013). He re-calculated it as 87.4 mortalities per year with an 80% confidence interval (CI) of 69.6 to 105.5.

Although Solar One is a central receiver plant and therefore not directly comparable to the proposed Helena Solar 1 PV plant, the results of the Solar One study indicates that collisions with reflective surfaces are a significant impact at solar facilities in general.

Avian monitoring surveys were conducted at the 1 600ha Ivanpah Solar Electric Generating System CSP (Ivanpah) facility in accordance with the Project’s Avian & Bat Monitoring and Management Plan over four seasons from 29 October 2013 to 20 October 2014 (Harvey & Associates 2015). These surveys included avian point counts, raptor/large bird surveys and facility monitoring for avian fatalities. Overall, approximately 29.2% of the facility was searched (not including offsite transects, which are outside the facility). A total of 695 avian mortalities (including 25 injured birds that died), and eight injured birds were found over the first four seasons. These avian fatality search results, along with searcher efficiency carcass removal rates from trials conducted onsite, were input into a fatality estimator model (Huso 2010) to provide an estimate of the fatalities for the facility. Overall, the estimated avian mortality was 1492 or 42.6% of birds (90% confidence interval 1,046-2,371) from known causes and 2012 or 57.4% of birds (90% confidence interval 1,450-3,334) from unknown causes. The sources of mortality for known causes were 47.4% singed, 51.9% with evidence of collision effects, and

0.7% from other Project causes. For the fatalities from unknown causes, the estimate was driven by a high number of feather spots (47.2% of all detections) which may have led to over-estimation of the number of unknowns.

The estimate of 3 504 mortalities at Ivanpah contrasts markedly with an earlier estimate by Smallwood (2014). Smallwood calculated the estimated annual mortality at Ivanpah to be potentially as high as 28 380 birds per year. In his testimony to the California Energy Commission he explains as follows: *"The April searches turned up 101 fatalities and the May searches discovered another 82 fatalities. If the searches were performed according to document TB201315, which summarised a monitoring plan for Ivanpah, then weekly searches were performed at 20% of the heliostat mirrors at Ivanpah during April and May 2014. Given the size range of the birds found, including many hummingbirds, swallows and warblers, I would predict that the overall adjustment rate for searcher detection and carcass persistence would be no greater than 20%. That means the number of fatalities found would be divided by 0.2 to arrive at an adjusted estimate of 473 fatalities per month within the search areas. This number then would be divided by 0.2 (corresponding with 20% of the project being searched) to extrapolate the fatality estimate to the rest of Ivanpah, yielding 2,365 birds per month during April and May 2014. If this rate persisted yearlong, then Ivanpah might be killing 28,380 birds, which would be 3.6 times greater than the fatality rate I predicted."* With such widely differing estimates, it is clear that systematic study and efforts to standardize data through the development of systematic monitoring protocols are needed to make any conclusions about the avian risks of utility-scale solar development.

Although Ivanpah is also a CSP plant and therefore not directly comparable to the proposed Helena Solar 1 PV development, it again points to collisions with reflective surfaces as a potentially significant cause of mortality at solar plants.

Weekly mortality searches at 20% coverage are also being conducted at the 1 300ha California Valley Solar Ranch PV site (Harvey & Associates 2014a and 2014b). According to the information that could be sourced from the internet (two quarterly reports), 152 avian mortalities were reported for the period 16 November 2013 – 15 February 2014, and 54 for the period 16 February 2014 – 15 May 2014, of which approximately 90% were based on feathers spots which precluded a finding on the cause of death. These figures give an estimated unadjusted 1 030 mortalities per year, which is obviously an underestimate as it does not include adjustments for carcasses removed by scavengers and missed by searchers. The authors stated clearly that these quarterly reports do not include the results of searcher efficiency trials, carcass removal trials, or data analyses, nor does it include detailed discussions.

Although the quarterly reports compiled for the California Valley Solar Ranch PV site do not attempt to identify the cause of death, the fact that collisions with reflective surfaces are a proven cause of mortality at solar plants makes this the most likely cause of death for the majority of recorded mortalities.

In a report by the National Fish and Wildlife Forensic Laboratory (Kagan *et al.* 2014), the cause of avian mortalities was estimated based on opportunistic avian carcass collections at the 1 600ha Ivanpah CSP, 1 600ha Desert Sunlight PV and 1 880ha Genesis Parabolic Trough solar plants. The results of the investigation are tabled below in Table 2:

Table 2: Comparison of avian mortality causes at three solar plants in California, USA (Kagan et al. 2014).

Cause of death	Ivanpah CSP	Genesis Parabolic trough CSP	Desert Sunlight PV	Total
Solar flux	47	0	0	47
Impact trauma	24	6	19	49
Predation trauma	5	2	15	22
Trauma of undetermined causes	14	0	0	14
Electrocution	1	0	0	1
Emaciation	1	0	0	1
Undetermined (remains in poor condition)	46	17	22	85
No evident cause of death	3	6	5	14
Total	141	31	61	233

When the results of the three solar plants are pooled, collisions with reflective surfaces (impact trauma) emerge as the highest single identifiable cause of avian mortality. In the case of Desert Sunlight PV, impact trauma and predation trauma together are the biggest identifiable causes of avian mortality.

Sheet glass used in commercial and residential buildings has been well established as a hazard for birds. A recent comprehensive review estimated between 365 – 988 million birds are killed annually in the USA due to collisions with glass panels (Loss *et al.* 2014). It is therefore to be expected that the reflective surfaces of solar panels will constitute a similar risk to avifauna. A related problem is the so-called “lake effect” i.e. it seems very likely that reflections from solar facilities' infrastructure, particularly large sheets of dark blue photovoltaic panels, may well be attracting birds in flight across the open desert, who mistake the broad reflective surfaces for water (Kagan *et al.* 2014). This could either result in birds colliding directly with the solar panels, or getting stranded and unable to take off again because many aquatic bird species find it very difficult and sometimes impossible to take off from dry land e.g. grebes and cormorants. This exposes them to predation, even if they do not get injured through direct collisions with the panels. The unusually high number of waterbird mortalities at the Desert Sunlight PV facility (44%) seems to support this hypothesis. In the case of Desert Sunlight, the proximity of evaporation ponds may act as an additional risk increasing factor, in that birds are both attracted to the water feature and habituated to the presence of an accessible aquatic environment in the area. This may translate into the misinterpretation of diffusely reflected sky or horizontal polarised light source as a body of water.

Variables that may affect the illusory characteristics of solar panels are structural elements or markings that may break up the reflection. Visual markers spaced at distances of 28cm apart or less have been shown to reduce the number of window strike events on large commercial buildings (Kagan *et al.* 2014). A paper by Horvath *et al.* (2010) provides experimental evidence that placing a white outline and/or white grid lines on solar panels significantly reduce the attractiveness of those panels to aquatic insects, with a loss of only 1.8% in energy producing surface area. While similar detailed studies have yet to be carried out with birds, this work, combined with the window strike results, suggest that significant reductions in avian mortality at solar facilities could be achieved by relatively minor modifications of panel and mirror design (Kagan *et al.* 2014). **This could be an experimental mitigation measure should results of the operational phase monitoring indicate significant mortality of priority avifauna due to collisions with the solar arrays at the proposed Helena Solar 1 PV plant.**

5.1.2 Displacement due to habitat transformation and disturbance associated with the construction and operation of the plant

The activities listed below are typically associated with the construction and operation of solar facilities and could have direct impacts on avifauna (County of Merced 2014):

- Preparation of solar panel areas for installation, including vegetation clearing, grading, cut and fill;
- Excavation/trenching for water pipelines, cables, fibre-optic lines, and the septic system;
- Construction of piers and building foundations;
- Construction of new dirt or gravel roads and improvement of existing roads;
- Temporary stockpiling and side-casting of soil, construction materials, or other construction wastes;
- Soil compaction, dust, and water runoff from construction sites;
- Increased vehicle traffic;
- Short-term construction-related noise (from equipment) and visual disturbance;
- Degradation of water quality in drainages and other water bodies resulting from project runoff;
- Maintenance of fire breaks and roads; and
- Weed removal, brush clearing, and similar land management activities related to the ongoing operation of the project.

These activities could have an impact on birds breeding, foraging and roosting in or in close proximity of the servitude through disturbance and transformation of habitat, which could result in temporary or permanent displacement.

At the 1 600ha Ivanpah Solar Electric Generating System CSP (Ivanpah) facility, seventeen avian use surveys were conducted at each of 80 survey points (40 in desert bajada habitat and 40 in heliostat arrays), representing more than 350 hours of survey effort. Species composition was compared between these avian use survey results and detections during standardized monitoring surveys. A total of 54 bird species were recorded on avian use surveys during the first four seasons. Total species richness was highest in the desert (47 species), and much lower in the heliostat grids (24 species).

Evidently, the same is true for PV plants. In a study comparing the avifaunal habitat use in PV arrays with adjoining managed grassland at airports in the USA, DeVault *et al*. (2014) found that species diversity in PV arrays was reduced compared to the grasslands (37 vs 46), supporting the view that solar development is generally detrimental to wildlife on a local scale. **It is highly likely that the same pattern of reduced avifaunal densities will manifest itself at the proposed Helena Solar 1 PV plant.**

5.1.3 Mortality on associated transmission line infrastructure

Negative impacts on birds by electricity infrastructure generally take two forms namely electrocution and collisions (Ledger & Annegarn 1981; Ledger 1983; Ledger 1984; Hobbs and Ledger 1986a; Hobbs & Ledger 1986b; Ledger, Hobbs & Smith, 1992; Verdoorn 1996; Kruger & Van Rooyen 1998; Van Rooyen 1998; Kruger 1999; Van Rooyen 1999; Van Rooyen 2000; Van Rooyen 2004; Jenkins *et al* 2010). Birds also impact on the infrastructure through nesting and streamers, which can cause interruptions in the electricity supply (Van Rooyen *et al.* 2002).

Electrocution refers to the scenario where a bird is perched or attempts to perch on the electrical structure and causes an electrical short circuit by physically bridging the air gap between live components and/or live and earthed components (Van Rooyen 2004). The electrocution risk is largely determined by the pole/tower design. In the case of the proposed Helena Solar 1 PV plant, no electrocution risk is envisaged because the design of the steel mono-pole 132kV lines will not pose an electrocution threat to any of the priority species which are likely to occur at the site.

Collisions are probably the bigger threat posed by transmission lines to birds in southern Africa (Van Rooyen 2004). Most heavily impacted upon are bustards, storks, cranes and various species of waterbirds. These species are mostly heavy-bodied birds with limited manoeuvrability, which makes it difficult for them to take the necessary evasive action to avoid colliding with transmission lines (Van Rooyen 2004, Anderson 2001). In a recent PhD study, Shaw (2013) provides a concise summary of the phenomenon of avian collisions with transmission lines:

> "*The collision risk posed by power lines is complex and problems are often localised. While any bird flying near a power line is at risk of collision, this risk varies greatly between different groups of birds, and depends on the interplay of a wide range of factors (APLIC 1994). Bevanger (1994) described these factors in four main groups – biological, topographical, meteorological and technical. Birds at highest risk are those that are both susceptible to collisions and frequently exposed to power lines, with waterbirds, gamebirds, rails, cranes and bustards usually the most numerous reported victims (Bevanger 1998, Rubolini et al. 2005, Jenkins et al. 2010).*

The proliferation of man-made structures in the landscape is relatively recent, and birds are not evolved to avoid them. Body size and morphology are key predictive factors of collision risk, with large-bodied birds with high wing loadings (the ratio of body weight to wing area) most at risk (Bevanger 1998, Janss 2000). These birds must fly fast to remain airborne, and do not have sufficient manoeuvrability to avoid unexpected obstacles. Vision is another key biological factor, with many collision-prone birds principally using lateral vision to navigate in flight, when it is the lower-resolution, and often restricted, forward vision that is useful to detect obstacles (Martin & Shaw 2010, Martin 2011, Martin et al. 2012). Behaviour is important, with birds flying in flocks, at low levels and in crepuscular or nocturnal conditions at higher risk of collision (Bevanger 1994). Experience affects risk, with migratory and nomadic species that spend much of their time in unfamiliar locations also expected to collide more often (Anderson 1978, Anderson 2002). Juvenile birds have often been reported as being more collision-prone than adults (e.g. Brown et al. 1987, Henderson et al. 1996).

Topography and weather conditions affect how birds use the landscape. Power lines in sensitive bird areas (e.g. those that separate feeding and roosting areas, or cross flyways) can be very dangerous (APLIC 1994, Bevanger 1994). Lines crossing the prevailing wind conditions can pose a problem for large birds that use the wind to aid take-off and landing (Bevanger 1994). Inclement weather can disorient birds and reduce their flight altitude, and strong winds can result in birds colliding with power lines that they can see but do not have enough flight control to avoid (Brown et al. 1987, APLIC 2012).

The technical aspects of power line design and siting also play a big part in collision risk. Grouping similar power lines on a common servitude, or locating them along other features such as tree lines, are both approaches thought to reduce risk (Bevanger 1994). In general, low lines with short span lengths (i.e. the distance between two adjacent pylons) and flat conductor configurations are thought to be the least dangerous (Bevanger 1994, Jenkins et al. 2010). On many higher voltage lines, there is a thin earth (or ground) wire above the conductors, protecting the system from lightning strikes. Earth wires are widely accepted to cause the majority of collisions on power lines with this configuration because they are difficult to see, and birds flaring to avoid hitting the conductors often put themselves directly in the path of these wires (Brown et al. 1987, Faanes 1987, Alonso et al. 1994a, Bevanger 1994)."

From incidental record keeping by the Endangered Wildlife Trust, it is possible to give a measure of what species are generally susceptible to power line collisions in South Africa (see Figure 10 below - Jenkins *et al.* 2010).

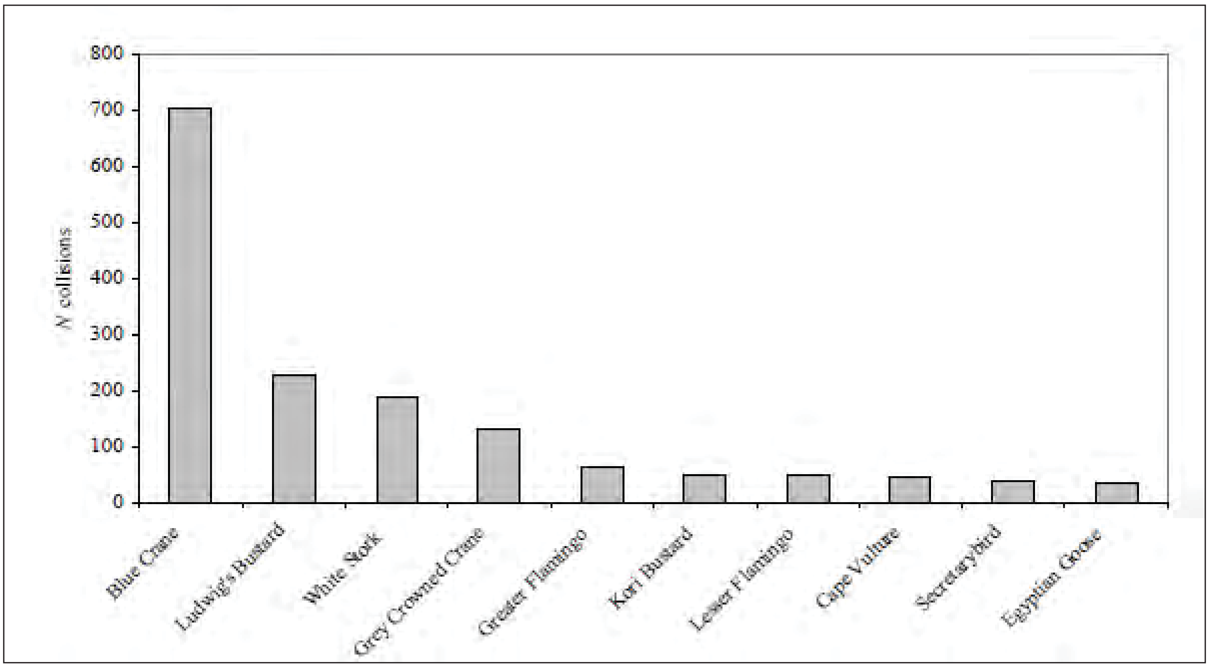

Figure 9: The top 10 collision prone bird species in South Africa, in terms of reported incidents contained in the Eskom/EWT Strategic Partnership central incident register 1996 - 2008 (Jenkins *et al.* 2010)

Power line collisions are generally accepted as a key threat to bustards (Raab *et al.* 2009; Raab *et al.* 2010; Jenkins & Smallie 2009; Barrientos *et al.* 2012, Shaw 2013). In a recent study, carcass surveys were performed under high voltage transmission lines in the Karoo for two years, and low voltage distribution lines for one year (Shaw 2013). Ludwig's Bustard was the most common collision victim (69% of carcasses), with bustards generally comprising 87% of mortalities recovered. Total annual mortality was estimated at 41% of the Ludwig's Bustard population, with Kori Bustards also dying in large numbers (at least 14% of the South African population killed in the Karoo alone). Karoo Korhaan was also recorded, but to a much lesser extent than Ludwig's Bustard. The reasons for the relatively low collision risk of this species probably include their smaller size (and hence greater agility in flight) as well as their more sedentary lifestyles, as local birds are familiar with their territory and are less likely to collide with power lines (Shaw 2013).

Several factors are thought to influence avian collisions, including the manoeuvrability of the bird, topography, weather conditions and power line configuration. An important additional factor that previously has received little attention is the visual capacity of birds; i.e. whether they are able to see obstacles such as power lines, and whether they are looking ahead to see obstacles with enough time to avoid a collision. In addition to helping explain the susceptibility of some species to collision, this factor is key to planning effective mitigation measures. Recent research provides the first evidence that birds can render themselves blind in the direction of travel during flight through voluntary head movements (Martin & Shaw 2010). Visual fields were determined in three bird species representative of families known to be subject to high levels of mortality associated with power lines i.e. Kori Bustards, Blue Cranes (*Anthropoides* *paradiseus*) and White Storks (*Ciconia ciconia*). In all species the frontal visual fields showed narrow and vertically long binocular fields typical of birds that take food items directly in the bill under visual guidance. However, these species differed markedly in the vertical extent of their binocular fields and in the extent of the blind areas which project above and below the binocular fields in the forward facing hemisphere. The importance of these blind areas is that when in flight, head movements in the vertical plane (pitching the head to look downwards) will render the bird blind in the direction of travel. Such movements may frequently occur when birds are scanning below them (for foraging or roost sites, or for conspecifics). In bustards and cranes pitch movements of only 25° and 35°, respectively, are sufficient to render the birds blind in the direction of travel; in storks head movements of 55° are necessary. That flying birds can render themselves blind in the direction of travel has not been previously recognised and has important implications for the effective mitigation of collisions with human artefacts including wind turbines and power lines. These findings have applicability to species outside of these families especially raptors (*Accipitridae*) which are known to have small binocular fields and large blind areas similar to those of bustards and cranes, and are also known to be vulnerable to power line collisions.

Despite doubts about the efficacy of line marking to reduce the collision risk for bustards (Jenkins *et al.* 2010; Martin *et al.* 2010), there are numerous studies which prove that marking a line with PVC spiral type Bird Flight Diverters (BFDs) generally reduce mortality rates (e.g. Barrientos *et al.* 2011; Jenkins *et al.* 2010; Alonso & Alonso 1999; Koops & De Jong 1982), including to some extent for bustards (Barrientos *et al.* 2012; Hoogstad 2015 pers.comm). Beaulaurier (1981) summarised the results of 17 studies that involved the marking of earth wires and found an average reduction in mortality of 45%. Barrientos *et al.* (2011) reviewed the results of 15 wire marking experiments in which transmission or distribution wires were marked to examine the effectiveness of flight diverters in reducing bird mortality. The presence of flight diverters was associated with a decrease of 55–94% in bird mortalities. Koops and De Jong (1982) found that the spacing of the BFDs were critical in reducing the mortality rates - mortality rates are reduced up to 86% with a spacing of 5m, whereas using the same devices at 10m intervals only reduces the mortality by 57%. Barrientos *et al.* (2012) found that larger BFDs were more effective in reducing Great Bustard collisions than smaller ones. Line markers should be as large as possible, and highly contrasting with the background. Colour is probably less important as during the day the background will be brighter than the obstacle with the reverse true at lower light levels (e.g. at twilight, or during overcast conditions). Black and white interspersed patterns are likely to maximise the probability of detection (Martin *et al.* 2010).

5.2 Assessment Helena Solar 1 PV and associated infrastructure

5.2.1 Displacement due to disturbance associated with the construction and de-commissioning of the PV plant and associated infrastructure (construction and de-commissioning)

The construction (and de-commissioning) of the PV plant and associated infrastructure (buildings and access roads) will result in a significant amount of movement and noise, which will lead to temporary displacement of avifauna from the site. It is highly likely that most priority species listed in Table 1 will vacate the area for the duration of these activities. There will be no material difference in the level of displacement due to disturbance associated with the two alternative road lay-outs.

5.2.2 Displacement due to habitat transformation associated with the PV plant and associated infrastructure (operation)

The construction of the PV plant and associated infrastructure will result in the radical transformation of the existing habitat, i.e. Bushmanland Basin Shrubland. The vegetation will be cleared prior to construction commencing. Once operational, the construction of the PV arrays will prevent sunlight from reaching the vegetation below the solar panels, which is likely to result in stunted vegetation growth and possibly complete eradication of some species below the solar panels. The natural vegetation is likely to persist in the rows between the PV arrays, but it will be a fraction of what was available before the construction of the plant, and it will contain few shrubs as this will most likely have been cleared prior to construction. Table 1 lists the priority species that could potentially be affected by this impact. Small birds are often capable of surviving in small pockets of suitable habitat, and are therefore generally less affected by habitat fragmentation than larger species. It is, therefore, likely that most of the smaller species will continue to use the habitat available within the solar facility albeit at lower densities. This will however differ from species to species and it may not be true for all of the smaller species. Larger species which require contiguous, un-fragmented tracts of suitable habitat (e.g. large raptors, korhaans and bustards) are more likely to be displaced entirely from the area of the proposed plant although in the case of some raptors (e.g. Southern Pale Chanting Goshawk) the potential availability of carcasses or injured birds due to collisions with the PV panels may actually attract them to the area. The significance of the potential displacement impact is difficult to assess at this stage and will only become clear through operational phase surveys. There will be no material difference in the level of displacement due to disturbance associated with the two alternative road lay-outs.

5.2.3 Collisions with the solar panels of the PV plant (operation)

The 47 priority species that were recorded in the study area which could potentially be exposed to collision risk at the PV1 site is set out in Table 1. The so-called “lake effect” could act as an important attraction to some species and it is expected that flocking species such as Namaqua Sandgrouse, mixed flocks of seed-eaters consisting of inter alia Cape Sparrow, Sociable Weaver, Yellow Canary, Scaly-feathered Finch, Cape Bunting, Lark-like Bunting, Black-eared Sparrow-lark, Sclater’s Lark and several species of doves would be most susceptible to this impact as they habitually arrive in flocks at water holes to drink. Multiple mortalities could potentially result from this, which in turn could attract raptors e.g. Southern Pale Chanting Goshawk and Lanner Falcon which will feed on dead and injured birds which could in turn expose them to collision risk, especially when pursuing injured birds. In addition, the “lake effect" produced by the solar panels may draw various water birds to the area, including endemics e.g. the South African Shelduck and possibly even the Greater Flamingo *Phoenicopterus ruber* (Red Data Status – NT), although the species was not recorded by SABAP2, probably due to the absence of major water bodies within the 9 pentad block where the site is situated. Flamingos often fly long distances at night, which may compound the problem in that they might be more inclined to mistake the PV panels for water during full moon conditions. There are a number of pans situated within a 40km radius around the development site which could potentially be utilised by waterbirds when filled with water, but these are likely to be stochastic events after major rainfall events. It is difficult to assess whether waterbirds will be affected by the "lake effect" at the PV site and it will only become clear once operational phase monitoring takes place.

5.2.4 Other impacts

Cape Sparrows and other small birds will very likely attempt to nest underneath the solar panels to take advantage of the shade, but this should not adversely affect the operation of the equipment. The solar panels are probably too low for Sociable Weavers to nest on them, but they might attempt to build their giant nests on other infrastructure. Another impact that could potentially materialise is the pollution of the solar panels by large birds, particularly Pied Crows and raptors, if they get to perch regularly on the solar arrays. It is hoped that the regular cleaning and maintenance activities will prevent this from becoming a problem, but close monitoring will still be required.

5.3 Assessment Proposed Powerline Corridor Option 1

5.3.1 Displacement of priority species due to disturbance and habitat transformation during the construction and de-commissioning of the 132kV transmission line (construction and de-commissioning)

The noise and movement associated with the construction of the 132kV transmission line will have a temporary displacement impact on the majority priority species. Larger, sensitive species such as Ludwig's Bustard, Northern Black Korhaan, Karoo Korhaan, Secretarybird and Kori Bustard are most likely to be most affected by this temporary impact, although the proximity of the R357 road probably already act as a deterrent for these species. Many studies have shown that bird abundance, occurrence and species richness are reduced near roads, with the largest reductions where traffic levels are high (Summers et.al 2011). Due to the nature of the vegetation, very little if any vegetation clearing will be required. Loss of habitat is therefore likely to be minimal and should not materially affect any priority species.

The situation with regard to the pair of Martial Eagles that bred in 2013 on tower 519 of the 400kV Hydra-Kronos transmission line is more complex. Based on information gathered in the early 2000s, it seems the pair has three alternative nest platforms, i.e. at towers 519, 516 and 512 (Jenkins *et al.* 2013). Tower 519 is situated approximately 330m away from the Kronos MTS perimeter fence; Tower 516 is 1.2km away and 512 is 2.6km away. During the site visit in June 2015, no breeding activity was recorded at the nest site at tower 519, possibly due to the result of high levels of anthropogenic activity at the Kronos MTS (people and construction vehicles). It may be that the birds were using one of the alternative platforms, but it could not be confirmed. The vehicle and people traffic associated with the construction of the 132kV line and other solar facilities in the vicinity of the Kronos MTS would most likely displace the birds from Tower 519, should they attempt to occupy this nest site again in future.

5.3.2 Collisions with the earthwire of the 132kV power line (operational)

The most likely priority species candidates for collision mortality on the proposed 132kV power line Option 1 at the Helena Solar 1 PV site are Ludwig's Bustards, South African Shelduck, Northern Back Korhaan, Karoo Korhaan, Kori Bustard and Secretarybird. Namaqua Sandgrouse might also be at risk if the birds descend in flocks to the surface water in the borrow pits next to the R357. The same problem could present itself with waterbirds. However, the presence of the road will in itself be a mitigating factor in that the vicinity of the road will most likely be avoided by many power line sensitive species, or they will naturally cross the road at a higher altitude. There are a number of pans situated within a 40km radius around the development site which could potentially be utilised by waterbirds when filled with water, but these are likely to be stochastic events after major rainfall events. Regular occurrence of waterbirds at the site is therefore not anticipated.

5.3.3 Other impacts

Sociable Weavers might attempt to nest on the 132kV structures. Whether they are successful in doing so will depend on the type of structure that is used. The steel-monopole structure is generally not very suitable for this purpose. However, if they are successful, this could potentially lead to short circuits when the nests get wet during rainfall events, if the nest straddles two or more phases, or a live and earthed component. Regular removal of nests is the only remedy to prevent this from happening. Pied Crows *Corvus albus* could potentially breed on the structures. Their nests could in turn be utilised by priority species such as Lanner Falcon and Southern Pale Chanting Goshawk.

5.4 Assessment Proposed Powerline Corridor Option 2

5.4.1 Displacement of priority species due to disturbance and habitat transformation during the construction and de-commissioning of the 132kV transmission line (construction and de-commissioning)

The noise and movement associated with the construction of the 132kV transmission line will have a temporary displacement impact on the majority priority species. Larger, sensitive species such as Ludwig's Bustard, Northern Black Korhaan, Karoo Korhaan, Secretarybird and Kori Bustard are most likely to be most affected by this temporary impact. The existing Aries-Kronos 400kV line was inspected but no large raptor nests were discovered on any of the structures. If the status quo persist, no displacement of large raptors is likely to happen in the section between the proposed PV plant and the Kronos MTS when the 132kV line is constructed directly next to it. However, this could change in future and should therefore not be taken as a constant.

The issue of the Martial Eagles breeding on structure 519 of the Hydra-Kronos 400kV line is discussed above under 5.3.1, and the situation will be identical for this option.

5.4.2 Collisions with the earthwire of the 132kV power line (operational)

The most likely priority species candidates for collision mortality on the proposed 132kV power line Option 2 at the Helena Solar 1 PV site are Ludwig's Bustards, South African Shelduck, Northern Back Korhaan, Karoo Korhaan, Kori Bustard and Secretarybird. The presence of the Aries- Kronos 400kV line which will be running adjacent to the 132kV line may to some extent act as a shield in that resident birds may have become accustomed to the presence of an obstacle in this location and learnt to avoid the larger 400kV line by flying over it, reducing the risk of collisions with the 132kV line to some extent.

5.5 Assessment Proposed Substation Option 1

5.5.1 Displacement of priority species due to disturbance and habitat transformation during the construction and de-commissioning of the on-site substation (construction and de-commissioning)

The total area of the proposed substation site comprises approximately 2.96 hectares. The habitat is typical Bushmanland Basin Shrubland, consisting of short, hardy shrubs with areas of bare ground, with no features distinguishing it from the rest of the study area. The habitat is ubiquitous and representative of that which occurs across huge areas of Bushmanland. Viewed in isolation, it is not envisaged that the numbers of priority species that will be permanently displaced from the substation site through habitat transformation will materially threaten the local or regional populations of priority species. However, the considerable spatial extent of the PV development as a whole suggests that it may be an important contributor to the potentially significant, cumulative impacts imposed by this and a number of other planned renewable energy projects on the natural environment of the Copperton area.

5.6 Assessment Proposed Substation Option 2

5.6.1 Displacement of priority species due to disturbance and habitat transformation during the construction and de-commissioning of the on-site substation (construction and de-commissioning)

The situation from an avifaunal perspective with Option 2 is similar to Option 1, as the habitat and size of the two proposed substation sites are essentially identical.

6 ENVIRONMENTAL IMPACT ASSESSMENT METHODOLOGY

The EIA Methodology assists in evaluating the overall effect of a proposed activity on the environment. The determination of the effect of an environmental impact on an environmental parameter is determined through a systematic analysis of the various components of the impact. This is undertaken using information that is available to the environmental practitioner through the process of the environmental impact assessment. The impact evaluation of predicted impacts was undertaken through an assessment of the significance of the impacts.

6.1 Determination of Significance of Impacts

Significance is determined through a synthesis of impact characteristics which include context and intensity of an impact. Context refers to the geographical scale i.e. site, local, national or global whereas Intensity is defined by the severity of the impact e.g. the magnitude of deviation from background conditions, the size of the area affected, the duration of the impact and the overall probability of occurrence. Significance is calculated as shown in the table below.

Significance is an indication of the importance of the impact in terms of both physical extent and time scale, and therefore indicates the level of mitigation required. The total number of points scored for each impact indicates the level of significance of the impact.

6.2 Impact Rating System

Impact assessment must take account of the nature, scale and duration of effects on the environment whether such effects are positive (beneficial) or negative (detrimental). Each issue / impact is also assessed according to the project stages:

- construction
- operation
- decommissioning

Where necessary, the proposal for mitigation or optimisation of an impact has been detailed. A brief discussion of the impact and the rationale behind the assessment of its significance has also been included.

Rating System Used To Classify Impacts

The rating system is applied to the potential impact on the receiving environment and includes an objective evaluation of the mitigation of the impact. Impacts have been consolidated into one rating. In assessing the significance of each issue the following criteria (including an allocated point system) is used:

NATURE
Include a brief description of the impact of environmental parameter being assessed in the context of the project. This criterion includes a brief written statement of the environmental aspect being impacted upon by a particular action or activity.
GEOGRAPHICAL EXTENT
This is defined as the area over which the impact will be expressed. Typically, the severity and significance of an impact have different scales and as such bracketing ranges are often required. This is often useful during the detailed assessment of a project in terms of further defining the determined.

1	Site	The impact will only affect the site
2	Local/district	Will affect the local area or district
3	Province/region	Will affect the entire province or region
4	International and National	Will affect the entire country
PROBABILITY		
This describes the chance of occurrence of an impact		
1	Unlikely	The chance of the impact occurring is extremely low (Less than a 25% chance of occurrence).
2	Possible	The impact may occur (Between a 25% to 50% chance of occurrence).
3	Probable	The impact will likely occur (Between a 50% to 75% chance of occurrence).
4	Definite	Impact will certainly occur (Greater than a 75% chance of occurrence).
REVERSIBILITY		
This describes the degree to which an impact on an environmental parameter can be successfully reversed upon completion of the proposed activity.		
1	Completely reversible	The impact is reversible with implementation of minor mitigation measures
2	Partly reversible	The impact is partly reversible but more intense mitigation measures are required.
3	Barely reversible	The impact is unlikely to be reversed even with intense mitigation measures.
4	Irreversible	The impact is irreversible and no mitigation measures exist.
IRREPLACEABLE LOSS OF RESOURCES		
This describes the degree to which resources will be irreplaceably lost as a result of a proposed activity.		
1	No loss of resource.	The impact will not result in the loss of any resources.
2	Marginal loss of resource	The impact will result in marginal loss of resources.
3	Significant loss of resources	The impact will result in significant loss of resources.
4	Complete loss of resources	The impact is result in a complete loss of all resources.
DURATION		
This describes the duration of the impacts on the environmental parameter. Duration indicates the lifetime of the impact as a result of the proposed activity		
1	Short term	The impact and its effects will either disappear with mitigation or will be mitigated through natural process in a span shorter than the construction phase (0 – 1 years), or the impact and its effects will last for the period of a relatively short construction period and a limited recovery

		time after construction, thereafter it will be entirely negated (0 – 2 years).
2	Medium term	The impact and its effects will continue or last for some time after the construction phase but will be mitigated by direct human action or by natural processes thereafter (2 – 10 years).
3	Long term	The impact and its effects will continue or last for the entire operational life of the development, but will be mitigated by direct human action or by natural processes thereafter (10 – 50 years).
4	Permanent	The only class of impact that will be non-transitory. Mitigation either by man or natural process will not occur in such a way or such a time span that the impact can be considered transient (Indefinite).
CUMULATIVE EFFECT		
This describes the cumulative effect of the impacts on the environmental parameter. A cumulative effect/impact is an effect which in itself may not be significant but may become significant if added to other existing or potential impacts emanating from other similar or diverse activities as a result of the project activity in question.		
1	Negligible Cumulative Impact	The impact would result in negligible to no cumulative effects
2	Low Cumulative Impact	The impact would result in insignificant cumulative effects
3	Medium Cumulative impact	The impact would result in minor cumulative effects
4	High Cumulative Impact	The impact would result in significant cumulative effects
INTENSITY / MAGNITUDE		
Describes the severity of an impact		
1	Low	Impact affects the quality, use and integrity of the system/component in a way that is barely perceptible.
2	Medium	Impact alters the quality, use and integrity of the system/component but system/ component still continues to function in a moderately modified way and maintains general integrity (some impact on integrity).
3	High	Impact affects the continued viability of the system/component and the quality, use, integrity and functionality of the system or component is severely impaired and may temporarily cease. High costs of rehabilitation and remediation.

4	Very high	Impact affects the continued viability of the system/component and the quality, use, integrity and functionality of the system or component permanently ceases and is irreversibly impaired (system collapse). Rehabilitation and remediation often impossible. If possible rehabilitation and remediation often unfeasible due to extremely high costs of rehabilitation and remediation.
SIGNIFICANCE		
Significance is determined through a synthesis of impact characteristics. Significance is an indication of the importance of the impact in terms of both physical extent and time scale, and therefore indicates the level of mitigation required. This describes the significance of the impact on the environmental parameter. The calculation of the significance of an impact uses the following formula: **(Extent + probability + reversibility + irreplaceability + duration + cumulative effect) x magnitude/intensity.** The summation of the different criteria will produce a non weighted value. By multiplying this value with the magnitude/intensity, the resultant value acquires a weighted characteristic which can be measured and assigned a significance rating.		
Points	**Impact Significance Rating**	**Description**
6 to 28	Negative Low impact	The anticipated impact will have negligible negative effects and will require little to no mitigation.
6 to 28	Positive Low impact	The anticipated impact will have minor positive effects.
29 to 50	Negative Medium impact	The anticipated impact will have moderate negative effects and will require moderate mitigation measures.
29 to 50	Positive Medium impact	The anticipated impact will have moderate positive effects.
51 to 73	Negative High impact	The anticipated impact will have significant effects and will require significant mitigation measures to achieve an acceptable level of impact.
51 to 73	Positive High impact	The anticipated impact will have significant positive effects.
74 to 96	Negative Very high impact	The anticipated impact will have highly significant effects and are unlikely to be able to be mitigated adequately. These impacts could be considered "fatal flaws".
74 to 96	Positive Very high impact	The anticipated impact will have highly significant positive effects.

6.3 Impact Assessments

6.3.1 Construction Phase

CONSTRUCTION: PV PLANT AND ASSOCIATED INFRASTRUCTURE		
Environmental Parameter	*Avifauna*	
Issue/Impact/Environmental Effect/Nature	*Displacement of priority species due to disturbance and habitat transformation associated with construction of the PV plant and associated infrastructure.*	
Extent	*Site = 1 The displacement impact will be restricted to the site.*	
Probability	*Definite = 4 The impact will definitely occur.*	
Reversibility	*Barely reversible = 3 The impact is unlikely to be reversed as the habitat transformation after the construction phase will be significant. Many species will not be able to re-colonise the area.*	
Irreplaceable loss of resources	*Significant loss of resources = 3 The impact on priority species will result in a significant loss of resources at a site level (see also discussion on cumulative impacts below).*	
Duration	*Long term = 3 The impact is likely to continue for the duration of the operational phase.*	
Cumulative effect	*High cumulative impact = 4 The cumulative impact will be high at a site level (see also discussion on cumulative impacts below)*	
Intensity/magnitude	*High = 3 At a site level the functioning of the bird population will be severely impacted and for many species it will cease completely.*	
Significance Rating	*18 x 3 = 54* *Negative high impact*	
	Pre-mitigation impact rating	Post mitigation impact rating
Extent	1	1
Probability	4	3
Reversibility	3	3
Irreplaceable loss	3	3
Duration	3	3
Cumulative effect	4	4
Intensity/magnitude	3	3
Significance rating	-54 (High negative)	-51 (High negative)
Mitigation measures	• *Construction activity should be restricted to the immediate footprint of the infrastructure.* • *Access to the remainder of the site should be strictly controlled to prevent unnecessary disturbance of priority species.* • *Measures to control noise and dust should be applied according to current best practice in the industry.*	

	• *Maximum used should be made of existing access roads and the construction of new roads should be kept to a minimum.*

CONSTRUCTION: 132KV POWER LINE OPTION 1		
Environmental Parameter	*Avifauna*	
Issue/Impact/Environmental Effect/Nature	*Displacement of priority species due to disturbance and habitat transformation associated with construction of the 132kV power line.*	
Extent	*Local = 2 The displacement impact could affect the local population of Martial Eagles if the pair at tower 519 is displaced.*	
Probability	*Probable = 3 The impact will likely occur.*	
Reversibility	*Barely reversible = 3 Once the construction activity ceases, the source of displacement will be removed and the priority species should be able to utilise the habitat again. However, in the case of the Martial Eagles, construction activities linked to other renewable projects could prevent the birds from returning. This would require relocation of the nest to an area away from the Kronos MTS.*	
Irreplaceable loss of resources	*Significant loss of resources = 3The impact on the Martial Eagles will result in a significant loss of resources at a local level (see also discussion on cumulative impacts below).*	
Duration	*Medium term = 2The impact is likely to continue for 2 – 10 years as several renewable projects are developed with grid connection to Kronos MTS.*	
Cumulative effect	*High cumulative impact = 4The cumulative impact of the loss of a pair of Martial Eagles will be high at a local level (see also discussion on cumulative impacts below)*	
Intensity/magnitude	*Medium = 2 At a local level the functioning of the bird population will be moderately affected.*	
Significance Rating	*15 x 3 = 45* *Negative medium impact*	
	Pre-mitigation impact rating	Post-mitigation impact rating
Extent	2	1
Probability	3	2
Reversibility	3	1
Irreplaceable loss	3	2

Duration	2	1
Cumulative effect	4	2
Intensity/magnitude	2	2
Significance rating	-34 (medium negative)	-18 (low negative)
Mitigation measures	• *Construction activity should be restricted to the immediate footprint of the infrastructure.* • *Access to the remainder of the site should be strictly controlled to prevent unnecessary disturbance of priority species.* • *Measures to control noise and dust should be applied according to current best practice in the industry.* • *Maximum used should be made of existing access roads and the construction of new roads should be kept to a minimum.* • *Given that the Martial Eagle nest site at tower 519 has been confirmed as having been occupied and active in 2013, the recommendation made in an earlier impact study (Jenkins & du Plessis 2013) that efforts should be made to encourage these eagles to move to an alternative, less disturbed and hazardous nesting site, is supported here. The extent of energy development planned for the immediate vicinity of this probably preclude a short-range relocation, and a dedicated structure, strategically situated off the power line network aggregated around the Kronos MTS, may be the best option.*	

CONSTRUCTION: 132KV POWER LINE OPTION 2	
Environmental Parameter	*Avifauna*
Issue/Impact/Environmental Effect/Nature	*Displacement of priority species due to disturbance and habitat transformation associated with construction of the 132kV power line.*
Extent	*Local = 2 The displacement impact could affect the local population of Martial Eagles if the pair at tower 519 is displaced.*
Probability	*Probable = 3 The impact will likely occur.*
Reversibility	*Barely reversible = 3Once the construction activity ceases, the source of displacement will be removed and the priority species should be able to utlise the habitat again. However, in the case of the Martial Eagles, construction activities linked to other renewable projects could prevent the birds from returning.*
Irreplaceable loss of resources	*Significant loss of resources = 3The impact on the Martial Eagles will result in a significant loss of resources at a*

	local level (see also discussion on cumulative impacts below).	
Duration	*Medium term = 2The impact is likely to continue for 2 – 10 years as several renewable projects are developed with grid connection to Kronos MTS.*	
Cumulative effect	*High cumulative impact = 4The cumulative impact of the loss of a pair of Martial Eagles will be high at a local level (see also discussion on cumulative impacts below)*	
Intensity/magnitude	*Medium = 2 At a local level the functioning of the bird population will be moderately affected.*	
Significance Rating	*15 x 3 = 45* *Negative medium impact*	
	Pre-mitigation impact rating	Post mitigation impact rating
Extent	2	1
Probability	3	2
Reversibility	3	1
Irreplaceable loss	3	2
Duration	2	1
Cumulative effect	4	2
Intensity/magnitude	2	2
Significance rating	-34 (medium negative)	-18 (low negative)
Mitigation measures	• *Construction activity should be restricted to the immediate footprint of the infrastructure.* • *Access to the remainder of the site should be strictly controlled to prevent unnecessary disturbance of priority species.* • *Measures to control noise and dust should be applied according to current best practice in the industry.* • *Maximum used should be made of existing access roads and the construction of new roads should be kept to a minimum.* • *Given that the Martial Eagle nest site at tower 519 has been confirmed as having been occupied and active in 2013, the recommendation made in an earlier impact study (Jenkins & du Plessis 2013) that efforts should be made to encourage these eagles to move to an alternative, less disturbed and hazardous nesting site, is supported here. The extent of energy development planned for the immediate vicinity of this probably preclude a short-range relocation, and a dedicated structure, strategically situated off the power line network*	

	aggregated around the Kronos substation, may be the best option.

CONSTRUCTION: SUBSTATION OPTION 1		
Environmental Parameter	*Avifauna*	
Issue/Impact/Environmental Effect/Nature	*Displacement of priority species due to disturbance and habitat transformation associated with construction of the substation.*	
Extent	*Site = 1 The displacement impact will be restricted to the site.*	
Probability	*Possible = 3 The impact will possibly occur.*	
Reversibility	*Completely reversible = 1 The impact will be completely reversible on de-commissioning of the plant provided the substation infrastructure is removed and the habitat rehabilitated.*	
Irreplaceable loss of resources	*Marginal loss of resources = 2The impact on priority species will result in a marginal loss of resources at a site level (see also discussion on cumulative impacts below).*	
Duration	*Long term = 3 The impact is likely to continue right through the operational life-time of the facility.*	
Cumulative effect	*Low cumulative impact = 2 The cumulative impact will be low at a site level (see also discussion on cumulative impacts below)*	
Intensity/magnitude	*Low = 1 At a site level the functioning of the bird population will be slightly impacted.*	
Significance Rating	*12 x 1 = 12* *Negative low impact*	
	Pre-mitigation impact rating	Post mitigation impact rating
Extent	1	1
Probability	3	2
Reversibility	1	1
Irreplaceable loss	2	2
Duration	3	2
Cumulative effect	2	2
Intensity/magnitude	1	1
Significance rating	-12 (low negative)	-11 (low negative)

Mitigation measures	• *Construction activity should be restricted to the immediate footprint of the infrastructure.* • *Access to the remainder of the site should be strictly controlled to prevent unnecessary disturbance of priority species.* • *Measures to control noise and dust should be applied according to current best practice in the industry.* • *Maximum used should be made of existing access roads and the construction of new roads should be kept to a minimum.*

CONSTRUCTION: SUBSTATION OPTION 2		
Environmental Parameter	*Avifauna*	
Issue/Impact/Environmental Effect/Nature	*Displacement of priority species due to disturbance and habitat transformation associated with construction of the substation.*	
Extent	*Site = 1 The displacement impact will be restricted to the site.*	
Probability	*Possible = 3 The impact will possibly occur.*	
Reversibility	*Completely reversible = 1 The impact will be completely reversible on de-commissioning of the plant provided the substation infrastructure is removed and the habitat rehabilitated.*	
Irreplaceable loss of resources	*Marginal loss of resources = 2The impact on priority species will result in a marginal loss of resources at a site level (see also discussion on cumulative impacts below).*	
Duration	*Long term = 3The impact is likely to continue right through the operational life-time of the facility.*	
Cumulative effect	*Low cumulative impact = 2The cumulative impact will be low at a site level (see also discussion on cumulative impacts below)*	
Intensity/magnitude	*Low = 1 At a site level the functioning of the bird population will be slightly impacted.*	
Significance Rating	*12 x 1 = 12* *Negative low impact*	
	Pre-mitigation impact rating	Post mitigation impact rating
Extent	1	1
Probability	3	2
Reversibility	1	1
Irreplaceable loss	2	2
Duration	3	2

Cumulative effect	2	2
Intensity/magnitude	1	1
Significance rating	-12 (low negative)	-11 (low negative)
Mitigation measures	• *Construction activity should be restricted to the immediate footprint of the infrastructure.* • *Access to the remainder of the site should be strictly controlled to prevent unnecessary disturbance of priority species.* • *Measures to control noise and dust should be applied according to current best practice in the industry.* • *Maximum used should be made of existing access roads and the construction of new roads should be kept to a minimum.*	

6.3.2 Operational Phase

OPERATION: PV PLANT AND ASSOCIATED INFRASTRUCTURE		
Environmental Parameter	*Avifauna*	
Issue/Impact/Environmental Effect/Nature	*Displacement of priority species due to habitat transformation associated with construction of the PV plant and associated infrastructure.*	
Extent	*Site = 1 The displacement impact will be restricted to the site.*	
Probability	*Definite = 4 The impact will definitely occur.*	
Reversibility	*Completely reversible = 1 The impact will be completely reversible on de-commissioning of the plant provided the solar panels are all removed and the habitat allowed to recover over time.*	
Irreplaceable loss of resources	*Significant loss of resources = 3The impact on priority species will result in a significant loss of resources at a site level (see also discussion on cumulative impacts below).*	
Duration	*Long term = 3The impact is likely to continue right through the operational life-time of the facility.*	
Cumulative effect	*High cumulative impact = 4The cumulative impact will be high at a site level (see also discussion on cumulative impacts below)*	
Intensity/magnitude	*High = 3 At a site level the functioning of the bird population will be severely impacted and for many species it will cease completely.*	
Significance Rating	*15 x 3 = 45* *Negative medium impact*	
	Pre-mitigation impact rating	Post mitigation impact rating

Extent	1	1
Probability	4	3
Reversibility	1	1
Irreplaceable loss	3	3
Duration	3	3
Cumulative effect	4	4
Intensity/magnitude	3	3
Significance rating	-48 (medium negative)	-45 (medium negative)
Mitigation measures	• *Construction activity should be restricted to the immediate footprint of the infrastructure.* • *Access to the remainder of the site should be strictly controlled to prevent unnecessary disturbance of priority species.* • *Measures to control noise and dust should be applied according to current best practice in the industry.* • *Maximum used should be made of existing access roads and the construction of new roads should be kept to a minimum.*	

OPERATION: PV PLANT AND ASSOCIATED INFRASTRUCTURE		
Environmental Parameter	*Avifauna*	
Issue/Impact/Environmental Effect/Nature	*Mortality of priority species due to collisions with solar panels*	
Extent	*Site = 1The impact should only affect the site*	
Probability	*Probable = 3*	
Reversibility	*Completely reversible = 1 The impact will be completely reversible on de-commissioning of the plant provided the solar panels are all removed.*	
Irreplaceable loss of resources	*Marginal loss of resources = 2The impact on priority species is likely to be moderate.*	
Duration	*Long term = 3The impact is likely to continue right through the operational life-time of the facility.*	
Cumulative effect	*Medium cumulative impact = 3 The cumulative impact on priority species is likely to be moderate.*	
Intensity/magnitude	*Medium = 2 At a local level the functioning of the bird population will be moderately affected.*	
Significance Rating	*13 x 2 = 26* *Negative low impact*	
	Pre-mitigation impact rating	Post mitigation impact rating
Extent	1	1

Probability	3	2
Reversibility	1	1
Irreplaceable loss	2	2
Duration	3	3
Cumulative effect	3	2
Intensity/magnitude	2	2
Significance rating	-26 (low negative)	-22 (low negative)
Mitigation measures	• *Monitoring should be implemented to search the ground between arrays of solar panels on a weekly basis (every two weeks at the longest) for at least one year to determine the magnitude of collision fatalities. Searches should be done on foot. Searches should be conducted randomly or at systematically selected arrays of solar panels to the extent that equals 33% or more of the project area. Detection trials should be integrated into the searches.* • *The EMP should provide for the on-going inputs of an avifaunal specialist to oversee the operational phase monitoring and assist with the on-going management of bird impacts that may emerge as the operational phase monitoring programme progresses.* • *The exact protocol to be followed for the operational phase monitoring should be compiled by the avifaunal specialist in consultation with the plant operator and Environmental Control Officer before the commencement of operations. The exact scope and nature of the operational phase monitoring will be informed on an ongoing basis by the result of the monitoring and the EMP will be updated accordingly.* • *Depending on the results of the carcass searches, a range of mitigation measures will have to be considered if mortality levels turn out to be significant, including minor modifications of panel and mirror design to reduce the illusory characteristics of solar panels. What is considered to be significant will have to be established on a species specific basis by the avifaunal specialist.*	

OPERATION: 132KV POWER LINE OPTION 1		
Environmental Parameter	*Avifauna*	
Issue/Impact/Environmental Effect/Nature	*Collisions of priority species with the proposed 132kV line.*	
Extent	*Regional = 3 The collision mortality may affect regional populations of some highly mobile priority species e.g. Ludwig's Bustard.*	
Probability	*Probable = 3 The impact will likely occur.*	
Reversibility	*Completely reversible = 1 If the power line gets removed after decommissioning, the impact will also be removed.*	
Irreplaceable loss of resources	*Marginal loss of resources = 2 (see also discussion on cumulative impacts below).*	
Duration	*Long term = 3The impact is likely to continue for the lifetime of the facility.*	
Cumulative effect	*Moderate cumulative impact = 3 (see also discussion on cumulative impacts below)*	
Intensity/magnitude	*Medium = 2 At a local level the functioning of the bird population will be moderately affected.*	
Significance Rating	*15 x 2 = 30* *Negative medium impact*	
	Pre-mitigation impact rating	Post-mitigation impact rating
Extent	3	3
Probability	3	2
Reversibility	1	1
Irreplaceable loss	2	2
Duration	3	3
Cumulative effect	3	2
Intensity/magnitude	2	2
Significance rating	-30 (medium negative)	-28 (low negative)
Mitigation measures	• *The 132kV grid connection should be inspected at least once a quarter for a minimum of three years by the avifaunal specialist to establish if there is any significant collision mortality. Thereafter the frequency of inspections will be informed by the results of the first three years.* • *The detailed protocol to be followed for the inspections will be compiled by the avifaunal specialist prior to the first inspection.*	

	• *The line should be marked with Bird Flight Diverters (BFDs) for their entire length on the earth wire of the line, 5m apart, alternating black and white. See Appendix 3 for the type of BFD which is recommended.*

OPERATION: 132KV POWER LINE OPTION 2		
Environmental Parameter	*Avifauna*	
Issue/Impact/Environmental Effect/Nature	*Collisions of priority species with the proposed 132kV line.*	
Extent	*Regional = 3 The collision mortality may affect regional populations of some highly mobile priority species e.g. Ludwig's Bustard.*	
Probability	*Probable = 3 The impact will likely occur.*	
Reversibility	*Completely reversible = 1 If the power line gets removed after decommissioning, the impact will also be removed.*	
Irreplaceable loss of resources	*Marginal loss of resources = 2 (see also discussion on cumulative impacts below).*	
Duration	*Long term = 3The impact is likely to continue for the lifetime of the facility.*	
Cumulative effect	*Moderate cumulative impact = 3 (see also discussion on cumulative impacts below)*	
Intensity/magnitude	*Medium = 2 At a local level the functioning of the bird population will be moderately affected.*	
Significance Rating	*15 x 2 = 30* *Negative medium impact*	
	Pre-mitigation impact rating	Post-mitigation impact rating
Extent	3	3
Probability	3	2
Reversibility	1	1
Irreplaceable loss	2	2
Duration	3	3
Cumulative effect	3	2
Intensity/magnitude	2	2
Significance rating	-30 (medium negative)	-28 (low negative)

Mitigation measures	• *The 132kV grid connection should be inspected at least once a quarter for a minimum of three years by the avifaunal specialist to establish if there is any significant collision mortality. Thereafter the frequency of inspections will be informed by the results of the first three years.* • *The detailed protocol to be followed for the inspections will be compiled by the avifaunal specialist prior to the first inspection.* • *The line should be marked with Bird Flight Diverters (BFDs) for their entire length on the earth wire of the line, 5m apart, alternating black and white. See Appendix 3 for the type of BFD which is recommended.*

6.3.3 De-commissioning Phase

DE-COMMISSIONING: PV PLANT AND ASSOCIATED INFRASTRUCTURE	
Environmental Parameter	*Avifauna*
Issue/Impact/Environmental Effect/Nature	*Displacement of priority species due to disturbance associated with de-commissioning of the PV plant and associated infrastructure.*
Extent	*Site = 1 The displacement impact will be restricted to the site.*
Probability	*Definite = 4 The impact will definitely occur.*
Reversibility	*Completely reversible = 1 The impact will be completely reversible on de-commissioning of the plant provided the solar panels are all removed and the habitat allowed to recover over time.*
Irreplaceable loss of resources	*Marginal loss of resources = 2 The impact on priority species will result in a minor loss of resources at a site level.*
Duration	*Short term = 1 The impact is likely to last for a short time (0-2 years).*
Cumulative effect	*Low cumulative impact = 2 The cumulative impact will be high at a site level (see also discussion on cumulative impacts below)*
Intensity/magnitude	*Low = 1 At a site level the functioning of the bird population will be slightly impacted.*
Significance Rating	*11 x 1 = 11* *Negative low impact*

	Pre-mitigation impact rating	Post mitigation impact rating
Extent	1	1
Probability	4	3
Reversibility	1	1
Irreplaceable loss	2	2
Duration	1	1
Cumulative effect	2	2
Intensity/magnitude	1	1
Significance rating	-11 (low negative)	-10 (low negative)
Mitigation measures	• *De-commissioning activity should be restricted to the immediate footprint of the infrastructure.* • *Access to the remainder of the site should be strictly controlled to prevent unnecessary disturbance of priority species.* • *Measures to control noise and dust should be applied according to current best practice in the industry.* • *Maximum used should be made of existing access roads and the construction of new roads should be kept to a minimum.*	

DE-COMMISSIONING: 132KV POWER LINE OPTION 1	
Environmental Parameter	*Avifauna*
Issue/Impact/Environmental Effect/Nature	*Displacement of priority species due to disturbance and habitat transformation associated with de-commissioning of the 132kV power line.*
Extent	*Site = 1*
Probability	*Probable = 3 The impact will likely occur.*
Reversibility	*Completely reversible = 1 Once the de-commissioning activity ceases, the source of displacement will be removed and the priority species should be able to utlise the habitat again.*
Irreplaceable loss of resources	*Marginal loss of resources = 2*
Duration	*Short term = 1*
Cumulative effect	*Low cumulative impact = 2 (see also discussion on cumulative impacts below)*
Intensity/magnitude	*Medium = 2 At a local level the functioning of the bird population will be moderately affected.*
Significance Rating	*10 x 2 = 20* *Negative low impact*

	Pre-mitigation impact rating	Post-mitigation impact rating
Extent	1	1
Probability	3	2
Reversibility	1	1
Irreplaceable loss	2	2
Duration	1	1
Cumulative effect	2	2
Intensity/magnitude	2	2
Significance rating	-20 (low negative)	-18 (low negative)
Mitigation measures	• *De-commissioning activity should be restricted to the immediate footprint of the infrastructure.* • *Access to the remainder of the site should be strictly controlled to prevent unnecessary disturbance of priority species.* • *Measures to control noise and dust should be applied according to current best practice in the industry.* • *Maximum used should be made of existing access roads and the construction of new roads should be kept to a minimum.*	

DE-COMMISSIONING: 132KV POWER LINE OPTION 2	
Environmental Parameter	*Avifauna*
Issue/Impact/Environmental Effect/Nature	*Displacement of priority species due to disturbance and habitat transformation associated with de-commissioning of the 132kV power line.*
Extent	*Site = 1*
Probability	*Probable = 3 The impact will likely occur.*
Reversibility	*Completely reversible = 1 Once the de-commissioning activity ceases, the source of displacement will be removed and the priority species should be able to utlise the habitat again.*
Irreplaceable loss of resources	*Marginal loss of resources = 2*
Duration	*Short term = 1*
Cumulative effect	*Low cumulative impact = 2 (see also discussion on cumulative impacts below)*
Intensity/magnitude	*Medium = 2 At a local level the functioning of the bird population will be moderately affected.*

Significance Rating	*10 x 2 = 20* *Negative low impact*	
	Pre-mitigation impact rating	Post-mitigation impact rating
Extent	1	1
Probability	3	2
Reversibility	1	1
Irreplaceable loss	2	2
Duration	1	1
Cumulative effect	2	2
Intensity/magnitude	2	2
Significance rating	-20 (low negative)	-18 (low negative)
Mitigation measures	• *De-commissioning activity should be restricted to the immediate footprint of the infrastructure.* • *Access to the remainder of the site should be strictly controlled to prevent unnecessary disturbance of priority species.* • *Measures to control noise and dust should be applied according to current best practice in the industry.* • *Maximum used should be made of existing access roads and the construction of new roads should be kept to a minimum.*	

DE-COMMISSIONING: SUBSTATION OPTION 1	
Environmental Parameter	*Avifauna*
Issue/Impact/Environmental Effect/Nature	*Displacement of priority species due to disturbance associated with de-commissioning of the substation.*
Extent	*Site = 1 The displacement impact will be restricted to the site.*
Probability	*Possible = 3 The impact will possibly occur.*
Reversibility	*Completely reversible = 1 The impact will be completely reversible on de-commissioning of the plant provided the substation infrastructure is removed and the habitat rehabilitated.*
Irreplaceable loss of resources	*Marginal loss of resources = 2 The impact on priority species will result in a marginal loss of resources at a site level (see also discussion on cumulative impacts below).*
Duration	*Short term = 1 The impact is likely to continue for 0-2 years*

Cumulative effect	*Low cumulative impact = 2The cumulative impact will be low at a site level (see also discussion on cumulative impacts below)*	
Intensity/magnitude	*Low = 1 At a site level the functioning of the bird population will be slightly impacted.*	
Significance Rating	*10 x 1 = 10* *Negative low impact*	
	Pre-mitigation impact rating	Post mitigation impact rating
Extent	1	1
Probability	3	2
Reversibility	1	1
Irreplaceable loss	2	2
Duration	1	1
Cumulative effect	2	2
Intensity/magnitude	1	1
Significance rating	-10 (low negative)	-9 (low negative)
Mitigation measures	• *De-commissioning activity should be restricted to the immediate footprint of the infrastructure.* • *Access to the remainder of the site should be strictly controlled to prevent unnecessary disturbance of priority species.* • *Measures to control noise and dust should be applied according to current best practice in the industry.* • *Maximum used should be made of existing access roads and the construction of new roads should be kept to a minimum.*	

DE-COMMISSIONING: SUBSTATION OPTION 2	
Environmental Parameter	*Avifauna*
Issue/Impact/Environmental Effect/Nature	*Displacement of priority species due to disturbance associated with de-commissioning of the substation.*
Extent	*Site = 1 The displacement impact will be restricted to the site.*
Probability	*Possible = 3 The impact will possibly occur.*
Reversibility	*Completely reversible = 1 The impact will be completely reversible on de-commissioning of the plant provided the substation infrastructure is removed and the habitat rehabilitated.*
Irreplaceable loss of resources	*Marginal loss of resources = 2 The impact on priority species will result in a marginal loss of resources at a site level (see also discussion on cumulative impacts below).*

Duration	*Short term = 1 The impact is likely to continue for 0-2 years*	
Cumulative effect	*Low cumulative impact = 2The cumulative impact will be low at a site level (see also discussion on cumulative impacts below)*	
Intensity/magnitude	*Low = 1 At a site level the functioning of the bird population will be slightly impacted.*	
Significance Rating	*12 x 1 = 12* *Negative low impact*	
	Pre-mitigation impact rating	Post mitigation impact rating
Extent	1	1
Probability	3	2
Reversibility	1	1
Irreplaceable loss	2	2
Duration	1	1
Cumulative effect	2	2
Intensity/magnitude	1	1
Significance rating	-10 (low negative)	-9 (low negative)
Mitigation measures	• *De-commissioning activity should be restricted to the immediate footprint of the infrastructure.* • *Access to the remainder of the site should be strictly controlled to prevent unnecessary disturbance of priority species.* • *Measures to control noise and dust should be applied according to current best practice in the industry.* • *Maximum used should be made of existing access roads and the construction of new roads should be kept to a minimum.*	

6.4 Impact Summary

The impacts were summarized and a comparison made between pre and post mitigation phases as shown in Table 3 below. The rating of environmental issues associated with different parameters prior to and post mitigation of a proposed activity was averaged. A comparison was then made to determine the effectiveness of the proposed mitigation measures. The comparison identified critical issues related to the environmental parameters.

Environmental parameter	**Issues**	**Rating prior to mitigation**	**Rating post mitigation**
Avifauna	Displacement by PV plant construction	-54 (High negative)	-51 (High negative)

	Displacement by power line construction	-34 (Medium negative)	-18 (Low negative)
	Displacement by the substation construction	-12 (Low negative)	-11 (Low negative)
	Displacement by PV plant operation	-48 (Medium negative)	-45 (Medium negative)
	Collisions with solar panels	-26 (Low negative)	-22 (Low negative)
	Collisions with 132kVpowerline	-30 (Medium negative)	-28 (Low negative)
	Displacement by PV plant de-commissioning	-11 (Low negative)	-10 (Low negative)
	Displacement by power line de-commissioning	-20(Low negative)	-18 (Low negative)
	Displacement by the substation de-commissioning	-10 (Low negative)	-9 (Low negative)
	Average	**-27.2 (Low negative)**	**-23.5 (Low negative)**

Table 3: Comparison of summarised impacts on environmental parameters

The 2010 EIA regulations also specify that alternatives must be compared in terms of impact assessment. Table 4 below sets out the comparative assessment of the various alternatives.

PREFERRED	The alternative will result in a low impact / reduce the impact
FAVOURABLE	The impact will be relatively insignificant
NOT PREFERRED	The alternative will result in a high impact / increase the impact
NO PREFERENCE	The alternative will result in equal impacts

Alternative	**Preference**	**Reasons**
SUBSTATION		
Substation Site Alternative 1	NO PREFERENCE	The habitat at the two substation alternatives is very similar. The alternative will result in equal impacts
Substation Site Alternative 2	NO PREFERENCE	The habitat at the two substation alternatives is very similar. The alternative will result in equal impacts
INTERNAL ROADS		

Alternative	Preference	Reasons
Internal Road Alternative 1	NO PREFERENCE	The extent of the impacts of the two internal road network alternatives is very similar. The alternative will result in equal impacts.
Internal Road Alternative 2	NO PREFERENCE	The extent of the impacts of the two internal road network alternatives is very similar. The alternative will result in equal impacts.
POWER LINES		
Power Line Corridor Alternative 1		The extent of the impacts of the two power line corridor alternatives is very similar. The alternative will result in equal impacts.
Power Line Corridor Alternative 2		The extent of the impacts of the two power line corridor alternatives is very similar. The alternative will result in equal impacts.

Table 4: Comparison of alternatives

6.4.1 Cumulative impacts

A cumulative impact, in relation to an activity, is the impact of an activity that may not be significant on its own but may become significant when added to the existing and potential impacts arising from similar or other activities in the area.

Currently there is no agreed method for determining significant adverse cumulative impacts on ornithological receptors, although clearly a more strategic approach should be followed than is currently the case (Jenkins *et al.* 2011). The Scottish Natural Heritage (2005) recommends a five-stage process to aid in the ornithological assessment:

- Define the species/habitat to be considered;
- Consider the limits or 'search area' of the study;
- Decide the methods to be employed;
- Review the findings of existing studies; and
- Draw conclusions of cumulative effects within the study area.

Table 5 below sets out the criteria applied to rank potential cumulative impacts:

Table 5: Framework for assessing significance of cumulative effects

Significance	Effect
Severe	Effects that the decision-maker must take into account as the receptor/resource is irretrievably compromised.
Major	Effects that may become a key decision-making issue.
Moderate	Effects that are unlikely to become issues on whether the project design should be selected, but where future work may be needed to improve on current performance.
Minor	Effects which are locally significant.
Not Significant	Effects that are beyond the current forecasting ability or are within the ability of the resource to absorb such change.

6.4.1.1 Cumulative impacts at a local level (within a 20km radius)

The Kronos MTS forms the hub of a renewable energy node which is planned for the future (See Figure 10 below). The total potentially transformed area is within a 20km radius around the Kronos MTS amounts to 593km^2[2], which amounts to 47% of the available land within the 20km radius, or the equivalent of 2.1 Martial Eagle territories in Nama Karoo habitat (Hockey *et al.* 2005).

[2] This calculation is based on the size of land parcels. The whole land parcel will not be covered with infrastructure, but in the case of solar developments the majority of the land parcel is likely to be transformed.

Potential mortality due to collisions with the proposed PV arrays

In the current instance, not all the criteria proposed above by the Scottish Natural Heritage can be met in assessing the cumulative impact of potential mortality due to collisions with the proposed PV arrays at a local level. The main reason is that no scientifically verified information exists with regard to actual avifaunal mortality levels with the status quo as it currently exists, in other words there are no existing studies to review as far as existing impacts on the avifauna is concerned. In the absence of any scientifically verified data, general knowledge and experience will have to suffice. Given the extensive farming practices which are currently used in the study area, it can be surmised that the existing anthropogenic impacts on avifauna in the study area is relatively low. Although it cannot be confirmed, interviews with the landowner indicate that active persecution of large raptors for alleged stock killing is not commonly practised. Hunting of avifauna is also not a major impact. Overall, the very low human population is definitely advantageous to avifauna in general. All of these assertions would ideally need to be tested empirically in order to make comparisons possible, but a study of that proportion falls outside the scope of this project.

The one existing impact that can be taken as confirmed is the mortality of Ludwig's Bustard due to collisions with the existing high voltage network in the 20km radius around the proposed development. Due to the presence of the Kronos MTS, there is an extensive network of HV lines feeding into the substation. The extent of this mortality factor is unknown, but it can be assumed that it is a regular occurrence (Shaw 2013). The key question therefore is to what extent potential collisions with the PV arrays will contribute to this existing and potentially significant mortality factor, taking into account not only the status quo as it currently stands, but also the future situation should all the proposed renewable energy projects materialise. It is not envisaged that collisions of Ludwig's Bustard with the PV arrays will be a major impact, as the species is not likely to be attracted by the "lake effect". The cumulative impact of mortality of Ludwig's Bustard at the proposed Helena PV site, due to collisions with the PV arrays, is therefore likely to be negligible.

As far as the other priority species are concerned, the cumulative impact may be more significant, assuming that all the proposed renewable energy plants will be built. Overall, the cumulative impact of collisions with renewable energy infrastructure (solar panels and wind turbines) consisting of a total surface area of approximately 593km², or 47% of the area within a 20km radius, could be **Moderate** at a local level for priority species. With mitigation, this could probably be reduced to **Minor,** but it must be borne in mind that mitigation for this type of impact still in an experimental phase.

Displacement of priority species due to habitat transformation and disturbance

The difficulties associated with the quantification of cumulative impacts of the renewable energy facilities at a local level have already been explained above. The current land use, namely extensive sheep farming, is not displacing any priority species although it may be that periodic overgrazing might have an impact on the habitat and therefore the densities of some species. However, that cannot be categorically confirmed without more research. As far as potential future impacts are concerned, the cumulative impact of habitat transformation due to renewable energy infrastructure consisting of a total surface area of approximately 593km², or 47% of the area within a 20km radius, is likely to be significant for many species, especially large terrestrial species such as Ludwig's Bustard, Northern Black Korhaan, Karoo Korhaan, Secretarybird, large raptors (particularly Martial Eagle) and range restricted species such as Sclater's Lark. Apart from the direct habitat loss due to solar panels and wind turbines, the habitat fragmentation caused by the proposed road networks might indirectly have a significant impact on large terrestrial species, particularly Ludwig's Bustard, as it is known that the species avoids the vicinity of roads (Shaw 2013). Overall, the significance of this impact is rated at **Major** at a local level (i.e. within a 20km radius), and will remain so irrespective of mitigation. It should however not be viewed as a fatal flaw, as the regional impact is not as severe (see 6.7.3.2 below)

<u>Bird collisions, particularly priority species, with the proposed 132kV grid connection</u>

The difficulties associated with the quantification of cumulative impacts at a local level have already been explained above. The risks that power lines pose to avifauna, and specifically to Ludwig's Bustards, is well researched (Shaw 2013). These transmission lines will increase the already high collision risk to the species that power lines pose throughout its range. No quantification of Ludwig's Bustard collision mortality has been undertaken for the local area, but it can be assumed that it is a regular occurrence (Shaw 2013). The key question therefore is to what extent transmission line collisions will contribute to this existing and potentially significant mortality factor. All in all, it is envisaged that collisions of priority species, particularly Ludwig's Bustard, with the new Helena 132kV grid connection will have a **Moderate** cumulative impact at a local scale. If the recommendations in this report are implemented, it is envisaged that the cumulative impact of this mortality factor could be reduced to a **Minor** level for the local area. In this respect it should be mentioned that the extensive habitat transformation that is envisaged should all the projects materialise, will definitely reduce the occurrence of the species at a local level and therefore also the collision risk.

6.4.1.2 <u>Cumulative impacts at a regional level (within a 40km radius)</u>

The total amount of land that could potentially be transformed within a 40km radius through renewable energy projects is 926km², which is 18% of the surface area within this 40km radius[3] (see Figure 10 below), or the equivalent of 3.3 Martial Eagle territories in the Nama Karoo (Hockey *et al.* 2005).

The difficulty associated with the quantification of cumulative impacts of the renewable energy facilities at a local level have already been explained above, and is equally valid on a regional scale.

<u>Potential mortality due to collisions with the proposed PV arrays</u>

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[3] This calculation is based on the size of land parcels. The whole land parcel will not be covered with infrastructure, but in the case of solar developments the majority of the land parcel is likely to be transformed.

Given the extensive farming practices which are currently used in the region, it can be surmised that the existing anthropogenic impacts on avifauna is relatively low. Although it cannot be confirmed, interviews with the landowner at Nelspoortjie indicate that active persecution of large raptors for alleged stock killing is not commonly practised. Hunting of avifauna is also not a major impact. Overall, the very low human population is definitely advantageous to avifauna in general. All of these assertions would ideally need to be tested empirically in order to make comparisons possible, but a study of that extent falls outside the scope of this project.

The one existing impact that can be taken as confirmed is the mortality of Ludwig's Bustard due to collisions with the existing power line network in the 40km radius around the proposed development. Due to the presence of the Kronos MTS, there is an extensive network of HV and MV lines feeding into the substation. The extent of this mortality factor is unknown, but it can be assumed that it is a regular occurrence (Shaw 2013). The key question therefore is to what extent collisions with the PV arrays will contribute to this existing and potentially significant mortality factor, taking into account not only the status quo as it currently stands, but also the future situation should all the proposed renewable energy projects materialise. It is not envisaged that collisions of Ludwig's Bustard with the PV arrays will be a major impact, as the species is not likely to be attracted by the "lake effect". The cumulative impact of mortality of Ludwig's Bustard at the proposed Helena PV site, due to collisions with the PV arrays, is therefore likely to be **Insignificant** at a regional scale.

As far as the other priority species are concerned, the cumulative impact at a regional scale may be more significant, assuming that all the proposed renewable energy plants will be built. The cumulative impact of collisions with solar panels and wind turbines consisting of a total surface of approximately 926km², or 18% of the area within a 40km radius, may be more significant, but still relatively minor on a regional scale. The overall cumulative impact is therefore rated as **Minor** on a regional scale.

Displacement of priority species due to habitat transformation and disturbance

The difficulties associated with the quantification of cumulative impacts of the renewable energy facilities at a regional level have already been explained above. The current land use, namely extensive sheep farming, is not displacing any priority species although it may be that periodic overgrazing might have an impact on the habitat and therefore the densities of some species. However, that cannot be categorically confirmed without more research. As far as potential future impacts are concerned, the cumulative impact of habitat transformation due to renewable energy infrastructure consisting of a total surface area of approximately 926km², or 18% of the area within a 40km radius, is not likely to be catastrophic for any of the priority species, as they all have large distribution ranges with healthy populations in the Nama Karoo, with the exception of Sclater's Lark. For the latter species the impact may be more significant, but still within acceptable levels. The overall impact is therefore rated as **Minor** on a regional scale.

<u>Bird collisions, particularly priority species, with the proposed 132kV grid connection</u>

The difficulties associated with the quantification of cumulative impacts at a local level have already been explained above and the same is applicable as far as regional impacts are concerned. The risks that power lines pose to avifauna, and specifically to Ludwig's Bustards, is well researched (Shaw 2013). These transmission lines will increase the already high collision risk to the species that power lines pose throughout its range. No quantification of Ludwig's Bustard collision mortality has been undertaken for the regional area, but it can be assumed that it is a regular occurrence (Shaw 2013). The key question therefore is to what extent transmission line collisions will contribute to this existing and potentially significant mortality factor. All in all, it is envisaged that collisions of priority species particularly Ludwig's Bustard, with the new Helena 132kV grid connections will have a low cumulative impact at a regional scale. If the recommendations in this report are implemented, it is envisaged that the cumulative impact of this mortality factor could be reduced, but will remain at a low level for the regional area. In this respect it should be mentioned that the extensive habitat transformation that is envisaged should all the solar projects materialise, will definitely reduce the occurrence of the species at a local level and therefore also the collision risk. Furthermore, from a regional perspective, the proposed 132kV grid connections are relatively short compared to the existing high voltage network and therefore of moderate/low significance. The overall significance of this impact is therefore rated as **Minor** on a regional scale.

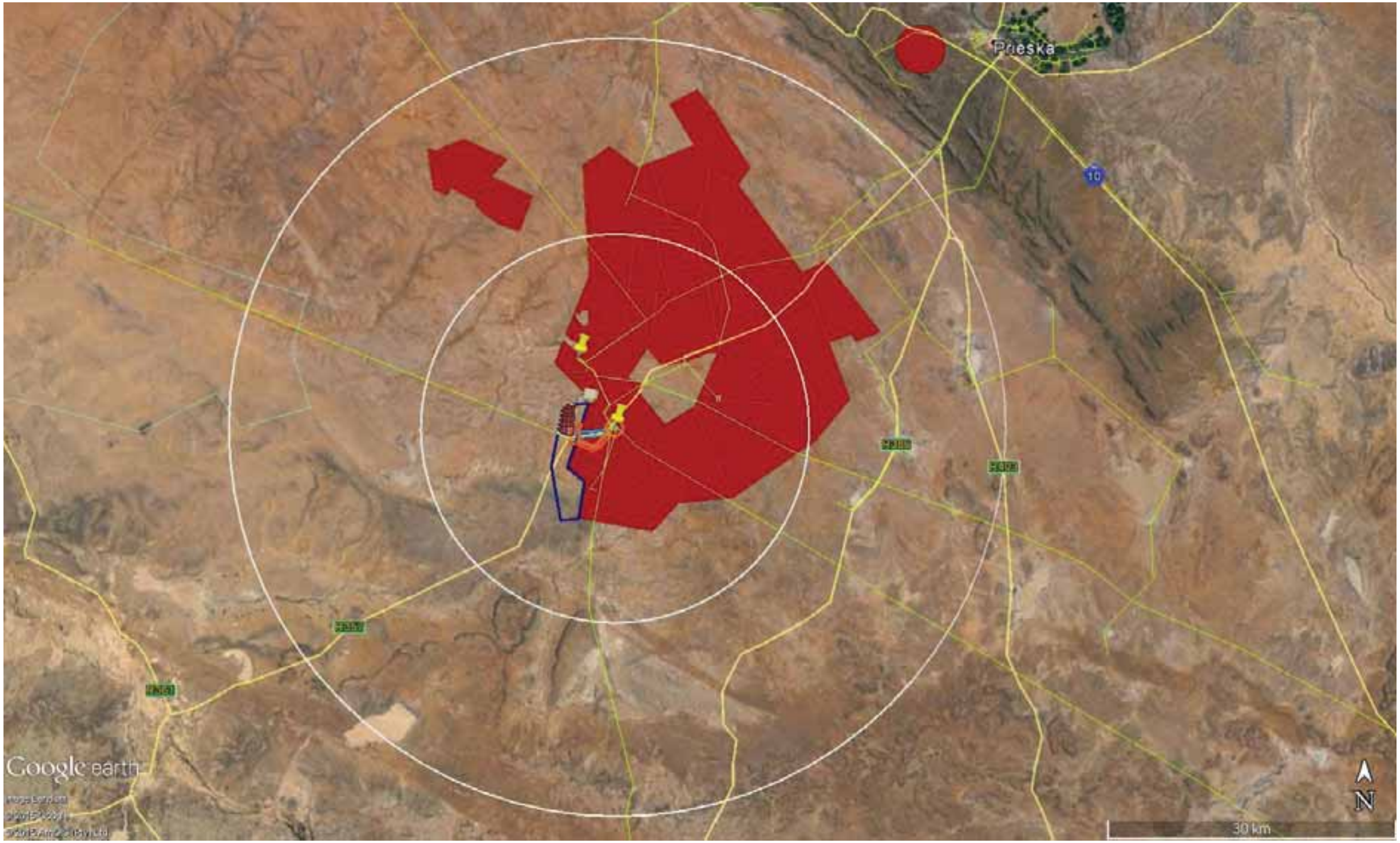


Figure 10: Renewable energy developments planned for the Copperton area (red areas). The inner circle indicates a 20km radius and the outer circle a 40km radius around Kronos MTS. The green lines are existing power lines.

6.4.2 No-Go Alternative

The no-go alternative will result in the current status quo being maintained as far as the avifauna is concerned. Given the extensive farming practices which are currently used in the region, it can be surmised that the existing anthropogenic impacts on avifauna is relatively low. Although it cannot be confirmed, interviews with the landowner at Nelspoortjie indicate that active persecution of large raptors for alleged stock killing is not commonly practised. Hunting of priority avifauna is also not a major impact. Overall, the very low human population in the study area is definitely advantageous to avifauna in general. The no-go option would maintain the ecological integrity of the study area as a whole far as avifauna is concerned.

7 MITIGATION MEASURES

7.1 PV plant, substation and associated infrastructure

7.1.1 Construction

- Construction activity should be restricted to the immediate footprint of the infrastructure.
- Access to the remainder of the site should be strictly controlled to prevent unnecessary disturbance of priority species.
- Measures to control noise and dust should be applied according to current best practice in the industry.
- Maximum use should be made of existing access roads and the construction of new roads should be kept to a minimum.
- The recommendations of the ecological and botanical specialist studies must be strictly implemented, especially as far as limitation of the construction footprint and rehabilitation of disturbed areas is concerned.

7.1.2 Operation

- An avifaunal specialist must be appointed to oversee all aspects of operational phase monitoring (including carcass searches) and assist with the on-going management of bird impacts that may emerge as the monitoring programme progresses. Formal operational phase monitoring should be implemented once the solar arrays have been constructed. The purpose of this would be to establish to what extent displacement of priority species have taken place. The exact time when operational phase monitoring should commence, will depend on the construction schedule, and will be agreed upon with the site operator once these timelines have been finalised.
- As an absolute minimum, operational phase monitoring should be undertaken for the first two years of operation, and then repeated again in year 5, and again every five years thereafter. This is necessary to account for inter-annual variations in avifaunal activity as the result of varying rainfall patterns which can be highly erratic in this arid habitat. The exact scope and nature of the operational phase monitoring will be informed by the results of the monitoring on an ongoing basis and the EMP will be updated accordingly.

- Carcass searches should be implemented to search the ground between arrays of solar panels on a weekly basis (every two weeks at the longest) for at least one year to determine the magnitude of collision fatalities. Searches should be done on foot. Searches should be conducted randomly or at systematically selected arrays of solar panels to the extent that equals 33% or more of the project area. Detection trials should be integrated into the searches.
- Depending on the results of the carcass searches, a range of mitigation measures will have to be considered if mortality levels turn out to be significant, including minor modifications of panel and mirror design to reduce the illusory characteristics of solar panels. What is considered to be significant will have to be established on a species specific basis by the avifaunal specialist, in consultation with Birdlife South Africa.
- The exact protocol to be followed for the carcass searches and operational phase monitoring must be compiled by the avifaunal specialist in consultation with the plant operator and Environmental Control Officer before the commencement of operations.

7.1.3 De-commissioning

- De-commissioning activity should be restricted to the immediate footprint of the infrastructure.
- Access to the remainder of the site should be strictly controlled to prevent unnecessary disturbance of priority species.
- Measures to control noise and dust should be applied according to current best practice in the industry.
- Maximum use should be made of existing access roads and the construction of new roads should be kept to a minimum.
- The recommendations of the ecological and botanical specialist studies must be strictly implemented, especially as far as limitation of the de-commissioning footprint and rehabilitation of disturbed areas is concerned.

7.2 The 132kV grid connection

7.2.1 Construction

- Construction activity should be restricted to the immediate footprint of the infrastructure.
- Access to the remainder of the site should be strictly controlled to prevent unnecessary disturbance of priority species.
- Measures to control noise and dust should be applied according to current best practice in the industry.
- Maximum used should be made of existing access roads and the construction of new roads should be kept to a minimum.

- To protect the Martial Eagle nest site located Tower 519 of the Hydra-Kronos 400kV line, it shall be necessary to relocate the nest site to a more distant, less disturbed area (e.g.

Jenkins et al. 2007, 2013). The extent and distribution of other renewable energy developments planned for the immediate vicinity probably precludes a short-range relocation, and a dedicated structure, strategically situated off the power line network aggregated around the Kronos substation, may be the best option. The requirements of such an undertaking shall be further investigated if the development is authorised and selected as a preferred site by the DoE.

7.2.2 Operation

- The 132kV grid connection should be inspected at least once a quarter for a minimum of three years by the avifaunal specialist to establish if there is any significant collision mortality. Thereafter the frequency of inspections will be informed by the results of the first three years.
- The detailed protocol to be followed for the inspections will be compiled by the avifaunal specialist prior to the first inspection.
- The proposed transmission line for evacuation of the electricity generated by the PVs should be marked with Bird Flight Diverters (BFDs) for their entire length on the earth wire of the line, 5m apart, alternating black and white. See Appendix 3 for the type of BFD which is recommended.

8 CONCLUSIONS

The negative impacts of the proposed Helena PV solar facility on local priority avifauna will range from low to high, depending on the type of impact.
In the case of the PV plant and associated infrastructure, the displacement impact due to disturbance during construction is rated as high to start with, and will remain as such after application of mitigation measures. In the case of habitat transformation during operation, the displacement impact is medium – negative and will remain as such after the application of mitigation measures. The impact of direct mortality due to collisions with the solar panels is likely to be low. The displacement impact associated with the construction of the on-site substation will be low, but should not be viewed in isolation, but rather as part of the overall displacement impact associated with the PV plant.

The proposed 132kV circuit grid connection will have a medium negative collision impact on avifauna during operation which should be reduced to low-negative through the application of anti-collision mitigation measures. The impact of displacement caused by the construction of the power line will be medium negative, but it could be reduced to low if the Martial Eagle nest on the Hydra-Kronos 400kV line could be re-located.

The cumulative impacts of the facility on priority avifauna will range from major to minor on a local scale, and minor to insignificant on a regional scale.

9 REFERENCES

- ALLAN, D.G. 1994. The abundance and movements of Ludwig's Bustard *Neotis ludwigii*. *Ostrich* 65: 95-105
- ANIMAL DEMOGRAPHY UNIT. The southern African Bird Atlas Project 2. University of Cape Town. http://sabap2.adu.org.za. Accessed 02/03/2015.
- AVIAN POWER LINE INTERACTION COMMITTEE (APLIC). 2012. *Mitigating Bird Collisions with Power Lines: The State of the Art in 2012*. Edison Electric Institute. Washington D.C.
- BARNES, K.N. (ed.) 1998. The Important Bird Areas of southern Africa. BirdLife South Africa: Johannesburg.
- BARRIENTOS R, PONCE C, PALACIN C, MARTÍN CA, MARTÍN B, ET AL. 2012. Wire marking results in a small but significant reduction in avian mortality at power lines: A BACI Designed Study. PLoS ONE 7(3): e32569. doi:10.1371/journal.pone.0032569.
- BARRIENTOS, R., ALONSO, J.C., PONCE, C., PALACÍN, C. 2011. Meta-Analysis of the effectiveness of marked wire in reducing avian collisions with power lines. Conservation Biology 25: 893-903.
- BEAULAURIER, D.L. 1981. Mitigation of bird collisions with transmission lines. Bonneville Power Administration. U.S. Dept. of Energy.
- BIRDLIFE SOUTH AFRICA 2014. http://www.birdlife.org.za/conservation/important-bird-areas.
- COUNTY OF MERCED. 2014. Draft Environmental Impact Report for the Wright Solar Park Conditional Use Permit Application CUP12-017. Public Draft. July. (ICF 00552.13.) Merced, CA. Prepared by ICF International, Sacramento, CA.
- H. T. HARVEY & ASSOCIATES. 2014a. California Valley Solar Ranch Project Avian and Bat Protection Plan Sixth Quarterly Post construction Fatality Report 16 November 2013 - 15 February 2014.
- H. T. HARVEY & ASSOCIATES. 2014b. California Valley Solar Ranch Project Avian and Bat Protection Plan Sixth Quarterly Post construction Fatality Report 16 February 2014 - 15 May 2014.
- H. T. HARVEY & ASSOCIATES. 2015. Ivanpah Solar Electric Generating System Avian & Bat Monitoring Plan 2013-2014 Annual Report.
- HARRISON, J.A., ALLAN, D.G., UNDERHILL, L.G., HERREMANS, M., TREE, A.J., PARKER, V & BROWN, C.J. (eds). 1997. The atlas of southern African birds. Vol 1 & 2. BirdLife South Africa, Johannesburg.
- HERNANDEZ, R.R., et al., 2014, "Environmental Impacts of Utility-Scale Solar Energy," Renewable and Sustainable Energy Reviews 29: 766–779.

- HOBBS, J.C.A. & LEDGER J.A. 1986a. The Environmental Impact of Linear Developments; Power lines and Avifauna. *Proceedings of the Third International Conference on Environmental Quality and Ecosystem Stability*. Israel, June 1986.
- HOBBS, J.C.A. & LEDGER J.A. 1986b. Power lines, Birdlife and the Golden Mean. *Fauna and Flora,* 44:23-27.
- HOOGSTAD, C. Email communication from the manager of the Eskom-EWT Strategic Partnership to the author on 25 June 2015.
- HOCKEY P.A.R., DEAN W.R.J., AND RYAN P.G. 2005. Robert's Birds of Southern Africa, seventh edition. Trustees of the John Voelcker Bird Book Fund, Cape Town.
- HUSO, M. 2010. An estimator of wildlife fatality from observed carcasses. Environmetrics 22(3):318–329. Doi: 10.1002/env.1052
- IVANPAH SOLAR ELECTRIC GENERATING SYSTEM. 2014a. ISEGS Monthly Compliance Report 43 April_2014.
- IVANPAH SOLAR ELECTRIC GENERATING SYSTEM. 2014b. ISEGS Monthly Compliance Report 44 May_2014.
- JENKINS, A., DE GOEDE, J.H. & VAN ROOYEN, C.S. 2006. Improving the products of the Eskom Electric Eagle Project. Unpublished report to Eskom. Endangered Wildife Trust.
- JENKINS, A.R. & DU PLESSIS, J.I. 2014. Proposed PV2-10 photovoltaic energy plants on the farm Hoekplaas, near Copperton, Northern Cape: Pre-construction monitoring. Report to Aurecon South Africa (Pty) Ltd.
- JENKINS, A.R. & DU PLESSIS, J.I. 2013. Proposed PV2-10 photovoltaic energy plants on the farm Hoekplaas, near Copperton, Northern Cape: Avian impact assessment. Report to Aurecon South Africa (Pty) Ltd.
- JENKINS, A. & SMALLIE, J. 2009. Terminal velocity: the end of the line for Ludwig's Bustard? Africa Birds and Birding. Vol 14, No 2.
- JENKINS, A.R., SMALLIE, J.J. & DIAMOND, M. 2010. Avian collisions with power lines: a global review of causes and mitigation with a South African perspective. *Bird Conservation International* 20: 263-278.
- KAGAN, R. A., T. C. VINER, P. W. TRAIL, AND E. O. ESPINOZA. 2014. Avian Mortality at Solar Energy Facilities in Southern California: A Preliminary Analysis. National Fish and Wildlife Forensics Laboratory.
- KOOPS, F.B.J. & DE JONG, J. 1982. Vermindering van draadslachtoffers door markering van hoogspanningsleidingen in de omgeving van Heerenveen. Electrotechniek 60 (12): 641 – 646.
- KRUGER, R. & VAN ROOYEN, C.S. 1998. Evaluating the risk that existing power lines pose to large raptors by using risk assessment methodology: The Molopo Case Study. *Proceedings of the 5th World Conference on Birds of Prey and Owls*. August 4-8,1998. Midrand, South Africa.

- KRUGER, R. 1999. *Towards solving raptor electrocutions on Eskom Distribution Structures in South Africa*. Bloemfontein (South Africa): University of the Orange Free State. (M. Phil. Mini-thesis)
- LEDGER, J. 1983. *Guidelines for Dealing with Bird Problems of Transmission Lines and Towers.* Eskom Test and Research Division. (Technical Note TRR/N83/005).
- LEDGER, J.A. & ANNEGARN H.J. 1981. Electrocution Hazards to the Cape Vulture (*Gyps coprotheres*) in South Africa. *Biological Conservation* 20:15-24.
- LEDGER, J.A. 1984. Engineering Solutions to the Problem of Vulture Electrocutions on Electricity Towers. *The Certificated Engineer*, 57:92-95.
- LEDGER, J.A., J.C.A. HOBBS & SMITH T.V. 1992. Avian Interactions with Utility Structures: Southern African Experiences. *Proceedings of the International Workshop on Avian Interactions with Utility Structures*. Miami (Florida), Sept. 13-15, 1992. Electric Power Research Institute.
- MACLEAN, G.L. 1999. Southern African endemic birds: their distribution and conservation. An invited evening public lecture. http://www.int-ornith-union.org/files/proceedings/durban/South%20African%20Papers/SApaper1.htm.
- MARTIN, G., SHAW, J., SMALLIE J. & DIAMOND, M. 2010. Bird’s eye view – How birds see is key to avoiding power line collisions. Eskom Research Report. Report Nr: RES/RR/09/31613.
- MCCRARY, M. D., R. L. MCKERNAN, R. W. SCHREIBER, W. D. WAGNER, AND T. C. SCIARROTTA. 1986. Avian mortality at a solar energy plant. J. Field Ornithology 57:135-141.
- MUCINA. L. & RUTHERFORD, M.C. (Eds) 2006. The vegetation of South Africa, Lesotho and Swaziland. *Strelitzia* 19. South African National Biodiversity Institute, Pretoria.
- RAAB, R., JULIUS, E., SPAKOVSZKY, P. & NAGY, S. 2009. Guidelines for best practice on mitigating impacts of infrastructure development and afforestation on the Great Bustard. Prepared for the Memorandum of Understanding on the conservation and management of the Middle-European population of the Great Bustard under the Convention on Migratory species (CMS). Birdlife International. European Dvision.
- RAAB, R., SPAKOVSZKY, P., JULIUS, E., SCHÜTZ, C. & SCHULZE, C. 2010. Effects of powerlines on flight behaviour of the West-Pannonian Great Bustard *Otis tarda* population. Bird Conservation International. Birdlife International.
- LOSS, S.R., WILL, T., LOSS, S.S., & MARRA, P.P. 2014. Bird–building collisions in the United States: Estimates of annual mortality and species vulnerability. The Condor 116(1):8-23. 2014.
- SHAW, J.M. 2013. Power line collisions in the Karoo: Conserving Ludwig’s Bustard. Unpublished PhD thesis. Percy FitzPatrick Institute of African Ornithology, Department of Biological Sciences, Faculty of Science University of Cape Town May 2013.

- SMALLWOOD, K.S. 2014. Docket Number: 09-AFC-07C. Project Title: Palen Solar Power Project - Compliance. Exhibit 3128. Testimony of K. Shawn Smallwood, Ph.D. California Energy Commission.
- SMALLWOOD, K. S. 2007. Estimating wind turbine-caused bird mortality. Journal of Wildlife Management 71:2781-2791.
- SMALLWOOD, K.S. 2013. Comparing bird and bat fatality-rate estimates among North American wind-energy projects. Wildlife Society Bulletin 37: 19-33.
- SMIT, H.A. 2012. Guidelines to minimise the impact on birds of solar facilities and associated infrastructure in South Africa. Birdlife South Africa.
- SUMMERS, P.D., CUNNINGTON G. M., and FAHRIG, L. 2011. Are the negative effects of roads on breeding birds caused by traffic noise? Journal of Applied Ecology 2011, 48, 1527–1534.
- VAN ROOYEN, C.S. & LEDGER, J.A. 1999. *Birds and utility structures: Developments in southern Africa*. Pp 205-230, in Ferrer, M. & G.F.M. Janns. (eds.). *Birds and Power lines*. Quercus, Madrid (Spain). Pp 238.
- VAN ROOYEN, C.S. & TAYLOR, P.V. 1999. Bird Streamers as probable cause of electrocutions in South Africa. EPRI Workshop on Avian Interactions with Utility Structures 2-3 December 1999. Charleston, South Carolina.
- VAN ROOYEN, C.S. 1998. Raptor mortality on power lines in South Africa. *Proceedings of the 5th World Conference on Birds of Prey and Owls*. Midrand (South Africa), Aug.4 – 8, 1998. .
- VAN ROOYEN, C.S. 1999. An overview of the Eskom-EWT Strategic Partnership in South Africa. *EPRI Workshop on Avian Interactions with Utility Structures* Charleston (South Carolina), Dec. 2-3 1999.
- VAN ROOYEN, C.S. 2000. An overview of Vulture Electrocutions in South Africa. *Vulture News,* 43: 5-22. (Vulture Study Group, Johannesburg, South Africa).
- VAN ROOYEN, C.S. 2007. Eskom-EWT Strategic Partnership: Progress Report April-September 2007. Endangered Wildlife Trust, Johannesburg.
- VAN ROOYEN, C.S. VOSLOO, H.F. & R.E. HARNESS. 2002. Eliminating bird streamers as a cause of faulting on transmission lines in South Africa. *Proceedings of the IEEE 46th Rural Electric Power Conference.* Colorado Springs (Colorado), May. 2002.
- VERDOORN, G.H. 1996. Mortality of Cape Griffons *Gyps coprotheres* and African Whitebacked Vultures *Pseudogyps africanus* on 88kV and 132kV power lines in Western Transvaal, South Africa, and mitigation measures to prevent future problems. *Proceedings of the 2nd International Conference on Raptors*: Urbino (Italy), Oct. 2-5, 1996.

APPENDIX 1: FIELD SURVEYS

Monitoring was conducted in the following manner:

- Field surveys were conducted from 13 – 17 June 2015 at the three proposed Helena PV sites.
- One drive transect was identified totalling 6.87km which covered all three PV sites (see Figure 1 below). One observer travelling slowly (± 5km/h) in a vehicle recorded all species on both sides of the transect. The observer stopped at regular intervals to scan the environment with binoculars.
- Three walk transects of 1km each (one transect in each PV site) were also identified and surveyed three times each.
- The following variables were recorded:
    - Species;
    - Number of birds;
    - Date;
    - Start time and end time;
    - Distance from transect (0-50 m, 50-100 m, >100 m);
    - Wind direction;
    - Wind strength (calm; moderate; strong);
    - Weather (sunny; cloudy; partly cloudy; rain; mist);
    - Temperature (cold; mild; warm; hot);
    - Behaviour (flushed; flying-display; perched; perched-calling; perched-hunting; flying- foraging; flying-commute; foraging on the ground.

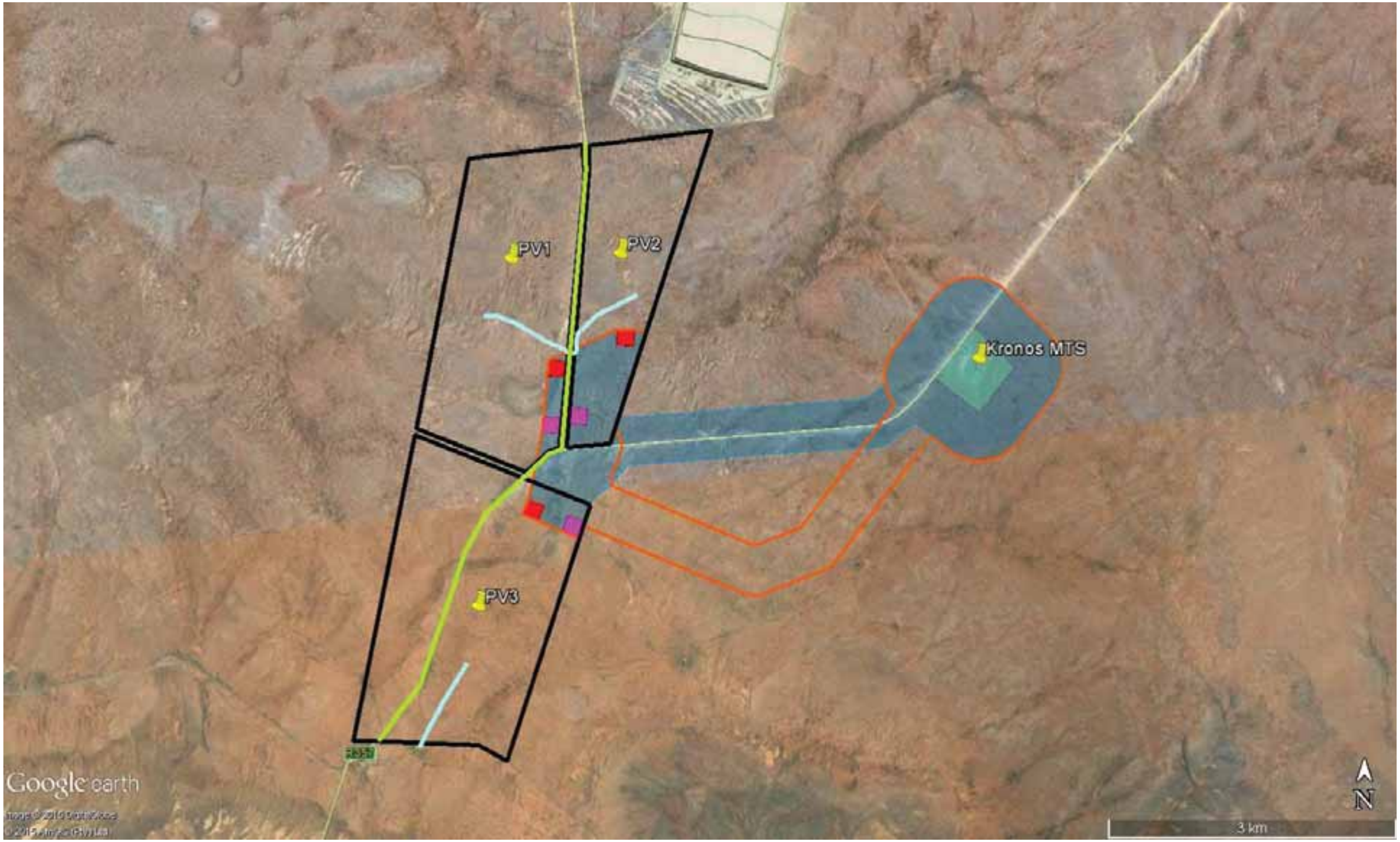


Figure 1: Map of drive and walk transect used during field surveys. The green line is the drive transect, the blue lines are the walk transects.

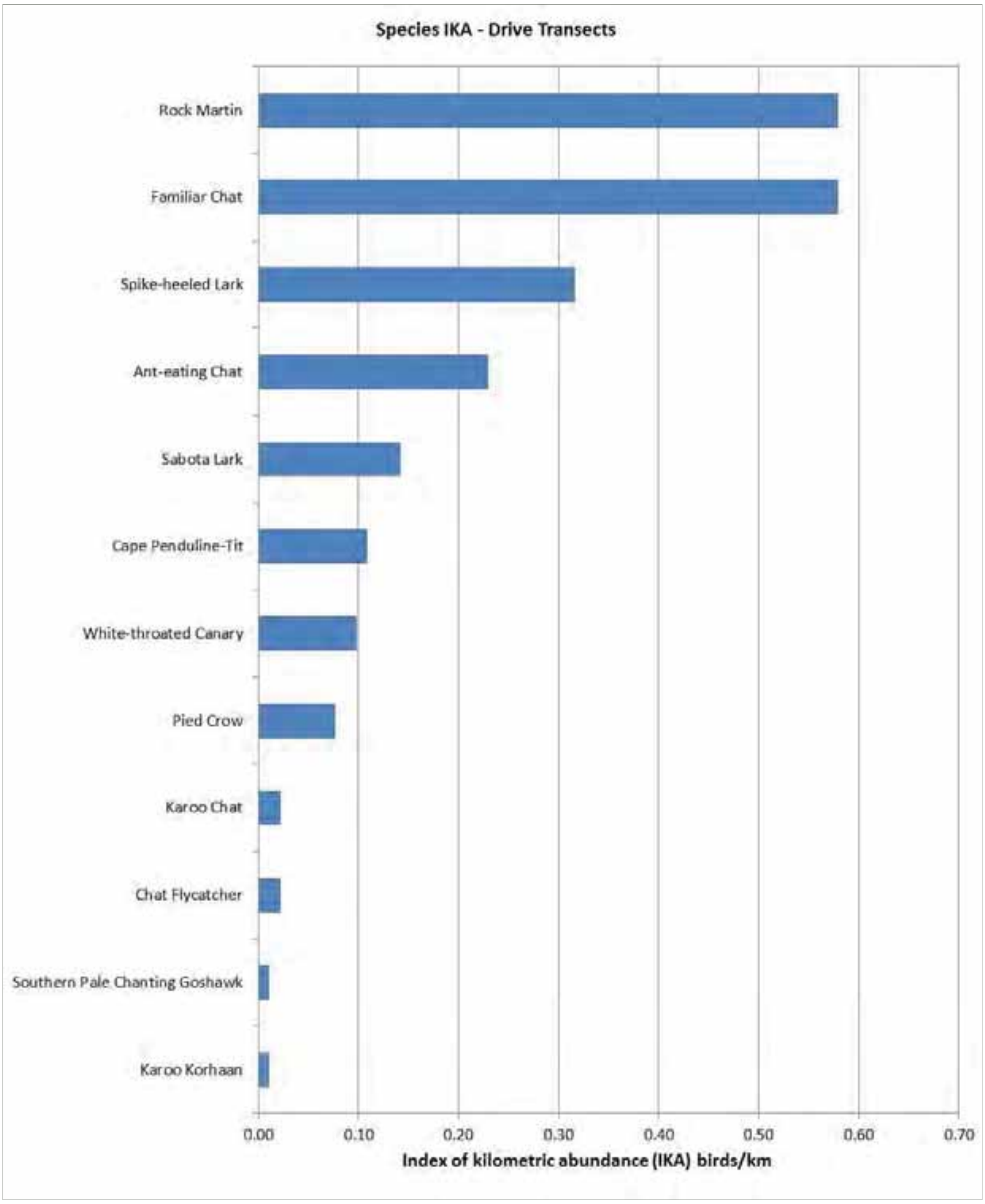


Figure 2: Index of kilometric abundance for birds recorded at the Helena PV sites during drive transect surveys

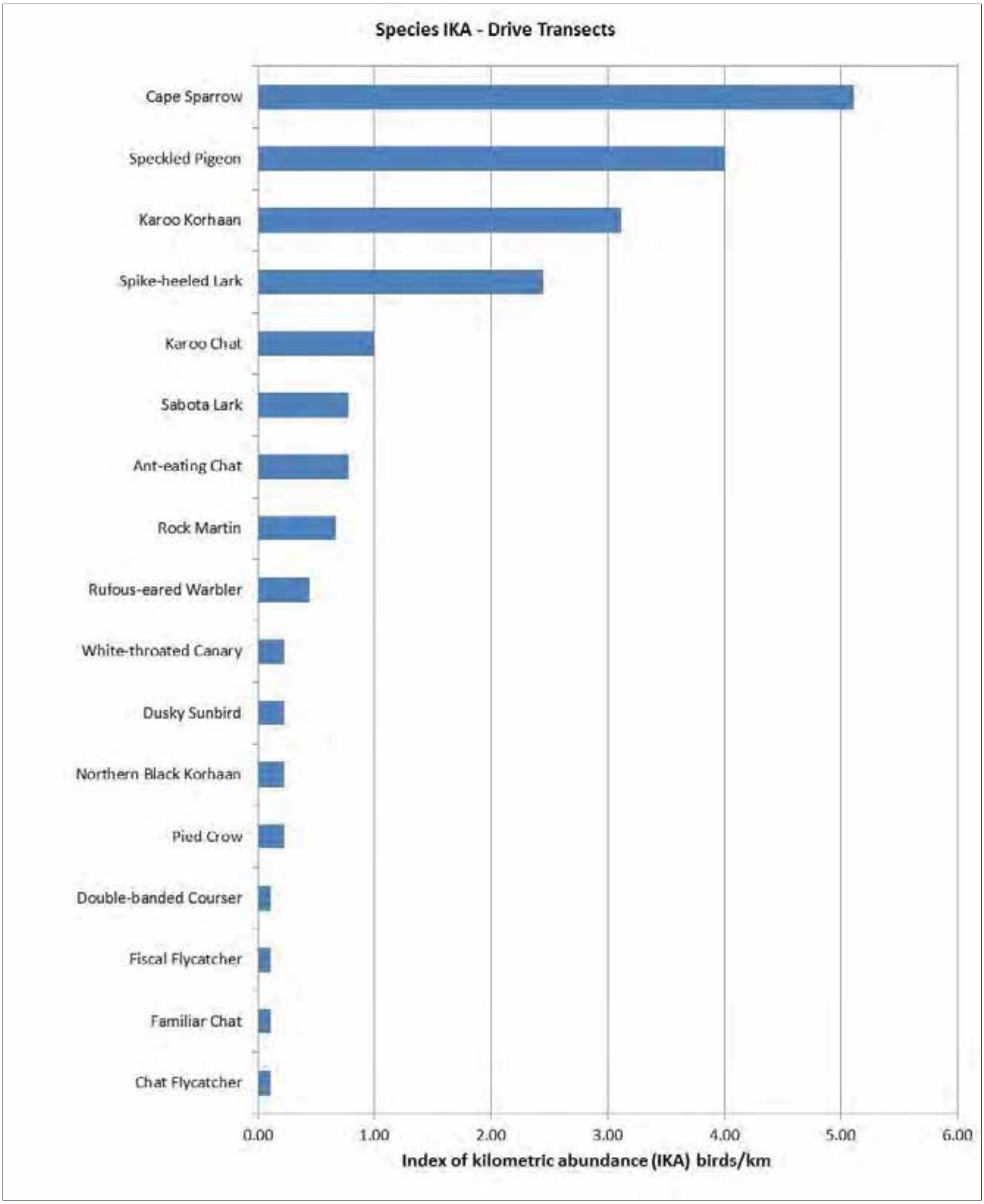


Figure 3: Index of kilometric abundance for birds recorded at the Helena PV sites during walk transect surveys.

APPENDIX 2: SPECIES LIST

	Species	Scientific name	National Red Data	Global	Endemic	SABAP2 reporting rate %	Recorded during field surveys in winter	Recorded during field surveys in summer
1	Barbet, Acacia Pied	*Tricholaema leucomelas*				57.69		
2	Barbet, Crested	*Trachyphonus vaillantii*				3.85		
3	Batis, Pririt	*Batis pririt*			Near - endemic	19.23		
4	Bokmakierie	*Telophorus zeylonus*			Near - endemic	69.23		
5	Bulbul, African Red-eyed	*Pycnonotus nigricans*			Near - endemic	26.92		
6	Bunting, Cape	*Emberiza capensis*			Near - endemic	15.38		
7	Bunting, Lark-like	*Emberiza impetuani*			Near - endemic	53.85		x
8	Bustard, Kori	*Ardeotis kori*	NT	NT		0		
9	Bustard, Ludwig's	*Neotis ludwigii*	EN	EN	Near - endemic	34.62		x
10	Buzzard, Jackal	*Buteo rufofuscus*			Endemic	3.85		x
11	Buzzard, Steppe	*Buteo vulpinus*				3.85		
12	Canary, Black-throated	*Crithagra atrogularis*				30.77		
13	Canary, White-throated	*Crithagra albogularis*			Near - endemic	42.31	x	
14	Canary, Yellow	*Crithagra flaviventris*			Near - endemic	30.77		x
15	Chat, Anteating	*Myrmecocichla formicivora*			Endemic	53.85	x	x
16	Chat, Familiar	*Cercomela familiaris*				61.54		x
17	Chat, Karoo	*Cercomela schlegelii*			Near - endemic	0	x	x
18	Chat, Sickle-winged	*Cercomela sinuata*			Endemic	7.69		
19	Chat, Tractrac	*Cercomela tractrac*			Near - endemic	7.69		x

	Species	Scientific name	National Red Data	Global	Endemic	SABAP2 reporting rate %	Recorded during field surveys in winter	Recorded during field surveys in summer
20	Cisticola, Desert	*Cisticola aridulus*				46.15		
21	Cisticola, Grey-backed	*Cisticola subruficapilla*			Near - endemic	30.77		
22	Courser, Double-banded	*Rhinoptilus africanus*	NT	LC		15.38	x	
23	Crombec, Long-billed	*Sylvietta rufescens*				30.77		
24	Crow, Cape	*Corvus capensis*				3.85		
25	Crow, Pied	*Corvus albus*				80.77	x	x
26	Cuckoo, Diderick	*Chrysococcyx caprius*				7.69		
27	Dove, Laughing	*Streptopelia senegalensis*				34.62		
28	Dove, Namaqua	*Oena capensis*				23.08		x
29	Dove, Red-eyed	*Streptopelia semitorquata*				3.85		
30	Dove, Rock	*Columba livia*				3.85		
31	Eagle, Martial	*Polemaetus bellicosus*	EN	VU		0		
32	Eagle, Verreaux's	*Aquila verreauxii*	VU	LC		3.85		
33	Eagle-Owl, Spotted	*Bubo africanus*				34.62		
34	Eremomela, Yellow-bellied	*Eremomela icteropygialis*				15.38		
35	Falcon, Lanner	*Falco biarmicus*	VU	LC		7.69		
36	Falcon, Pygmy	*Polihierax semitorquatus*				15.38		
37	Finch, Red-headed	*Amadina erythrocephala*			Near - endemic	23.08		

	Species	Scientific name	National Red Data	Global	Endemic	SABAP2 reporting rate %	Recorded during field surveys in winter	Recorded during field surveys in summer
38	Finch, Scaly-feathered	*Sporopipes squamifrons*			Near - endemic	42.31		x
39	Fiscal, Common	*Lanius collaris*				50		x
40	Flycatcher, Chat	*Bradornis infuscatus*			Near - endemic	46.15	x	x
41	Flycatcher, Fairy	*Stenostira scita*			Endemic	3.85		
42	Flycatcher, Fiscal	*Sigelus silens*				11.54	x	
43	Flycatcher, Spotted	*Muscicapa striata*				3.85		
44	Goose, Egyptian	*Alopochen aegyptiacus*				19.23		x
45	Goose, Spur-winged	*Plectropterus gambensis*				3.85		
46	Goshawk, Southern Pale Chanting	*Melierax canorus*				84.62	x	x
47	Grebe, Little	*Tachybaptus ruficollis*				3.85		
48	Greenshank, Common	*Tringa nebularia*				3.85		
49	Guineafowl, Helmeted	*Numida meleagris*				50		
50	Hoopoe, African	*Upupa africana*				19.23		
51	Ibis, African Sacred	*Threskiornis aethiopicus*				3.85		
52	Ibis, Hadeda	*Bostrychia hagedash*				30.77		
54	Kestrel, Greater	*Falco rupicoloides*				19.23		x
55	Kestrel, Rock	*Falco rupicolus*				11.54		
56	Korhaan, Karoo	*Eupodotis vigorsii*	NT	LC	Endemic	65.38	x	x

	Species	Scientific name	National Red Data	Global	Endemic	SABAP2 reporting rate %	Recorded during field surveys in winter	Recorded during field surveys in summer
57	Korhaan, Northern Black	*Afrotis afraoides*			Endemic	80.77	x	x
58	Lapwing, Blacksmith	*Vanellus armatus*				19.23		
59	Lark, Eastern Clapper	*Mirafra fasciolata*			Near - endemic	65.38		x
60	Lark, Fawn-coloured	*Calendulauda africanoides*				19.23		x
61	Lark, Karoo Long-billed	*Certhilauda subcoronata*			Endemic	23.08		
62	Lark, Large-billed	*Galerida magnirostris*			Endemic	11.54		x
63	Lark, Pink-billed	*Spizocorys conirostris*				3.85		
64	Lark, Sabota	*Calendulauda sabota*			Near - endemic	73.08	x	x
65	Lark, Sclater's	*Spizocorys sclateri*	NT	NT	Endemic	11.54		
66	Lark, Spike-heeled	*Chersomanes albofasciata*			Near - endemic	53.85	x	x
67	Lark, Stark's	*Spizocorys starki*			Near - endemic	15.38		x
68	Martin, Rock	*Hirundo fuligula*				69.23	x	x
69	Masked-Weaver, Southern	*Ploceus velatus*				84.62		
70	Mousebird, Red-faced	*Urocolius indicus*				7.69		
71	Mousebird, White-backed	*Colius colius*				38.46		x
72	Nightjar, Rufous-cheeked	*Caprimulgus rufigena*				7.69		
73	Ostrich, Common	*Struthio camelus*				3.85		

	Species	Scientific name	National Red Data	Global	Endemic	SABAP2 reporting rate %	Recorded during field surveys in winter	Recorded during field surveys in summer
74	Owl, Barn	*Tyto alba*				3.85		
75	Palm-Swift, African	*Cypsiurus parvus*				3.85		
76	Penduline-Tit, Cape	*Anthoscopus minutus*			Near - endemic	3.85	x	x
77	Pigeon, Speckled	*Columba guinea*				61.54	x	
78	Pipit, African	*Anthus cinnamomeus*				3.85		
79	Pipit, Long-billed	*Anthus similis*				7.69		
80	Plover, Three-banded	*Charadrius tricollaris*				3.85		
81	Prinia, Black-chested	*Prinia flavicans*			Near - endemic	73.08		x
82	Prinia, Karoo	*Prinia maculosa*			Near - endemic	3.85		
83	Quelea, Red-billed	*Quelea quelea*				11.54		
84	Robin-Chat, Cape	*Cossypha caffra*				11.54		
85	Roller, European	*Coracias garrulus*	NT	NT		3.85		
86	Sandgrouse, Namaqua	*Pterocles namaqua*			Near - endemic	38.46		x
87	Sandpiper, Common	*Actitis hypoleucos*				3.85		
88	Scrub-Robin, Kalahari	*Cercotrichas paena*			Near - endemic	50		
89	Scrub-Robin, Karoo	*Cercotrichas coryphoeus*			Near - endemic	53.85		x
90	Secretarybird	*Sagittarius serpentarius*				3.85		

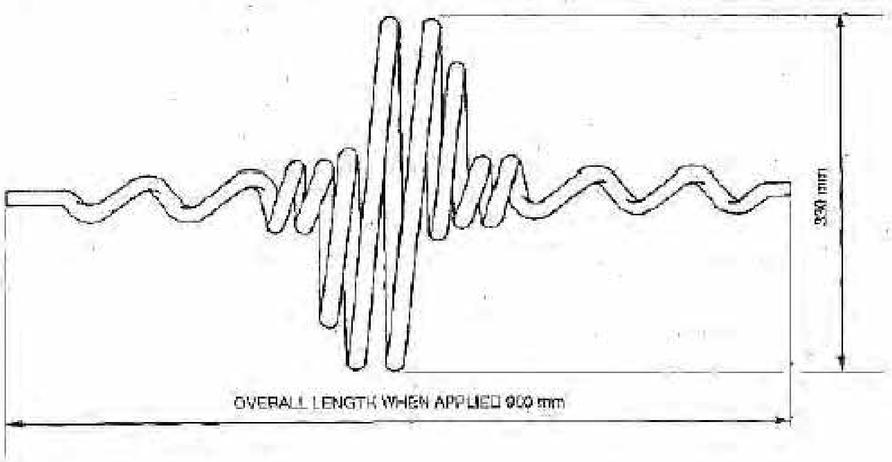
	Species	Scientific name	National Red Data	Global	Endemic	SABAP2 reporting rate %	Recorded during field surveys in winter	Recorded during field surveys in summer
91	Shelduck, South African	*Tadorna cana*			Endemic	11.54		
92	Shrike, Lesser Grey	*Lanius minor*				3.85		
93	Snake-Eagle, Black-chested	*Circaetus pectoralis*				15.38		
94	Sparrow, Cape	*Passer melanurus*			Near - endemic	92.31	x	x
95	Sparrow, House	*Passer domesticus*				61.54		
96	Sparrow, Southern Grey-headed	*Passer diffusus*				3.85		
97	Sparrowlark, Black-eared	*Eremopterix australis*			Endemic	15.38		x
98	Sparrowlark, Grey-backed	*Eremopterix verticalis*			Near - endemic	42.31		x
99	Sparrow-Weaver, White-browed	*Plocepasser mahali*				46.15		
100	Stilt, Black-winged	*Himantopus himantopus*				3.85		
101	Sunbird, Dusky	*Cinnyris fuscus*			Endemic	23.08	x	
102	Swallow, Barn	*Hirundo rustica*				38.46		x
103	Swallow, Greater Striped	*Hirundo cucullata*				53.85		
104	Swallow, White-throated	*Hirundo albigularis*				3.85		
105	Swift, Common	*Apus apus*				15.38		x
106	Swift, Little	*Apus affinis*				34.62		
107	Swift, White-rumped	*Apus caffer*				26.92		

	Species	Scientific name	National Red Data	Global	Endemic	SABAP2 reporting rate %	Recorded during field surveys in winter	Recorded during field surveys in summer
108	Thick-knee, Spotted	*Burhinus capensis*				23.08		
109	Thrush, Karoo	*Turdus smithi*			Endemic	26.92		
110	Tit, Ashy	*Parus cinerascens*			Near - endemic	11.54		
111	Tit-Babbler, Chestnut-vented	*Parisoma subcaeruleum*			Near - endemic	19.23		
112	Turtle-Dove, Cape	*Streptopelia capicola*				50		
113	Wagtail, Cape	*Motacilla capensis*				46.15		
114	Warbler, Rufous-eared	*Malcorus pectoralis*			Endemic	84.62	x	x
115	Waxbill, Black-faced	*Estrilda erythronotos*				3.85		
116	Waxbill, Violet-eared	*Granatina granatina*				3.85		
117	Weaver, Sociable	*Philetairus socius*			Endemic	61.54		
118	Wheatear, Capped	*Oenanthe pileata*				23.08		x
119	Wheatear, Mountain	*Oenanthe monticola*			Near - endemic	11.54		
120	White-eye, Cape	*Zosterops virens*				3.85		
121	White-eye, Orange River	*Zosterops pallidus*			Endemic	19.23		

APPENDIX 3: BIRD FLIGHT DIVERTER

PLP – The connection you can count on

Double Loop Bird Flight Diverter



Material Used: Manufactured from rigid solid high impact polyvinyl chloride, possessing excellent chemical and strength properties and which will retain good physical characteristics within the range of extreme temperatures. Outdoor aging tests indicate that the material does not deteriorate in function or appearance from the effects of severe weather conditions. Industrial fumes and salt water cannot seriously degrade the properties of rigid PVC.

Colour: White or Black

Lay Direction: Bird Flight Diverters are supplied right hand lay for both right hand and left hand lay bare conductors and insulated cables.

CATALOGUE NO.	CONDUCTOR/ E/WIRE DIA. RANGE
BFD 0914/LD2*	9 mm – 14 mm

* Add B or W to denote colour

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Website: www.preformedsa.co.za

Appendix 6C:

Surface Water Assessment

BIOTHERM ENERGY (PTY) LTD

Proposed Construction of the Helena 1 Solar Photovoltaic (PV) Energy Facility near Copperton, Northern Cape Province

Surface Water Impact Assessment Report – Impact Phase

Issue Date: 12th October 2015
Revision No.: 2
Project No.: 13031

Date:	12th October 2015
Document Title:	Proposed Construction of the Helena 1 Solar Photovoltaic (PV) Energy Facility near Copperton, Northern Cape Province: Surface Water Assessment Impact Report
Author:	Shaun Taylor
Revision Number:	2
Checked by:	Dr. Martin Ferreira (*Pr. Sci. Nat.*) – Jeffares and Green External Reviewer
Approved:	Andrea Gibb
Signature:	
For:	SiVEST Environmental Division

environmental affairs

Department:
Environmental Affairs
REPUBLIC OF SOUTH AFRICA

DETAILS OF SPECIALIST AND DECLARATION OF INTEREST

	(For official use only)
File Reference Number:	12/12/20/ or 12/9/11/L
NEAS Reference Number:	DEA/EIA
Date Received:	

Application for integrated environmental authorisation and waste management licence in terms of the-

(1) National Environmental Management Act, 1998 (Act No. 107 of 1998), as amended and the Environmental Impact Assessment Regulations, 2014; and

(2) National Environmental Management Act: Waste Act, 2008 (Act No. 59 of 2008) and Government Notice 921, 2013

PROJECT TITLE

Proposed Construction of the Helena 1 Solar Photovoltaic (PV) Energy Facility near Copperton, Northern Cape Province: Surface Water Assessment Impact Report

Specialist:	SiVEST South Africa (Pty) Ltd		
Contact person:	Shaun Taylor		
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E-mail:	shaunt@sivest.co.za		
Professional affiliation(s) (if any)	South African Wetland Society		

Project Consultant:	SiVEST South Africa (Pty) Ltd		
Contact person:	Andrea Gibb		
Postal address:	P O Box 2921		
Postal code:	2128	Cell:	072 587 6525
Telephone:	011 798 0638	Fax:	011 803 7272
Email:	andreag@sivest.co.za		

4.2 The specialist appointed in terms of the Regulations

I, Shaun Taylor, declare that –

General declaration:

- I act as the independent specialist in this application;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, Regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, Regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- all the particulars furnished by me in this form are true and correct; and
- I realise that a false declaration is an offence in terms of regulation 48 and is punishable in terms of section 24F of the Act.

Signature of the specialist:

SiVEST (Pty) Ltd

Name of company (if applicable):

12th October 2015

Date:

BIOTHERM ENERGY (PTY) LTD

PROPOSED CONSTRUCTION OF THE HELENA 1 SOLAR PHOTOVOLTAIC (PV) ENERGY FACILITY NEAR COPPERTON, NORTHERN CAPE PROVINCE

SURFACE WATER IMPACT REPORT

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PROPOSED CONSTRUCTION OF THE HELENA 1 SOLAR PHOTOVOLTAIC (PV) ENERGY FACILITY NEAR COPPERTON, NORTHERN CAPE PROVINCE

SURFACE WATER IMPACT REPORT

1 INTRODUCTION

SiVEST have been appointed by Biotherm Energy (Pty) Ltd to undertake an Environmental Impact Assessment (EIA) for the proposed construction of the Helena 1 Solar Photovoltaic (PV) Energy Facility near Copperton, Northern Cape Province (hereafter referred to as, "the proposed development"). As part of the EIA studies being conducted for the proposed development, the need to undertake a surface water impact assessment was identified. During the Scoping Phase of the EIA, a desktop assessment of the surface water environment within the study area was undertaken in order to characterise the area and broadly identify all the potential surface water impacts and issues relating to the proposed development.

Having completed the scoping phase assessment, the purpose of this study is to undertake an in-field verification and delineation of the surface water resources identified in the scoping-level report. This study will re-visit the scoping-level impacts based on the current layout alternatives of the proposed development to determine any potential additional or change to the identified impacts. The impacts will also be evaluated and rated in terms of the significance of the potential impact. Appropriate mitigation measures and recommendations will be suggested for each impact. Furthermore, this report will undertake an alternatives comparative assessment to identify which alternative may be associated with the least potential impact from a surface water perspective. The implications of the proposed development and the identified potential impacts on surface water resources will also be evaluated in terms of the relevant environmental and water legislation. Finally, general specialist recommendations will be provided.

1.1 Legislative Context

1.1.1 National Water Act, 1998 (Act No. 36 of 1998)

The National Water Act, 1998 (Act. No. 36 of 1998) (NWA) was created in order to ensure the protection and sustainable use of water resources in South Africa. The NWA recognises that the ultimate aim of water resource management is to achieve the sustainable use of water for the benefit of all users. Bearing these principles in mind, there are a number of stipulations of the NWA that are relevant to potential impacts on surface water resources that can be associated with the proposed development. These stipulations are explored below and are discussed in the context of the proposed development.

It is important to note that water resources, including wetlands are protected under the NWA. Wetlands are defined as water resources under the NWA. 'Protection' of a water resource, as defined in the NWA entails:

- maintenance of the quality of the quality of the water resource to the extent that the water use may be used in a sustainable way;
- prevention of degradation of the water resource; and
- the rehabilitation of the water resource.

In the context of the proposed development and the identification of potential impacts on surface water resources, the definition of pollution and pollution prevention contained within the Act is relevant. 'Pollution', as described by the Act is the direct or indirect alteration of the physical, chemical or biological properties of a water resource, so as to make it (*inter alia*):

- less fit for any beneficial purpose for which it may reasonably be expected to be used; or
- harmful or potentially harmful to the welfare or human beings, to any aquatic or non-aquatic organisms, or to the resource quality.

The inclusion of physical properties of a water resource within the definition of pollution entails that any physical alterations to a water body (for example, the excavation of a wetland or changes to the morphology of a water body) can be considered to be pollution. Activities which cause the alteration of the biological properties of a watercourse (i.e. the fauna and flora) contained within that watercourse are also considered pollution.

In terms of section 19 of the NWA owners / managers / people occupying land on which any activity or process undertaken which causes, or is likely to cause pollution of a water resource must take all reasonable measures to prevent any such pollution from occurring, continuing or recurring. These measures may include measures to (*inter alia*):

- cease, modify, or control any act or process causing the pollution;
- comply with any prescribed waste standard or management practice;

- contain or prevent the movement of pollutants;
- remedy the effects of the pollution; and
- remedy the effects of any disturbance to the bed and banks of a watercourse.

1.1.2 National Environmental Management Act, 1998 (Act No. 107 of 1998)

The National Environmental Management, 1998 (Act No. 107 of 1998) (NEMA) was created essentially to establish:

- principles for decision-making on matters affecting the environment;
- institutions that will promote co-operative governance; and
- procedures for co-ordinating environmental functions exercised by organs of the state to provide for the prohibition, restriction or control of activities which are likely to have a detrimental effect on the environment.

It is stipulated in NEMA *inter alia* that everyone has the right to an environment that is not harmful to his or her health or well-being. Moreover, everyone has the right to have the environment protected, for the benefit of present and future generations, through reasonable legislative and other measures that prevent pollution and ecological degradation, promote conservation and secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development.

Accordingly, several of the principles of NEMA contained in **Chapter 1 Section 2**, as applicable to wetlands, stipulate that:

- Development must be socially, environmentally and economically sustainable;
- Sustainable development requires the consideration of all relevant factors including the following:
    - That the disturbance of ecosystems and loss of biological diversity are avoided, or, where they cannot be altogether avoided, are minimised and remedied.
    - That pollution and degradation of the environment are avoided, or, where they cannot be altogether avoided, are minimised and remedied.
    - 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 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 by those responsible for harming the environment.
- Sensitive, vulnerable, highly dynamic or stressed ecosystems, such as coastal shores, estuaries, wetlands, and similar systems require specific attention in management and planning procedures, especially where they are subject to significant human resource usage and development pressu*re.*

In line with the above, **Chapter 7** further elaborates on the application of appropriate environmental management tools in order to ensure the integrated environmental management of activities. In other words, this chapter of NEMA addresses the tools that must be utilised for effective environmental management and practice. Under these auspices, the Environmental Impact Regulations (2010) were devised in order to give effect to the objectives set out in NEMA. Subsequently, activities were defined in a series of listing notices for various development activities. Should any of these activities be triggered, an application for Environmental Authorisation subject to a Basic Assessment (BA) or Environmental Impact Assessment (EIA) process is to be applied for. Fundamentally, applications are to be applied for so that any potential impacts on the environment in terms of the listed activities are considered, investigated, assessed and reported on to the competent authority charged with granting the relevant environmental authorisation.

The above stipulations of the NWA and NEMA have implications for the proposed development in the context of surface water resources. Accordingly, implications and potential impacts / issues of the proposed development on potentially affected surface water resources are addressed later in this report (**Section 8** and **9**).

1.2 Definition of Surface Water Resources as Assessed in this Study

Using the definition of a surface water resource under the NWA, this study will include a river, a natural channel in which water flows regularly or intermittently, a wetland, or dam into which, or from which, water flows.

1.2.1 Wetlands

For wetlands, the lawfully accepted definition of a wetland in South Africa is that which is contained within the NWA. Accordingly, the NWA defines a wetland as, "land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or land which is periodically covered with shallow water, and which land in normal circumstances supports or would support vegetation typically adapted to life in saturated soil".

Moreover, wetlands are accepted as a piece of land on which the period of water saturation (hydro-period) is sufficient to allow for the development of hydric soils, which in normal circumstances would support hydrophytic vegetation (i.e. vegetation adapted to grow in saturated and anaerobic conditions).

Inland wetlands can be categorised into hydrogeomorphic units (HGM units). **Ollis *et al*. (2013)** have described a number of different wetland hydrogeomorphic forms which include the following:

- Channel (river, including the banks): a linear landform with clearly discernible bed and banks, which permanently or periodically carries a concentrated flow of water. A river is taken to include both the active channel and the riparian zone as a unit.
- Channelled valley-bottom wetland: a valley-bottom wetland with a river channel running through it. Channelled valley-bottom wetlands must be considered as wetland ecosystems that are distinct from, but sometimes associated with, the adjacent river channel itself, which must be classified as a "river".
- Unchannelled valley-bottom wetland: a valley-bottom wetland without a river channel running through it.
- Floodplain wetland: a wetland area on the mostly flat or gently-sloping land adjacent to and formed by an alluvial river channel, under its present climate and sediment load, which is subject to periodic inundation by over-topping of the channel bank. Floodplain wetlands must be considered as wetland ecosystems that are distinct from but associated with the adjacent river channel itself, which must be classified as a "river".
- Depression: a wetland or aquatic ecosystem with closed (or near-closed) elevation contours, which increases in depth from the perimeter to a central area of greatest depth and within which water typically accumulates.
- Flat: a Level or near-level wetland area that is not fed by water from a river channel, and which is typically situated on a plain or a bench, closed elevation contours are not evident around the edge of a wetland flat.
- Hillslope seep: a wetland are located on gently to steeply sloping land and dominated by collluvial (i.e. gravity-driven), unidirectional movement of water and material down-slope.

1.2.2 Watercourses

According to the NWA, a watercourse falls within the ambit of a 'water resource'. For watercourses however, the following is relevant:

- A river or;
- A natural channel in which water flows regularly or intermittently.

Watercourses may be perennial or non-perennial in nature. Moreover, non-perennial watercourses can encompass seasonal or ephemeral watercourses (including drainage channels) depending on the climate and other environmental constraints.

1.2.3 Riparian Habitat

Riparian habitats may potentially occur in the study area. Riparian habitats (also known as riparian areas or zones) include plant communities usually adjacent to or along natural channels that are affected by surface and subsurface flows (**DWAF, 2005**). Riparian habitats can be found on the edges of lakes, or drainage lines but are more commonly associated with channelled flowing systems like streams and rivers. Riparian habitats can also be associated with wetlands that form components of adjacent streams and rivers (for example, floodplain wetlands). These can be defined as riparian wetlands.

Any of the above mentioned wetland forms, watercourses and/or riparian habitats may occur within the study area. The types of wetland, watercourses and riparian habitats identified by the study are addressed later in the report (**Section 6**).

1.3 Wetlands and Hydromorphic Soils

Wetlands are a very important component of the natural environment. Wetlands are typically characterised by high levels of faunal biodiversity and are critical in sustaining human livelihoods through the provision of ecosystem services. Ecosystem services refer to the benefits provided to people (society) by wetland ecosystems. These benefits may derive from outputs that can be consumed directly; indirect uses which arise from the functions or attributes occurring within the ecosystem; or possible future direct outputs or indirect uses **(Howe *et al.*, 1991)**. Wetland ecosystem services can include flood attenuation, sediment trapping, erosion control, nutrient cycling etc.

Wetlands are sensitive features of the natural environment, and pollution or degradation of surface water can result in a loss of biodiversity, as well as an adverse impact on the human users whom depend on the resource to sustain their livelihoods. As such, wetlands are specifically protected under the NWA and generally under NEMA as covered in the **Section 1.1** above.

Hydric soils, which are soils that are found within wetlands, are defined by the U.S. Department of Agriculture Natural Resources Conservation Service (NRCS) as being, "soils that formed under conditions of saturation, flooding or ponding long enough during the growing season to develop anaerobic conditions in the upper part". These anaerobic conditions would typically support the growth of hydromorphic vegetation (vegetation adapted to grow in soils that are saturated and starved of oxygen) and are typified by the presence of redoximorphic features (**Section 3.2**). The presence of hydric (wetland) soils on the site of a proposed development is significant, as the alteration or destruction of these areas, or development within a certain radius of these areas would require authorisation in terms of the NWA and in terms of the Environmental Impact Assessment Regulations promulgated under the NEMA.

1.4 Assumptions and Limitations

This study has only focused on the delineation of surface water resources within the proposed development area. Aquatic studies of fish, invertebrates, amphibians etc. have not been included in this report. Nor has a hydrological or groundwater study been included. Wetland or river health, ecosystem services and the ecological importance and sensitivity category have also not been assessed in this study.

2 TECHNICAL DETAILS OF THE PROJECT

The proposed project (Helena 1 Solar Facility) will encompass the installation of a solar PV field and associated components, in order to generate electricity that is to be fed into the Eskom grid. The facility will have a maximum export capacity of 75MW. The proposed development area is approximately 430 ha, however it is envisaged that the 75MW energy facility layout will only require approximately 250 ha. The voltage of the connection lines from the solar PV energy facility substation to the grid is likely to be 132kV.

2.1 PV Project Components

This proposed PV energy facility forms one of three PV energy facilities with a 75MW export capacity that BioTherm are proposing to develop on Portion 3 of the farm Klipgats Pan No 117 (**Figure 1**). In order to accommodate the Department of Energy's (DoE) competitive bidding process for procuring renewable energy from Independent Power Producers in South Africa each PV energy facility will be developed under a separate Special Purpose Vehicle (SPV) and therefore each requires a separate Environmental Authorisation. However, the possibility to allow shared associated infrastructure will be considered.

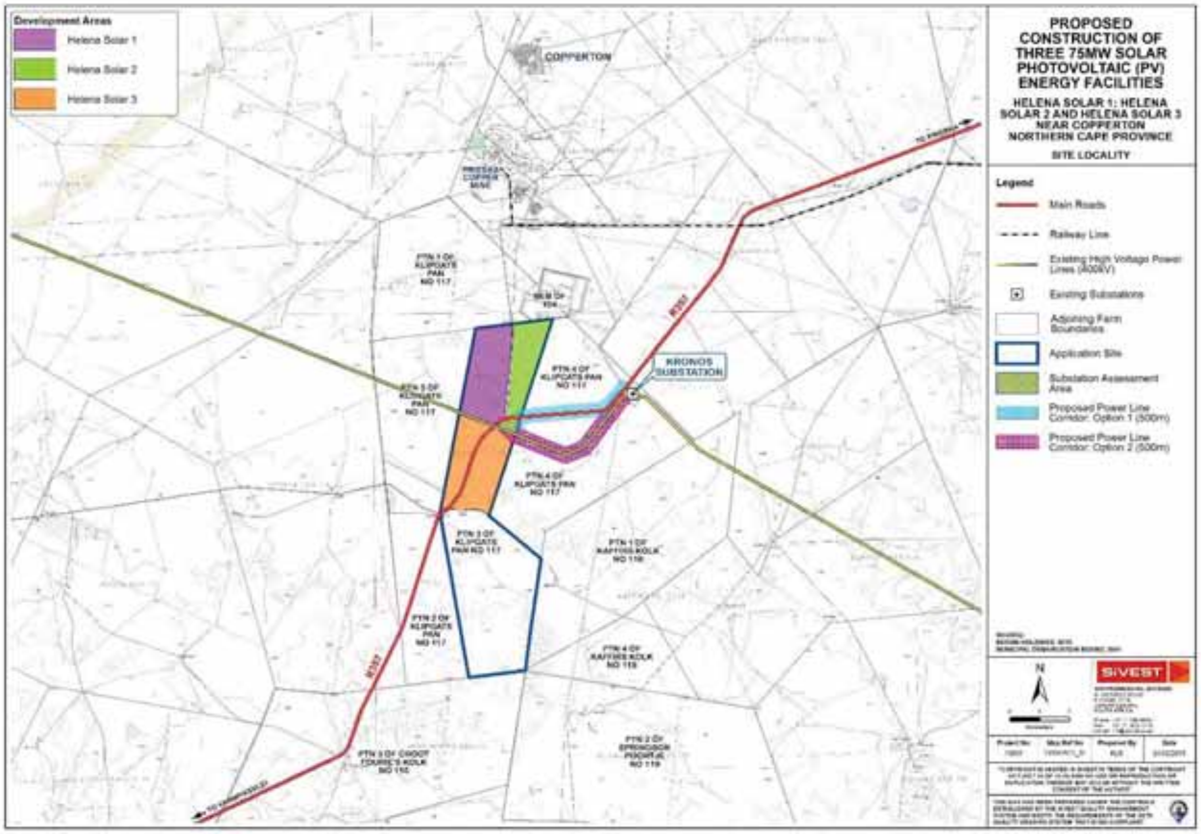

Figure 1: Proposed solar PV energy facility study area

The key technical details and infrastructure required is presented in the table below (**Table 1**).

Table 1: Helena Solar 1 Phase Summary

Phase Name	DEA Reference	Farm name and area	Technical details and infrastructure necessary for each phase
Helena Solar 1	14/12/16/3/3/2/765	Portion 3 of Klipgats Pan No 117 (PV site) and Portion 4 of Klipgats Pan No 117 (power lines) PV Site Area: 427.56 ha	▪ Approximately 300 000 **solar PV panels** with a total export capacity of 75MW; ▪ Panels will be either **fixed axis mounting or single axis tracking solutions**, and will be either crystalline silicon or thin film technology; ▪ Onsite **switching station**, with the transformers for voltage step up from medium voltage to high voltage; ▪ The panels will be connected in strings to inverters, approximately **43 inverter stations** will be required throughout the site. Inverter stations will house 2 x 1MW inverters and 1 x 2MVA transformers; ▪ DC power from the panels will be converted into AC power in the inverters and the voltage will be stepped up to 22-33kV (medium voltage) in the transformers. ▪ The **22-33kV cables** will be run underground in the facility to a common point before being fed to the **onsite substation** where the voltage will typically be stepped up to 132kV. ▪ Grid connection is to the Kronos substation. A **power line** with a voltage of 132kV is proposed and will run from the onsite substation to the Kronos substation. The distance will be about 4km. The final grid connection voltage will be below 275kV. ▪ A **laydown area** for the temporary storage of materials during the construction activities; ▪ **Access roads and internal roads**; ▪ Construction of a **car park and fencing** around the project; and ▪ **Administration, control and warehouse buildings**

2.2 Solar Field

Solar PV panels are usually arranged in rows or 'arrays' consisting of a number of PV panels. The area required for the PV panel arrays will likely need to be entirely cleared or graded. Where tall vegetation is present, this vegetation will be removed from the PV array area.

Approximately 300 000 solar PV panels will be required per project for a total export capacity of 75MW. Support structures will either be fixed axis mounting or single axis tracking solutions. The modules will be either crystalline silicon or thin film technology. The solar PV panels are variable in size, and are affected by advances in technology between project inception and project realisation. The actual size of the PV panels to be used will be determined in the final design stages of the project. The PV panels are mounted onto metal frames which are usually aluminium. Rammed or screw pile foundations are commonly used to support the panel arrays (**Figure 2**).

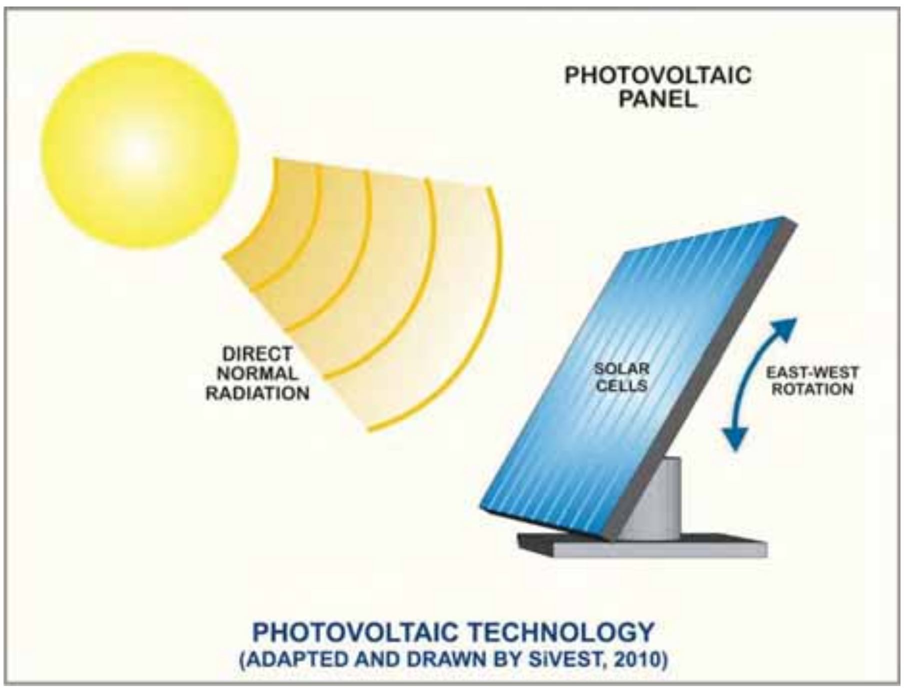

Figure 2: Example of a Photovoltaic Panel with tracking capability

2.3 Associated Infrastructure

2.3.1 Electrical Infrastructure

The solar PV panel arrays are connected to each other in strings, which are in turn connected to inverters. For a 75MW size facility, typically 2MW inverter stations which are containerised stations housing 2x1MW inverters and 1x2MVA transformers will be used; therefore approximately 43 inverter stations will be required throughout the site for the proposed solar PV energy facility (**Figure 3**). DC power from the panels will be converted into AC power in the inverters and the voltage will be stepped up to 22-33kV (medium voltage) in the transformers. The 22-33kV cables will be run underground in the facility to a common point before being fed to the onsite substation and switching station where the voltage will typically be stepped up to 132kV. A power line with a voltage of up to 132kV will run from the onsite substation to the existing Kronos substation. The distance will be about 4km.

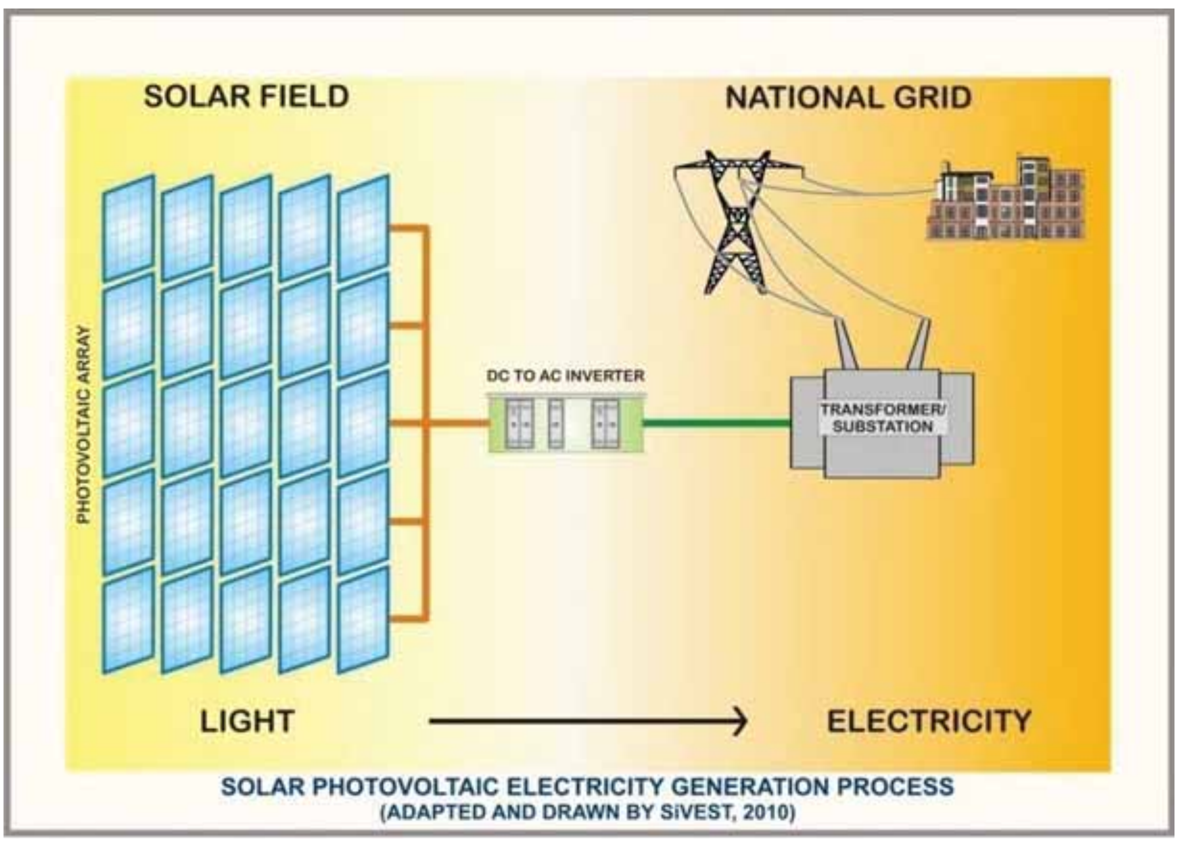

Figure 3: PV energy generation process diagram

2.3.2 Buildings

The solar field will require onsite buildings which will be used in the daily operation of the plant and includes an administration building (office). The buildings will likely be single storey buildings which will be required to accommodate the following:

- Control room;
- Workshop;
- High Voltage (HV) switchgear;
- Mess Room;
- Toilets;
- Warehouse for storage; and
- Car park and fencing around the project.

2.3.3 Construction Lay-down Area

A general construction lay-down area will be required for the construction phase of the proposed solar PV energy facility. The size of this area is yet to be determined, but 3 to 5 hectares is likely.

2.3.4 Other Associated Infrastructure

Other associated infrastructure includes the following:

- Access roads and internal roads;
- A car park; and
- Fencing around the project.

2.4 Alternatives

Due to the limited space available as well as the constraints of the sensitive areas, no alternative PV panel layouts were identified. It was felt that it would be environmentally preferable to assess one viable panel layout rather than two panel layouts that are not technically or environmentally viable. Other design or layout alternatives have been identified. Two alternative site locations for the substation were also proposed, as well as two alternative route corridors for the proposed power line. Additionally, two road and cabling layout alternatives were identified. Based on the scoping phase specialist findings the substation assessment area was eliminated as an appropriate area for the proposed substation as most of this site was found to be potentially sensitive by the specialists. As such, two alternative substation sites that cover an area of 3 ha each were proposed to be assessed in the EIA phase. Should the other two PV projects that are being proposed by BioTherm on the same farm also be granted EAs and be awarded preferred bidder status by the DoE the possibility of sharing the substation site to reduce the environmental impact will be considered.

These layout for the proposed PV facility is presented in **Figure 4**.

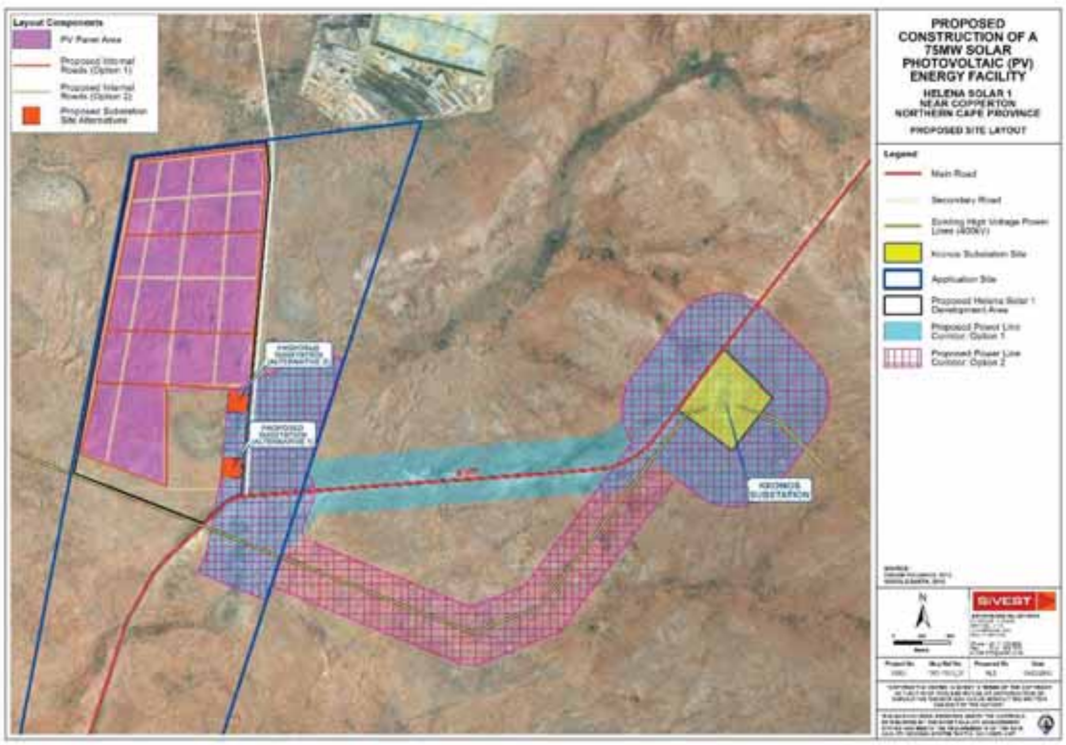

Figure 4: Proposed Layout Alternatives

3 METHODOLOGY

3.1 Revise Initial Desktop Delineation Findings of Surface Water Resources

The first step in the impact level surface water assessment was to revisit the initial scoping level desktop findings of the surface water features. This was undertaken using Geographic Information System (GIS) software. The software ArcView developed by ESRI was used. The collection of data source information encompassed (but is not limited to) the National Freshwater Ecosystem Priority Areas **(NFEPA, 2011)** database, the Northern Cape Environmental Potential Atlas **(ENPAT, 2000)** database, and the National Biodiversity Assessment **(SANBI, 2012)** database. The use of Google Earth™ imagery supplemented these data sources.

Utilising these resources, the wetlands and any other surface water resources that were identified in the scoping phase were mapped and highlighted for the in-field phase of the assessment. The supplementary use of satellite imagery (**Google Earth™**) allowed for other potentially overlooked surface water resources, not contained within the above mentioned databases, to be identified and ground-truthed in the field work phase.

3.2 Field-based Surface Water Resources Delineation Techniques

3.2.1 Wetlands

Wetland delineations are based primarily on soil wetness indicators. For an area to be considered a wetland, redoximorphic features must be present within the top 50cm of the soil profile **(Collins, 2005)**. Redoximorphic features are the result of the reduction, translocation and oxidation (precipitation) of Fe (iron) and Mn (manganese) oxides that occur when soils alternate between aerobic (oxygenated) and anaerobic (oxygen depleted) conditions. Only once soils within 50cm of the surface display these redoximorphic features, can the soils be considered 'hydric soils'. Redoximorphic features typically occur in three types **(Collins, 2005)**:

- A reduced matrix - i.e. an in situ low chroma (soil colour), resulting from the absence of Fe^{3+} ions which are characterised by "grey" colours of the soil matrix;
- Redox depletions - the "grey" (low chroma) bodies within the soil where Fe-Mn oxides have been stripped out, or where both Fe-Mn oxides and clay have been stripped. Iron depletions and clay depletions can occur;
- Redox concentrations - Accumulation of iron and manganese oxides (also called mottles). These can occur as:
    - Concretions - harder, regular shaped bodies;
    - Mottles - soft bodies of varying size, mostly within the matrix, with variable shape appearing as blotches or spots of high chroma colours;
    - Pore linings - zones of accumulation that may be either coatings on a pore surface, or impregnations of the matrix adjacent to the pore. They are recognized as high chroma colours that follow the route of plant roots, and are also referred to as oxidised rhizospheres.

The potential occurrence / non-occurrence of wetlands and wetland (hydric) soils on the study site were assessed according to the **DWAF (2005)** guidelines, "A practical field procedure for the identification and delineation of wetlands and riparian areas". According to the **DWAF (2005)** guidelines, soil wetness indicators (i.e. identification of redoximorphic features) are the most important indicator of wetland occurrence. This is mainly due to the fact that soil wetness indicators remain in wetland soils, even if they are degraded or desiccated. It is important to note that the presence or absence of redoximorphic features within the upper 50cm of the soil profile alone is sufficient to identify the soil as being hydric or non-hydric (non-wetland soil) **(Collins, 2005)**. Three other indicators (vegetation, soil form and terrain unit) are typically used in combination with soil wetness indicators to supplement findings. Where soil wetness and/or soil form could not be identified, information and personal professional judgment was exercised using the other indicators to determine what area would represent the outer edge of the wetland.

It must be recognised that there are normally three zones to every wetland including the permanent zone, seasonal zone and the temporary zone. Each zone is differentiated based on the degree and duration of soil saturation. The permanent zone usually reflects soils that indicate inundation cycles that last more or less throughout the year, whilst the seasonal zone may only reflect soils that indicate inundation cycles for a significant period during the rainy season. Lastly, the temporary zone reflects soils that indicate the shortest period(s) of inundation that are long enough, under normal circumstances, for the formation of hydromorphic soils and the growth of wetland vegetation **(DWAF, 2005)**.

Vegetation identification was based on identifying general plant species within the wetland boundaries focusing on the occurrence of hydrophytic (water loving) wetland vegetation. In identifying hydrophytic vegetation, it is important to distinguish between plant species that are **(DWAF, 2005)**:

- Obligate wetland species (ow): always grows in wetland - >99% chance of occurrence;
- Facultative wetland species (fw): usually grow in wetlands – 67-99% chance of occurrence;
- Facultative species (f): are equally likely to grow in wetlands and non-wetland areas – 34-66% chance of occurrence;
- Facultative dry-land species (fd): usually grow in non-wetland areas but sometimes grow in wetland = 1-34% chance of occurrence.

The actual delineation process essentially entailed drawing soil samples, at depths between 0-50 cm in the soil profile, using a soil augur. This is done in order to determine the location of the outer edge of the temporary zone for wetlands. The outer edge of the temporary zone will usually constitute the full extent of the wetland, thereby encompassing any other inner lying zones that are saturated for longer periods. Where the appropriate wetland soil form is of interest, soil samples are drawn up to a depth of 1.2 metres (where possible).

Where a wetland was identified, a conventional handheld Global Positioning System (GPS) was used to record the points taken in the field. The GPS points were then imported into a GIS system for mapping purposes. The GPS is expected to be accurate from 5 up to 15 metres depending on meteorological conditions. A GIS shapefile was created to represent the boundaries of the delineated wetlands or other surface water resources.

3.2.2 Riparian Habitat

In terms of watercourses and riparian habitats, the **DWAF (2005)**, the assessment for riparian habitats requires the following aspects to be taken into account:

- topography associated with the watercourse;
- vegetation; and
- alluvial soils and deposited material.

The topography associated with a watercourse can (but not always limited to) comprise the macro channel bank. This is a rough indicator of the outer edge of the riparian habitat.

The riparian habitat relies primarily on vegetation indicators. The outer edge of the riparian habitat can be delineated where there is a distinctive change in the species composition to the adjacent terrestrial area or where there is a difference in the physical structure (robustness or growth forms – size, structure, health, compactness, crowding, number of individual plants) of the species from the adjacent terrestrial area (**DWAF, 2005**).

Riparian habitats are usually associated with alluvial soils (relatively recent deposits of sand, mud or any type of soil sediment) (**DWAF, 2005**). This indicator is not commonly viewed as the primary indicator but rather as a supplementary indicator to confirm either topographical or vegetation indicators, or both.

Where riparian habitats occur, the above mentioned indicators were used to identify the outer edge. A GPS was used to record the points taken in the field.

3.2.3 Drainage Pathways

In terms of drainage lines or pathways, as there are no official methodologies for delineating drainage lines in the country, the environmental indicators used to identify riparian habitats (such as vegetation, channel characteristics, alluvial soils and deposited materials) which also form integral components of drainage lines where used to identify these temporary conduits for surface water run-off.

3.3 Surface Water Buffer Zones

Depending on the type of land use or development proposed, an appropriate buffer zone to protect wetlands (and any other surface water resource) should also be delineated **(DWAF, 2005)**. Buffer zones are typically required to protect and minimise edge impacts to wetlands or any other surface water resource.

At present, there are no official guidelines with respect to the application of buffer zones for surface water resources in the Northern Cape Province. However, the Gauteng Minimum Requirements for Biodiversity Studies **(GDACE, 2009)** contains a set of guidelines which can equally be applied to surface water resources in the Northern Cape Province. Accordingly, this guideline was used to inform the implementation of an appropriate buffer zone for the surface water features identified.

3.4 Impact Assessment Method

Current and potential impacts will be identified based on the proposed development and potential impacts that may result for the construction, operation and decommissioning of the proposed development. The identified potential impacts will be evaluated using an impact rating method **(Appendix A)**. This is addressed in **Section 9**.

4 STUDY AREA

The proposed development site (study area) falls within the Siyathemba Local Municipality, which is located within the greater Pixley ka Seme District Municipality. It is located approximately 9km south of Copperton, on two (2) farms namely:

- Portion 3 of the farm Klipgatspan No. 117 (solar facilities); and
- Portion 4 of the farm Klipgatspan No. 117 (power line).

The proposed development site is situated directly adjacent to the R357. The surrounding land use within the direct proximity of the site comprises predominantly vacant land, commercial/industrial and residential.

The study area falls within the Nama-Karoo Biome (**Mucina and Rutherford, 2006**). Within a biome, smaller groupings referred to as bioregions can be found which provide more specific but general details as to the biophysical characteristics of smaller areas. The study sites can be found within the Bushmanland bioregion. Going into even finer detail, vegetation units are classified which contain a set of general but more local biophysical characteristics as opposed to the entire bioregion. The proposed development is found within the Bushmanland Basin Shrubland vegetation unit. The description of Vegetation and Landscape Features, Geology and Soils, and Climate as contained in **Mucina and Rutherford (2006)** are provided below for these vegetation units.

4.1 Bushmanland Basin Shrubland Vegetation Unit

The vegetation and landscape features of the Bushmanland Basin Shrubland are characterised by slightly irregular plains with dwarf shrubland dominated by a mixture of low sturdy and spiny (and sometimes also succulent) shrubs (*Rhigozum, Salsola, Pentzia, Eriocephalus*), “white” grasses (*Stipagrostis*) and in years of high rainfall also by abundant annuals such as species of *Gazania* and *Leysera*.

The geology and soils comprise of mudstones and shales of Ecca Group (Prince Albert and Volksrust Formations) and Dwyka tillites, both of early Karoo age, dominate. About 20% of rock outcrop is formed by Jurassic intrusive dolerite sheets and dykes. Soils are shallow Glenrosa and Mispah forms, with lime generally present in the entire landscape (Fc land type) and, to a lesser extent, red-yellow apedal, freely drained soils with a high base status and usually <15% clay (Ah and Ai land types) are also found. The salt content in these soils is very high.

Rainfall occurs in late summer and early autumn. Mean Annual Precipitation (MAP) ranges from about 100-200m. Mean maximum and minimum monthly temperatures in Brandvlei are 39.6°C and -2.2°C for January and July, respectively. Corresponding values for Van Wyksvlei are 39.5°C and -4.6°C.

The conservation status of the vegetation unit is described as least threatened. None of the unit is conserved in statutory conservation areas. No signs of serious transformation is present, but scattered individuals of *Prosopis* sp. occur in some areas (e.g. in the vicinity of the Sak River drainage system), and some localised dense infestation form closed “woodlands” along the eastern border of the unit with Northern Upper Karoo (east of Van Wyksvlei). Erosion is moderate (56%) and low (34%).

5 STUDY AREA DRAINAGE AND HYDROLOGY

5.1 Drainage Context

According to **Dollar *et al*. (2007)**, regions can be grouped that have similar land areas containing a limited range of recurring landforms that reflect comparable erosion, climatic and tectonic influences, and impose broad constraints on lower levels of organisation, e.g., drainage basins, macro-reaches and channel types. Hence, on this basis, geomorphic provinces (**Partridge *et al*. 2010**) have been delineated that reflect a relatively common set of climatic, vegetation, geological and topographical characteristics that are akin to one another. Utilising this information, the regional drainage characteristics of the broader study area can be elucidated. Under this context, the study site is located within the Western Transvaal Basin geomorphic province of South Africa.

5.1.1 Northern Cape Pan Veld Geomorphic Province

The main feature of this province, which straddles the uplifted Griqualand-Transvaal axis, is the frequency of pans (some vast in size e.g., Verneukpan and Grootvloer) that are remnants of earlier (Cretaceous) drainage systems (**De Wit, 1993**). The province is underlain by Karoo rocks (Ecca and Dwyka Groups) in the south and east and by Namaqua gneiss in the west and north. Each pan has its own endorheic drainage net and several are used for the evaporative production of salt. These pans can be regarded as discontinuous groundwater windows, in which the substantial excess of evaporation over precipitation under the prevailing hot, dry climate, leads to rapid concentration of dissolved solids within each discrete basin. These drainage systems were disrupted both by progressive aridification and by uplift along the Griqualand-Transvaal axis, causing the dismembering of several rivers (e.g., the Koa and Vis/Hartbees rivers) (**Partridge & Maud, 2000**).

Four main drainage systems traverse this province; from east to west of which these are the Boesak, Vis/Hartbees and Brak rivers. Those in the east (Boesak and Vis/Hartbees) display remarkable uniformity, with flat slopes, and wide valley cross-sectional profiles. The rivers in the extreme northwest (e.g., the Brak) are, however, characterised by narrower valley cross-sectional profiles, steeper slopes and convex longitudinal profiles. The Brak River in fact follows the Koa valley, the course of which was disrupted by uplift along the Griqualand-Transvaal axis which crosses it at right angles (**Partridge *et al*. 2010**).

6 FINDINGS

6.1 Overview of Scoping Study Findings

The scoping assessment encompassed identifying and delineating surface water resources within the proposed development site at a database- and desktop-level. For the Helena 1 Solar PV Energy Facility two depression wetlands were provisionally identified. For the Power Line Option 1 Alternative, one non-perennial river was identified. For the Power Line Option 2 Alternative, one depression wetland was identified. Finally, for the Substation site, one depression wetland was identified.

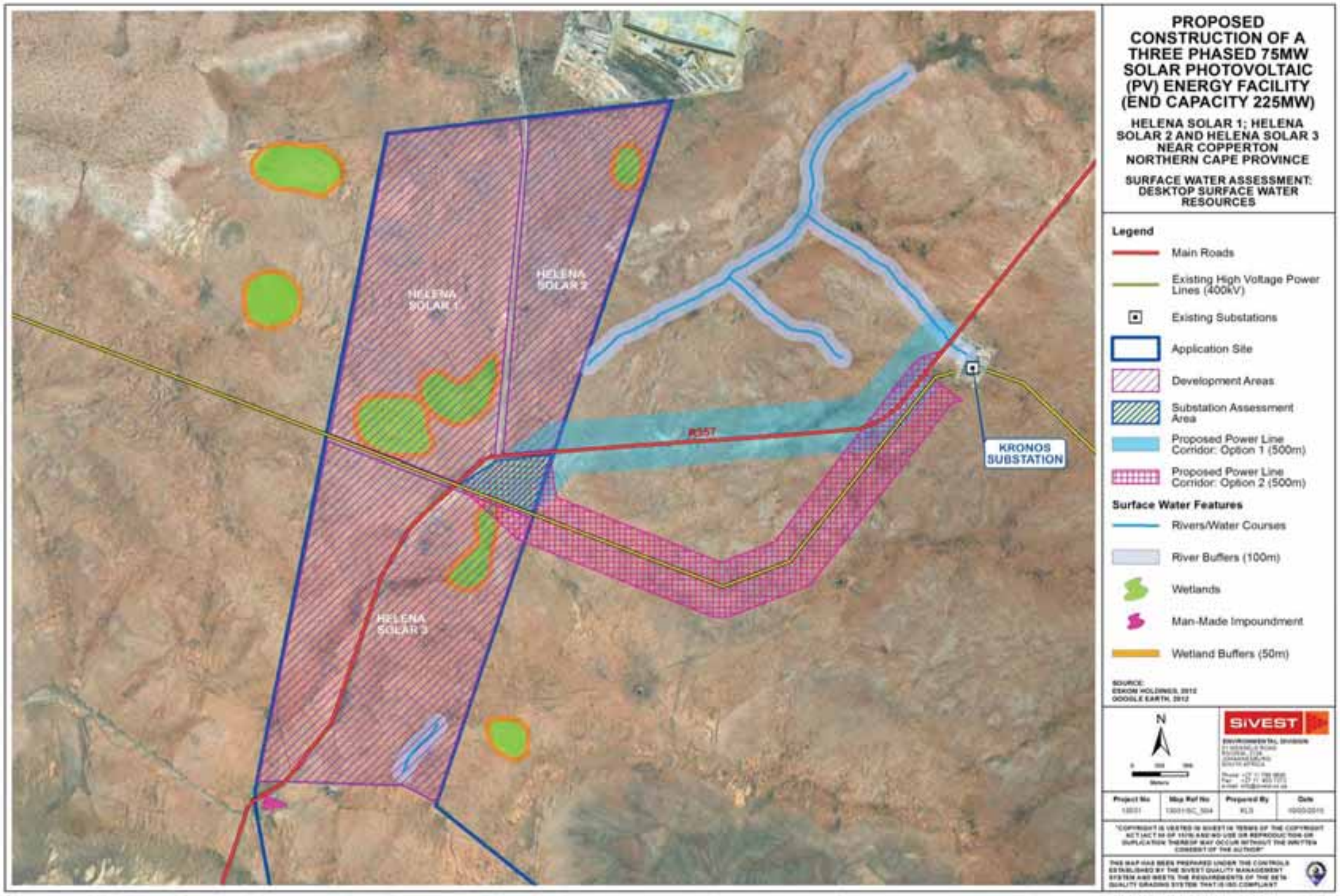

Figure 5: Desktop Surface Water Resources for the Three Phased Solar Energy Facility

6.2 In-field Surface Water Delineation

The in-field surface water delineation assessment took place on the 12th and 13th of August 2015. The fieldwork verification and ground-truthing assessment was undertaken to scrutinize the results of the database and desktop study and to identify any other potentially overlooked surface water resources in the field. The results are presented below. Ultimately, it was found that the proposed development for the Helena 1 Phase Solar Facility contained only one (1) ephemeral depression wetland. The power line component of the proposed development was found to contain one (1) man-made impoundment (Power Line Alternative 1). In addition, an old borrow pit excavation area and a drainage pathway was identified within both the Power Line Alternative 1 and 2 corridors.

The above findings were found not to be totally in line with the desktop assessment. The second depression wetland identified from a desktop level was not verified in the field. Furthermore, the depression wetland identified at the Kronos Substation site was not identified as it appears that the substation may currently occupy the area where the potential feature may have been. However, it may also be possible that there may never have been a feature present and this is an error in the database. Aside from this, the man-made impoundment found within the power line alternative 1 corridor was not identified at a desktop level. This meant that one additional wetland was identified which had not been initially identified, whilst simultaneously two others were not identified in the field and were excluded. A drainage pathway was added to the delineated features.

A graphic illustration of the findings is presented in **Figure 6** and **Figure 7**. The general characteristics of each surface water feature are elaborated on below.

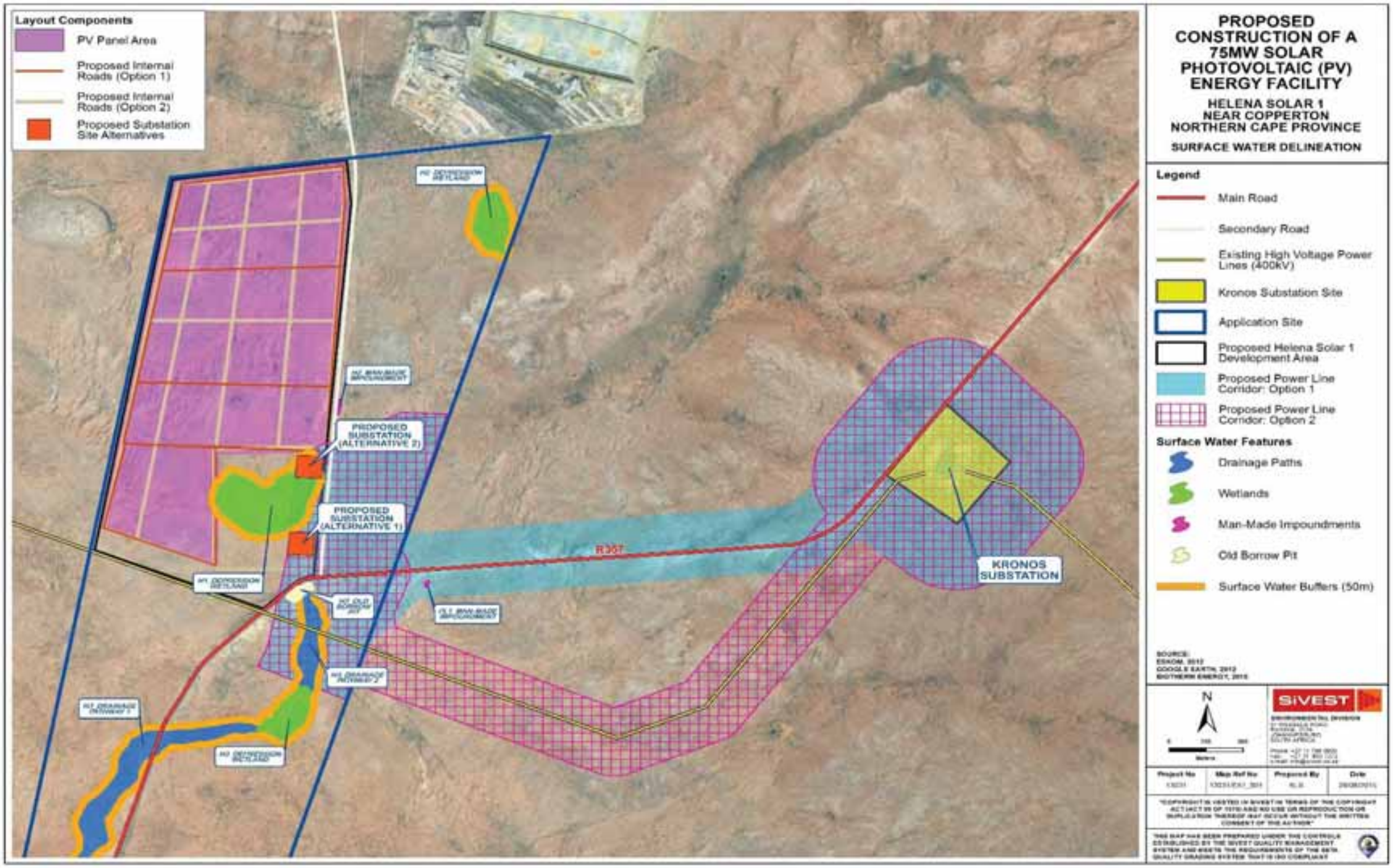

Figure 6. In-field delineated Surface Water Resources within the Helena 1 Phase Proposed Development Site

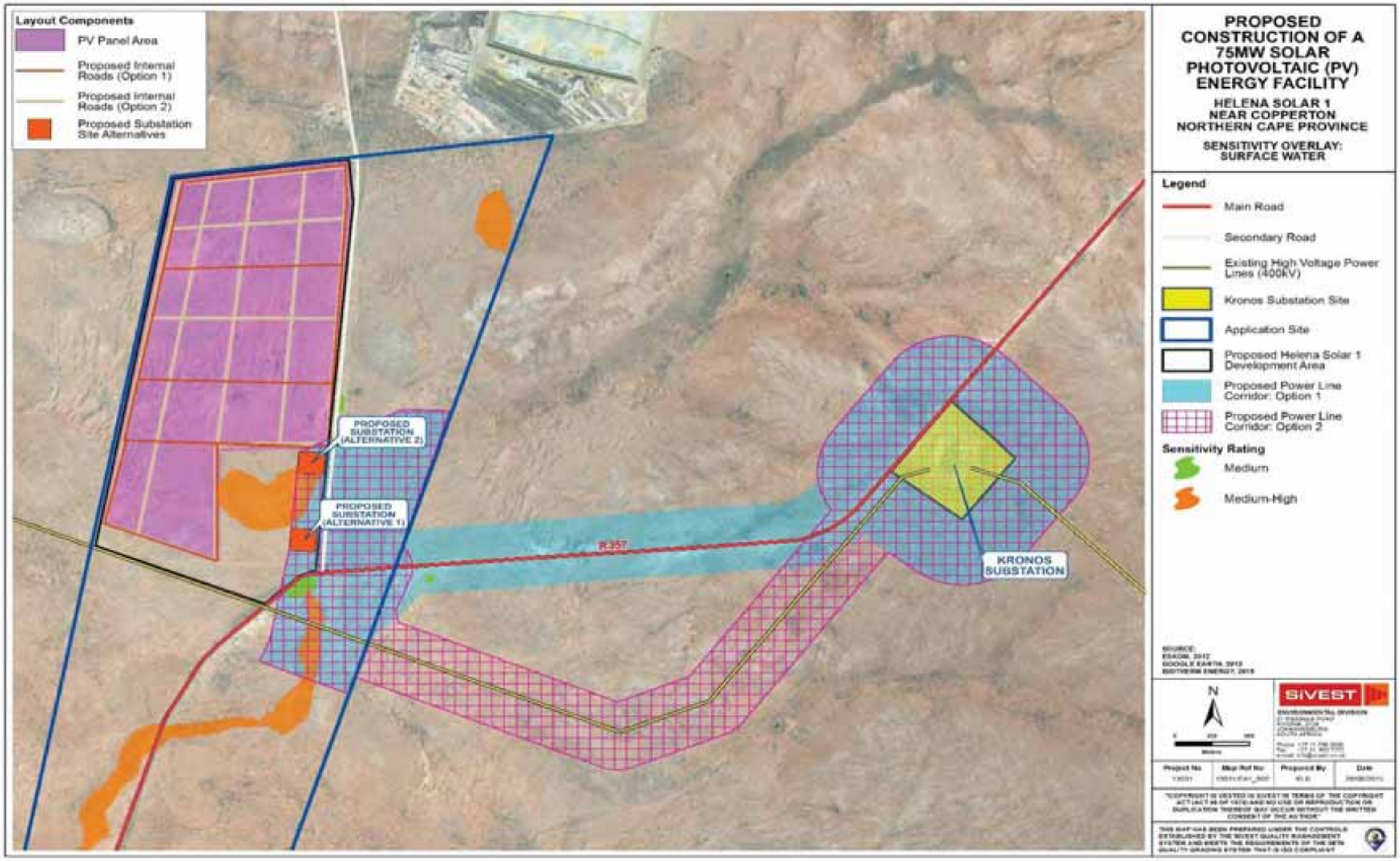

Figure 7. Sensitivity Rating for the Delineated Surface Water Features

6.2.1 Ephemeral Depression Wetland

6.2.1.1 Terrain and Soils

The topography of the site is predominantly flat. However, a slightly lower lying depression area is present which aids in funneling drainage in the localized catchment towards a central point where the depression wetland can be found. The depression wetland is therefore endorheic (inward draining).

Figure 8. General Topography associated with the Depression Wetland

Generally, given the dry climate (relatively high evaporation potential and low annual rainfall), any surface water that accumulates in the pan is not likely to be present for an extended period (few days to several weeks). Examination of the soil samples shows that the soil profile is relatively shallow (30-40cm deep), although deeper than the surrounding terrestrial areas where rock extrudes at the surface in places. Lime nodules are present in the soil matrix, although the soil profile is generally made up of an Orthic A horizon which overlies hard rock. The soil form is therefore representative of the Mispah Soil Form. This is not considered a wetland soil form. However, the shallow soil profile means that water is generally close to the surface but will not be present for long due to high temperatures and evaporation. Conditions are therefore presumably not suitable for the formation of hydrogeomorphism to take place. Moreover, the soil particles are predominantly fine but porous (with the exception of a few lime granules and rock fragments found in the soil matrix). The soils can therefore be considered highly oxidized for the most part throughout the year when not completely inundated.

6.2.1.2 Vegetation

The vegetation in the area is mainly made up of dwarf shrubland and scrubs. Within the depression wetland, small clumps of thickets can be found which are slightly taller and more robust than the surrounding vegetation. Towards the core of the wetland, vegetation becomes less dense to absent in the central parts of the wetland (**Figure 9**). Species that were noted included *Eriocephalus*, *Salsola*, *Aptosimum* and *Pentzia* (**Hoare, 2015**). The depression wetland was dominated by thorny, low, tangled shrubs, including *Rhigozum trichotomum*, *Asparagus burchellii* and a species of *Lycium* which is consistent with the Mucina and Rutherford (2006) published description for Bushmanland Vloere vegetation type (Hoare, 2015). Small assemblages of *Stipagrostis* species were also noted. The variation in habitat and potential presence of surface water (albeit seldom) makes this surface water feature ecologically significant considering the arid nature of the landscape. However, no notable species of conservation concern were noted. The sensitivity of this surface water feature is considered Medium-High.

Figure 9. Vegetation within the Depression Wetland showing change in Density

6.2.2 Man-made Impoundment

6.2.2.1 Terrain and Soils

An area has been excavated to create a man-made impoundment, which serves as a water source for sheep farming that is currently take place on the site. This surface water feature is therefore artificial.

Figure 10. Excavated man-made impoundment

An exposed soil profile on the edge of the man-made impoundment shows that the soils go from what can be described as an Orthic A horizon into a Hard Pan Carbonate B horizon (**Figure 11**). The combination of these two soil horizons can be attributed to the Prieska Soil Form which is not considered a wetland soil form.

Figure 11. Soil Profile at the edge of the excavated Man-made Impoundment

6.2.2.2 Vegetation

Vegetation within the man-made impoundment was limited to a few clumps of graminoid species (*Stipagrostis*, *Centropodia*) in the central part of the surface water feature. *Prosopis glandulosa* var. *torreyana* (Category 2 invader species under the Conservation of Agricultural Resources Act, 1983 (Act No. 43 of 1983) as amended in 2001) (**Figure 12**) was also observed. The composition and state of vegetation decreases the ecological significance of this surface water feature. However, when inundated, it will provide a water source for avi-faunal, faunal and amphibian species. The sensitivity of this feature is considered to be Medium.

Figure 12. *Prosopis glandulosa* var. *torreyana* in the Man-made Impoundment

6.2.3 Old Borrow Pit Excavation

6.2.3.1 Terrain and Soils

An excavation adjacent to the R357 presumably was created for the purposes of a borrow pit to utilize the soil for construction purposes in the nearby area. The soils are therefore terrestrial in nature. Ponding of water was noted during the site investigation. The presence of bedrock near the surface within the excavation can be taken as a factor preventing further drainage of surface water into the soils.

Figure 13. Old excavated Borrow Pit

6.2.3.2 Vegetation

The vegetation was very limited and comprised mainly terrestrial species along with *Stipagrostis* species. The habitat is therefore no more distinct than that of the surrounding landscape with the exception of surface water which may provide aquatic habitat for potential amphibian species. The sensitivity of this surface water feature is considered to be Medium.

6.2.4 Drainage Pathway

6.2.4.1 Terrain and Soils

The drainage pathway is situated in a low lying valley in the landscape. As with the endorheic depression wetland, the soil profile is relatively shallow before reaching bedrock. In some areas, the bedrock was exposed at the surface. However, no distinct channel was identified. As such, the soil characteristics are very similar to the depression wetland. The soils are yellow-brown in colour and also finely grained, but porous (**Figure 14**). No signs of wetness were evident in the soils precluding it as a potential wetland. Nonetheless, drainage flows through this low point in the landscape albeit infrequent.

Figure 14. Example of the Soils drawn near to the Surface (20cm) of the Drainage Pathway

6.2.4.2 Vegetation

Vegetation structure and composition was similar to that of the depression wetland. The same increase in robustness and height of the shrub and scrub species was evident (**Figure 15**). Again, species such as *Eriocephalus*, *Salsola*, *Aptosimum* and *Pentzia* were noted. As such, the variation in habitat and drainage of water (albeit infrequent) through this part of the landscape, makes the surface water feature distinct from the surrounding environment and therefore of higher ecological significance. However, as no species of notable concern or importance were noted, the sensitivity is considered to be Medium-High.

Figure 15. Taller more robust vegetation within the Drainage Pathway. Note the exposed bedrock at the surface.

6.2.5 Comment on Wetland Functionality, Sensitivity and Importance

The drainage lines and wetlands within study area were found to be dry and colonised by typically terrestrial species, indicating that these systems are ephemeral in nature, as defined by **Rossouw *et al*., 2005** (in terms of drainage lines and watercourses) and **SANBI, 2013** (in terms of wetlands). However, it must be noted that a number of vegetation species could not be identified due lack of identifiable plant parts. Nonetheless, presumably surface and sub-surface water occurrence is scarce enough to the extent that herbaceous species are able to colonise the surface water features as opposed to typically hydrophytic vegetation species. Disturbance from cattle grazing is also likely to contribute to the degraded habitat in these systems and prominence of shrub species.

The presence of these ephemeral surface water features in dry lands are however important for the vegetation and biota that they support (**Rossouw *et al*., 2005**). Ephemeral rivers are characterised by much higher flow variability, extended periods of zero surface flow and the general absence of low flows (**Knighton & Nanson, 1997**). It may appear that variable flows and intermittency have largely negative effects, adversely affecting water quality during dry periods and limiting the diversity of water fauna and flora (**Rossouw *et al*., 2005**). Yet, dry periods are part of the natural climatic cycle experienced by the animals, plants and micro-organisms that live in arid regions. Natural low-flow and drought periods are as important for maintaining biodiversity and healthy rivers as natural high flows and floods are in other kinds of rivers (**Hughes, 2005**). The abilities of organisms to survive prolonged dry conditions / drought (resistance) and recovery from it (resilience) are “hard-wired” adaptations of healthy aquatic ecosystems from eons of evolution (**Jones, 2003**). The invertebrate fauna that inhabit these environments have various physiological, behavioural and structural adaptations, enabling their survival in a constantly changing environment. For example, the class *Branchiopoda* (and the order *Anostraca*) is of particular concern as many of the species belonging to this order are in the IUCN listed taxa. Dessication survival is achieved through the production of an egg bank. The egg bank consists of desiccation resistant eggs which lie dormant in the sediment during the dry phase, and only hatch upon the return of favourable conditions when the pan is once again inundated with water.

Additionally, pans (or in this case ephemeral and depression wetlands) act as critical biogeochemical cycling stations, especially in arid landscapes. Typically, these ephemeral wetlands undergo fluctuating conditions often switching from inundated to desiccated stages. As a result, the opposing dry and wet phase conditions, acting out over time and space, markedly influence the biogeochemical processes taking place in the water column and the substrate. In this context, ephemeral wetlands, as those identified within this study, can be regarded as biogeochemical ‘hot spots’ when viewed at the appropriate spatio-temporal scales (**McClain *et al*., 2003**). Classic biogeochemical processes often associated with wetlands include nitrification and denitrification processes, nitrogen fixation, nitrogen mineralization, nitrogen volatilization, phosphorous precipitation, phosphorous adsorption and absorption, ferrolysis, gleying, sulphur reduction, fermentation of organic carbon and methanogenesis amongst others (**Mitsch & Gosselink, 1986**).

With the above in mind, any potential impacts to these surface water features that could alter the established natural condition, can disrupt the systems and have far-reaching effects. For example, sedimentation within temporary/ephemeral wetlands could result in limited or no hatching of the invertebrate class *Branchiopoda* after rainfall. Ultimately, given the scarcity of water in the area, systems such as these provide unique habitats and can be considered to play an important role despite the enigmatic nature.

The general attitude of many seems to suggest that ephemeral systems already receive so little water, in such an unpredictable way, that a little less water should not make that much difference, whilst others feel that they already exist in such a marginal way that any further stress would have a massive (and largely unknown) effect on them (**Rossouw *et al*., 2005**). Ultimately, the safeguarding of ephemeral systems should be upheld in accordance with the pre-cautionary principle and regarded as sensitive until more comprehensive and long term studies can inform otherwise.

6.2.6 *Wetland Buffer Zones*

The Gauteng Minimum Requirements for Biodiversity Studies (**GDACE, 2009**) were utilised to implement a suitable buffer zone around the delineated wetlands for the proposed development. In accordance with these guidelines, a buffer zone of 50m was to be applied to the delineated wetland as it is located outside an urban area. The same buffer was applied to the drainage pathways since the vegetation composition was broadly similar and therefore had the same ecological significance. No buffer zones were implemented for the artificial surface water features as these features did not contain the same floristic significance exhibited by the wetland and drainage pathways.

7 ALTERNATIVES COMPARATIVE ASSESSMENT

Internal access roads, substation and power line corridor alternatives have been investigated for the proposed solar PV development. These alternatives have been comparatively assessed in order to determine the preferred alternatives from a surface water perspective.

The following factors were taken into account when comparatively evaluating the proposed alternatives:

- Size and number of potentially impacted surface water resource(s) in the proposed alternative;
- Proximity to the nearest surface water resource(s);
- The location of any surface water resources present and the ability of the proposed development to be constructed out of, around or away from any nearby surface water resources; and
- Existing impact factors (such as existing infrastructure, roads and impacted land).

In terms of the first criteria, the size and number of surface water resources within an alternative area was relevant. The more surface water resources that are present and the greater the area each occupies, it is likely that the impact of the proposed development will be greater.

The second criteria to consider is proximity of the proposed development positioning to any nearby surface water resources. The type of surface water resource and the distance of the proposed development to it will have a bearing on whether there may be direct or indirect impacts that could affect it.

The third criteria focuses on whether the proposed development may be able to be constructed with surface water resources present. It may be possible for the proposed development to be constructed if there are few surface water resources present and the facility component or infrastructure is repositioned to avoid the surface water feature. In this instance, maneuverability of the site layout may only also be possible should any surface water resources be located on the boundary of the proposed development area under consideration.

The final criteria of significance, when selecting the most suitable alternative, is existing infrastructure (power lines, roads, railway etc.) and impacted land (agricultural fields, urban areas etc.). Disturbance to an existing impacted area will be less than if undisturbed, or where less impacted land is affected.

The logic for each criteria was applied in the assessment below.

Key

PREFERRED	The alternative will result in a low impact / reduce the impact
FAVOURABLE	The impact will be relatively insignificant
NOT PREFERRED	The alternative will result in a high impact / increase the impact
NO PREFERENCE	The alternative will result in equal impacts

Table 2. Surface Water Comparative Assessment Table

Alternative	Preference	Reasons
SUBSTATION		
Substation Site Alternative 1	Preferred	Not within any surface water feature
Substation Site Alternative 2	Not Preferred	Located within an ephemeral depression wetland
INTERNAL ROADS		
Internal Road Alternative 1	No Preference	Both road layouts route along the edge of the depression wetland. No other surface water features are affected by both layouts and therefore will have the same potential impact from a surface water perspective.
Internal Road Alternative 2	No Preference	Both road layouts route along the edge of the depression wetland. No other surface water features are affected by both layouts and therefore will have the same potential impact from a surface water perspective.
POWER LINES		
Power Line Corridor Alternative 1	Favourable	This alternative corridor has four surface water features either overlap or are contained within the corridor that may potentially be impacted on. These include the ephemeral depression wetland, the drainage pathway, the

Alternative	Preference	Reasons
		man-made impoundment and the old excavated borrow pit area. Despite power line corridor alternative 1 containing one extra surface water feature, this alternative is seen as favourable since the potential impact will be similar for both alternative corridors in that both share the same area for the initial part of the power line and will therefore have the same diversion and/or spanning issues. The impact is not seen as significant since with careful placement of the electricity pylons/towers, the surface water features can be spanned and direct impact can be avoided. Additionally, the proposed power line will be able to easily span the additional surface water feature (the man-made impoundment) given its limited extent.
Power Line Corridor Alternative 2	Favourable	This alternative corridor has three surface water features either overlap or are contained within the corridor that may potentially be impacted on. These include the ephemeral depression wetland, the drainage pathway and the old excavated borrow pit area. Although power line corridor alternative 2 containing one less surface water feature, this alternative is seen as favourable since the potential impact will be similar for both alternative corridors in that both share the same area for the initial part of the power line and will therefore have the same diversion and/or spanning issues. This is despite having one less surface water feature. Overall, the impact is not seen as significant since with careful

Alternative	Preference	Reasons
		placement of the electricity pylons/towers, the surface water features can be spanned and direct impact can be avoided.

8 LEGISLATIVE IMPLICATIONS

In the context of the proposed development impacting on surface water resources, the following environmental and water legislation is applicable.

8.1 National Environmental Management Act, 1998 (No. 107 of 1998) & Environmental Impact Assessment Regulations (2014)

- Environmental Impact Assessment regulations 2014, Listing Notice 1, GN. 983, Activity 12:

The development of-

(xii) *infrastructure or structures with a physical footprint of 100 m2 or more;*

where such development occurs-

(a) within a watercourse;

(c) if no development setback exists, within 32 m of a watercourse, measured from the edge of a watercourse; -

The proposed PV panel area, both substation sites and both internal access road layouts fall within 32m of the depression wetland. Activity 12 of Listing Notice 1 will therefore be triggered. Additionally, the proposed power line towers may need to be positioned within 32m of any of the identified surface water features depending on the final alignment. Should this take place, Activity 12 will be triggered in this respect too.

- Environmental Impact Assessment regulations 2014, Listing Notice 1, GN. 983, Activity 19:

The infilling or depositing of any material of more than 5 m³ into, or the dredging, excavation, removal or moving of soil, sand, shells, shell grit, pebbles or rock of more than 5 m³ from-

(i) a watercourse;

It may be required that the substation, internal access roads and power line will need to be within the identified wetlands. Should this be the case, this activity will be triggered.

8.2 National Water Act, 1998 (Act No. 36 of 1998)

According to the NWA, the following are considered "water uses" and will require licensing in the form of a water use license application:

a) Taking water from a water resource;
b) Storing water;
c) Impeding or diverting the flow of water in a watercourse;
d) Engaging in stream flow reduction activity contemplated in Section 36 of the NWA;
e) Engaging in a controlled activity identified as such in Section 37 (1) or declared under Section 38(1) of the NWA;
f) Discharging waste or water containing waste into a water resource through a pipe, canal, sewer, sea outfall or other conduit;
g) Disposing of waste in a manner which may detrimentally impact on a water resource;
h) Disposing of waste in a manner of water which contains waste from, or which has been heated in any industrial or power generation process;
i) Altering the bed, banks, course or characteristics of a watercourse;
j) Removing, discharging or disposing of water found underground if it is necessary for efficient continuation of an activity or for the safety of people; and
k) Using water for recreational purposes.

As the identified wetlands may be directly affected, it is expected that the following water uses will be required for the proposed development:

- (c) Impeding or diverting the flow of water in a watercourse;
- (i) Altering the bed, banks, course or characteristics of a watercourse;

9 POTENTIAL IMPACTS OF THE PROPOSED DEVELOPMENT ON SURFACE WATER RESOURCES

From a surface water resource perspective, potential impacts are anticipated to take place as a result of the proposed development in close proximity or directly within identified surface water resources. This section will identify and contextualise each of the potential impacts within the context of the proposed development and the identified surface water resources. This section will rate these impacts according to an impact rating system (see **Appendix A** for a full methodology and description of the impact rating system), determine the effect of the environmental impact and provide recommendations towards mitigating the anticipated impact. The identification and rating of impacts will be undertaken for the pre-construction, construction, operation and de-commissioning phase of the proposed development.

9.1 Pre-construction Phase Potential Impacts

9.1.1 Impacts associated with the Construction Lay-down Area

A construction lay-down area is likely to be required for the proposed development. The location of the construction lay-down area will be important, as placing this area near to surface water resources is likely to result in direct and/or indirect negative impacts. Direct impacts can be due to placement of the lay-down area directly within a surface water resources. Indirectly, potential downstream contamination and pollution impacts from stored oils, fuels, and other hazardous substances or materials being transported via run-off are a possibility. Where site clearing for the lay-down area may be required near surface water resources, clearance/removal of vegetation at the surface can leave downstream surface water resources vulnerable to erosion and sedimentation impacts from associated run-off.

Assessment of the above potential negative impacts and mitigation measures thereto are provided in **Table 3** below.

Table 3. Impact rating for pre-construction impacts related to the construction lay-down area and surface water resources

IMPACT TABLE	
Environmental Parameter	Surface Water Resources
Issue/Impact/Environmental Effect/Nature	Impacts associated with the construction lay-down area in or near to surface water resources

Extent	*Site*	
Probability	*Possible*	
Reversibility	*Partly reversible*	
Irreplaceable loss of resources	*Marginal loss of resources*	
Duration	*Medium term*	
Cumulative effect	*Low cumulative impact*	
Intensity/magnitude	*Medium*	
Significance Rating	*Pre-mitigation significance rating is low and negative. With appropriate mitigation measures, the impact can be further reduced.*	
	Pre-mitigation impact rating	Post mitigation impact rating
Extent	1	1
Probability	2	1
Reversibility	2	1
Irreplaceable loss	2	1
Duration	2	1
Cumulative effect	2	1
Intensity/magnitude	2	1
Significance rating	- 22 (low negative)	- 6 (low negative)
Mitigation measures	**Seasonal Scheduling of the Construction Process** – It is important that construction activities must be scheduled to take place over the dry winter season when rainfall and flows are low (June/July/August/September). **Location of the Lay-down Area** – The lay-down area must not be placed within any surface water resources. Environmental authorisation and a water use license will be required should the construction lay-down area need to be placed inside a surface water resource.	

9.2 Construction Phase Potential Impacts

9.2.1 Vehicle and Machinery Degradation Impacts

Construction vehicles (heavy and light) are likely to require access to the proposed development footprint and construction lay-down area. Potential negative impacts can include the need to travel into or through surface water resources using the current internal road layout which routes through the depression wetland, thereby resulting in physical degradation. Moreover, downstream leaks or spills of oils, fluids and/or fuels from vehicles and machinery in general or during re-fuelling or servicing in the surface water resources are a possibility. Should any leakage or spillage occur in and/or near the surface water resources, potential soil/water contamination can result. Fuels and oils also pose a fire risk not only to the surface water resources but also neighbouring grazing lands or nearby settlement areas.

Assessment of the above potential negative impacts and mitigation measures thereto are provided in **Table 4** below.

Table 4. Impact rating for construction vehicle and machinery degradation impacts to surface water resources

IMPACT TABLE		
Environmental Parameter	Surface Water Resources	
Issue/Impact/Environmental Effect/Nature	Vehicle and machinery degradation to surface water resources	
Extent	*Site*	
Probability	*Possible*	
Reversibility	*Partly reversible*	
Irreplaceable loss of resources	*Marginal loss of resources*	
Duration	*Medium term*	
Cumulative effect	*Medium cumulative Impact*	
Intensity/magnitude	*Medium*	
Significance Rating	*Pre-mitigation significance rating is low and negative. With appropriate mitigation measures, the impact can be reduced.*	
	Pre-mitigation impact rating	Post mitigation impact rating
Extent	1	1
Probability	2	1

Reversibility	2	1
Irreplaceable loss	2	1
Duration	2	1
Cumulative effect	3	1
Intensity/magnitude	2	1
Significance rating	- 24 (low negative)	- 6 (low negative)
Mitigation measures	**Preventing Physical Degradation of Surface Water Resources** – Surface water resources and the associated buffer zones are to be designated as "highly sensitive areas". Vehicle access is not to be allowed in the highly sensitive areas. Internal access roads are not to be routed in any surface water resources. Should this be required, environmental authorisation and a water use license will be required before construction takes place and all mitigation measures are to be implemented. Construction workers are only allowed in the designated construction areas of the proposed development and not into the surrounding surface water resources. Highly sensitive areas are to be clearly demarcated prior to the commencement of construction and no access beyond these areas is to be allowed. **Preventing Soil Contamination** – No vehicles are to be allowed in the highly sensitive areas unless authorised. Should vehicles be authorised in highly sensitive areas, all vehicles and machinery are to be checked for oil, fuel or any other fluid leaks before entering the required construction areas. All vehicles and machinery must be regularly serviced and maintained before being allowed to enter the construction areas. No fuelling, re-fuelling, vehicle and machinery servicing or maintenance is to take place in the highly sensitive areas. The study site is to contain sufficient spill contingency measures throughout the construction process. These include, but are not limited to, oil spill kits to be available, fire extinguishers, fuel, oil or hazardous substances	

	storage areas must be bunded to prevent oil or fuel contamination of the ground and/or nearby surface water resources or associated buffer zones.

9.2.2 Human Degradation of Flora and Fauna associated with Surface Water Resources

The possibility of human degradation to the surface water resources is likely to occur during the construction phase, since construction activities will take place in close proximity to surface water resources. Human degradation can take the form of physical / direct degradation such as lighting fires (purposefully or accidentally) in or near to surface water resources. Usage of the surface water resources for sanitation purposes may take place resulting in pollution of the surface water resources. The surface water resources may also be utilised as a source of water for domestic use, building and general cleaning purposes.

Fauna and avi-fauna associated with surface water resources are often hunted, trapped, killed or eaten. This impact must be prevented. Finally, flora associated with surface water resources may need to be cleared or removed for building storage purposes which can result in a loss of resources.

Assessment of the above potential negative impacts and mitigation measures thereto are provided in **Table 5** below.

Table 5. Impact rating for construction phase human degradation of flora and fauna associated with surface water resources

IMPACT TABLE	
Environmental Parameter	Surface Water Resources
Issue/Impact/Environmental Effect/Nature	Human degradation to fauna and flora associated with surface water resources
Extent	*Site*
Probability	*Probable*
Reversibility	*Completely reversible*
Irreplaceable loss of resources	*Marginal loss of resources*
Duration	*Short term*
Cumulative effect	*Low cumulative impact*
Intensity/magnitude	*Low*
Significance Rating	*Pre-mitigation significance rating is low and negative. With appropriate mitigation measures, the impact can be further reduced.*

	Pre-mitigation impact rating	Post mitigation impact rating
Extent	1	1
Probability	3	1
Reversibility	1	1
Irreplaceable loss	2	1
Duration	1	1
Cumulative effect	2	1
Intensity/magnitude	1	1
Significance rating	- 10 (low negative)	- 6 (low negative)
Mitigation measures	**Minimising Human Physical Degradation of Sensitive Areas** - Construction workers are only allowed in designated construction areas and not into the surface water resources designated as highly sensitive. The highly sensitive areas are to be clearly demarcated and no access beyond these areas is to be allowed unless authorised. No animals on the construction site or surrounding areas are to be hunted, captured, trapped, removed, injured, killed or eaten. Should any party be found guilty of such an offence, stringent penalties should be imposed. The appointed ECO is to be contacted should removal of any fauna be required during the construction phase. No "long drop" toilets are allowed on the study site. Suitable temporary chemical sanitation facilities are to be provided. Temporary chemical sanitation facilities must be placed at least 100 meters from any surface water resource where required. Temporary chemical sanitation facilities must be placed over a bunded or a sealed surface area and adequately maintained to prevent pollution impacts. No water is to be extracted unless a water use license is granted for specific quantities for a specific water resource.	

	No hazardous or building materials are to be stored or brought into the highly sensitive areas. Should a designated storage area be required, the storage area must be placed at the furthest location from the highly sensitive areas. Appropriate safety measures as stipulated above must be implemented. No cement mixing is to take place in a surface water resource. In general, any cement mixing should take place over a bin lined (impermeable) surface or alternatively in the load bin of a vehicle to prevent the mixing of cement with the ground. Importantly, no mixing of cement directly on the surface is allowed in the highly sensitive areas.

9.2.3 Degradation and Removal of Soils and Vegetation associated with Surface Water Resources

It may be required that the proposed development is to be located within the identified surface water resources and the associated buffer zones. Foundations will need to be laid for the various building structures of the solar PV power plant, substation, power lines and associated infrastructure. The depth of the various substation/building foundations may be up to 4m. Where the placement of the foundations extend into the surface water resource areas, the excavation of potential soils are likely to affect the functionality of these hydrological systems. Functionality may be affected in terms of hydrological functionality as well as pedological functionality. Moreover, the implementation of the foundations are considered a permanent structure, meaning that the area occupied by the foundation will result in a degree of permanent surface water resource habitat (vegetation) loss. Moreover, soil may also need to be removed during this process.

Assessment of the above potential negative impacts and mitigation measures thereto are provided in **Table 6** below.

Table 6. Impact rating for construction phase degradation and removal of vegetation and soils associated with surface water resources and the associated buffer zone

IMPACT TABLE	
Environmental Parameter	Surface Water Resources
Issue/Impact/Environmental Effect/Nature	Degradation and removal of soils and vegetation associated with surface water resources

Extent	*Site*	
Probability	*Possible*	
Reversibility	*Barely reversible*	
Irreplaceable loss of resources	*Marginal loss of resources*	
Duration	*Long term*	
Cumulative effect	*Medium cumulative Impact*	
Intensity/magnitude	*Medium*	
Significance Rating	*Pre-mitigation significance rating is low and negative. With appropriate mitigation measures, the impact can be further reduced.*	
	Pre-mitigation impact rating	Post mitigation impact rating
Extent	1	1
Probability	2	1
Reversibility	3	1
Irreplaceable loss	2	1
Duration	3	1
Cumulative effect	3	1
Intensity/magnitude	2	1
Significance rating	- 28 (low negative)	- 6 (low negative)
Mitigation measures	**Obtaining Relevant Authorisations and Licenses** – Before any construction or removal of soils and vegetation in any delineated surface water resources is undertaken, the relevant water use license and environmental authorisation is to be obtained and conditions adhered to should development need to take place directly in wetlands. Ideally, all surface water resources are to be avoided as far as possible however. **Limiting Damage to Surface Water Resources** – Ideally, to minimise any impact to surface water resources, the proposed development should seek to avoid all surface water resources as far as possible. Where this is not possible a single access route or "Right of Way" (RoW) is to be established to the desired construction area in the surface water resources. The environmentally authorized and license permitted construction area is to be demarcated and made visible. The establishment of	

	the RoW likewise must be demarcated and made visible. The width of the RoW must be limited to the width of the vehicles required to enter the surface water resource (no more than a 3m width). An area around the locations of the proposed development structures, buildings, infrastructure will be required in order for construction vehicles and machinery to operate/maneuver. This too must be limited to the smallest possible area (no bigger than 100m²) and made visible by means of demarcation. **Limiting Removal of Excavated Soils** – Should the necessary authorisations (water use license, environmental authorisation etc.) be obtained for the solar PV panels, buildings or structures and other associated infrastructure to be placed in surface water resources, excavated topsoils should be stockpiled separately from subsoils so that it can be replaced in the correct order for rehabilitation purposes post-construction. Soils removed from surface water resources must only be removed if absolutely required. Furthermore, any removed soils and vegetation that are not required should be taken to a registered landfill site that has sufficient capacity to assimilate the spoil. The topsoil is to be used for rehabilitation purposes and should not be removed unless there is surplus that cannot be utilised. It is important that when the soils are reinstated, the subsoils are to be backfilled first followed by the topsoil. The topsoil contains the natural seedbank from which the affected surface water resources or the associated buffer zone can naturally rehabilitate. Where the soils are excavated from the sensitive areas, it is preferable for them to be stockpiled adjacent to the excavation pit to limit vehicle and any other movement activities around the excavation areas.

	Preventing Pollution Impacts – Any cement mixing should take place over a bin lined (impermeable) surface or alternatively in the load bin of a vehicle to prevent the mixing of cement with the ground of the surface water resource or the associated buffer zone. Importantly, no mixing of cement directly on the surface is allowed in the construction and RoW areas in surface water resources. **Protection of Stockpiled Soils** – Stockpiled soils will need to be protected from wind and water erosion. Stockpiled soils are not to exceed a 3m height and are to be bunded by suitable materials. Stacked bricks surrounding the stockpiled soils can be adopted. Alternatively, wooden planks pegged around the stockpiled soils can be used. **Rehabilitation of RoW areas** – Ideally, the affected RoW zones in the sensitive areas must be re-instated with the soils removed from the surface water resource(s), and the affected areas must be levelled, or appropriately sloped and scarified to loosen the soil and allow seeds contained in the natural seed bank to re-establish. However, given the aridity of the study area, it is likely that vegetation recovery will be slow. Rehabilitation areas will need to be monitored for erosion until vegetation can re-establish where prevalent. If affected areas are dry and no vegetation is present, the soil is to be re-instated and sloped.

9.2.4 Increased Run-off, Erosion and Sedimentation Impacts

Vegetation clearing will need to take place for the construction process. Excessive or complete vegetation clearance in the highly sensitive and nearby surrounding areas is likely to result in exposing the soil and leaving the ground susceptible to wind and water erosion, particularly during and after rainfall events. Due to the climate of the study area and sudden sporadic rainfall, general soil erosion, as a consequence of the proposed development, is a distinct possibility. A further impact due to erosion and storm water run-off impacts is increased sedimentation to surface water resources. Deposited sediments can smother vegetation and change flow paths and dynamics making affected areas susceptible to alien plant invasion leading to further degradation.

Assessment of the above potential negative impacts and mitigation measures thereto are provided in **Table 7** below.

Table 7. Impact rating for construction phase increased storm water run-off, erosion and sedimentation impacts

IMPACT TABLE		
Environmental Parameter	Surface Water Resources	
Issue/Impact/Environmental Effect/Nature	Increased storm water run-off, erosion and increased sedimentation impacting on surface water resources	
Extent	*Site*	
Probability	*Probable*	
Reversibility	*Partly reversible*	
Irreplaceable loss of resources	*Marginal loss of resources*	
Duration	*Medium term*	
Cumulative effect	*Medium cumulative impact*	
Intensity/magnitude	*Medium*	
Significance Rating	*Pre-mitigation significance rating is low and negative. With appropriate mitigation measures, the impact can be further reduced.*	
	Pre-mitigation impact rating	Post mitigation impact rating
Extent	1	1
Probability	3	1
Reversibility	2	1
Irreplaceable loss	2	1
Duration	2	1
Cumulative effect	3	1
Intensity/magnitude	2	1
Significance rating	- 26 (medium negative)	- 6 (low negative)
Mitigation measures	**Preventing Increased Run-off and Sedimentation Impacts** - Vegetation clearing should take place in a phased manner, only clearing areas that will be constructed on immediately. Vegetation clearing must not take place in areas where construction will only take place in the distant future.	

	An appropriate storm water management plan formulated by a suitably qualified professional must accompany the proposed development to deal with increased run-off in the designated construction areas. In general, adequate structures must be put into place (temporary or permanent where necessary in extreme cases) to deal with increased/accelerated run-off and sediment volumes. The use of silt fencing and potentially sandbags or hessian "sausage" nets can be used to prevent erosion in susceptible construction areas. Grass blocks on the perimeter of the building structure footprints can also be used to reduce run-off and onset of erosion. Where required more permanent structures such as attenuation ponds and gabions can be constructed if needs be. All impacted areas are to be adequately sloped to prevent the onset of erosion.

9.3 Operation Phase Anticipated Potential Impacts

9.3.1 Vehicle Damage to Surface Water Resources

Vehicle access may be required to construction areas for structures, buildings and infrastructure that have been permitted to be constructed in surface water resources. It is important that roads are not planned and constructed within surface water resources and/or associated buffer zones. However, where this is required and the relevant environmental authorization and water use license is obtained, access areas may be susceptible to compaction and erosion impacts. Regular vehicle movement in surface water resources can compact the soil affecting the hydrology of the surface water resource. Similarly, regular movement from vehicles can smooth the ground surface making it susceptible to accelerated run-off which may result in erosion. Compaction from vehicles can also create incisions which may induce erosion.

Service roads are to be required for access to the proposed power lines during the operation and maintenance phase. One surface water resource (man-made impoundment) was identified which could be physically affected depending on the final alignment.

Assessment of the above potential negative impacts and mitigation measures thereto are provided in **Table 8** below.

Table 8. Impact rating for operation phase vehicle damage

IMPACT TABLE		
Environmental Parameter	Surface Water Resources	
Issue/Impact/Environmental Effect/Nature	Vehicle damage to surface water resources	
Extent	*Local*	
Probability	*Possible*	
Reversibility	*Partly reversible*	
Irreplaceable loss of resources	*Marginal loss of resources*	
Duration	*Long term*	
Cumulative effect	*Medium cumulative impact*	
Intensity/magnitude	*High*	
Significance Rating	*Pre-mitigation significance rating is medium and negative. With appropriate mitigation measures, the impact can be reduced to a low negative impact.*	
	Pre-mitigation impact rating	Post mitigation impact rating
Extent	2	1
Probability	2	1
Reversibility	2	1
Irreplaceable loss	2	1
Duration	3	3
Cumulative effect	3	1
Intensity/magnitude	3	1
Significance rating	- 42 (medium negative)	- 8 (low negative)
Mitigation measures	**Minimising Vehicle Damage to the Surface Water Resources** – Potential impacts can be avoided by the routing of access roads outside of and away from surface water resources. Additionally there are existing service roads where existing power lines have been established. Should the final alignment follow alongside existing power lines, the existing service roads are to be used and no new roads will be required to be established.	

	Where access through surface water resources are unavoidable and are absolutely required, it is recommended that any road plan and associated structures be submitted to the relevant environmental and water departments for approval prior to implementation. Access roads authorised in sensitive areas will have to be regularly monitored and checked for erosion. Monitoring should be conducted once every two months. Moreover, after short or long periods of heavy rainfall or after long periods of sustained rainfall the roads will need to be checked for erosion. Rehabilitation measures will need to be employed should erosion be identified. Where erosion begins to take place, this must be dealt with immediately to prevent significant erosion damage to the surface water resources. Should large scale erosion occur, a rehabilitation plan will be required. Input, reporting and recommendations from a suitably qualified wetland/surface water specialist must be obtained in this respect.

9.3.2 Stormwater Run-off Impacts resulting from the PV Facility, Buildings, Substation and associated Infrastructure

The impact of stormwater run-off is primarily related to the types of structures and surfaces that will need to be established for the proposed development. Hard impermeable surfaces and foundations are to be laid over the extent of the proposed development for the required PV mounting areas, buildings and the substation. Flat and hard surfaces aid with the acceleration and generation of run-off which can impact on nearby surface water resources through the onset of erosion due to increased run-off as well as increased sedimentation.

Assessment of the above potential negative impacts and mitigation measures thereto are provided in **Table 9** below.

Table 9. Storm-water run-off associated with roads, the substation and operation control buildings

IMPACT TABLE		
Environmental Parameter	Surface water resources	
Issue/Impact/Environmental Effect/Nature	Impermeable and hardened surfaces creating accelerated run-off and consequent erosion and sedimentation	
Extent	Site	
Probability	Probable	
Reversibility	Partly reversible	
Irreplaceable loss of resources	Marginal loss of resource	
Duration	Long term	
Cumulative effect	Medium cumulative impact	
Intensity/magnitude	Medium	
Significance Rating	*Pre-mitigation significance rating is low and negative. With appropriate mitigation measures, the impact can be reduced.*	
	Pre-mitigation impact rating	Post mitigation impact rating
Extent	1	1
Probability	3	2
Reversibility	2	2
Irreplaceable loss	2	2
Duration	3	3
Cumulative effect	3	1
Intensity/magnitude	2	1
Significance rating	-28 (low negative)	-11 (low negative)
Mitigation measures	Any hardstand area, building or substation inside or within 50m proximity to a surface water resource must have energy dissipating structures on the perimeter of the structures to prevent increased run-off entering adjacent areas or surface water resources. This can be in the form of hard concrete structures or soft structures such as grass blocks for example. Alternatively, a suitable operational storm water management design or plan can be compiled and implemented that accounts for the use of appropriate alternative structures or devices that will prevent	

	increased run-off entering adjacent areas or surface water resources.

9.3.3 Oil Leakages from the Substation

The main potential impact that may result from the operation phase of the substation is the potential spillage of oil from the transducers that are to be housed. If oil were to spill or accidentally leak for a prolonged period from the substation site, it could be transported via storm water run-off into the adjacent surface water resources, thereby polluting not only the water but the soils as well causing possible groundwater and soil contamination.

Assessment of the above potential negative impacts and mitigation measures thereto are provided in **Table 10** below.

Table 10. Oil leaks from the Substation

IMPACT TABLE		
Environmental Parameter	Surface water resources	
Issue/Impact/Environmental Effect/Nature	Oil leakage from the substation	
Extent	Local	
Probability	Possible	
Reversibility	Partly reversible	
Irreplaceable loss of resources	Marginal loss of resource	
Duration	Long term	
Cumulative effect	High cumulative impact	
Intensity/magnitude	High	
Significance Rating	*Pre-mitigation significance rating is medium and negative. With appropriate mitigation measures, the impact can be reduced to a low negative impact.*	
	Pre-mitigation impact rating	Post mitigation impact rating
Extent	2	1
Probability	3	2
Reversibility	2	2
Irreplaceable loss	2	2
Duration	3	3
Cumulative effect	4	1

Intensity/magnitude	3	1
Significance rating	- 48 (medium negative)	- 11 (low negative)
Mitigation measures	Importantly the substation is to contain adequate bunding structures around any oil containing structure to prevent any oil leakage from leaving the substation site. Oil leak monitoring must take place on a regular basis to ensure that where leaks are identified, these can be dealt with appropriately. Oil spill kits must be available at the substation site to deal with ad hoc oil spills.	

9.4 Decommissioning Phase Anticipated Potential Impacts

9.4.1 Decommissioning Impacts

Should the proposed development need to be decommissioned, the same impacts as identified for the construction phase of the proposed development can be anticipated. Similar impacts are therefore expected to occur and the stipulated mitigation measures where relevant must be employed as appropriate to minimise impacts.

9.5 Cumulative Impacts

Although it is important to assess the surface water impacts of the proposed solar facility and the associated components, it is equally important to assess the potential cumulative surface water impact that could materialise in the area should other renewable energy facilities (both wind and solar facilities) be granted environmental authorisation and be constructed. Cumulative impacts are the impacts, which combine from different developments / facilities and result in significant impacts that may be larger than the sum of all the impacts combined.

The renewable energy developments that are being proposed within a 5km radius from the study site are indicated in **Table 11** and **Figure 16** below.

Table 11: Renewable energy developments proposed within the vicinity of the proposed development

Proposed Development	DEA Reference Number	Current Status of EIA	Proponent	Proposed Capacity	Farm Details
Bosjesmansberg Solar Energy Facility	14/12/16/3/3/2/579	Unknown	Networx Renewables (Pty) Ltd	up to 300MW	Ptn 1 of Farm Bosjesmansberg 67
Aletta Wind Energy Facility	N/A	Application to be submitted	BioTherm Energy (Pty) Ltd	140MW	Re of Farm Uitzigt 69 Portions 1, 2, 3 and Re of Farm Drielings Pan 101
Copperton Wind Energy Facility	12/12/20/2099	Environmental Authorisation (EA) Issued	Plan 8 Infinite Energy (Pty) Ltd	up to 200MW	Ptn 4 an 7 of Farm Nelspoorttje 103
Eureka Wind Energy Facility	N/A	Application to be submitted	BioTherm Energy (Pty) Ltd	140MW	Re of Farm Witfontein 54 Ptn 2, 3 and Re of Farm Blaaubosch Poortje 66 Ptn 8 and 9 of Farm Nelspoortje 103
Garob Wind Energy Facility	14/12/16/3/3/2/279	EA Amendment Application underway	Garob Wind Farm (Pty) Ltd	140MW	Ptn 5 of Farm Nelspoorttje 103
Mierdam Solar Photovoltaic (PV) Facility	12/12/20/2320/2	EA Issued	South Africa Mainstream Renewable Power Mierdam (Pty) Ltd	75MW	Portion 1 of Farm Kaffirs Kolk 118
Platsjambok West PV Facility	12/12/20/2320/5	EA Issued	South Africa Mainstream Platsjambok West (Pty) Ltd	75MW	Remainder of Farm Platsjambok 102
Platsjambok East PV Facility	12/12/20/2320/4	EA Issued	South Africa Mainstream Platsjambok East (Pty) Ltd	75MW	Remainder of Farm Platsjambok 102
Klipgats Pan PV Facility	12/12/20/2501	EA Issued	Mulilo Renewable Energy	100MW	Ptn 4 of Farm Klipgats Pan 117
Hedley Plains PV Facility	14/12/16/3/3/2/608	Unknown	NK Energie (Pty) Ltd	Unknown	Ptn 3 of Farm Hedley Plains A 64
Doonies Pan PV Facility	14/12/16/3/3/2/609	Unknown	NK Energie (Pty) Ltd	Unknown	Ptn 5 of Farm Doonies Pan 106

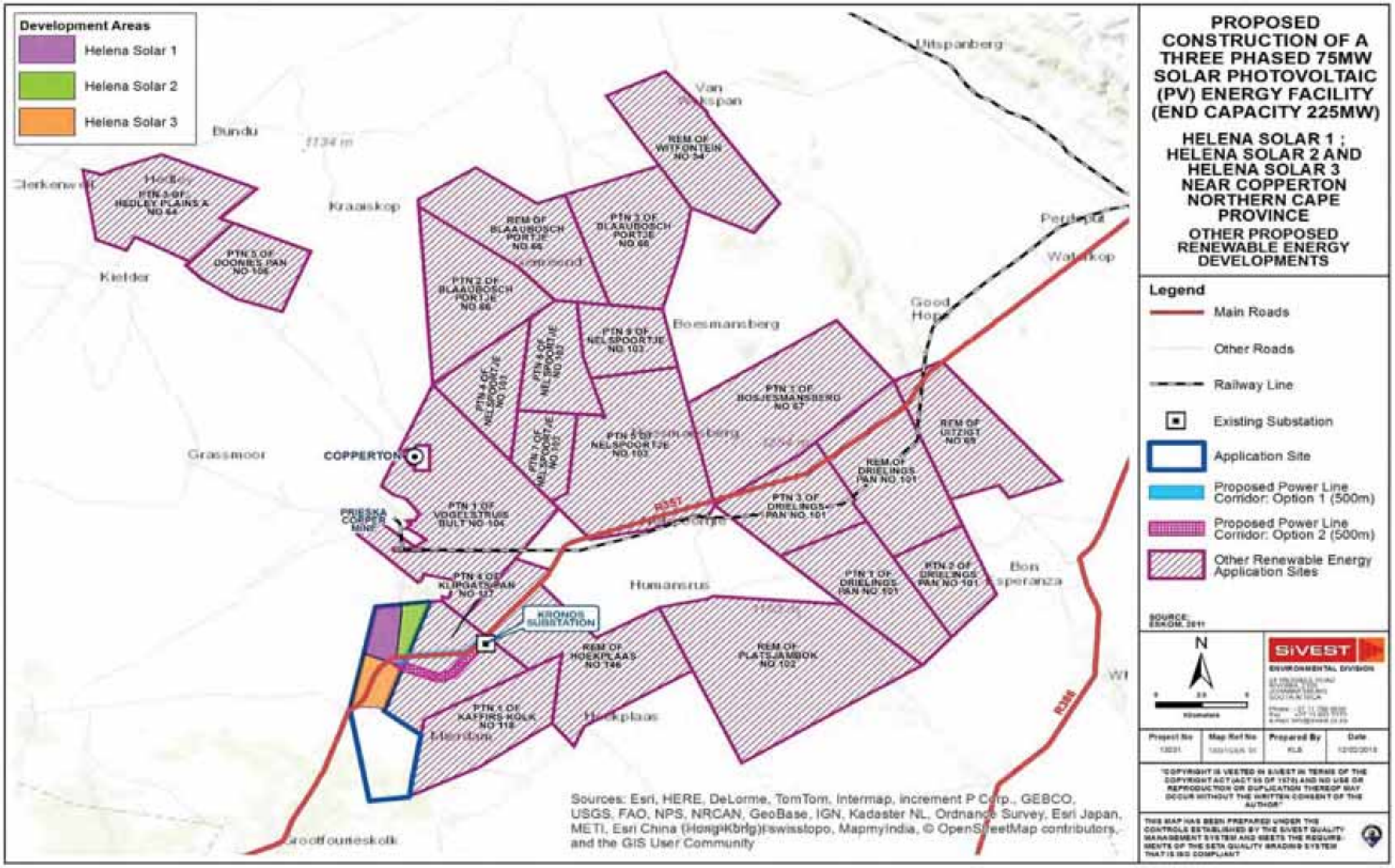

Figure 16: Renewable energy facilities proposed within the vicinity of the proposed development site

It must be noted that surface water resources change from one site to another and can range in number of surface water resources from one property to another depending on factors such as topography, geology, local rainfall and other environmental factors. Additionally, the characteristics of surface water resources can change along its course where longitudinal hydrological systems are involved. Nonetheless, the most important factor to consider when evaluating surface water impacts from a cumulative perspective is downstream impacts. Where a development takes place upstream, should impacts occur these are likely to have a downstream impact to some degree.

In the context of the proposed development, similar developments (wind farms and solar facilities) are located directly to the east. Several more are located to the north and north east where a cluster of developments are being proposed. Importantly, drainage is mainly towards the north east on the proposed development site. As such, the proposed development could have a potential cumulative impact on surrounding properties and the surface water resources found on each. Hence, the potential cumulative impact is not anticipated on the proposed development site but rather on the neighbouring properties. The primary impact of concern relates to increased surface run-off and consequent potential erosion and sedimentation primarily as a result of construction activities. The degree of impact can be expected to be compounded with construction activities taking place at the same time should construction of the Helena 2 and 3 solar facilities take place, and where sudden and heavy rainfall is experienced. However, where mitigation measures are strictly adhered to, potential impacts radiating outwards as a result of the proposed development can be minimized significantly. Additionally, it is expected that should any cumulative impacts occur, these will take place on the properties directly adjacent and not those located several kilometers away. Overall, the cumulative impact is therefore also limited to the immediate project site and directly adjacent proposed developments.

10 SPECIALIST RECOMMENDATIONS

It has been identified that the PV panel area and an internal access road are directly located in the outer edge of the ephemeral depression wetland. It is strongly recommended that the layout is revised to avoid directly impacting on this surface water resource. Furthermore, as it is uncertain at this stage where some infrastructure and buildings/substations are to be placed due to the awaited selection of a preferred location and establishment of final alignments (roads/power lines) as an outcome of the environmental authorization process, it is strongly recommended that when final designs are established, the identified surface water resources that could potentially be affected as highlighted in **Section 7** are to be avoided. Importantly, with careful placement of the structures, roads and electricity pylons/towers, the surface water features can be avoided or spanned (for power lines). Should no direct impacts need to take place to the identified surface water resources, the need for water use licensing can be avoided where it can be demonstrated to the Department Water and Sanitation that significant impacts will not take place and/or where other water uses (other than those identified in **Section 8**) are not required.

Where impacts to surface water resources is not avoidable, the relevant water use license and environmental authorisations are to be applied for before construction is allowed to commence. In this instance, where any structures are within 50m of any surface water resource, adequate run-off mitigation measures need to be accounted for as stipulated in Section 9 above to prevent/minimize accelerated run-off, erosion and sedimentation impacts.

All the identified triggered activities and water uses identified in **Section 8** should be confirmed with the relevant government authoritative departments.

11 CONCLUSIONS

A surface water delineation and impact assessment is provided in this report for the proposed development. Findings were based on a method for delineating wetlands and riparian habitat as per the **DWAF 2005** guidelines. Ultimately, it was found that there is only one (1) ephemeral depression wetland on the proposed Helena 1 Phase PV study site. The power line component of the proposed development was found to contain one (1) man-made impoundment (Power Line Alternative 1). In addition, an old borrow pit excavation area and a drainage pathway was identified within both the Power Line Alternative 1 and 2 corridors. A 50m buffer zone was applied to the wetland and drainage pathway which was applied with guidance from the Gauteng Minimum Requirements for Biodiversity Studies (**GDACE, 2009**).

A comparative assessment was undertaken to determine which of the proposed substation, internal access roads and power line corridor alternatives would be most suitable from a surface water perspective. Accordingly, substation alternative location 1 was preferred as there were no surface water resources that could be affected in this area. No preference was found however in terms of the internal access road layouts since both have a segment of the road routing through the ephemeral depression wetland. Finally, both power line corridor alternatives were found to be favourable since the potential impact will be similar for both alternative corridors in that both share the same area for the initial part of the power line and will therefore have the same diversion and/or spanning issues. The impact is not seen as significant since with careful placement of the electricity pylons/towers, the surface water features can be spanned and direct impact can be avoided.

In terms of potentially applicable environmental and water related legislature, several listed activities and water uses have provisionally been identified that may be applicable to the proposed development. In terms of NEMA and the EIA Regulations (2014), Activities 12 and 19 of Government Notice 983 have been identified as being applicable where the proposed development will take place within 32m or directly within the identified surface water resources respectively. With respect to the NWA, water uses (c) and (i) will be applicable where the proposed development will be directly with the identified surface water resources. The above identified activities and water uses should however be confirmed with the relevant government departments.

Foreseen potential negative impacts in terms of the pre-construction, construction, operation and decommissioning phases of the proposed development were identified and assessed. Mitigation measures have been stipulated and must be included and implemented as part of the Environmental Management Programme (EMPr) for the proposed development. The impacts for each phase of the proposed development are summarised as follows:

PRE-CONSTRUCTION PHASE		
	Pre-mitigation Rating	**Pre-mitigation Rating**
Construction Lay-down Area	- 22 (low negative)	- 6 (low negative)
CONSTRUCTION PHASE		
	Pre-mitigation Rating	**Pre-mitigation Rating**
Vehicle and Machinery Degradation	- 24 (low negative)	- 6 (low negative)
Human Degradation of Flora and Fauna associated with Surface Water Resources	- 10 (low negative)	- 6 (low negative)
Degradation and Removal of Soils and Vegetation associated with surface water resources	- 28 (low negative)	- 6 (low negative)
Increased Run-off and Sedimentation	- 26 (medium negative)	- 6 (low negative)
OPERATION PHASE		
	Pre-mitigation Rating	**Pre-mitigation Rating**
Vehicle Damage to Surface Water Resources	- 42 (medium negative)	- 8 (low negative)
Stormwater Run-off associated with the PV Facility, Buildings, Substation and associated Infrastructure	- 28 (low negative)	- 11 (low negative)
Oil Leaks from the Substation	- 48 (medium negative)	- 11 (low negative)

It is not anticipated that the proposed development will need to be decommissioned. However, should this need to take place, all relevant identified potential impacts will be applicable and the relevant mitigation measures must be implemented.

For cumulative potential impacts, no impacts are anticipated on the proposed development site but rather on the neighbouring properties since drainage flows towards the north east and there are no proposed developments to the west or south of the proposed development site. The primary impact of concern relates to increased surface run-off and consequent potential erosion and sedimentation primarily as a result of construction activities. The degree of impact can be expected to be compounded with construction activities taking place at the same time should construction of the Helena 2 and 3 solar facilities take place, and where sudden and heavy rainfall is experienced. However, where mitigation measures are strictly adhered to, potential impacts radiating outwards as a result of the proposed development can be minimized significantly. Additionally, it is expected that should any cumulative impacts occur, these will take place on the properties directly adjacent and not those located several kilometers away. Overall, the cumulative impact is therefore also limited to the immediate project site and directly adjacent proposed developments

In terms of final specialist recommendations, it is strongly recommended that revision of the PV array area and road layout be undertaken to position these two components out of the ephemeral depression wetland. Additionally, where final placement of substations, buildings and power line alignments are yet to be established, these too must not be located within any of the identified surface water resources identified as far as possible.

Where impacts to surface water resources is not avoidable, the relevant water use license and environmental authorisations are to be applied for before construction is allowed to commence. In this instance, where any structures are within 50m of any surface water resource, adequate run-off mitigation measures need to be accounted for as stipulated in **Section 9** above to prevent/minimize accelerated run-off, erosion and sedimentation impacts.

Finally, all the identified triggered activities and water uses identified in **Section 8** should be confirmed with the relevant government authoritative departments.

12 REFERENCES

1. Bauer-Gottwein, P., Langer, T., Prommer, H., Wolski, P & Kinzelbach, W., 2007: Okavango Delta Islands: Interaction between density-driven flow and geochemical reactions under evapo-concentration, *Journal of Hydrology*, Vol. 335, 389– 405.
2. Collins, N.B., 2005: Wetlands: The basics and some more. Free State Department of Tourism, Environmental and Economic Affairs.
3. Department of Water Affairs and Forestry (DWAF), 2005: A practical field procedure for identification and delineation of wetlands and riparian areas (edition 1). DWAF, Pretoria.
4. Gauteng Department of Agriculture, Conservation and Environment (GDACE), 2005: Minimum Requirements for Biodiversity Assessments (Version 2). Directorate of Nature Conservation.
5. Hoare, D., 2015: Ecological study on the potential impacts of the proposed Biotherm Helena 1 Solar PV Energy Facility near Copperton in the Northern Cape. David Hoare Consulting cc.
6. Howe, C. P., Claridge, G. F., Hughes, R & Zuwendra, 1991: Manual of Guidelines for Scoping EIA in Tropical Wetlands, PHPA/Asian Wetland Bereau, Sumatra Wetland Project Report No. 5, Bogor.
7. Hughes, D.A., 2005: Hydrological issues asscoaited with the determination of environmental water requirements of ephemeral rivers, *River Research and Applications*, 21:899-908.
8. Jones, G. 2003. *Recovering from the drought*. In: Watershed, February 2003. CRC for Freshwater Ecology, Canberra.
9. Knighton AD, Nanson GC. 1997. *Distinctiveness, diversity and uniqueness in arid zone river systems*. In Arid Zone Geomorphology: Process, Form and Change in Drylands (2nd edn), Thomas DSG (ed.). John Wiley & Sons: Chichester; 185–203.
10. McCarthy, T. & Rubidge, B., 2005: The Story of Earth&Life: a Southern African Perspective on a 4.6-Billion-year Journey. Cape Town, Struik Publishers. 333 pp.
11. Mucina, L & Rutherford, M. C., 2006: The Vegetation of South Africa, Lesotho and Swaziland. Strelitzia 19, South African National Biodiversity Institute, Pretoria.
12. Ollis, D. J., Snaddon, C. D., Job, N. M & Mbona, M., 2013: Classification System for Wetlands and other Aquatic Ecosystems in South Africa, User Manual: Inland Systems.
13. Partridge, T.C. 1998: Of diamonds, dinosaurs and diastrophism: 150 million years of landscape evolution in southern Africa. South African Journal of Geology 101: 3 167–184.
14. Partridge, T. C., & Maud, R.R. 1987: Geomorphic evolution of southern Africa since the Mesozoic. South African Journal of Geology 90: 179–208.
15. Partridge, T. C., Dollar, E. S. J., Moolman, J., & Dollar, 2010. The geographic 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.

Appendix A

Environmental Impact Assessment Methodology

The EIA Methodology assists in evaluating the overall effect of a proposed activity on the environment. The determination of the effect of an environmental impact on an environmental parameter is determined through a systematic analysis of the various components of the impact. This is undertaken using information that is available to the environmental practitioner through the process of the environmental impact assessment. The impact evaluation of predicted impacts was undertaken through an assessment of the significance of the impacts.

Determination of Significance of Impacts

Significance is determined through a synthesis of impact characteristics which include context and intensity of an impact. Context refers to the geographical scale i.e. site, local, national or global whereas Intensity is defined by the severity of the impact e.g. the magnitude of deviation from background conditions, the size of the area affected, the duration of the impact and the overall probability of occurrence. Significance is calculated as shown in table below.

Significance is an indication of the importance of the impact in terms of both physical extent and time scale, and therefore indicates the level of mitigation required. The total number of points scored for each impact indicates the level of significance of the impact.

Impact Rating System

Impact assessment must take account of the nature, scale and duration of effects on the environment whether such effects are positive (beneficial) or negative (detrimental). Each issue / impact is also assessed according to the project stages:

- planning
- construction
- operation
- decommissioning

Where necessary, the proposal for mitigation or optimisation of an impact should be detailed. A brief discussion of the impact and the rationale behind the assessment of its significance has also been included.

Rating System Used To Classify Impacts

The rating system is applied to the potential impact on the receiving environment and includes an objective evaluation of the mitigation of the impact. Impacts have been consolidated into one rating. In assessing the significance of each issue the following criteria (including an allocated point system) is used:

NATURE		
Include a brief description of the impact of environmental parameter being assessed in the context of the project. This criterion includes a brief written statement of the environmental aspect being impacted upon by a particular action or activity.		
GEOGRAPHICAL EXTENT		
This is defined as the area over which the impact will be expressed. Typically, the severity and significance of an impact have different scales and as such bracketing ranges are often required. This is often useful during the detailed assessment of a project in terms of further defining the determined.		
1	Site	The impact will only affect the site
2	Local/district	Will affect the local area or district
3	Province/region	Will affect the entire province or region
4	International and National	Will affect the entire country
PROBABILITY		
This describes the chance of occurrence of an impact		
1	Unlikely	The chance of the impact occurring is extremely low (Less than a 25% chance of occurrence).
2	Possible	The impact may occur (Between a 25% to 50% chance of occurrence).
3	Probable	The impact will likely occur (Between a 50% to 75% chance of occurrence).
4	Definite	Impact will certainly occur (Greater than a 75% chance of occurrence).
REVERSIBILITY		
This describes the degree to which an impact on an environmental parameter can be successfully reversed upon completion of the proposed activity.		
1	Completely reversible	The impact is reversible with implementation of minor mitigation measures
2	Partly reversible	The impact is partly reversible but more intense mitigation measures are required.

3	Barely reversible	The impact is unlikely to be reversed even with intense mitigation measures.
4	Irreversible	The impact is irreversible and no mitigation measures exist.
IRREPLACEABLE LOSS OF RESOURCES		
This describes the degree to which resources will be irreplaceably lost as a result of a proposed activity.		
1	No loss of resource.	The impact will not result in the loss of any resources.
2	Marginal loss of resource	The impact will result in marginal loss of resources.
3	Significant loss of resources	The impact will result in significant loss of resources.
4	Complete loss of resources	The impact is result in a complete loss of all resources.
DURATION		
This describes the duration of the impacts on the environmental parameter. Duration indicates the lifetime of the impact as a result of the proposed activity		
1	Short term	The impact and its effects will either disappear with mitigation or will be mitigated through natural process in a span shorter than the construction phase (0 – 1 years), or the impact and its effects will last for the period of a relatively short construction period and a limited recovery time after construction, thereafter it will be entirely negated (0 – 2 years).
2	Medium term	The impact and its effects will continue or last for some time after the construction phase but will be mitigated by direct human action or by natural processes thereafter (2 – 10 years).
3	Long term	The impact and its effects will continue or last for the entire operational life of the development, but will be mitigated by direct human action or by natural processes thereafter (10 – 50 years).
4	Permanent	The only class of impact that will be non-transitory. Mitigation either by man or natural process will not occur in such a way or such a time span that the impact can be considered transient (Indefinite).
CUMULATIVE EFFECT		
This describes the cumulative effect of the impacts on the environmental parameter. A cumulative effect/impact is an effect which in itself may not be significant but may become significant if added to other existing or potential impacts emanating from other similar or diverse activities as a result of the project activity in question.		
1	Negligible Cumulative Impact	The impact would result in negligible to no cumulative effects
2	Low Cumulative Impact	The impact would result in insignificant cumulative effects
3	Medium Cumulative impact	The impact would result in minor cumulative effects

4	High Cumulative Impact	The impact would result in significant cumulative effects
INTENSITY / MAGNITUDE		
Describes the severity of an impact		
1	Low	Impact affects the quality, use and integrity of the system/component in a way that is barely perceptible.
2	Medium	Impact alters the quality, use and integrity of the system/component but system/ component still continues to function in a moderately modified way and maintains general integrity (some impact on integrity).
3	High	Impact affects the continued viability of the system/component and the quality, use, integrity and functionality of the system or component is severely impaired and may temporarily cease. High costs of rehabilitation and remediation.
4	Very high	Impact affects the continued viability of the system/component and the quality, use, integrity and functionality of the system or component permanently ceases and is irreversibly impaired (system collapse). Rehabilitation and remediation often impossible. If possible rehabilitation and remediation often unfeasible due to extremely high costs of rehabilitation and remediation.
SIGNIFICANCE		
Significance is determined through a synthesis of impact characteristics. Significance is an indication of the importance of the impact in terms of both physical extent and time scale, and therefore indicates the level of mitigation required. This describes the significance of the impact on the environmental parameter. The calculation of the significance of an impact uses the following formula: **(Extent + probability + reversibility + irreplaceability + duration + cumulative effect) x magnitude/intensity.** The summation of the different criteria will produce a non weighted value. By multiplying this value with the magnitude/intensity, the resultant value acquires a weighted characteristic which can be measured and assigned a significance rating.		
Points	**Impact Significance Rating**	**Description**
6 to 28	Negative Low impact	The anticipated impact will have negligible negative effects and will require little to no mitigation.
6 to 28	Positive Low impact	The anticipated impact will have minor positive effects.

29 to 50	Negative Medium impact	The anticipated impact will have moderate negative effects and will require moderate mitigation measures.
29 to 50	Positive Medium impact	The anticipated impact will have moderate positive effects.
51 to 73	Negative High impact	The anticipated impact will have significant effects and will require significant mitigation measures to achieve an acceptable level of impact.
51 to 73	Positive High impact	The anticipated impact will have significant positive effects.
74 to 96	Negative Very high impact	The anticipated impact will have highly significant effects and are unlikely to be able to be mitigated adequately. These impacts could be considered "fatal flaws".
74 to 96	Positive Very high impact	The anticipated impact will have highly significant positive effects.

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ENGINEERING & ENVIRONMENTAL CONSULTING

Your Ref. Helena PV Plants
Our Ref. 3903-03

4/09/2015

SiVEST
51 Wessel Road
Rivonia, 2128
By email: ShaunT@sivest.co.za

ATT: Mr Shaun Taylor

RE: PROPOSED CONSTRUCTION OF THE HELENA SOLAR PHOTOVOLTAIC (PV) ENERGY FACILITY NEAR COPPERTON, NORTHERN CAPE PROVINCE: SURFACE WATER IMPACT REPORT

SiVEST have been appointed by Biotherm Energy (Pty) Ltd to undertake an Environmental Impact Assessment (EIA) for the proposed construction of the Helena Solar Photovoltaic (PV) Energy Facility near Copperton, Northern Cape Province. Three different projects have been identified, each project proposed to be constructed on different farm portions. These projects are referred to as Helena 1, Helena 2, and Helena 3

Each of the three proposed projects will encompass the installation of a solar PV field and associated components, in order to generate electricity that is to be fed into the Eskom grid. The facilities will have a maximum export capacity of 75MW. The Helena 1 project proposed development area is approximately 430 ha, The Helena 2 proposed development area is approximately 270 ha and the Helena 3 proposed development area is approximately 530 ha. However it is envisaged that the 75MW energy facility layout for each project will only require approximately 250 ha. The voltage of the connection lines from the solar PV energy facility substation to the grid is likely to be 132kV.

It was noted that all the relevant conservation and development planning tools were applied for the purpose of the report. This included the National Freshwater Priority Areas database (2011), the Environmental Potential Atlas database (2000) and the National Biodiversity Assessment database (2012) Relevant legislation such as the *National Water Act, 1998 (Act No. 36 of 1998)* and the *National Environmental Management Act, 1998 (Act No. 107 of 1998)* was also considered. Spatial planning with regards to biodiversity and protected areas have been undertaken for some provinces such as Mpumalanga, Gauteng and Limpopo. Spatial planning for the Northern Cape Province is restricted to the Municipal Biodiversity Summaries Project (2010), the Namakwa District Biodiversity Sector Plan and a Fine Scale Biodiversity Conservation Plans (2009) for the Hantam Municipality. None of these databases have relevant information for the specific study area.

The acceptable methodologies as required by the Department of Water and Sanitation (A practical field procedure for the identification and delineation of wetlands and riparian areas, 2005). Was used to identify and delineate wetland areas and classification of wetland types was also undertaken using the latest available methodologies (Ollis *et al*., 2013).

Several impacts have been identified during the pre-construction, construction and operational phases. Of particular concern for all projects are potential hydrological and geomorphological alterations that may occur as a result of the construction of the PV plants and the associated infrastructure. These impacts are of particular concern to the erratic nature of rainfall within the study area. In addition, potential water quality related impacts have been identified for the Helena 1 and Helena 3 projects, which relates to the operation of the proposed substation. Mitigation measures have been indicated in the reports and the implementation of these mitigation measure can reduce the significance of all the identified impacts.

The preferred alternatives as indicated in each report should also be accepted, as these alternatives have been selected based on a rigorous process, considering the potential impacts and the various surface water resources that could be affected.

If any of the wetlands identified in the project are directly impacted by the construction activities (e.g, due to excavation for foundations or roads) a wetland rehabilitation plan must be developed prior to construction.

Dr Martin Ferreira

Appendix 6D:
Soils and Agricultural Potential Assessment

SCOPING REPORT

On contract research for

SiVEST

SOIL INFORMATION FOR PROPOSED HELENA SOLAR 1 ENERGY PLANT, NEAR COPPERTON, NORTHERN CAPE

By

D.G. Paterson (Pr. Sci. Nat. 400463/04)

Report No. GW/A/2015/8

March 2015

ARC-Institute for Soil, Climate and Water,
Private Bag X79, Pretoria 0001, South Africa

Tel (012) 310 2500 Fax (012) 323 1157

DECLARATION

I hereby declare that I am qualified to compile this report as a registered Natural Scientist and that I am independent of any of the parties involved and that I have compiled an impartial report, based solely on all the information available.

D G Paterson
March 2015

CONTENTS Page

1. TERMS OF REFERENCE

The ARC-Institute for Soil, Climate and Water (ARC-ISCW) was contracted by SiVEST to undertake a soil investigation near Copperton, in the Northern Cape Province. The objectives of the study are;

- To obtain all existing soil information and to produce a soil map of the specified area as well as

- To assess broad agricultural potential and the impacts thereon.

Three separate projects within the broader application area have been proposed (see Figure 1) namely:

- Helena Solar 1, which lies in the north-western part,
- Helena Solar 2, which lies in the north-eastern part and
- Helena Solar 3, which lies in the southern part.

Each project comprises the establishment of a 75 MW PV plant, connecting to a new substation and then through power lines to the existing Kronos substation, which lies approximately 6 km to the east.

This report deals with the proposed Helena Solar 1 Plant.

2. SITE CHARACTERISTICS

2.1 Location

An area was investigated lying approximately 15 km to the south of the town of Copperton. The area lies between 30º 00' and 30º 04' S and between 22º 16' and 22º 19' E.

The Helena Solar 1 project is indicated by the **pink area** in Figure 1.

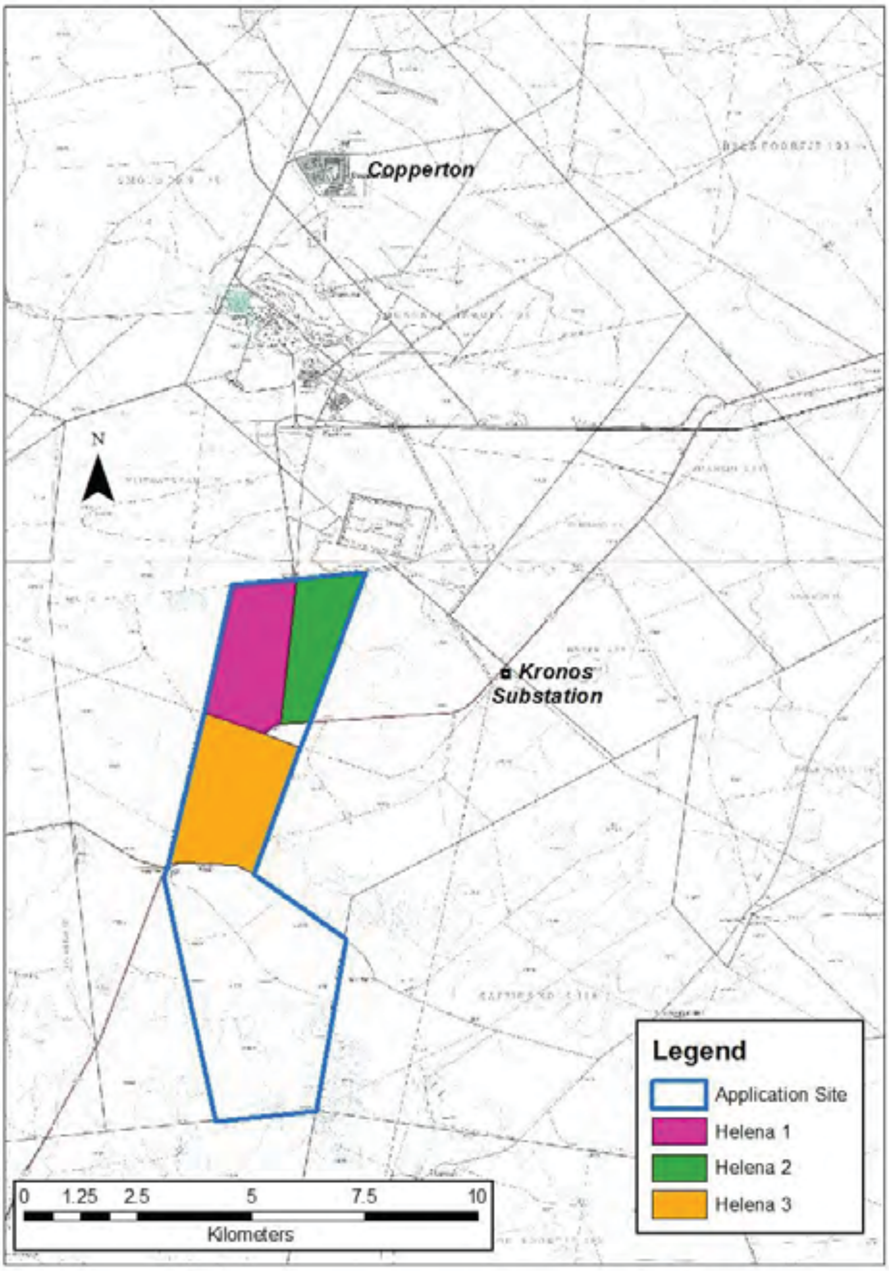


Figure 1 Locality map (Helena Solar 1, in pink)

2.2 Terrain

The area lies at a height of approximately 1 030 to 1 060 metres above sea level. The area slopes very gently (<2%) to the south-west). No permanent drainageways are present in the vicinity but a pan occurs in the south-eastern portion of the Helena 1 site.

2.3 Climate

The climate of the study area (Monnik & Malherbe, 2005) can be regarded as warm to hot with occasional rain in summer and dry winters. The long-term average annual rainfall in this region of the Northern Cape is only 198 mm, of which 138 mm, or 69%, falls from November to April. Rainfall is erratic, both locally and seasonally and therefore cannot be relied on for agricultural practices. The average evaporation is over 2 100 mm per year, peaking at over 8.5 mm per day in December.

Temperatures vary from an average monthly maximum and minimum of 31.6ºC and 11.8ºC for January to 15.9ºC and 1.0ºC for July respectively. The extreme high temperature that has been recorded is over 42ºC and the extreme low –10.0ºC. Frost occurs most years on 30-40 days on average between early May and mid-September.

2.4 Parent Material

The geology of the Helena Solar 1 area comprises tillite of the Dwyka Formation (Geological Survey, 1977).

The distribution of the geological units in the area is shown in Figure 2.

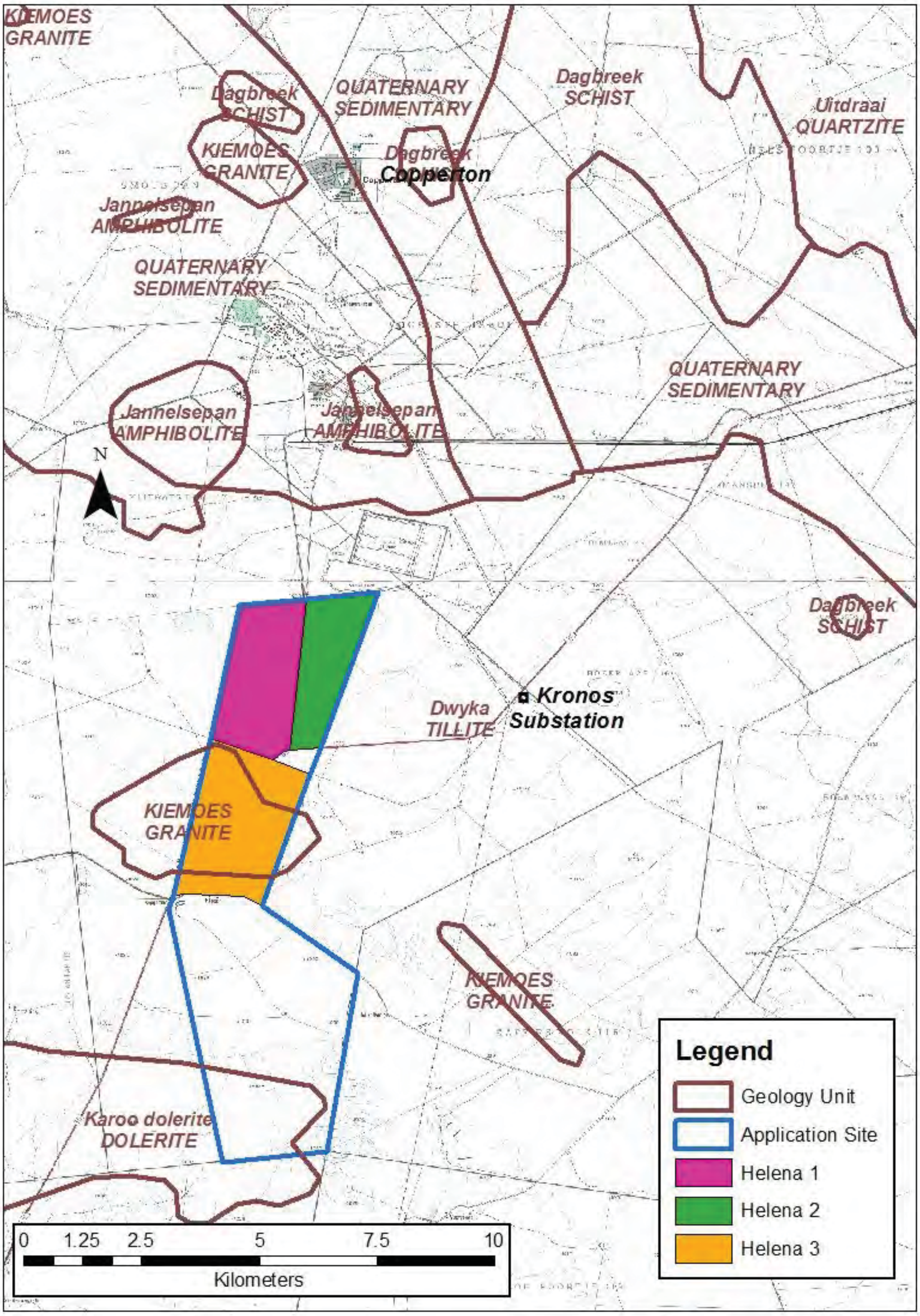


Figure 2 Geology

3. METHODOLOGY - SOILS

Existing soil information was obtained from the map sheets 2922 Prieska and 3022 Britstown (Bruce & Geers, 2005) from the national Land Type Survey, published at 1:250 000 scale. A ***land type*** is defined as an area with a uniform terrain type, macroclimate and broad soil pattern. The soils are classified according to MacVicar *et al* (1977).

The area under investigation for Helena Solar 1 is covered by only one land type, as shown on the map in the Appendix, namely:

- **Ah93** (Red and yellow, freely-drained soils, high base status)

It should be clearly noted that, since the information contained in the land type survey is of a reconnaissance nature, only the general dominance of the soils in the landscape can be given, and not the actual areas of occurrence within a specific land type. Also, other soils that were not identified due to the scale of the survey may also occur. **The site was not visited during the course of this study, and so the detailed composition of the specific land types has not been ground-truthed.**

A summary of the dominant soil characteristics of the land type is given in Table 2 below.

The distribution of soils with high, medium and low agricultural potential within each land type is also given, with the dominant class shown in **bold type**.

4. SOIL PATTERN

The soils are all shallow to very shallow (<500 mm), usually sandy and calcareous, overlying either rock or cemented hardpan calcrete. Some rock outcrops occur in places in the landscape.

The occurrence and distribution of the land types is shown in the Appendix.

A summary of the dominant soil characteristics is given in **Table 2** below.

Table 2 Land types occurring (with soils in order of dominance)

Land Type	Depth (mm)	Dominant soils	Percent of land type	Characteristics	Agric. Potential* (%)
Ah93	20-100	Mispah 22/Glenrosa 23	25%	Brown, sandy topsoils, on hardpan calcrete	High:0.0 Mod: 0.0 **Low: 100.0**
	100-250	Clovelly 43	24%	Yellow-brown, sandy soils on rock or hardpan calcrete	
	100-500	Hutton 33/43	21%	Red, sandy soils on rock or hardpan calcrete	

*Note: Agricultural Potential refers to **soil characteristics only**, without potentially restricting climatic factors

5. AGRICULTURAL POTENTIAL

The entire Helana 1 study area comprises shallow, calcareous soils with rock (land type ***Ah93***), as can be seen from the information contained in Table 2 and the Appendix.

Coupled with these shallow soils, the very low rainfall in the area (Section 2.3) means that the only means of cultivation would be by irrigation and the Google Earth image of the area (Figure 3, pink outlined boundary) shows absolutely no signs of any agricultural infrastructure and certainly none of irrigation.

Figure 3 Google Earth image of study area

The climatic restrictions mean that this part of the Northern Cape is suited at best for grazing and here the grazing capacity is low, around 20-25 ha/large stock unit (ARC-ISCW, 2004).

5.1 Land Use

The land use in the area is dominantly "shrubland and low fynbos" with some small areas of "bare rock and soil (natural)" as classified by the National Land Cover

(Thompson, 1999). As previously mentioned, there are no areas of cultivation that were identified, only a few small, isolated areas of "Improved grassland".

6. IMPACTS

The Impact Assessment Methodology assists in evaluating the overall effect of a proposed activity on the environment. The determination of the effect of an environmental impact on an environmental parameter is determined through a systematic analysis of the various components of the impact.

Two potential impacts from the project are considered, namely:

1) Loss of agricultural soil (due to construction of facilities)
2) Increased wind erosion potential (due to disturbance of naturally sandy soils)

Table 4a Impact Summary Table (***Agricultural Potential***)

IMPACT TABLE FORMAT		
Environmental Parameter	*Soils and agricultural potential*	
Issue/Impact/Environmental Effect/Nature	*Loss of agriculturally productive soil*	
Extent (E)	*Site only*	
Probability (P)	*Unlikely*	
Reversibility (R)	*Reversible*	
Irreplaceable loss of resources (I)	*No loss of resources*	
Duration (D)	*Short term*	
Cumulative effect (C)	*Negligible*	
Intensity/magnitude (M)	*Low*	
Significance Rating		
	Pre-mitigation impact rating	Post mitigation impact rating
Extent	1	1
Probability	1	1
Reversibility	1	1
Irreplaceable loss	1	1
Duration	1	1
Cumulative effect	1	1
Intensity/magnitude	1	1
Significance rating *(E+P+R+I+D+C) x M*	-6 (Low negative)	-6 (low negative)
Mitigation measures	*Virtually none applicable, as soils in vicinity are all shallow, with dry climate and little or no potential for agricultural use.*	

Table 4b Impact Summary Table (***Wind erosion hazard***)

IMPACT TABLE FORMAT		
Environmental Parameter	*Soils and agricultural potential*	
Issue/Impact/Environmental Effect/Nature	*Increased susceptibility of topsoil to removal by wind due to disturbance caused by construction activities.*	
Extent (E)	*Local/District*	
Probability (P)	*Probable*	
Reversibility (R)	*Partly Reversible*	
Irreplaceable loss of resources (I)	*Significant loss of resources*	
Duration (D)	*Long term*	
Cumulative effect (C)	*Medium cumulative effect (wind-transported topsoil may be deposited many kilometres distant).*	
Intensity/magnitude (M)	*Medium*	
Significance Rating		
	Pre-mitigation impact rating	Post mitigation impact rating
Extent	2	1
Probability	3	2
Reversibility	2	1
Irreplaceable loss	3	2
Duration	3	1
Cumulative effect	3	2
Intensity/magnitude	2	1
Significance rating *(E+P+R+I+D+C) x M*	-32 (Medium negative)	-9 (low negative)
Mitigation measures	• *Minimize removal of surface vegetation* • *keep topsoils watered if possible* • *re-vegetate with local species as soon as possible* • *Ensure all access roads/tracks are surfaced/treated to increase cohesion*	

6.1 Cumulative Impacts

The main cumulative impact for this project may be as a result of several similar solar power projects in close proximity to Helena 1. Regarding the soil resource, this should not have any significant effect, due to the dry climate and predominance of shallow, low potential agricultural soils that occur. Each project is developed in isolation and the soils as such will not be affected.

However, the possibility of an increased wind erosion hazard may be significant. This is because the prevailing sandy topsoils in the vicinity are prone to removal by wind action if vegetation is disturbed or removed. If this happens, the soil becomes air-borne dust and is subject to the force and direction of the prevailing wind, which can result in such dust being transported many kilometres in almost any direction. One of the potential results of increased dust content in the atmosphere could be the build-up of a layer on infrastructure, including solar panels, which would lessen efficiency of solar radiation collection.

For this reason, effective soil conservation and dust suppression measures are essential for mitigation purposes.

6.2 Comparative assessment

Due mainly to the uniformity of the environment, including soil pattern, there is no preferred alternative for the various proposed infrastructure.

Table 5 Alternatives

Alternative	Preference	Reasons
SUBSTATION		
Substation Site Alternative 1	No Preference	Shallow soils, dry climate
Substation Site Alternative 2	No Preference	Shallow soils, dry climate
INTERNAL ROADS		
Internal Road Alternative 1	No Preference	Shallow soils, dry climate
Internal Road Alternative 2	No Preference	Shallow soils, dry climate
POWER LINES		
Power Line Corridor Alternative 1	No Preference	Shallow soils, dry climate
Power Line Corridor Alternative 2	No Preference	Shallow soils, dry climate

REFERENCES

ARC-ISCW, 2004. Overview of the status of the agricultural natural resources of South Africa (First Edition). ARC-Institute for Soil, Climate and Water, Pretoria

Bruce, R.W. & Geers, B.C., 2005. Field information. In: Land types of the maps 2922 Prieska and 3022 Britstown. *Mem. Agric. nat. Res. S. Afr*. No. 33. ARC-Institute for Soil, Climate and Water, Pretoria.

Geological Survey, 1984. 1:1 million scale geological map of South Africa. Department of Mineral and Energy Affairs, Pretoria.

Monnik, K.A. & Malherbe, J., 2005. Climate data. In: Land types of the maps 2922 Prieska and 3022 Britstown. *Mem. Agric. nat. Res. S. Afr*. No. 33. ARC-Institute for Soil, Climate and Water, Pretoria.

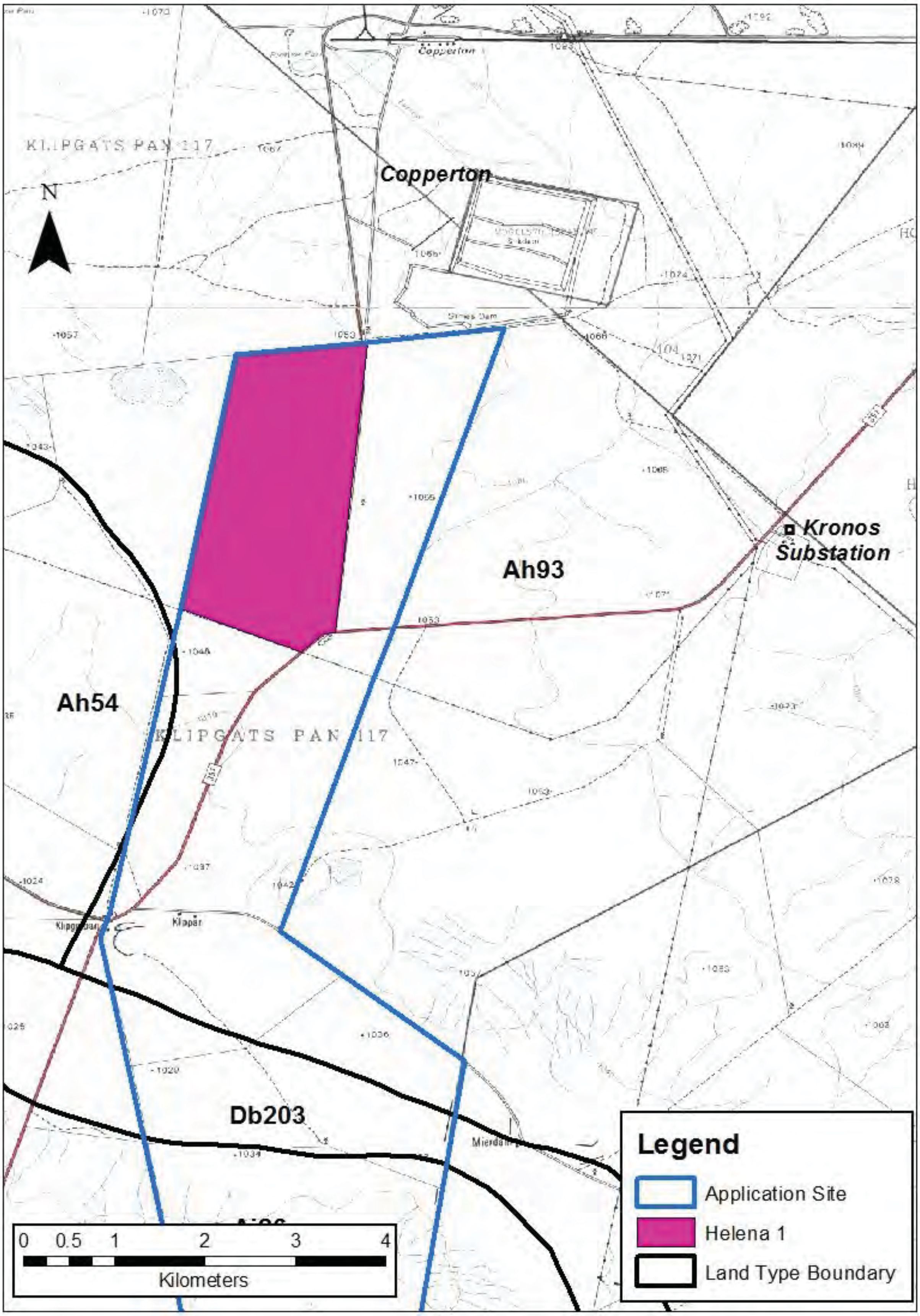
MacVicar, C.N., de Villiers, J.M., Loxton, R.F, Verster, E., Lambrechts, J.J.N., Merryweather, F.R., le Roux, J., van Rooyen, T.H. & Harmse, H.J. von M., 1977. Soil classification. A binomial system for South Africa. ARC-Institute for Soil, Climate & Water, Pretoria.

Thompson, M.W., 1999. South African National Land-cover Database Project. CSIR Environmentek, ENV/P/C 98136, Pretoria.

APPENDIX:

MAP OF LAND TYPES

(Helena Solar 1)



KLIPGATS PAN 117
Copperton
N
Kronos
Substation
Ah93
Ah54
KLIPGATS PAN 117
Db203
Legend
Application Site
Helena 1
Land Type Boundary
0 0.5 1 2 3 4
Kilometers

Appendix 6E:
Visual Assessment

BIOTHERM ENERGY PTY (LTD)

Proposed Construction of the Helena 1 Solar Photovoltaic (PV) Energy Facility near Copperton, Northern Cape Province

Visual Impact Assessment Report – Impact Phase

Issue Date: 08 January 2016
Revision No.: **2**
Project No.: 13031

Date:	08 January 2016
Document Title:	Proposed Construction of the Helena 1 Solar Photovoltaic (PV) Energy Facility near Copperton, Northern Cape Province: Visual Impact Assessment Report – Impact Phase
Author:	Andrea Gibb B.Sc. (Hons) Environmental Management (UNISA) BSc Landscape Architecture *Cum Laude* (UP)
Revision Number:	#2
Checked by:	Keagan Allan – SRK Consulting (South Africa) (Pty) Ltd Pr. Sci Nat
Approved:	Kelly Tucker
Signature:	
For:	SiVEST Environmental Division

environmental affairs

Department:
Environmental Affairs
REPUBLIC OF SOUTH AFRICA

DETAILS OF SPECIALIST AND DECLARATION OF INTEREST

	(For official use only)
File Reference Number:	**14/12/16/3/3/2/765**
NEAS Reference Number:	
Date Received:	**5 December 2014**

Application for authorisation in terms of the National Environmental Management Act, 1998 (Act No. 107 of 1998), as amended and the Environmental Impact Assessment Regulations, 2010

PROJECT TITLE

Proposed Construction of the Helena 1 Solar Photovoltaic (PV) Energy Facility near Copperton, Northern Cape Province

Specialist:	**SiVEST Environmental**		
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Project Consultant:	**SiVEST Environmental**		
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E-mail:	andreag@sivest.co.za		

The specialist appointed in terms of the Regulations

I, **Andrea Gibb**, declare that --

General declaration:

- I act as the independent specialist in this application;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- all the particulars furnished by me in this form are true and correct; and
- I realise that a false declaration is an offence in terms of Regulation 71 and is punishable in terms of section 24F of the Act.

Signature of the specialist

SiVEST Environmental

Name of company (if applicable)

08 January 2016

Date

BIOTHERM ENERGY PTY (LTD)

PROPOSED CONSTRUCTION OF THE HELENA 1 SOLAR PHOTOVOLTAIC (PV) ENERGY FACILITY NEAR COPPERTON, NORTHERN CAPE PROVINCE

VISUAL IMPACT ASSESSMENT REPORT – IMPACT PHASE

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GLOSSARY OF TERMS

ABBREVIATIONS

DM	District Municipality
EIA	Environmental Impact Assessment
GIS	Geographic Information System
I&AP	Interested and/or Affected Party
kV	Kilovolt
LM	Local Municipality
NGI	National geo-spatial information
SANBI	South African National Biodiversity Institute
VIA	Visual Impact Assessment

Definitions

Anthropogenic feature: An unnatural feature as a result of human activity.

Aspect: Direction in which a hill or mountain slope faces.

Cultural landscape: A representation of the combined worlds of nature and of man illustrative of the evolution of human society and settlement over time, under the influence of the physical constraints and/or opportunities presented by their natural environment and of successive social, economic and cultural forces, both external and internal (World Heritage Committee, 1992).

Kraal: A South African colloquial term referring to an enclosure for cattle or sheep.

Sense of place: The unique quality or character of a place, whether natural, rural or urban. It relates to uniqueness, distinctiveness or strong identity.

Scenic route: A linear movement route, usually in the form of a scenic drive, but which could also be a railway, hiking trail, horse-riding trail or 4x4 trail.

Sensitive visual receptors: An individual, group or community that is subject to the visual influence of the proposed development and is adversely impacted by it. They will typically include locations of human habitation and tourism activities.

Stoep: A South African colloquial term referring to the veranda or small porch at the front of a house

Study area: The study area is assumed to encompass a zone of 5km from the outer boundary of the corridor alternatives for all three proposed power lines. This area is also referred to as the visual assessment zone.

Viewshed: The outer boundary defining a visual envelope, usually along crests and ridgelines.

Visual character: The physical elements and forms and land use related characteristics that make up a landscape and elicit a specific visual quality or nature. Visual character can be defined based on the level of change or transformation from a completely natural setting.

Visual contrast: The degree to which the development would be congruent with the surrounding environment. It is based on whether or not the development would conform with the land use, settlement density, forms and patterns of elements that define the structure of the surrounding landscape.

Visual envelope: A geographic area, usually defined by topography, within which a particular project or other feature would generally be visible.

Visual exposure: The relative visibility of a project or feature in the landscape.

Visual impact: The effect of an aspect of the proposed development on a specified component of the visual, aesthetic or scenic environment within a defined time and space.

Visual receptors: An individual, group or community that is subject to the visual influence of the proposed development but is not necessarily adversely impacted by it. They will typically include commercial activities and motorists travelling along routes that are not regarded as scenic.

Visual sensitivity: The inherent sensitivity of an area to potential visual impacts associated with a proposed development. It is based on the physical characteristics of the area (visual character), spatial distribution of potential receptors, and the likely value judgements of these receptors towards the new development, which are usually based on the perceived aesthetic appeal of the area.

BIOTHERM ENERGY PTY (LTD)

PROPOSED CONSTRUCTION OF THE HELENA 1 SOLAR PHOTOVOLTAIC (PV) ENERGY FACILITY NEAR COPPERTON, NORTHERN CAPE PROVINCE

VISUAL IMPACT ASSESSMENT REPORT – IMPACT PHASE

1 INTRODUCTION

SiVEST have been appointed by BioTherm Energy (Pty) Ltd to undertake an Environmental Impact Assessment (EIA) for the proposed development of the Helena 1 solar photovoltaic (PV) energy facility near Copperton in the Northern Cape Province. As part of the EIA studies being conducted for the proposed development, the need to undertake a visual impact assessment was identified. During the Scoping Phase of the EIA, a desktop assessment of the visual environment within the study area was undertaken in order to characterise the area and broadly identify all the potential visual impacts and issues relating to the proposed development. The visual assessment (this report) undertaken during the EIA phase focuses on the potential sensitive receptor locations, and provides an assessment of the magnitude and significance of the visual impacts associated with the proposed solar PV energy facility. The main deliverable of this study is the generation of maps indicating visual receptors within the various distance bands and this report indicating the findings of the study.

1.1 Project Description

The proposed project will encompass the installation of a solar PV field and associated components, in order to generate electricity that is to be fed into the Eskom grid. The facility will have a maximum export capacity of 75MW. The proposed development area is approximately 430 ha, however it is envisaged that the 75MW energy facility layout will only require approximately 250 ha. The voltage of the connection lines from the solar PV energy facility substation to the grid is likely to be 132kV.

1.1.1 *PV Project Components*

This proposed PV energy facility forms one of three PV energy facilities with a 75MW export capacity that BioTherm are proposing to develop on Portion 3 of the farm Klipgats Pan No 117 (Figure 1). In order to accommodate the Department of Energy's (DoE) competitive bidding process for procuring renewable energy from Independent Power Producers in South Africa, each PV energy facility will be developed under a separate Special Purpose Vehicle (SPV) and therefore each requires a separate Environmental Authorisation. However, the possibility to allow shared associated infrastructure will be considered.

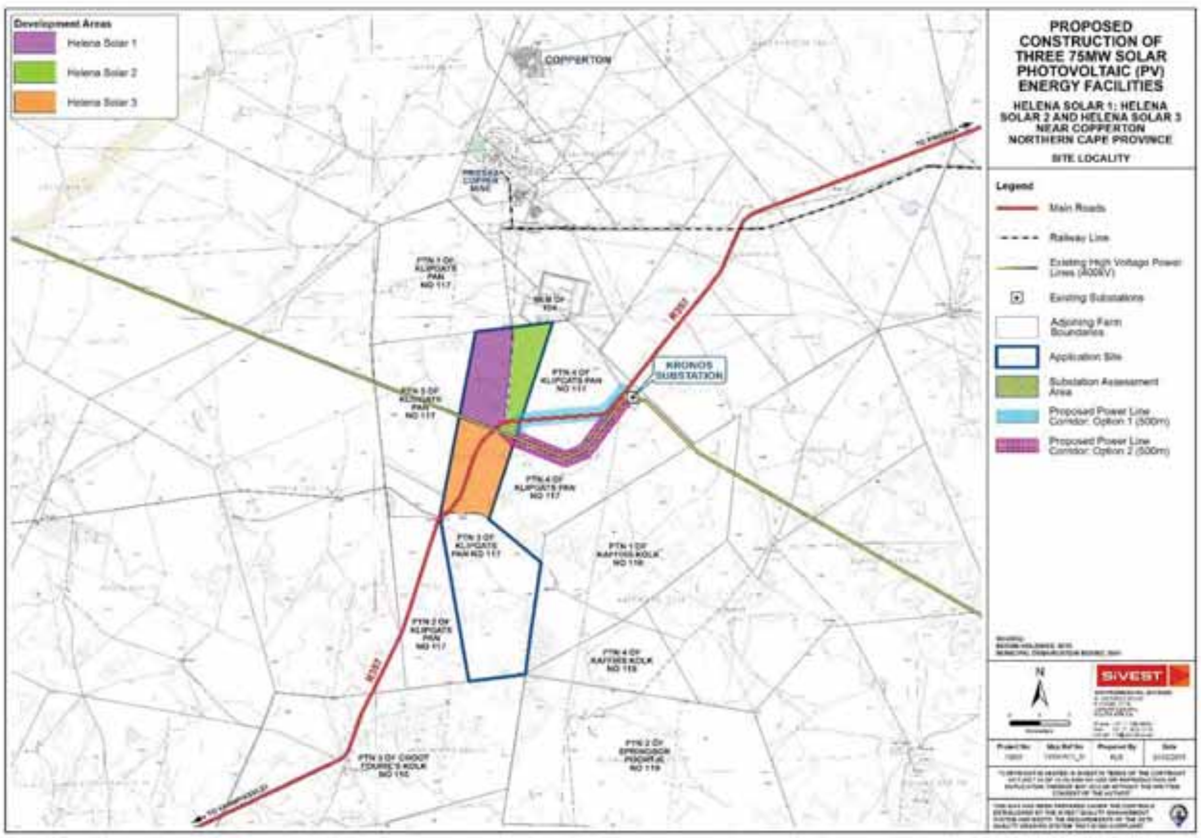

Figure 1: Proposed solar PV energy facilities

The key technical details and infrastructure required is presented in the table below (Table 1).

Table 1: Helena Solar 1 phase summary

Phase Name	DEA Reference	Farm name and area	Technical details and infrastructure necessary for each phase
Helena Solar 1	14/12/16/3/3/2/765	Portion 3 of Klipgats Pan No 117 (PV site) and Portion 4 of Klipgats Pan No 117 (power lines) PV Site Area: 427.56 ha	▪ Approximately 300 000 **solar PV panels** with a total export capacity of 75MW; ▪ Panels will be either **fixed axis mounting or single axis tracking solutions**, and will be either crystalline silicon or thin film technology; ▪ Onsite **switching station**, with the transformers for voltage step up from medium voltage to high voltage; ▪ The panels will be connected in strings to inverters, approximately **43 inverter stations** will be required throughout the site. Inverter stations will house 2 x 1MW inverters and 1 x 2MVA transformers; ▪ DC power from the panels will be converted into AC power in the inverters and the voltage will be stepped up to 22-33kV (medium voltage) in the transformers. ▪ The **22-33kV cables** will be run underground in the facility to a common point before being fed to the **onsite substation** where the voltage will typically be stepped up to 132kV. ▪ Grid connection is to the Kronos substation. A **power line** with a voltage of 132kV is proposed and will run from the onsite substation to the Kronos substation. The distance will be about 4km. The final grid connection voltage will be below 275kV. ▪ A **laydown area** for the temporary storage of materials during the construction activities; ▪ **Access roads and internal roads**; ▪ Construction of a **car park and fencing** around the project; and ▪ **Administration, control and warehouse buildings**

1.1.2 *Solar Field*

Solar PV panels are usually arranged in rows or 'arrays' consisting of a number of PV panels. The area required for the PV panel arrays will likely need to be entirely cleared or graded. Where tall vegetation is present, this vegetation will be removed from the PV array area.

Approximately 300 000 solar PV panels will be required per project for a total export capacity of 75MW. Support structures for the PV panels will either be fixed axis mounting or single axis tracking solutions. The PV modules themselves will either be crystalline silicon or thin film technology. Due to advances in technology, the final PV panels used in this project may differ between the initial and final designs. The actual size of the PV panels to be used will be determined in the final design stages of the project. The PV panels are mounted onto metal frames which are usually aluminium. Rammed or screw pile foundations are commonly used to support the panel arrays (Figure 2).

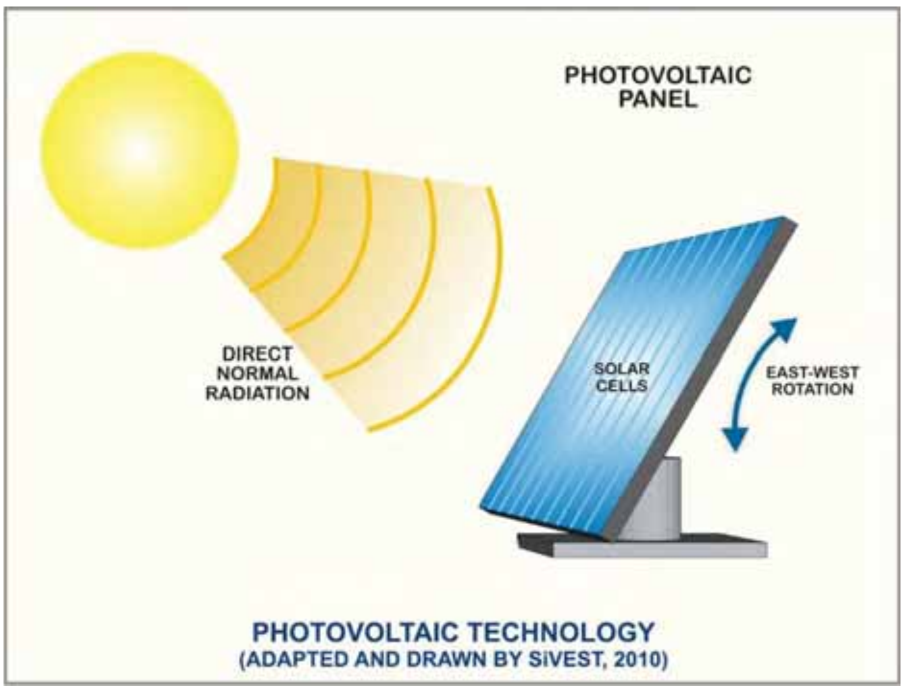

Figure 2: Example of a Photovoltaic Panel with tracking capability.

1.1.3 *Associated Infrastructure*

a. Electrical Infrastructure

The solar PV panel arrays are connected to each other in strings, which are in turn connected to inverters. For a 75MW size facility, typically 2MW inverter stations which are containerised stations housing 2x1MW inverters and 1x2MVA transformers will be used; therefore approximately 43 inverter stations will be required throughout the site for the proposed solar PV energy facility (Figure 3). DC power from the panels will be converted into AC power in the inverters and the voltage will be stepped up to 22-33kV (medium voltage) in the transformers. The 22-33kV cables will be run underground in the facility to a common point before being fed to the onsite substation and switching station where the voltage will typically be stepped up to 132kV. A Power line with a voltage of up to 132kV will run from the onsite substation to the existing Kronos substation. The distance will be about 4km.

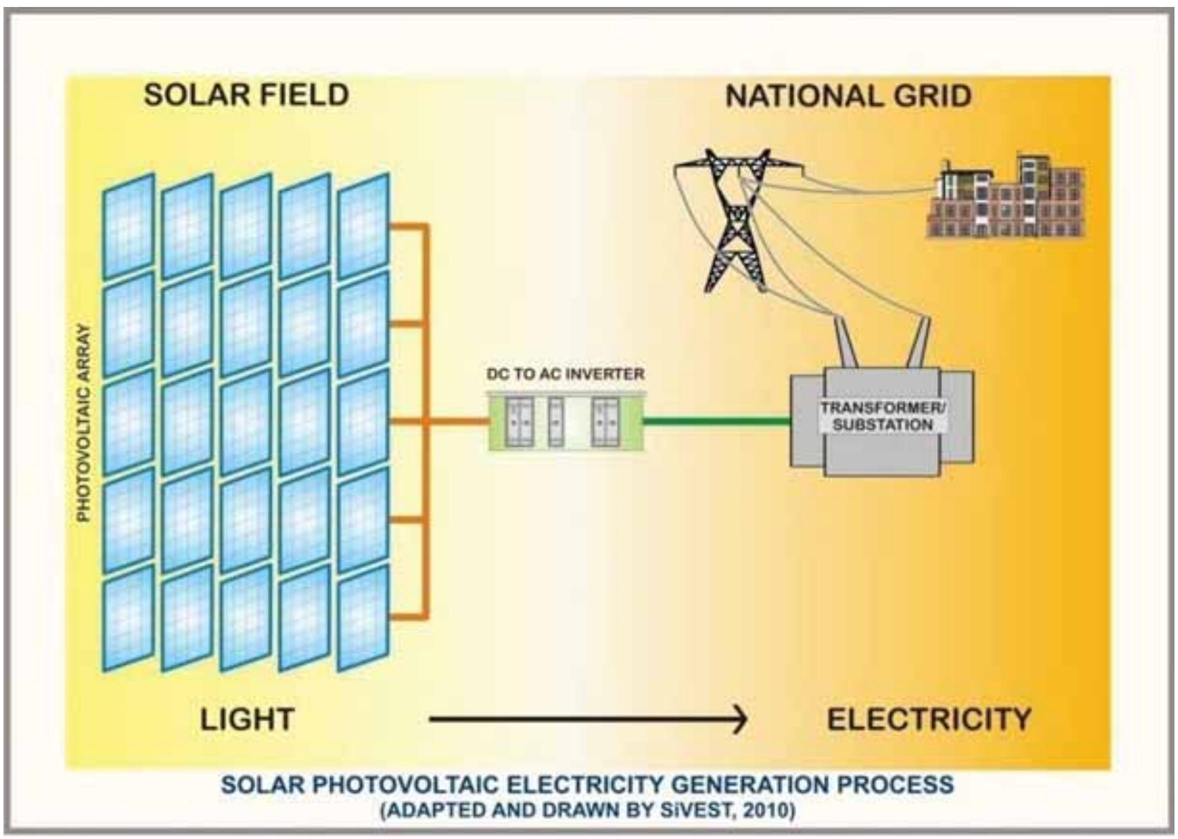

Figure 3: PV process

b. Buildings

The solar field will require onsite buildings which will be used in the daily operation of the energy facility and includes an administration building (office). The buildings are likely to be single storey buildings which will accommodate the following:

- Control room
- Workshop
- High Voltage (HV) switchgear
- Mess Room
- Toilets
- Warehouse for storage
- Car park and fencing around the project

c. Construction Lay-down Area

A general construction lay-down area will be required for the construction phase of the proposed solar PV energy facility. The size of this area is yet to be determined, but 3 to 5 hectares is likely.

d. Other Associated Infrastructure

Other associated infrastructure includes the following:

- Access roads and internal roads;
- A car park; and
- Fencing around the project.

1.2 Alternatives

Due to the limited space available as well as the constraints of the sensitive areas, no alternative PV panel layouts were identified. Other design or layout alternatives have been identified, which include two alternative site locations for the substation and two alternative route corridors for the proposed power line. Additionally, two road and cabling layout alternatives were identified (Figure 4). Should the other two proposed PV projects, located on the same farm, also be granted EAs and be awarded preferred bidder status by the DoE, the possibility of sharing the substation site to reduce the environmental impact will be considered.

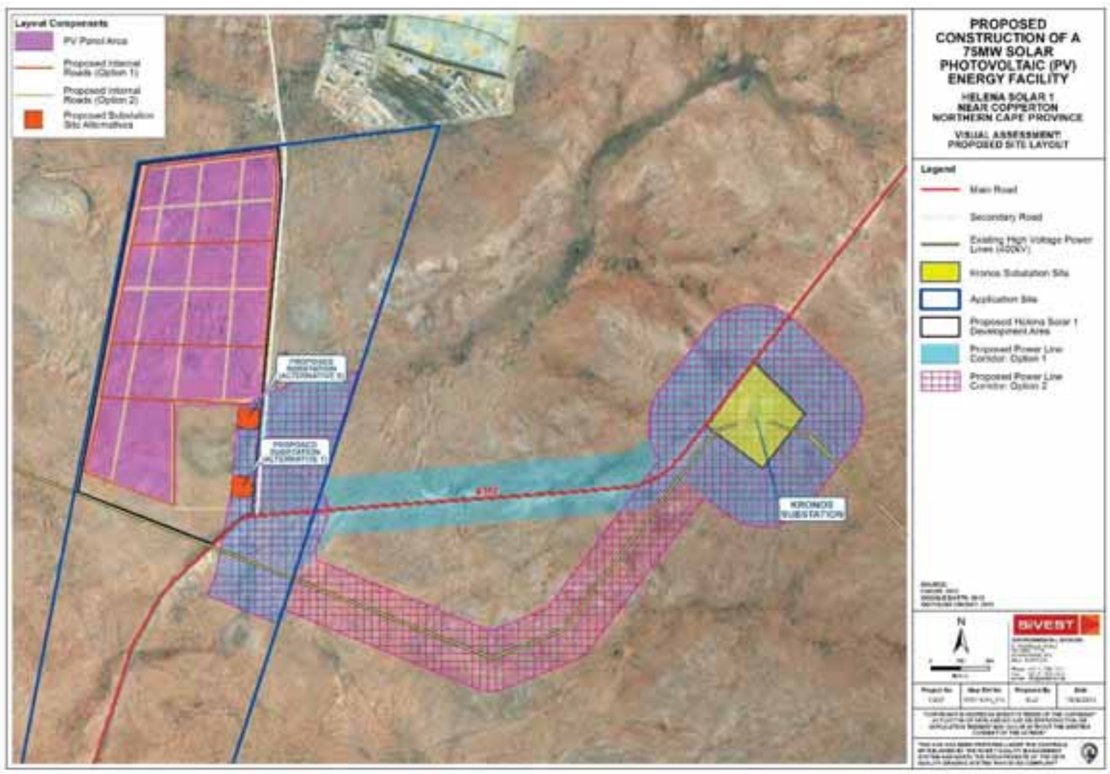

Figure 4: Proposed Site Layout Alternatives

1.3 Site location

The proposed PV energy facility will be situated on Portion 3 of the farm Klipgats Pan No 117 and the proposed power line corridor alternatives transect Portion 4 of the farm Klipgats Pan No 117 (Figure 5). Portion 3 of Klipgats Pan No 117 is a small private sheep farm with four people living on the farm and one labourer working there. Portion 4 of the farm Klipgats Pan No 117 is currently under construction for Mulilo's Prieska PV energy facility.

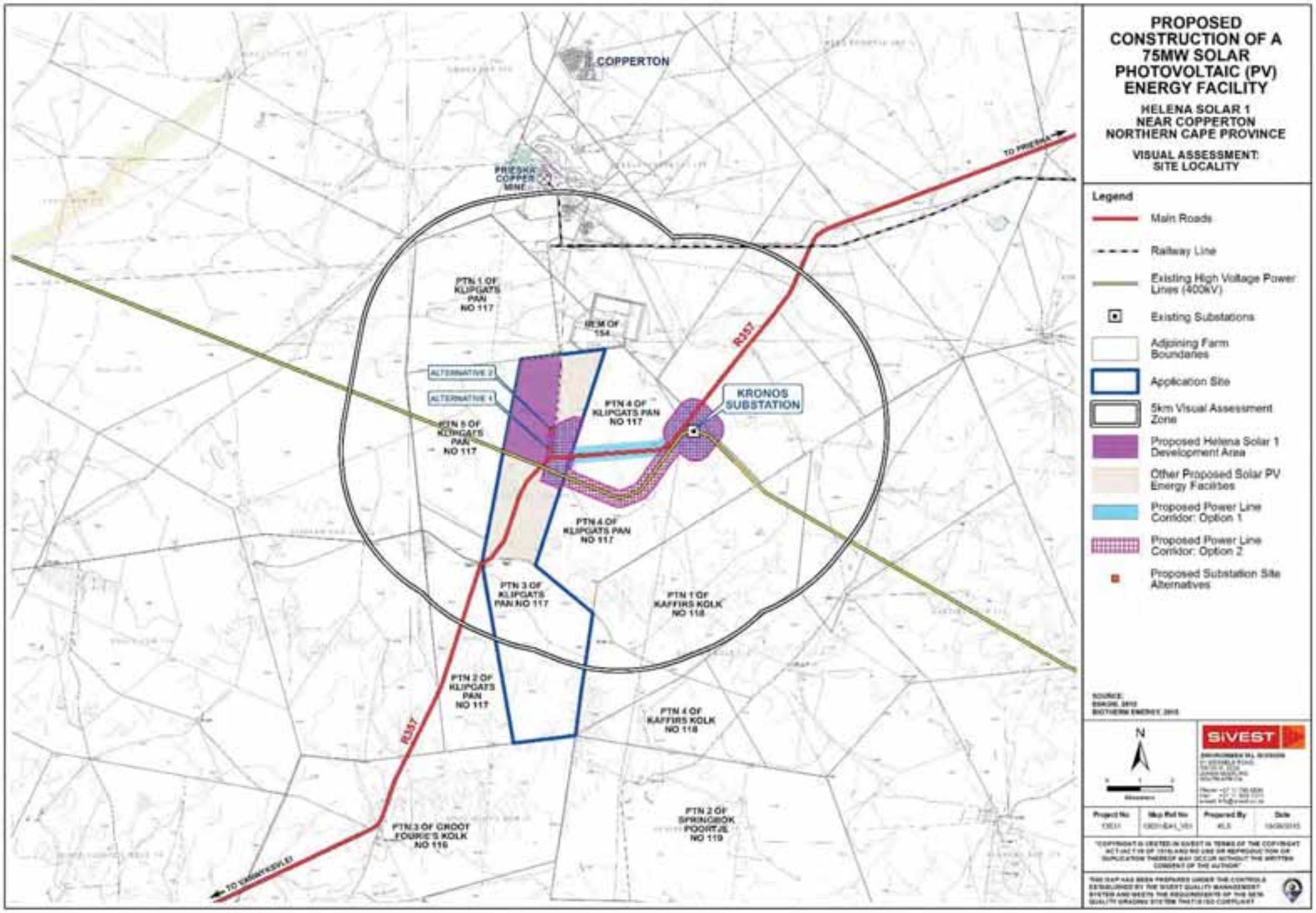

Figure 5: Site Locality

The proposed development site is situated near Copperton in the Siyathemba Local Municipality (LM) of the greater Pixley ka Seme District Municipality (DM), within the Northern Cape Province (Figure 6). The site is located approximately 10km south of Copperton, 60km south-west of Prieska, and 280km south-west of Kimberley. Copperton is an abandoned town that previously serviced a now closed mine. The proposed solar PV energy facility will be accessed by the R357 which transects the site.

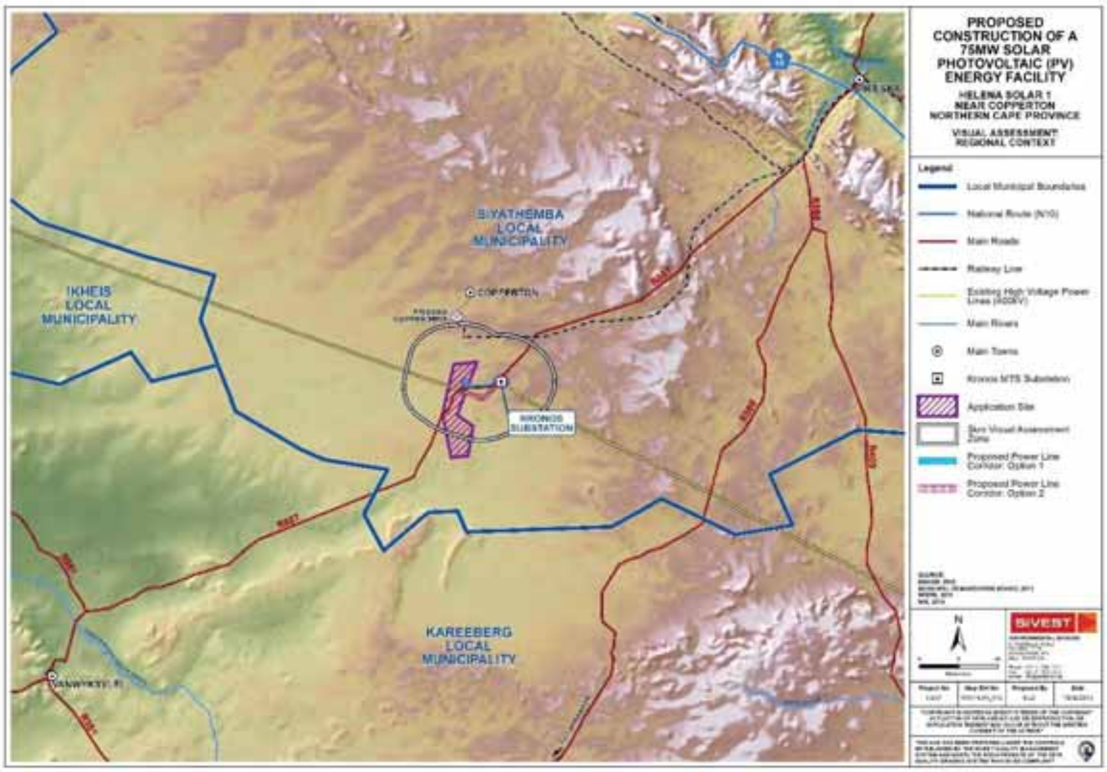

Figure 6: Regional Context

1.4 Assumptions and Limitations

- For the purpose of this visual study, the study area is assumed to encompass a zone of 5km from the PV panel area and associated infrastructure. This area was assigned, as the height of the development in combination with distance are critical factors when assessing visual impacts. Beyond 5km the solar energy facility may still be visible; however the degree of visual impact would diminish considerably and thus the need to assess the impact on potential receptors beyond this distance would not be warranted.

- The identification of visual receptors has been based on a combination of a desktop assessment as well as field-based observation. Initially Google Earth imagery was used to identify potential receptors within the study area. Thereafter a site visit was undertaken to verify the sensitive visual receptors within the study area and assess the visual impact of the development from these receptor locations. A number of broad assumptions have been made in terms of the sensitivity of the receptors to the proposed development. It should be noted that not all receptor locations would necessarily perceive the proposed development in a negative way. This is usually dependent on the use of the facility and the economic dependency on the scenic quality of views from the facility. Sensitive receptor locations typically include sites that are likely to be adversely affected by the visual intrusion of the proposed development. They include; tourism facilities and scenic sites within natural settings.

- No viewsheds were generated during this visual study, as the topography within the study area is relatively flat. Within this context, minor topographical features, vegetative screening, or man-made structures would be important factors which would influence the degree of visibility would not be factored in by the viewsheds.

- A matrix has been developed to assist in the assessment of the potential visual impact at each receptor location. The limitations of quantitatively assessing a largely subjective or qualitative type of impact should be noted. The matrix is relatively simplistic in considering five main parameters relating to visual impact, but provides a reasonably accurate indicative assessment of the degree of visual impact likely to be exerted on each receptor location by the proposed solar energy facility. The matrix should therefore be seen as a representation of the likely visual impact at a receptor location.

- The assessment of receptor-based impacts has been based on the solar energy facility layout and alternatives provided by the proponent. It is recognised however that this layout is a preliminary one, and is subject to changes based on a number of potential factors, including the findings of the EIA studies. The PV panel area and associated infrastructure may thus move, which may result in greater or lesser visual impacts on receptor locations.

- A cumulative impact assessment has been undertaken to provide a representation of the number of proposed renewable energy facilities likely to be visible from each potentially sensitive receptor location, if they were all constructed. Factors affecting visibility, such as localised screening from trees or topographical undulations have not been factored into the cumulative impact assessment.

- Visualisation modelling has not been undertaken for the proposed development due to budget limitations. Should the need for visualisation modelling be requested by stakeholder / I&AP feedback, then this will be able to be incorporated into this assessment.

- No feedback related to the visual environment was received during the public participation process. Any additional feedback relevant to the visual environment received will be incorporated into further drafts of this report.

- Operational and security lighting will be required for the PV facility and substation proposed within the development footprint. At the time of undertaking the visual study no information was available regarding the type and intensity of lighting required and therefore the potential impact of lighting at night has not been assessed at a detailed level. General measures to mitigate the impact of additional light sources on the ambiance of the nightscape have been provided.

- It should be noted that the 'experiencing' of visual impacts is subjective and largely based on the perception of the viewer or receptor. The presence of a receptor in an area potentially affected by the proposed development does not thus necessarily mean that a visual impact will be experienced.

1.5 Assessment Methodology

1.5.1 *Field work and photographic review*

From the 12th to the 14th of August 2015 (Spring) the study area was visited in order to;

- verify the landscape characteristics identified during the scoping phase visual study;
- capture photos of the proposed study area;
- verify the sensitivity of visual receptor locations previously identified during the scoping phase; and
- identify any additional visually sensitive receptor locations within the study area; and
- undertake an impact rating assessment from each visually sensitive receptor location.

1.5.2 *Physical landscape characteristics*

A site visit and digital information from spatial databases such as the National Geo-spatial Information (NGI), the South African National Biodiversity Institute (SANBI) and the South African National Land Cover (Geoterraimage – 2014) were sourced to provide baseline information on the topography, vegetation and land use in the study area. These physical landscape characteristics are important factors which influence the visual character and visual sensitivity of the study area.

1.5.3 *Identification of sensitive receptors*

During the field investigation potentially sensitive visual receptor locations within the study area, such as residences, were identified and assessed as they may be potentially sensitive to the visual impacts associated with the proposed development.

1.5.4 *Impact Assessment*

A rating matrix was used to objectively evaluate the significance of the visual impacts associated with the proposed development, both before and after implementing mitigation measures. Mitigation measures were identified (where possible) in an attempt to minimise the potential visual impact of the proposed development. The rating matrix made use of a number of different factors including geographical extent, probability, reversibility, irreplaceable loss of resources, duration, cumulative effect and intensity, in order to assign a level of significance to the visual impact of the project. A separate rating matrix was used to assess the visual impact of the proposed development on the sensitive receptor locations, as identified. This matrix is based on the distance of a receptor from the proposed development, the primary focus / orientation of the receptor, the presence of screening factors, the visual character and sensitivity of the area / surrounding views and the degree to which the proposed development would contrast with the surrounding environment. Thereafter, the layout alternatives were comparatively assessed, in order to ascertain the preferred alternative from a visual perspective.

1.5.5 *Consultation with I&APs*

Continuous consultation with Interested and Affected Parties (I&APs) undertaken during the public participation process will be used to help establish how the proposed PV energy facility will be perceived by the various receptor locations and the degree to which the impact will be regarded as negative. Although I&APs have not as yet provided any feedback in this regard, the report will be updated to include relevant information as and when it becomes available.

2 VISUAL BASELINE ASSESSMENT

The physical and land use related characteristics are outlined below as they are important factors contributing to the visibility of a development and visual character of the study area. Defining the visual character is an important part of assessing visual impacts as it establishes the visual baseline or existing visual environment in which the development would be constructed. The visual impact of a development is measured according to this visual baseline by establishing the degree to which the development would contrast or conform with the visual character of the surrounding area. The inherent sensitivity of the area to visual impacts or visual sensitivity is thereafter determined, based on the visual character, economic importance of the scenic quality of the area, inherent cultural value of the area and presence of visual receptors.

2.1 Topography

The topography within and in the immediate vicinity of the proposed application site is characterised by a flat to gently undulating landscape (typical of much of the Karoo), that gently slopes down in a south-westerly direction. A slight variation in form can be seen to the north east of the site where an old slimes dam is still present (Figure 7).

Figure 7: View north from the R357 within the application site showing the typically flat terrain and derelict slimes dam within the study area

The topography in the wider visual assessment zone is characterised by a mix of very flat plains, as well as areas of slightly more undulating relief, including some low ridges and a number of isolated low koppies (Figure 8). In the wider area beyond the boundaries of the visual assessment zone, a low mountain range marks a change in topography; the Doringberge form a line of hills to the north-east of the site.

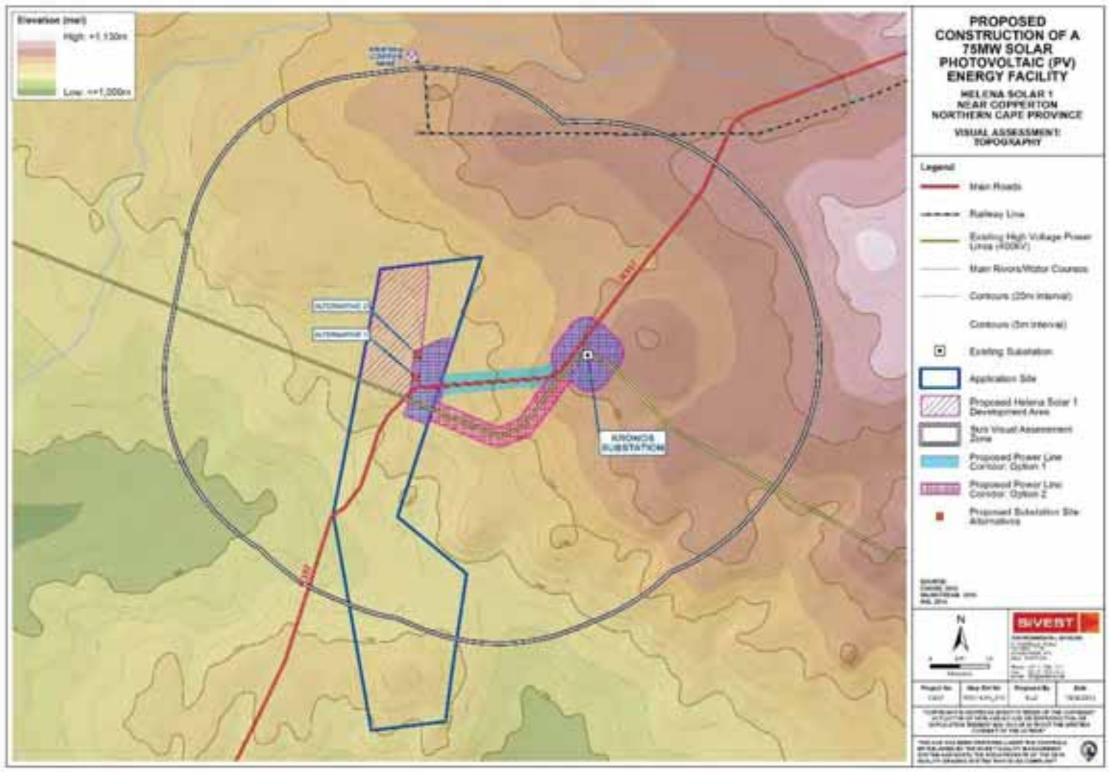

Figure 8: Topography within the study area

2.1.1 *Visual Implications*

The flat terrain that occurs within the immediate vicinity of application site results in generally wide-ranging vistas throughout the study area. The only exception to this generally flat topography is the range of mountains located to the north-west of the site and the Doringberge which are both located beyond the visual assessment zone. As such, there would be very little topographical shielding to lessen the impact of the PV energy facility from locally-occurring receptor locations.

2.2 Vegetation and land cover

Except for two isolated patches of Bushmanland Vloere, the entire visual assessment zone is covered by the Bushmanland Basin Shrubland vegetation type (Figure 10), which is characterised by dwarf shrubland dominated by a mixture of low sturdy and spiny shrubs. The aridity of the area has restricted the vegetation cover to this typically short scrub-type vegetation (Figure 9). In certain areas, man has had an impact on the natural vegetation, especially around farmsteads, where over many years tall exotic trees and other typical garden vegetation have been established.

Figure 9: Typical vegetation cover within the study area

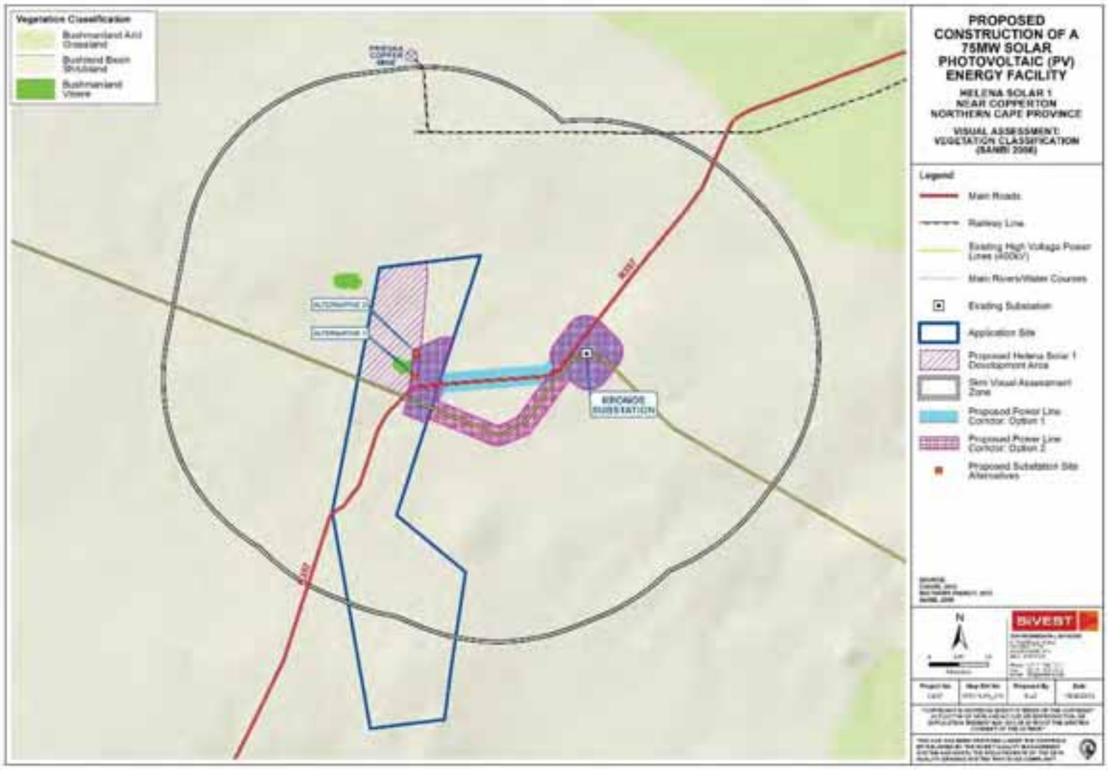

Figure 10: Vegetation within the study area

The prevailing land use in the wider study area is classified as undeveloped low shrubland (Figure 13).The highly arid nature of the area's climate, has resulted in livestock rearing (of sheep) dominating within the area. As such, the typical low, woody shrub, karroo-type communities have been retained across the vast majority of the study area, as sheep graze on natural vegetation (Geoterraimage, 2015).

The nature of the climate and corresponding land use has also resulted in low stocking densities and relatively large farm properties across the area. Therefore the area is very sparsely populated, and little human-related infrastructure exists.

Built form, in areas where livestock rearing occurs, is limited to isolated farmsteads, gravel access roads, ancillary farm buildings, telephone lines, windmills, fences and the remnants of old workers' dwellings.

Figure 11: Typical built form present within the study area

A high voltage 400kV power line bisects the application site and the tall steel structures that make up Kronos Substation are visible from the R357 as one approaches the site from the north-east and from the development site when looking in an easterly direction. In addition, the construction works that are currently underway for Mulilo's Prieska solar PV energy facility on the adjacent farm are also visible within study area. Once constructed, this solar PV energy facility and its associated infrastructure, will be highly visible.

Figure 12: View north east from the R357 within the application site showing Kronos Substation, the 400kV power line and the construction activities for Mulilo's Prieska solar PV energy facility

The closest built-up areas include the small mining town of Copperton, which is located outside the visual assessment zone approximately 8km north of the site, and the old Prieska Copper Mine which was closed in 1996 (Figure 13). Within this part of the study area, a greater human influence is visible in the form of mining infrastructure and electricity transmission infrastructure. Directly north of the application site, the infrastructure associated with the now-defunct mine still exists, with the headgear, as well as an old slimes dams being prominent landmarks. Further north, degraded land and some urban-built up form are located directly adjacent to the old Prieska Copper Mine.

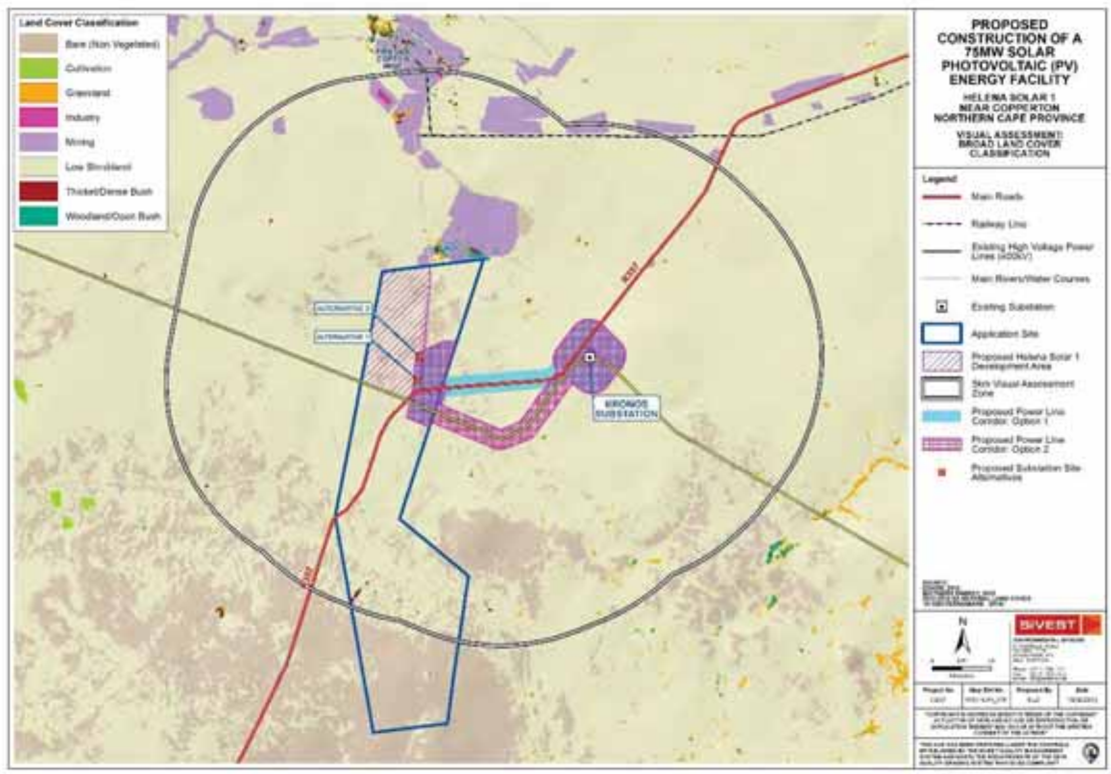

Figure 13: Land cover within the study area

2.2.1 *Visual Implications*

The natural short vegetation cover will offer no visual screening. Tall exotic trees may effectively screen the proposed development from farmhouses, where these trees occur in close proximity to the farmhouse and are located directly in the way of views toward the development. The general lack of human habitation and associated human infrastructure, has an obvious impact on the sense of place and thus giving the area a largely natural, rural feel. Only in areas further north will the landscape character appear more industrial and transformed.

The influence of the level of human transformation on the visual character of the area is described in more detail below.

2.3 Visual Character

Visual character can be defined based on the level of change or transformation from a completely natural setting, which would represent a natural baseline in which there is little evidence of human transformation of the landscape. Varying degrees of human transformation of a landscape would engender differing visual characteristics to that landscape, with a highly modified urban or industrial landscape being at the opposite end of the scale to a largely natural undisturbed landscape. Visual character is also influenced by the presence of built infrastructure such as buildings, roads and other objects such as electrical infrastructure.

Most of the study area is considered to have a rural or pastoral character as a result of the limited human habitation and associated human infrastructural footprint present within the area. The nature of the predominant land use (sheep farming) has retained the natural vegetation and natural appearance of the landscape. Built infrastructure within the study area is limited to isolated farmhouses, gravel access roads, farm boundary fences, several windmills, a high voltage power line which traverse the application site and the Eskom Kronos Substation. The infrastructure associated with the Copper Mine is unlikely to change the visual character of the study area as the relic mine has been non-functional for a number of years, and the transformation of the area around the mine is extremely localised.

The relatively low density of human transformation throughout the surrounding area is an important component contributing to the largely pastoral visual character of the study area. This is important in the context of potential visual impacts associated with the proposed development of a PV energy facility as introducing this type of development could be considered to be a degrading factor in this context.

It should however be noted that, other than Mulilo's Prieska energy facility, several other solar and wind energy facilities are being proposed within relatively close proximity to the proposed development. These facilities and their associated infrastructure, typically consist of very large structures which are highly visible. As such, these facilities will significantly alter the visual character and baseline in the study area and make it appear to have a more industrial-type visual character if constructed before the proposed Helena 1 PV facility.

2.4 Cultural, Historical and Scenic Value

Cultural landscapes are becoming increasingly important concepts in terms of the preservation and management of rural and urban settings across the world. The concept of 'cultural landscape' is a way of looking at a place that focuses on the relationship between human activity and the biophysical environment (Breedlove, 2002). The cultural landscape concept is relatively new in the heritage conservation movement across the world. In 1992 the World Heritage Committee adopted the following definition for cultural landscapes:

Cultural landscapes represent the combined worlds of nature and of man illustrative of the evolution of human society and settlement over time, under the influence of the physical constraints and/or opportunities presented by their natural environment and of successive social, economic and cultural forces, both external and internal.

According to the Committee's Operational Guidelines Cultural Landscapes can fall into three categories

i) *"a landscape designed and created intentionally by man";*
ii) *an "organically evolved landscape" which may be a "relict (or fossil) landscape" or a "continuing landscape";*
iii) *an "associative cultural landscape" which may be valued because of the "religious, artistic or cultural associations of the natural element"*

The greater area surrounding the proposed development site is an important component when assessing visual character and scenic value. The area can be considered to be typical of a Karoo or “platteland” landscape that would characteristically be encountered across the high-lying dry western and central interior of South Africa. Much of South Africa’s dry Karoo interior consists of wide open, uninhabited spaces sparsely punctuated by widely scattered farmsteads and small towns. Although the Karoo may be seen as a dull, lifeless part of the country, in the last couple of decades this has been changing, with the launching of tourism routes within the Karoo, and the promotion of tourism in this little visited, but large part of South Africa. In a context of increasing urbanisation in South Africa’s major centres, the Karoo is being marketed as an undisturbed getaway, especially as a stop on a longer journey from the northern parts of South Africa to the Western and Eastern Cape coasts. Examples of this may be found in the relatively recently published “Getaway Guide to Karoo, Namaqualand and Kalahari” (Moseley and Naude-Moseley, 2008). The exposure of the Karoo in the national press during 2011, as part of the debate around the potential for fracking (hydraulic fracturing) mining activities, has brought the natural resources, land use and lifestyle of the Karoo into sharp focus. Many potential objectors stress the need to preserve the environment of the Karoo, as well as preserve the ‘Karoo Way of Life’, i.e. the stock farming practices which are highly dependent on the use of abstracted ground water (e.g. refer to the Treasure Karoo Action Group website http://treasurethekaroo.co.za/).

Typical Karoo landscape can also be considered a valuable ‘cultural landscape’ in the South African context. Although the cultural landscape concept is relatively new, it is becoming an increasingly important concept in terms of the preservation and management of rural and urban settings across the world (Breedlove, 2002).

The typical Karoo landscape consisting of wide open plains, and isolated relief, interspersed with isolated farmsteads, windmills and stock holding pens, is an important part of the cultural matrix of the South African environment. The Karoo farmstead is also a representation of how the harsh arid nature of the environment in this part of the country has shaped the predominant land use and economic activity practiced in the area, as well as the patterns of human habitation and interaction. The presence of small Karoo towns, such as Prieska, engulfed by an otherwise rural environment, form an integral part of the wider Karoo landscape. As such, the Karoo landscape as it exists today has value as a cultural landscape in the South African context. In the context of the types of cultural landscape listed above, the Karoo cultural landscape would fall into the second category, that of an organically evolved, “continuing” landscape.

The study area, as visible to the viewer, represents a typical Karoo cultural landscape. This is important in the context of potential visual impacts associated with the proposed development of a PV energy facility as introducing this type of development could be considered to be a degrading factor in the context of the natural Karoo character of the study area, as discussed further below.

2.5 Sensitive Visual Receptor Locations

A sensitive receptor location is defined as a location, from where receptors would potentially be adversely impacted by a proposed development. This takes into account a subjective factor on behalf of the viewer – i.e. whether the viewer would consider the impact as a negative impact. As described above, the adverse impact is often associated with the alteration of the visual character of the area in terms of the intrusion of the PV energy facility into a ‘view’, which may affect the ‘sense of place’. The identification of sensitive receptors is typically undertaken based on a number of factors which include:

- the visual character of the area, especially taking into account visually scenic areas and areas of visual sensitivity;
- the presence of leisure-based (esp. nature-based) tourism in an area;
- the presence of sites / routes that are valued for their scenic quality and sense of place;
- the presence of homesteads / farmsteads in a largely natural settings where the development may influence the typical character of their views; and
- feedback from interested and affected parties, as raised during the public participation process conducted as part of the EIA study.

A distinction must be made between a receptor location and a sensitive receptor location. Receptor locations are sites from where the proposed PV energy facility may be visible, but the receptor may not necessarily be adversely affected by any visual intrusion associated with the development. Receptor locations include locations of commercial activities and certain movement corridors, such as roads that are not tourism routes. Sensitive receptor locations typically include sites that are likely to be adversely affected by the visual intrusion of the proposed development. They include; tourism facilities, scenic sites and residential dwellings in natural settings.

Generally, the visibility of the development would diminish exponentially over distance. In order to account for this distance bands were used to assign zones of visual impact from the proposed development site. As such, the proposed development would be more visible to receptors located within a short distance and these would experience a higher adverse visual impact than those located at a moderate or long distance from the proposed development.

Based on the height and scale of the project, the radii chosen to assign these zones of visual impact are as follows:

- 0 < 500m (very high impact zone)
- 500 < 1km (high impact zone)
- 1km < 2km (moderate impact zone)
- 2km < 5km (low impact zone)

There is limited human settlement within the immediate vicinity of the site. During the EIA Phase site visit, very few scattered farmsteads / homesteads which are used to house the local farmers as well as their farm workers were identified within the study area. These dwellings are regarded as potentially sensitive visual receptors as they are located within a mostly rural setting and the proposed development will likely alter natural vistas experienced from these dwellings. The degree of visual impact experienced will vary from one inhabitant to another, as it is largely based on the viewer's perception. Factors influencing the degree of visual impact experienced by the viewer include the following:

- Value placed by the viewer on the natural scenic characteristics of the area.
- The viewer's sentiments toward the proposed structures. These may be positive (a symbol of progression toward a less polluted future) or negative (foreign objects degrading the natural landscape).
- Degree to which the viewer will accept a change in the typical Karoo character of the surrounding area.

Table 2 below provides details of the potentially sensitive visual receptor locations that were identified within the study area.

Table 2: Visual receptor locations potentially sensitive to the proposed PV energy facility

Name	**Distance from the proposed PV development area or associated infrastructure**	**Visual Impact Zone**
*Klippan Farmstead	Approximately 3.27km	Low
Klipgat pan Farmstead	Approximately 3.6km	Low
Mierdam Farmstead	Approximately 4.12km	Low
Uitspan pan Farmstead	Approximately 5km	Low

**Klippan Farmstead is located within the proposed application site. It is assumed that the occupants would have a vested interest in the development and would therefore not perceive the proposed*

PV energy facility in a negative light. During the EIA phase fieldwork it was verified that the owner of Klippan Farm supports the proposed development.

In many cases, roads, along which people travel, are considered as sensitive receptors. The closest road to the application site is the R357 gravel road that traverses directly through the proposed PV application site and power line corridor alternatives. This road is not considered to be sensitive receptor road. It is used almost exclusively as a local access road, with very little use for any other purposes. As described above the area is not associated with any particular scenic value or any other tourism use. In addition the R357 passes close to the now disused Copperton Mine and associated slimes dam, as well as Kronos Substation. Thus the area around the development site traversed by this road can be considered to be visually 'degraded' by a prevalence of large human infrastructure, and is highly unlikely to be associated with any visual sensitivity.

The potentially sensitive visual receptor locations in relation to the zones of visual impact are indicted in Figure 14 below.

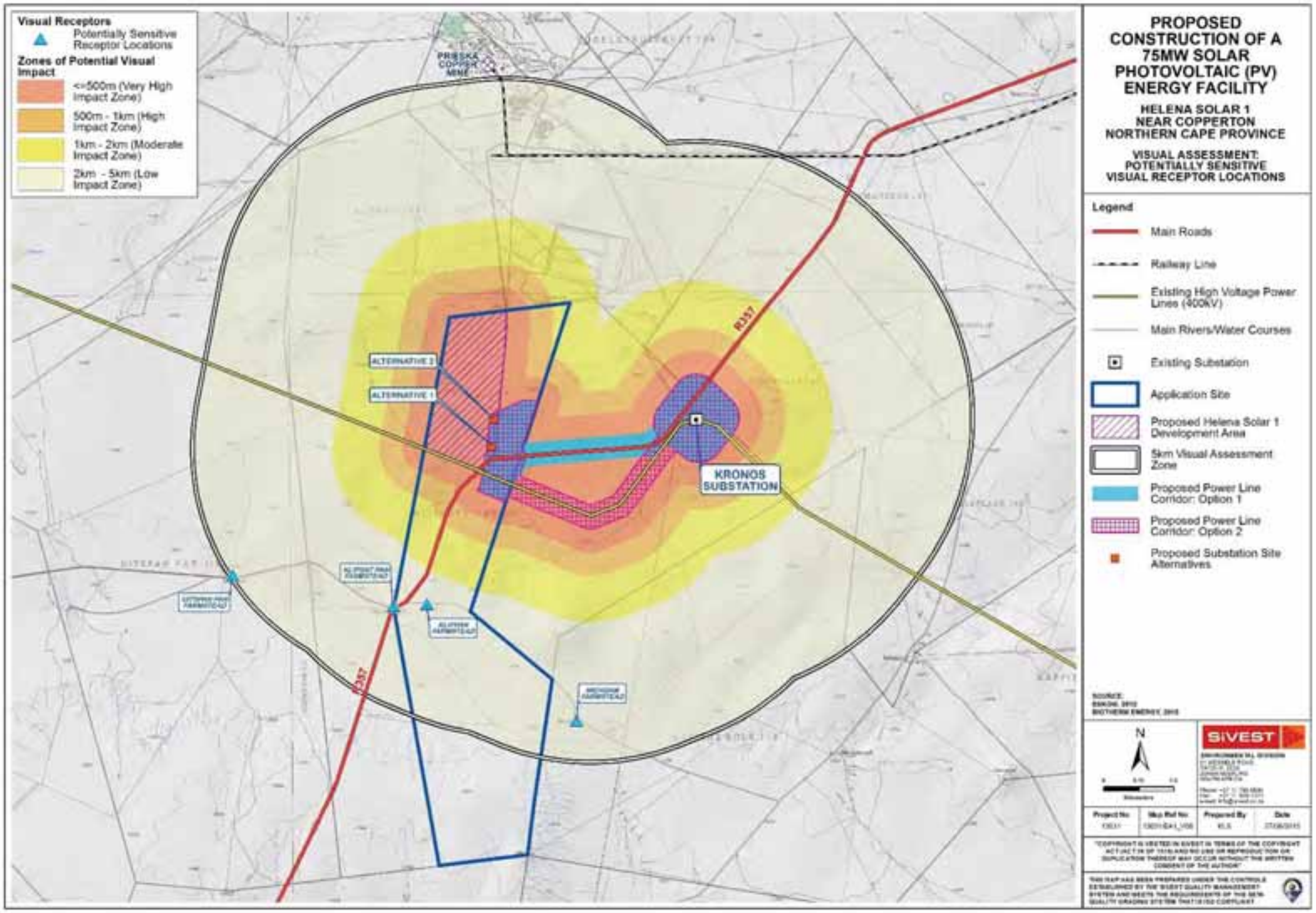

Figure 14: Visually sensitive receptors within the study area

3 VISUAL SENSITIVITY

Visual Sensitivity can be defined as the inherent sensitivity of an area to potential visual impacts associated with a proposed development. It is based on the physical characteristics of the area (i.e. topography, landform and land cover), spatial distribution of potential receptors, and the likely value judgements of these receptors towards a new development (Oberholzer: 2005). A viewer's perception is usually based on the perceived aesthetic appeal of an area and on the presence of economic activities (such as recreational tourism) which may be based on this aesthetic appeal.

In order to assess the visual sensitivity of the area SiVEST has developed a matrix based on the characteristics of the receiving environment which, according to the Guidelines for Involving Visual and Aesthetic Specialists in the EIA Processes, indicate that visibility and aesthetics are likely to be 'key issues' (Oberholzer: 2005).

Based on the criteria in the matrix (Table 3), the visual sensitivity of the area is broken up into a number of categories, as described below:

i) **High** - The introduction of a new development such as the erection of a PV facility or power line would be likely to be perceived negatively by receptors in this area; it would be considered to be a visual intrusion and may elicit opposition from these receptors

ii) **Moderate** - Presence of receptors, but due to the nature of the existing visual character of the area and likely value judgements of receptors, there would be limited negative perception towards the new development as a source of visual impact.

iii) **Low** - The introduction of a new development would not be perceived to be negative, there would be little opposition or negative perception towards it.

The table below outlines the factors used to rate the visual sensitivity of the study area. The ratings are specific to the visual context of the receiving environment within the study area.

Table 3: Environmental factors used to define visual sensitivity of the study area

FACTORS	**RATING**									
	1	2	3	4	5	6	7	8	9	10
Pristine / natural character of the environment										
Presence of sensitive visual receptors										
Aesthetic sense of place / scenic visual character										
Value to individuals / society										
Irreplaceability / uniqueness / scarcity value										
Cultural or symbolic meaning										
Scenic resources present in the study area										

Protected / conservation areas in the study area										
Sites of special interest present in the study area										
Economic dependency on scenic quality										
Local jobs created by scenic quality of the area										
International status of the environment										
Provincial / regional status of the environment										
Local status of the environment										
**Scenic quality under threat / at risk of change										

**A rating above '5' for this factor will trigger the need to undertake an assessment of cumulative visual impacts.

Low							**Moderate**							**High**
10	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**	**110**	**120**	**130**	**140**	**150**

Based on the above factors, the study area is rated as having a low visual sensitivity. This is mainly owing to the relatively uninhabited characteristics of the area and the relic mining infrastructure which would likely reduce the scenic quality of the area. An important factor contributing to the visual sensitivity of an area is the presence, or absence of visual receptors that may value the aesthetic quality of the landscape and depend on it to produce revenue and create jobs. As described below, very few potentially sensitive receptors are present in the study area. Although no formal protected areas or leisure / nature-based tourism activities exist within the study area, the area would still be valued as a typical Karoo cultural landscape.

Several solar energy facilities are proposed within relatively close proximity to the proposed project. As such, an assessment of the cumulative impact that will be experience from each potentially sensitive receptor is included in Section 5.4.

4 TYPICAL VISUAL IMPACT ASSOCIATED WITH PV ENERGY FACILITIES

In this section, the typical visual issues / impacts related to the establishment of a PV energy facility as proposed are discussed.

The solar power component of the proposed energy generation facility consists of photovoltaic (PV) panels, which grouped together form a 'solar field'. Each PV panel is a large structure, that is typically up to 10m high (equivalent in height to a building of approximately three storeys). The height of these objects will make them visible, especially in the context of a relatively flat landscape (Figure 15).

Figure 15: Photovoltaic Panels being erected near De Aar in the Northern Cape Province

More importantly, the concentration of these panels will make them highly visible, which will depend on the number of panels in each solar field, known as its spatial extent or footprint. Solar fields with a large spatial extent will become a distinctly visible black feature that contrasts with the landscape, especially if the landscape is natural in character or undeveloped (Figure 16). As most solar power energy facilities tend to be located in vacant or uninhabited areas due to space availability, the landscape context is often natural or undeveloped and in this context the solar field could be considered to be a visual intrusion that possibly acts to alter the visual environment.

Figure 16: Photovoltaic Panels being erected near Lime Acres in the Northern Cape Province

In the case of PV energy facilities, taller vegetation such as trees and shrubs will need to be cleared. This practice of clearing vegetation will intensify the visual prominence of the solar energy facility, particularly in natural locations where woody vegetation still exists, but to a lesser degree if the proposed facility is located on land that has already been cleared or where the natural vegetation cover is short.

4.1.1 *Associated Infrastructure*

The infrastructure typically associated with a PV energy facility development will include the following:

- Pole mounted / buried cables to collect the power from the inverter stations; and
- A solar resource measuring station (typically 100m² and 5m high).
- An onsite substation to supply electricity the Eskom grid;
- Overhead power lines to connect the substation to the Eskom grid;
- Cables connecting the PV panels, which will be buried where possible;
- Gravel access roads;
- Single storey administration buildings;
- Temporary lay down areas required during construction.

The new substation (approximately 90m x 120m) and overhead power lines by their nature are large objects and will typically be visible for great distances. Power lines consist of a series of tall towers thus making them highly visible. Like solar panels, power lines and substations are not features of the natural environment, but are representative of human (anthropogenic) alteration. Thus when placed in largely natural landscapes, they will be perceived to be highly incongruous in this setting. Conversely, the presence of other anthropogenic objects associated with the built environment, especially other power lines or substations, may result in the visual environment being considered to be 'degraded' and thus the introduction of a new power line into this setting may be less of a visual impact than if there was no existing built infrastructure visible.

Other associated infrastructure may also be associated with visual impacts. The solar PV panel arrays are connected to each other in strings, which are likely to be buried, but which also may take the form of above-ground power lines. These cables may become a visual intrusion if placed in areas of the site that are visible to the surrounding areas, especially if located on higher lying areas. A trench dug for the cable (both during construction and post-construction once the trench has become back-filled) may become prominent if it creates a linear feature that contrasts with the surrounding vegetation. A similar principle exists with respect to any access roads constructed in these parts of the site. Roads are likely to be wider than cable trenches and thus could be even more greatly visible than the cable servitude. Cutting a 'terrace' into a slope would increase the visibility and contrast the road against the surrounding vegetation.

Lastly, buildings placed in prominent positions such as on ridge tops may also break the natural skyline, drawing the attention of the viewer.

The visual impact of the other associated infrastructure is however generally not regarded to be a significant factor when compared to the visual impact associated with a PV energy facility. They would however, magnify the visual prominence of the development if located on ridge tops or flat sites in natural settings where there is limited tall wooded vegetation present to conceal the impact.

5 IMPACT ASSESSMENT

5.1 Sensitive Receptor Impact Rating

In order to assess the impact of the proposed development on the sensitive receptor locations listed above, a matrix that takes into account a number of factors has been developed (Table 4), and is applied to each receptor location.

The matrix has been based on a number of factors as listed below:

- Distance of receptor away from the proposed development (distance banding)
- Primary focus / orientation of the receptor
- Presence of screening factors (topography, vegetation etc.)
- Visual character and sensitivity of the surrounding area
- Visual contrast of the development with the landscape pattern and form

These factors are considered to be the most important factors when assessing the visual impact of a proposed development on a potentially sensitive receptor location in this context. It should be noted that this rating matrix is a relatively simplified way to assign a likely representative visual impact, which allows a number of factors to be considered. Experiencing of visual impacts is however a complex and qualitative phenomenon, and thus difficult to accurately quantify. The matrix should therefore be seen as a representation of the likely visual impact at a receptor location. Part of its limitation lies in the quantitative assessment of what is largely a qualitative or subjective impact.

Table 4: Visual assessment matrix used to rate the impact of the development on sensitive receptors

	VISUAL IMPACT RATING			
VISUAL FACTOR	**HIGH**	**MEDIUM**	**LOW**	**OVERRIDING FACTOR: NIL**
Distance of receptor away from proposed development	0 < 500m	500m < 2km	2km < 5km	5km <
Primary focus / orientation of receptor	'Arc of view' directly towards the proposed development	'Arc of view' partially towards the proposed development / no primary orientation	'Arc of view' in opposite direction of the proposed development	
Presence of screening factors	No screening factors – development highly visible	Screening factors partially obscure the development	Screening factors obscure most of the development	Screening factors completely block any views towards the development, i.e. the development is not within the viewshed
Visual character and sensitivity of the area / surrounding views	**Scenic:** Highly natural; almost no visually 'degrading' factors, the area is valued for its scenic quality and is **highly sensitive to change**	**Rural / pastoral:** Mostly natural with typical rural infrastructure present, the area is valued for its uninhabited nature and is **potentially sensitive to change**	**Transformed:** Presence of industrial-type infrastructure (e.g. urban areas and outlying residential areas), not highly valued and **not sensitive to change**	
Visual Contrast	**High contrast** with the pattern and form of the natural landscape elements (vegetation and land form), typical land use and/or human elements (infrastructural form)	**Moderate contrast** with the pattern and form of the natural landscape elements (vegetation and land form), typical land use and/or human elements (infrastructural form)	**Corresponds** with the pattern and form of the natural landscape elements (vegetation and land form), typical land use and/or human elements (infrastructural form)	

As described above, distance of the viewer / receptor location in relation to the development is an important factor in the context of experiencing of visual impacts. A high impact rating has thus been assigned to receptor locations that are located within 0<500m of the proposed development. Beyond 5km, the visual impact would be virtually nil, as the development would appear to merge with the elements on the horizon. Any receptor location beyond this distance has therefore been assigned an overriding nil impact rating. As such, despite the impact rating assigned to the other visual factors, the overall impact rating would remain nil, as the proposed development would not visually influence any receptors located more than 5km from the development. Where a receptor is located within more than one distance band, such as a receptor road, it is assigned the score according to the closest distance it will get from the proposed development i.e. the highest visual impact experienced.

The orientation of a receptor becomes important in many cases, as the receptor location is typically oriented in a certain direction, e.g. with views towards a certain area from a highly frequented area like a porch or garden. The visual impact of a development could thus be potentially much greater if the development intruded into such a view, and thus the highest rating has been given to a situation where the development would cross directly across an 'arc of view / orientation' – i.e. the 180^{o} panorama in a certain direction. Where the receptor does not have a primary orientation, such as a residential community where the dwellings are focused in different directions, a medium rating has been specified.

The presence of screening factors is equally important in this context as a receptors' distance from the development. Screening factors can be vegetation, buildings, as well as topography. For example, a grove of trees located between a receptor location and an object could completely shield the object from the receptor. Topography (relative elevation and aspect) plays a similar role as a receptor location in a deep or incised valley will have a very limited viewshed and may not be able to view an object that is in close proximity, but not in its viewshed. As such, the complete screening of the development has also been assigned an overriding nil impact rating, as the development would not impose any impact on the receptor.

The visual character of the surrounding area and views is also considered in the matrix, as introducing a development into a natural area may adversely affect or degrade scenic views experienced by receptors. Although pastoral' or rural landscapes often have a relative density of anthropogenic (human) infrastructure (e.g. fences, centre pivots, buildings such as barns and farmhouses), views of these landscape are often perceived as sensitive to visual impacts, particularly to visual impacts of more industrial or large-scale infrastructure. A moderate rating is thus assigned to the visual character of these views. Transformed industrial landscapes have been assigned a low impact rating as a new development is unlikely to be regarded as negative within this context.

The visual contrast of a development refers to the degree to which the development would be congruent with the surrounding environment. It is based whether or not the development would conform with the land use, settlement density, structural scale, form and pattern of natural elements that define the structure of the surrounding landscape. The visual compatibility is an important factor to be considered when assessing the impact of the development on receptors within a specific context. A development that is incongruent with the surrounding area could have a significant visual impact on sensitive receptors as it may change the visual character of the landscape.

Through the matrix a score for each receptor location is calculated. The range in which the score falls, as listed in Table 5 below, determines the visual impact rating for each receptor location.

Table 5: Ratings scores

Rating	Overall Score
High Visual Impact	13-15
Medium Visual Impact	9-12
Low Visual Impact	5-8
Negligible Visual Impact	(overriding factor)

The tables below present the results of the visual impact matrix.

Table 6: Visual impact of the Helena 1 solar PV energy facility at Klipgat Pan Farmstead

VISUAL FACTOR	RATING
Distance of receptor away from proposed development	**LOW:** The receptor is located approximately 3.6km from the proposed Helena 1 solar PV development area.
Primary focus / orientation of receptor	**MEDIUM:** The farmhouse is oriented in an easterly direction. The Helena 1 solar PV development area will be situated in a north easterly direction from the house. The house is therefore orientated partially towards the PV site. The windows and doors on the southern side of the house are, however, oriented in the opposite direction of the PV site.
Presence of screening factors	**HIGH:** The very few trees situated at the house will not allow for an adequate amount of screening from the development. The proposed PV plant would therefore be completely visible from large portions of the house and the east facing windows of the farmhouse. No other screening factors are present (Figure 17).
Visual character and sensitivity of the area / surrounding views	**MEDIUM:** Views from the farmhouse are typical of a rural or pastoral environment. Typical pastoral elements include; exotic trees, wire fences, windmills, water tanks and other associated infrastructure such as animal enclosures / kraals. Natural intact Karroo vegetation (low shrub vegetation) is prevalent in the surrounding environment.
Visual Contrast	**MEDIUM:** The surrounding environment is largely natural with a few linear elements present which include a few exotic trees around the

	farmhouse, telephone poles, large Eskom power lines, Kronos Substation to the northeast and fence poles. The vegetation is relatively short and appears as a relatively uniform medium shade of grey-green. The PV panels would rise above the natural vegetation, and appear as dark grey mass or 'blanket' contrasting with the relatively uniform flat landscape. It must be noted that a PV plant is currently being built near the Kronos Substation, approximately 4.5km from the house to the north east. In addition, another solar energy facility is proposed to be constructed on an adjacent farm located approximately 7.4km south east of the house. The presence of these large structures in the area would reduce the visual contrast of the proposed PV energy facility, should they both be constructed.
OVERALL IMPACT RATING	**MEDIUM**

Figure 17: Typical view of the development site from Klipgat Pan Farmstead

Figure 18: Klipgat Pan Farmstead

Table 7: Visual impact of the Helena 1 solar PV energy facility at Uitspan Pan Farmstead (Frans Eckerd)

VISUAL FACTOR	RATING
Distance of receptor away from proposed development	**LOW:** The receptor is located approximately 5km from the proposed Helena 1 solar PV development area.
Primary focus / orientation of receptor	**MEDIUM:** The farmhouse is orientated towards the east. The proposed development will be situated in a north easterly direction from the house. The house is therefore orientated partially towards the proposed Helena 1 solar PV development area.
Presence of screening factors	**MEDIUM:** Very few trees surround the northern and western sides of the house. No screening factors are, however, present on the eastern side of the house partially facing the proposed development. In addition, topographical undulations may screen views of the

	development from portions of the farm as is situated reasonably far away (Figure 19).
Visual character and sensitivity of the area / surrounding views	**MEDIUM:** Views from the farmhouse are characteristic of a typical natural or pastoral environment. Rural infrastructure and other anthropogenic elements surrounding the farmhouse include; wire fences, animal enclosures, windmills, telephone poles and water reservoirs / storage tanks. Natural intact Karroo vegetation is prevalent in the surrounding environment
Visual Contrast	**MEDIUM:** The surrounding environment is largely natural with a few linear elements present which include large Eskom power lines, smaller telephone poles and the Kronos Substation. Where visible the Helena 1 solar PV energy facility would contrast with the natural earthly tones of the prevailing Karroo vegetation by creating a dark grey mass within the relatively uniform flat landscape. It must also be noted that a solar PV plant is currently being constructed near the Kronos Substation to the north east. This PV facility will be located approximately 7km from the farmhouse. In addition, another solar energy facility is proposed to be constructed on an adjacent farm located approximately 7.4km south east of the house. The presence of these large structures in the area would reduce the visual contrast of the proposed PV energy facility, should they both be constructed.
OVERALL IMPACT RATING	**MEDIUM**

Figure 19: Typical view of the development site from Uitspan Pan Farmstead

Figure 20: Uitspan Pan Farmstead

Table 8: Visual impact of the Helena 1 solar PV energy facility at Klippan Farmstead (Gerhardus Rudolph)

VISUAL FACTOR	RATING
Distance of receptor away from proposed development	**LOW:** The receptor is located approximately 3.27km from the proposed Helena 1 solar PV development area.
Primary focus / orientation of receptor	**HIGH:** The farmhouse is orientated towards the north. The proposed Helena 1 solar PV development area is located to the north of the house. This farmstead is therefore orientated directly towards the proposed development. There are some windows and doors that face the southern direction, however the main “stoep” area of the house directly faces the development.
Presence of screening factors	**HIGH:** No screening factors on the northern side of the house which will successfully block out the views towards the proposed Helena 1 PV facility. There are some trees on the eastern, western and southern sides of the house but these will not provide any form of screening from the development. The shrubs located in the surrounding environment could marginally block out some views toward the proposed PV facility (Figure 20 and Figure 21).
Visual character and sensitivity of the area / surrounding views	**MEDIUM:** Views from the farmhouse are characteristic of a mostly natural environment with typical rural infrastructure present, such as wire fences, a garage building, telephone poles, water storage tanks and a windmill. The natural intact low shrub vegetation characteristic of the Karroo is prevalent in the surrounding environment.
Visual Contrast	**MEDIUM:** Where visible the PV plant would contrast with the natural earthly tones of the prevailing Karroo vegetation by creating a dark grey mass within the relatively uniform flat landscape. The existing Kronos Substation and associated power lines can be found to the northeast. These are relatively large vertical structures within the surrounding landscape. It must also be noted that a solar PV plant is currently being constructed near the Kronos Substation, approximately 4.3km from this farmstead to the north east. In addition, another solar energy facility is proposed to be constructed on an adjacent farm located approximately 3.5km south east of the house. The presence of these large structures in the area would further reduce the visual contrast of the proposed PV energy facility, should they both be constructed.
OVERALL IMPACT RATING	**MEDIUM**

Figure 21: Typical view of the development site from Klippan Pan Farmstead

Figure 22: Typical view of the development site from Klippan Pan Farmstead

Table 7: Visual impact of the Helena 1 solar PV plant site at Mierdam Farmstead (Coenie Viljoen)

VISUAL FACTOR	RATING
Distance of receptor away from proposed development	**LOW:** The receptor is located approximately 4.12km from the proposed Option 2 power line corridor alternative. As the receptor is located approximately 6.2km from the proposed PV development area, the impact of the PV energy facility will not be discussed.
Primary focus / orientation of receptor	**LOW:** The farmstead is orientated towards the north east. The proposed PV facility will be located in the north western direction from the house. This farmhouse is therefore not orientated towards the development. The "stoep" area of the house faces in the south eastern direction, away from the proposed development.
Presence of screening factors	**LOW:** A number of large trees surround the eastern, western and southern sides of the farmhouse. These trees, as well as shrubs and trees from the surrounding landscape, will provide some form of screening from the proposed PV facility. In addition, a "koppie" / low-rise to the north west (on the dirt road which leads to farmstead) will completely blocks out the view towards the development (Figure 23).
Visual character and sensitivity of the area / surrounding views	**MEDIUM:** The natural intact low shrub vegetation characteristic of the Karroo is prevalent in the surrounding environment. Views from the farmstead are mostly natural with typical rural or farming infrastructure present. Such infrastructure includes wire fences, windmills, telephone poles and existing Eskom power lines. It must be noted that the Kronos Substation can be found in the distance to the north of the house.
Visual Contrast	**MEDIUM:** The PV facility would contrast moderately with the pattern and form of the natural landscape elements. The surrounding environment is largely natural with a few linear elements present which include a number of trees around the house, telephone poles, large

	Eskom power lines, Kronos Substation to the north and fence poles. Where visible the PV panels would rise above the natural vegetation, and appear as dark grey mass or 'blanket' contrasting with the natural earthly tones of the prevailing Karroo vegetation. It must also be noted that a PV facility is currently being constructed approximately 5km from the house to the north (near Kronos Substation). In addition, another solar energy facility is proposed to be constructed on this farm to the north east of the house. The presence of these large structures in the area would further reduce the visual contrast of the proposed PV energy facility, should they both be constructed.
OVERALL IMPACT RATING	**LOW**

Figure 23: Typical view of the development site from Mierdam Farmstead

Figure 25: Typical view of the development site from Mierdam Farmstead

Figure 24: Mierdam Farmhouse

Figure 26: Typical view of the development site from Mierdam Farmstead

It should be noted that the landowner of the Klippan Farmstead would benefit financially from the proposed Helena 1 solar PV facility. The impact rating of the development is therefore not regarded as a realistic representation of the actual impact likely to be experienced at the receptor location. The visual impact is likely to be offset by the financial gains.

A summary of the above impact ratings are provided in Table 9 below.

Table 9: Visual impact of the proposed Helena 1 solar PV plant on sensitive receptors - summary and results

Receptor Location	Distance	Orientation	Screening	Character / Sensitivity	Contrast	OVERALL IMPACT RATING
Klipgat Pan Farmstead	Low (1)	Medium (2)	High (3)	Medium (2)	Medium (2)	**MEDIUM (10)**
Uitspan Pan Farmstead	Low (1)	Medium (2)	Medium (2)	Medium (2)	Medium (2)	**MEDIUM (9)**
Klippan Farmstead	Low (1)	High (3)	High (3)	Medium (2)	Medium (2)	**MEDIUM (11)**
Mierdam Farmstead	Low (1)	Low (1)	Low (1)	Medium (2)	Medium (2)	**LOW (7)**

5.2 Night-time Impacts

The visual impact of lighting on the nightscape is largely dependent on the existing lighting present in the surrounding area at night. The night scene in areas where there are numerous light sources will be visually degraded by the existing light pollution and therefore additional light sources are unlikely have a significant impact on the nightscape. In contrast, introducing light sources into a relatively dark night sky will impact on the visual quality of the area at night. It is thus important to identify a night-time visual baseline before exploring the potential visual impact of the proposed PV energy facility at night.

The area surrounding the proposed development site is largely uninhabited and as a result, very few light sources are present. The town of Prieska and the small mining town of Copperton are also too far away to have an impact on the night scene. At night, the study area is characterised by a picturesque dark starry sky and the visual character of the night environment is considered to be mostly 'unpolluted' and pristine. The most prominent light source within the study area at night is the security lighting at the Eskom Kronos Substation which, according to local farmers, can be seen from at least 7km away. Other sources of light are limited to, isolated lighting from the few surrounding farmsteads.

Security lighting at night will be required for the proposed PV energy facility. The type and intensity of lighting required was unknown at the time of writing this report and therefore the potential impact of the development at night has been discussed based on the general effect that additional light sources will have on the ambiance of the nightscape.

Although the area is not generally renowned as a tourist destination, the natural dark character of the nightscape will be sensitive to the impact of additional lighting at night, particularly from nearby farmhouses. The security lighting required for the proposed project is likely to intrude on the nightscape and create glare, which will contrast with the extremely dark backdrop of the surrounding area.

5.3 Visual Impacts of Associated Infrastructure

5.3.1 *Internal roads*

A network of gravel access roads will also be constructed to provide access to the PV panels. Roads are typically only associated with significant visual impacts if they traverse sloping ground on an aspect that is visible to the surrounding area. Considering the flat nature of the terrain on the site, it is likely that the visual impact associated with these roads would be limited to the impact of clearing the vegetation. However, if these roads are not maintained correctly during the construction phase, construction vehicles travelling along the gravel access roads could expose surrounding farmstead to dust plumes.

5.3.2 *Underground cabling*

The visual impact of the underground cabling would be very similar to roads in that the ‘scar’ associated with the cable could create a visual contrast with the largely natural vegetation on the site. However, as the PV panels are to be placed on flat terrain and there are no high ridges / high points on the proposed site, the visual impact of the cabling would be minimal. In spite of this it is strongly recommended that all reinstated cable trenches should be re-vegetated with indigenous vegetation with shallow root systems, in order to reduce the potential for creating unnatural linear features in the environment.

5.3.3 *Power Lines*

As mentioned above, two (2) alternative route corridors are being assessed to provide grid access from the proposed substation alternatives to the Eskom Kronos Substation (Figure 27). Power line corridor option 1 is aligned to follow the R357 gravel road and power line corridor option 2 is aligned to follow an existing 400kV power line (Figure 28).

Figure 27: View of the existing Eskom Kronos Substation

Figure 28: View of the existing power line and servitude which power line corridor option 2 is aligned to follow

Power lines are anthropogenic elements that are typically found in the landscape, both in urban or industrial and in more natural rural settings. The visual impact of a power line would largely be related to the physical characteristics of the area, land use and the spatial distribution of potential receptors. These factors are also important factors used to determine whether a power line would be congruent within an environment as the degree of visual contrast is generally based on the land use, settlement density, visual character and presence of existing power lines. When combining this with the distribution and likely value judgements of visual receptors, the visual impact of the proposed power line can be determined. In areas, where the power line would contrast with the surrounding area it may change the visual character of the landscape and be perceived negatively by visual receptors.

As mentioned above, the presence of other linear structures such as roads, railways and especially other power lines would influence the perception of whether a power line is a visual impact. Where existing power lines are present the visual environment would already be visually 'degraded' and thus the introduction of a new power line in this setting may be considered to be less of a visual impact than if no existing built infrastructure were visible.

The visual impact of the proposed power line alternatives in relation to the physical characteristics, land use, visual character, presence of visual receptors and existing power lines or other infrastructure in the surrounding landscape, are discussed in Table 10 below. These factors have been investigated in order to determine the degree to which the proposed power line alternatives would be visually compatible with the surrounding environment and to determine their overall visual impact.

Table 10: Visual assessment of the proposed power line route corridor alternatives in relation to surrounding environment

Physical and Land Use Characteristics	Visual Character	Visual Contrast	Presence of Visual Receptors	Overall Visual Impact
Topography: The power line would typically be highly visible due to the relatively flat terrain in the area. Localised topographical undulations, would offer minimal visual screening. **Vegetation:** The short nature of the natural shrubland vegetation would offer limited visual screening. **Land use:** The area is mainly used for sheep farming purposes with unimproved natural vegetation prevailing. The power line would contrast within this setting.	The area has a rural or pastoral character visual character. Built infrastructure is limited to isolated farmhouses, gravel access roads, farm boundary fences, several windmills, a high voltage power line which traverse the application site and the Eskom Kronos Substation.	Although the area is largely natural and the prevailing agricultural activities have left the vegetation mostly intact, the presence of the existing 400kV power line within power line corridor option 2 has introduced a distinct linear element into the landscape. As such, the addition of a power line which would either be aligned parallel to this power line (option 2) or be located to the north (option 1) of this power line would contrast moderately with the existing linear elements. The visual contrast would be slightly higher if the power line is constructed within corridor option 1. However the presence of the PV energy facility would lessen the visual contrast.	Potentially sensitive visual receptors within viewing distance (5km) from the power line corridor are limited to approximately four (4) scattered farmsteads. All of these farmsteads are located more than 2km from the power line corridors. From this distance the visibility of the power line would be significantly diminished.	Due to the limited number of visual receptors present within viewing distance from the proposed power line corridors and the fact that the alignments either run parallel to or in close proximity to an existing high voltage power line, the power line would result in a low visual impact.

5.3.4 *Substation*

A new substation (approximately 90m x 120m) is being proposed which will supply the generated electricity to the Eskom grid. In isolation, the substations may be considered to be visually intrusive; however, it must be assumed that if the substation would be built to serve the needs of the power generated from the PV energy facility. Thus the substation would only be constructed if the PV energy facility was developed as well. The substations would likely form part of the PV complex, as viewed from the surrounding farmsteads. Views of the substations would therefore be dwarfed by the large number of PV panels that would be visible. As such, the substations are not expected to be associated with a significant visual impact, or even a measurable cumulative impact.

5.4 Cumulative Impacts

Although it is important to assess the visual impacts of the proposed PV energy facility on its own, it is equally important to assess the cumulative visual impact that could materialise in the area should other renewable energy facilities (both wind and PV plants) be granted authorisation to proceed. Cumulative impacts are the impacts, which combine from different developments / facilities and result in significant impacts that may be larger than sum of all the impacts.

These renewable energy facilities and their potential for large scale visual impacts could significantly alter the sense of place and visual character in the study area, if constructed. The cumulative visual impact experienced by each visual receptor will depend on the number of proposed developments within a 5km radius from the receptor location, as beyond 5km the visual impact of the development would diminish to an insignificant level.

The renewable energy developments that are being proposed within a 5km radius from the receptor locations are indicated in Table 11 and Figure 29 below.

Table 11: Renewable energy developments proposed within a 5km radius from the receptor locations

Proposed Development	DEA Reference Number	Current Status of EIA	Proponent	Proposed Capacity	Farm Details
Helena 2 PV Energy Facility	14/12/16/3/3/2/766	EIA Underway	BioTherm Energy (Pty) Ltd	75MW	Ptn 3 of Farm Klipgats Pan 117
Helena 3 PV Energy Facility	14/12/16/3/3/2/767	EIA Underway	BioTherm Energy (Pty) Ltd	75MW	Ptn 3 of Farm Klipgats Pan 117
Mierdam Solar PV Facility	12/12/20/2320/2	Environmental Authorisation (EA) Issued	South Africa Mainstream Renewable Power Mierdam (Pty) Ltd	75MW	Portion 1 of Farm Kaffirs Kolk 118
Klipgats Pan PV Facility	12/12/20/2501	EA Issued (under construction)	Mulilo Renewable Energy	100MW	Ptn 4 of Farm Klipgats Pan 117

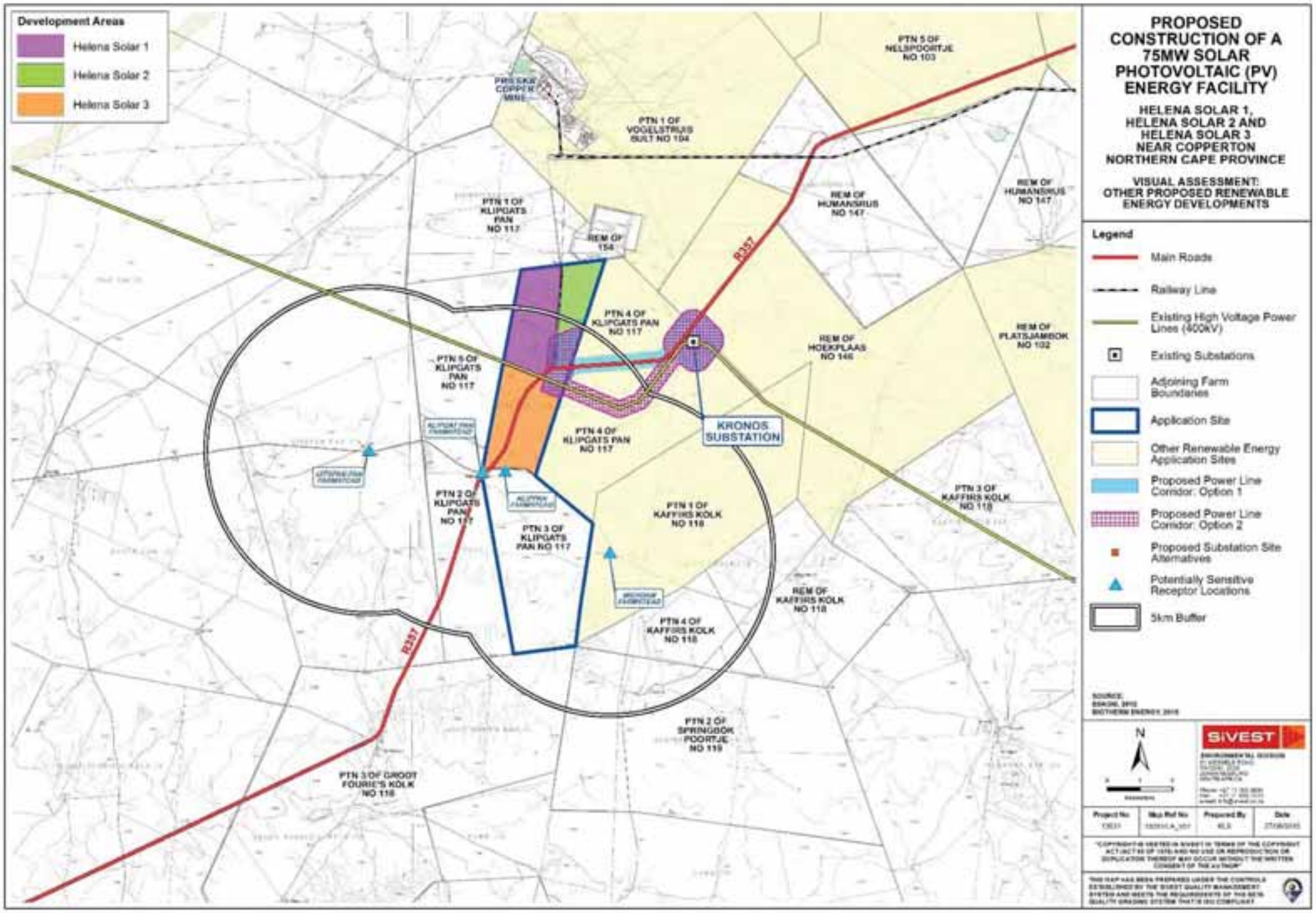

Figure 29: Renewable energy facilities proposed within a 5km radius from the potentially sensitive receptor locations

The number of proposed developments that each receptor would be visually exposed to (i.e. the cumulative impact experienced at each location) is indicated in Table 12 below. It should be noted that the impact on each receptor location is indicative of the 'worst case' scenario which assumes that all of the proposed facilities would be developed.

Key

Likely to be visually exposed to the proposed development (within viewing distance)
Limited visual exposure to the proposed development (not within viewing distance)

Table 12: Cumulative visual impact on potentially sensitive receptors

Potentially Sensitive Visual Receptors	Helena 2 PV Energy Facility	Helena 3 PV Energy Facility	Mierdam Solar PV Facility	Klipgats Pan PV Facility
Klipgat Pan Farmstead	√	√	√	√
Uitspan Pan Farmstead		√		
Klippan Farmstead	√	√	√	√
Mierdam Farmstead		√	√	√

As indicated in the table above, the greatest cumulative impact will be experienced from the main dwellings on Klipgat Pan Farmstead and Klippan Farmstead as they could be visually exposed to four additional proposed PV energy facilities should they all be constructed. As mentioned above, the landowner of the Klippan Farmstead would benefit financially from the proposed Helena 1, 2 and 3 solar PV facilities. This would likely offset the cumulative visual impact experienced by the landowner as it would reduce any negative sentiments towards the PV developments. Although the landowner of Mierdam Farmstead could be visually exposed to three additional proposed PV energy facilities, they would benefit financially from the proposed Mierdam Solar PV Facility if constructed, thus also reduce their negative sentiments towards the proposed PV developments.

5.5 Overall Visual Impact Rating

The EIA requires that an overall rating for visual impact be provided to allow the visual impact to be assessed alongside other environmental parameters. SiVEST has developed an impact rating matrix for this purpose. The tables below present the impact matrix for visual impacts associated with the proposed construction and operation of the PV energy facility and the associated infrastructure.

Please refer to Appendix A below for an explanation of the impact rating methodology.

5.5.1 *Planning*

No visual impacts are expected during planning.

5.5.2 *Construction*

Table 13: Rating of visual impacts of the proposed Helena 1 PV energy facility during construction

IMPACT TABLE		
Environmental Parameter	Visual Impact	
Issue/Impact/Environmental Effect/Nature	Large construction vehicles and equipment during the construction phase will alter the natural character of the study area and expose visual receptors to visual impacts associated with the construction phase. The construction activities may be perceived as an unwelcome visual intrusion, particularly in more natural undisturbed settings.	
Extent	Local / District (2)	
Probability	Probable (3)	
Reversibility	Completely reversible (1)	
Irreplaceable loss of resources	No loss (1)	
Duration	Short term (1)	
Cumulative effect	Medium cumulative effects (3)	
Intensity/magnitude	Medium (2)	
Significance Rating	**Prior to mitigation measures:** Low negative impact **After mitigation measures:** Low negative impact	
	Pre-mitigation impact rating	Post mitigation impact rating
Extent	2	2
Probability	3	2
Reversibility	1	1
Irreplaceable loss	1	1
Duration	1	1

Cumulative effect	3	3
Intensity/magnitude	2	2
Significance rating	-22 (negative low)	-20 (negative low)
Mitigation measures	▪ Carefully plan to reduce the construction period. ▪ Minimise vegetation clearing and rehabilitate cleared areas as soon as possible. ▪ Maintain a neat construction site by removing rubble and waste materials regularly. ▪ Make use of existing gravel access roads where possible. ▪ Ensure that dust suppression techniques are implemented on all access roads.	

** Please note in the context of the visual environment 'resources' are defined as scenic / natural views that are almost impossible to replace.*

Table 14: Rating of visual impacts of the infrastructure associated with the Helena 1 PV energy facility during construction

IMPACT TABLE	
Environmental Parameter	Visual Impact
Issue/Impact/Environmental Effect/Nature	Large construction vehicles and equipment during the construction of the proposed power line, substation, access road and building infrastructure could exert a visual impact by altering the visual character of the surrounding area and exposing sensitive visual receptor locations to visual impacts associated with the construction phase. The construction activities may be perceived as an unwelcome visual intrusion, particularly in more natural undisturbed settings.
Extent	Local/district (2)
Probability	Probable (3)
Reversibility	Completely reversible (1)
Irreplaceable loss of resources	No loss (1)
Duration	Short term (1)
Cumulative effect	Medium cumulative effects (3)
Intensity/magnitude	Medium (2)

Significance Rating	**Prior to mitigation measures:** Low negative impact **After mitigation measures:** Low negative impact	
	Pre-mitigation impact rating	Post mitigation impact rating
Extent	2	2
Probability	3	2
Reversibility	1	1
Irreplaceable loss	1	1
Duration	1	1
Cumulative effect	3	3
Intensity/magnitude	2	2
Significance rating	-22 (low negative)	-20 (low negative)
Mitigation measures	▪ All reinstated cable trenches should be re-vegetated with the same vegetation that existing prior to the cable being laid. ▪ Carefully plan to reduce the construction period. ▪ Minimise vegetation clearing and rehabilitate cleared areas as soon as possible. ▪ Maintain a neat construction site by removing rubble and waste materials regularly. ▪ Make use of existing gravel access roads where possible.	

** Please note in the context of the visual environment 'resources' are defined as scenic / natural views that are almost impossible to replace.*

5.5.3 *Operation*

Table 15: Rating of visual impacts of the proposed Helena 1 PV energy facility during operation

IMPACT TABLE	
Environmental Parameter	Visual Impact
Issue/Impact/Environmental Effect/Nature	The proposed PV energy facility could exert a visual impact by altering the visual character of the surrounding area and exposing sensitive visual receptor locations to visual impacts. The development may be perceived as an unwelcome visual intrusion, particularly in more natural undisturbed settings.
Extent	Local/district (2)
Probability	Definite (4)

Reversibility	Irreversible (4)	
Irreplaceable loss of resources	Marginal (2)	
Duration	Long term (3)	
Cumulative effect	Medium cumulative effects (3)	
Intensity/magnitude	Medium (2)	
Significance Rating	**Prior to mitigation measures:** Medium negative impact **After mitigation measures:** Medium negative impact	
	Pre-mitigation impact rating	Post mitigation impact rating
Extent	2	2
Probability	4	4
Reversibility	4	4
Irreplaceable loss	2	2
Duration	3	3
Cumulative effect	3	3
Intensity/magnitude	2	2
Significance rating	-36 (medium negative)	-36 (medium negative)
Mitigation measures	▪ Light fittings for security at night should reflect the light toward the ground and prevent light spill.	

** Please note in the context of the visual environment 'resources' are defined as scenic / natural views that are almost impossible to replace.*

Table 16: Rating of visual impacts of the infrastructure associated with the Helena 1 PV energy facility during operation

IMPACT TABLE	
Environmental Parameter	Visual Impact
Issue/Impact/Environmental Effect/Nature	The proposed power line, substation, access roads and building infrastructure could exert a visual impact by altering the visual character of the surrounding area and exposing sensitive visual receptors to visual impacts. The development may be perceived as an unwelcome visual intrusion, particularly in more natural undisturbed settings.
Extent	Local / District (2)
Probability	Possible (2)

Reversibility	Irreversible (4)	
Irreplaceable loss of resources	Marginal loss of resources (2)	
Duration	Long term (3)	
Cumulative effect	Low cumulative impact (1)	
Intensity/magnitude	Medium (2)	
Significance Rating	**Prior to mitigation measures:** Medium negative impact **After mitigation measures:** Low negative impact	
	Pre-mitigation impact rating	Post mitigation impact rating
Extent	2	2
Probability	2	2
Reversibility	4	4
Irreplaceable loss	2	2
Duration	3	3
Cumulative effect	1	1
Intensity/magnitude	2	1
Significance rating	-28 (low negative)	-14 (low negative)
Mitigation measures	▪ Light fittings for security at the proposed substation at night should reflect the light toward the ground and prevent light spill. ▪ The operations and maintenance buildings should not be illuminated at night. ▪ Align the power line to run parallel to existing power lines and other linear impacts, where possible. ▪ Bury cables under the ground where possible. ▪ The operation and maintenance building should be painted with natural tones that fit with the surrounding environment. Non-reflective surfaces should be utilised where possible. ▪ Select the alternatives that will have the least impact on visual receptors (refer to Table 17 below).	

** Please note in the context of the visual environment 'resources' are defined as scenic / natural views that are almost impossible to replace.*

5.5.4 *Decommissioning*

Visual impacts during the decommissioning phase are potentially similar to those during the construction phase.

6 COMPARATIVE ASSESSMENT OF ALTERNATIVES

As described above two (2) substation site alternatives, two (2) internal road alternatives and two (2) power line corridor alternatives were are being investigated.

The preference rating for each alternative is provided in Table **17** below. The alternatives are rated as being either preferred (the alternative will result in a low visual impact / reduce the visual impact), not-preferred (the alternative will result in relatively high visual impact / increase the visual impact), favourable (the visual impact will be relatively insignificant) and no-preference (each alternative would result in an equal visual impact).

The degree of visual impact and rating has been determined based on the following factors:

- The alignment of the power line in relation to existing power lines or other infrastructure, linear impacts or cut lines;
- The alignment of the power line / location of the roads or substation site in relation to areas of high elevation, especially ridges, koppies or hills;
- The alignment of the power line / location of the roads or substation site from sensitive receptor locations;
- The alignment of the power line / location of the roads or substation site in relation to areas of natural bushveld vegetation (clearing site for the development / a strip of vegetation under the power line servitude worsens the visibility).

Key

PREFERRED	The alternative will result in a low impact / reduce the impact
FAVOURABLE	The impact will be relatively insignificant
NOT PREFERRED	The alternative will result in a high impact / increase the impact
NO PREFERENCE	The alternative will result in equal impacts

Table 17: Comparative Assessment of Alternatives

Alternative	Preference	Reasons
SUBSTATION		

Alternative	Preference	Reasons
Substation Site Alternative 1 Substation Site Alternative 2	No Preference	Both alternative sites are located on flat terrain in an area dominated low shrubs. All the potentially sensitive receptor locations are located more than 2km from the site alternatives within the low impact zone.
INTERNAL ROADS		
Internal Road Alternative 1 Internal Road Alternative 2	No Preference	Both alternative road layouts are located on flat terrain in an area dominated low shrubs. All the potentially sensitive receptor locations are located more than 2km from the road layouts within the low impact zone.
POWER LINES		
Power Line Corridor Alternative 1	Favourable	The corridor is aligned parallel to an existing gravel road, in an area where the terrain is mostly flat. All the potentially sensitive receptor locations are located more than 2km from the power line corridor within the low impact zone.
Power Line Corridor Alternative 2	Preferred	The corridor is aligned parallel to an existing 400kV power line, in an area where the terrain is mostly flat. All the potentially sensitive receptor locations are located more than 2km from the power line corridor within the low impact zone.

7 CONCLUSIONS

The Visual Impact Assessment conducted for the proposed PV energy facility and associated infrastructure has demonstrated that much of the study area has a rural visual character and is not valued for its tourism significance. It was ascertained that due to the limited human habitation in the surrounding area, very few sensitive receptors are present in the study area and the proposed development would have a medium impact on most of these receptors. The assessment revealed that overall the proposed PV energy facility would have a low visual impact during construction and a medium visual impact during operation, with very few mitigation measures available. The associated infrastructure would have a low visual impact during construction and operation. The substation, internal road and power line corridor alternatives were comparatively assessed. It was established that there is no preference for the substation site and internal road alternatives, but Alternative 2 is preferred from a visual perspective for the power line. Overall it can be concluded that although the visual impact of the PV energy facility would be reduced due to the lack of visual receptors present, the facility does not correspond with the typical land use and would visually contrast with the natural earthly tones of the prevailing Karroo vegetation by creating a dark grey mass within the relatively uniform flat landscape.

8 REFERENCES

- Breedlove, G., 2002. A systematic for the South African Cultural Landscapes with a view to implementation. Thesis – University of Pretoria.

- Geoterraimage. 2015. 2013 – 2014 South African National Land-Cover Dataset: Data User Report and MetaData.

- Moseley,S., and Naude-Moseley,B., 2008. Getaway Guide to the Karoo, Namaqualand and Kalahari, Sunbird.

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

- Oberholzer, B. 2005. Guideline for involving visual & aesthetic specialists in EIA processes: *Edition 1.* CSIR Report No ENV-S-C 2005 053 F. Republic of South Africa, Provincial Government of the Western Cape, Department of Environmental Affairs & Development Planning, Cape Town.

- Treasure Karoo Action Group website: http://treasurethekaroo.co.za/

- UNESCO. 2005. Operational Guidelines for the Implementation of the World Heritage Convention. UNESCO World Heritage Centre. Paris.

Appendix A

IMPACT RATING METHODOLOGY

IMPACT RATING METHODOLOGY

The determination of the effect of an environmental impact on an environmental parameter (in this instance, wetlands) is determined through a systematic analysis of the various components of the impact. This is undertaken using information that is available to the environmental practitioner through the process of the environmental impact assessment. The impact evaluation of predicted impacts was undertaken through an assessment of the significance of the impacts.

Determination of Significance of Impacts

Significance is determined through a synthesis of impact characteristics which include context and intensity of an impact. Context refers to the geographical scale (i.e. site, local, national or global) whereas intensity is defined by the severity of the impact (e.g. the magnitude of deviation from background conditions, the size of the area affected, the duration of the impact and the overall probability of occurrence). Significance is calculated as per the example shown in Table ?.

Significance is an indication of the importance of the impact in terms of both physical extent and time scale, and therefore indicates the level of mitigation required. The total number of points scored for each impact indicates the level of significance of the impact.

Impact Rating System Methodology

Impact assessments must take account of the nature, scale and duration of effects on the environment whether such effects are positive (beneficial) or negative (detrimental). Each issue / impact is usually assessed according to the project stages:

- planning
- construction
- operation
- decommissioning

In this case, a unique situation is present whereby various scenarios have been posed and evaluated accordingly. A brief discussion of the impact and the rationale behind the assessment of its significance has also been included.

Rating System Used To Classify Impacts

The rating system is applied to the potential impact on the receiving environment and includes an objective evaluation of the mitigation of the impact. Impacts have been consolidated into one rating. In assessing the significance of each issue, the following criteria (including an allocated point system) is used:

Table 1. Example of the significance impact rating table.

NATURE		
Includes a brief description of the impact of environmental parameter being assessed in the context of the project. This criterion includes a brief written statement of the environmental aspect being impacted upon by a particular action or activity.		
GEOGRAPHICAL EXTENT		
This is defined as the area over which the impact will be expressed. Typically, the severity and significance of an impact have different scales and as such bracketing ranges are often required. This is often useful during the detailed assessment of a project in terms of further defining the determined.		
1	Site	The impact will only affect the site
2	Local/district	Will affect the local area or district
3	Province/region	Will affect the entire province or region
4	International and National	Will affect the entire country
PROBABILITY		
This describes the chance of occurrence of an impact		
1	Unlikely	The chance of the impact occurring is extremely low (Less than a 25% chance of occurrence).
2	Possible	The impact may occur (Between a 25% to 50% chance of occurrence).
3	Probable	The impact will likely occur (Between a 50% to 75% chance of occurrence).
4	Definite	Impact will certainly occur (Greater than a 75% chance of occurrence).
REVERSIBILITY		
This describes the degree to which an impact on an environmental parameter can be successfully reversed upon completion of the proposed activity.		
1	Completely reversible	The impact is reversible with implementation of minor mitigation measures
2	Partly reversible	The impact is partly reversible but more intense mitigation measures are required.
3	Barely reversible	The impact is unlikely to be reversed even with intense mitigation measures.
4	Irreversible	The impact is irreversible and no mitigation measures exist.

IRREPLACEABLE LOSS OF RESOURCES		
This describes the degree to which resources will be irreplaceably lost as a result of a proposed activity.		
1	No loss of resource.	The impact will not result in the loss of any resources.
2	Marginal loss of resource	The impact will result in marginal loss of resources.
3	Significant loss of resources	The impact will result in significant loss of resources.
4	Complete loss of resources	The impact is result in a complete loss of all resources.
DURATION		
This describes the duration of the impacts on the environmental parameter. Duration indicates the lifetime of the impact as a result of the proposed activity		
1	Short term	The impact and its effects will either disappear with mitigation or will be mitigated through natural process in a span shorter than the construction phase (0 – 1 years), or the impact and its effects will last for the period of a relatively short construction period and a limited recovery time after construction, thereafter it will be entirely negated (0 – 2 years).
2	Medium term	The impact and its effects will continue or last for some time after the construction phase but will be mitigated by direct human action or by natural processes thereafter (2 – 10 years).
3	Long term	The impact and its effects will continue or last for the entire operational life of the development, but will be mitigated by direct human action or by natural processes thereafter (10 – 50 years).
4	Permanent	The only class of impact that will be non-transitory. Mitigation either by man or natural process will not occur in such a way or such a time span that the impact can be considered transient (Indefinite).
CUMULATIVE EFFECT		
This describes the cumulative effect of the impacts on the environmental parameter. A cumulative effect/impact is an effect which in itself may not be significant but may become significant if added to other existing or potential impacts emanating from other similar or diverse activities as a result of the project activity in question.		
1	Negligible Cumulative Impact	The impact would result in negligible to no cumulative effects
2	Low Cumulative Impact	The impact would result in insignificant cumulative effects
3	Medium Cumulative impact	The impact would result in minor cumulative effects
4	High Cumulative Impact	The impact would result in significant cumulative effects

INTENSITY / MAGNITUDE		
Describes the severity of an impact		
1	Low	Impact affects the quality, use and integrity of the system/component in a way that is barely perceptible.
2	Medium	Impact alters the quality, use and integrity of the system/component but system/ component still continues to function in a moderately modified way and maintains general integrity (some impact on integrity).
3	High	Impact affects the continued viability of the system/component and the quality, use, integrity and functionality of the system or component is severely impaired and may temporarily cease. High costs of rehabilitation and remediation.
4	Very high	Impact affects the continued viability of the system/component and the quality, use, integrity and functionality of the system or component permanently ceases and is irreversibly impaired (system collapse). Rehabilitation and remediation often impossible. If possible rehabilitation and remediation often unfeasible due to extremely high costs of rehabilitation and remediation.
SIGNIFICANCE		
Significance is determined through a synthesis of impact characteristics. Significance is an indication of the importance of the impact in terms of both physical extent and time scale, and therefore indicates the level of mitigation required. This describes the significance of the impact on the environmental parameter. The calculation of the significance of an impact uses the following formula: **(Extent + probability + reversibility + irreplaceability + duration + cumulative effect) x magnitude/intensity.** The summation of the different criteria will produce a non weighted value. By multiplying this value with the magnitude/intensity, the resultant value acquires a weighted characteristic which can be measured and assigned a significance rating.		
Points	**Impact Significance Rating**	**Description**
6 to 28	Negative Low impact	The anticipated impact will have negligible negative effects and will require little to no mitigation.
6 to 28	Positive Low impact	The anticipated impact will have minor positive effects.

29 to 50	Negative Medium impact	The anticipated impact will have moderate negative effects and will require moderate mitigation measures.
29 to 50	Positive Medium impact	The anticipated impact will have moderate positive effects.
51 to 73	Negative High impact	The anticipated impact will have significant effects and will require significant mitigation measures to achieve an acceptable level of impact.
51 to 73	Positive High impact	The anticipated impact will have significant positive effects.
74 to 96	Negative Very high impact	The anticipated impact will have highly significant effects and are unlikely to be able to be mitigated adequately. These impacts could be considered "fatal flaws".
74 to 96	Positive Very high impact	The anticipated impact will have highly significant positive effects.

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23 October 2015
489025/ALLK/1510050

Ms. A. Gibb
SiVEST
PO Box 2921
Rivonia
2128

Attention: Ms. A. Gibb

Dear Ms. Gibb

Peer review of the Proposed Construction of the Helena 1 Solar Photovoltaic (PV) Energy Facility near Copperton, Northern Cape Province – Visual Impact Assessment

SiVEST Report: 13031

SiVEST (Pty) Ltd. (SiVEST) is undertaking an Environmental Impact Assessment (EIA) for the construction of the proposed Helena 1 solar photovoltaic (PV) energy facility near Copperton in the Northern Cape Province. As part of the EIA process, a Visual Impact Assessment (VIA) was commissioned. Due to SiVEST acting as the Environmental Impact Practitioner for the BA, as well as conducting the VIA, an external peer review of the VIA was required.

This letter constitutes the peer review conducted by SRK Consulting (South Africa) (Pty) Ltd. (SRK)

Summary of Review

It must be noted, that this review was focussed primarily on the content of the SiVEST VIA Report, and did not focus on formatting or grammatical errors. Some recommendations for grammatical review have however been made in the final report review.

SRK is of the opinion that the VIA Report, compiled by SiVEST is fair and that the methodology used was open and well stated. There is a heavy focus on potential sensitive viewers, with care taken to attempt to identify which sensitive viewers would likely be affected.

Some additional recommendations for improving the report were identified during the review process. These are listed below:

- The report contains some duplication of statements; these have been highlighted in the text of reviewed document.
- In terms of describing the visual character of the area, insights have been made to describe facilities that are yet to be developed. If these facilities are constructed before Helena 1, then these facilities will alter the baseline. If however Helena 1 is constructed prior to these facilities, then Helena 1 will alter the baseline for these facilities. This section has been noted in the text.
- Recommendations for additional mitigation measures have been included in the text.

Additional comments on the report have been compiled in a Word Document submitted to SiVEST on 23 October 2015 (SRK Report: 489025_SRK_Helena 1_VIAReview_20151023).

Should you have any queries regarding the review or comments made in the reviewed document, please do not hesitate to contact Mr. Keagan Allan, SRK (031 279 1200).

Yours faithfully,

SRK Consulting (South Africa) (Pty) Ltd

K. Allan (Pr. Sci. Nat)
Senior GIS Specialist

A.A. Smithen (Pr. Eng.)
Partner

Appendix 6F:

Heritage and Palaeontology Assessment

BIOTHERM ENERGY (PTY) LTD

PROPOSED CONSTRUCTION OF THE HELENA 1 SOLAR PHOTOVOLTAIC (PV) ENERGY FACILITY NEAR COPPERTON, NORTHERN CAPE PROVINCE

Heritage Assessment Report

Issue Date: 31 July 2015
Revision No.: 1
Project No.: 13031

Date:	31 07 2015
Document Title:	Heritage Assessment Report
Author:	Wouter Fourie
Revision Number:	1
Checked by:	Lynsey Rimbault, SiVEST
For:	SiVEST Environmental Division

Executive Summary

PGS Heritage was appointed by SiVEST Environmental Division to undertake a Heritage Impact Assessment (HIA) Study that forms part of the Environmental Impact Assessment (EIA) and Environmental Management Plan (EMP) for the proposed development of Helena 1 Solar 75MW solar photovoltaic (PV) energy facilities near Copperton, Northern Cape Province.

Heritage resources are unique and non-renewable and as such any impact on such resources must be seen as significant.

The Heritage Scoping Report has shown that the proposed Helena Solar projects may have heritage resources present on the property. This has been confirmed through archival research and evaluation of aerial photography of the sites.

Evaluation of aerial photography has indicated the following area that may be sensitive from an archaeological perspective (**Figure 9**). The analysis of the studies conducted in the area assisted in the development of the following landform type to heritage find matrix in **Table 4**.

Table 1: Landform to heritage matrix

LAND FROM TYPE	HERITAGE TYPE
Crest and foot hill	LSA and MSA scatters
Crest of small hills	Small LSA sites – scatters of stone artefacts, ostrich eggshell, pottery and beads
Pans	Dense LSA sites
Dunes	Dense LSA sites
Outcrops	Occupation sites dating to LSA, MSA and ESA
Farmsteads	Historical archaeological material

The fieldwork that covered the Helena 1 Solar site as well as the proposed power line corridors covered approximately 45km in total with an evaluation field of 20 meters for small finds (10 meters either side of the archaeologist) and 100 meters for larger finds such as marked cemeteries and historical structures (50 meters either side of the archaeologist).

A total of a 116 find spots were logged of which 13 (9 in proposed power line corridors and 4 in Helena 1 footprint area) can be described as archaeological sites.

1.1 Find spots

A total of 103 findspots were marked over the extent of the fieldwork. The findspots were mostly characterised by three types of setting, deflated red sands, and exposed pebble concentrations associated with a calcrete exposure and non-deflated red sand exposures in between low-density vegetation.

The findspots varied from Later Stone Age (LSA) scatters consisting of flakes, chips and some cores manufactured from fine-grained quartzite, chalcedony, and cryptocrystalline (ccs) material; Middle Stones Age (MSA) lithics consisting of cores, chips and flakes with a low occurrence of formal tools. The majority of the material utilised were either lideanite that occur in the form of medium sized boulders or round washed pebbles in the area or coarse-grained quartzite that occur as sporadic outcrops.

Earlier Stone Age (ESA) lithics found at some of these finds spots consisted of hand axes, cleavers and large flakes. Most of the lithics were either rolled or heavily weathered with patination evident on 95% of the lithics.

All these site have a low significance, however the possibility of subsurface deposits cannot be discounted and was kept in mind with the development of the mitigation recommendations.

Mitigation:

- The final alignment and pylon positions of the power line needs to be walked down and heritage features demarcated;
- Where required the sites identified during the walkdown will then need mitigation measures developed that will need to be completed before construction can commence;
- Such mitigation measures will require a permit from SAHRA before mitigation can be done as well as a final destruction permit on completion of the mitigation work.

Due to the large amount of Stone Age material present on site it is recommended that an archaeologist be appointed to monitor construction activity as part of a watching brief. The aim being the identification and mitigation of any newly discovered sites.

1.2 Sites

During the fieldwork 13 archaeological sites were identified of which all were archaeological sites representing the Earlier, Middle and Later Stone Age. The sites are all rated as having local heritage significance. Al the sites will require mitigation prior to construction.

Power line sites - *Mitigation:*

- The final alignment and pylon positions of the power line needs to be walked down and heritage features demarcated;
- Where required these site will then need mitigation measures developed that will need to be completed before construction can commence;
- Such mitigation measures will require a permit from SAHRA before mitigation can be done as well as a final destruction permit on completion of the mitigation work.

PV footprint - *Mitigation:*

- All four site will require mitigation work before construction can commence
- The mitigation work will be at a minimum:
    - a controlled surface collection of the material,
    - test excavations at site 034 and 046,;
    - analysis of material and final report;
- Such mitigation measures will require a permit from SAHRA before mitigation can be done as well as a final destruction permit on completion of the mitigation work.

Due to the large amount of Stone Age material present on site it is recommended that an archaeologist be appointed to monitor construction activity as part of a watching brief. The aim being the identification and mitigation of any newly discovered sites.

1.3 Impact Summary

Table 14 provides a summary of the projected impact rating for this project on heritage resources.

Table 2: Comparison of summarised impacts on environmental parameters

Environmental parameter	Issues	Rating prior to mitigation	Average	Rating post mitigation	Average
Heritage resources	Impact during construction	51		24	
			High Negative Impact		Low Negative Impact

1.4 Comparative Assessment for Helena Solar 1

Key

PREFERRED	The alternative will result in a low impact / reduce the impact
FAVOURABLE	The impact will be relatively insignificant
NOT PREFERRED	The alternative will result in a high impact / increase the impact
NO PREFERENCE	The alternative will result in equal impacts

Alternative	Preference	Reasons
SUBSTATION		
Substation Site Alternative 1	NO PREFERENCE	No heritage resources identified
Substation Site Alternative 2	NO PREFERENCE	No heritage resources identified

Alternative	Preference	Reasons
INTERNAL ROADS		
Internal Road Alternative 1	NOT PREFERRED	Some heritage resources identified close by
Internal Road Alternative 2	PREFERRED	No resources identified in close vicinity
POWER LINES		
Power Line Corridor Alternative 1	FAVOURABLE	More heritage sites identified in this corridor
Power Line Corridor Alternative 2	PREFERRED	Less heritage sites identified in this corridor

BIOTHERM ENERGY (PTY) LTD

HERITAGE ASSESSMENT REPORT

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Appendices

A: LEGISLATIVE PRINCIPLES
B: HERITAGE IMPACT ASSESSMENT METHODOLOGY
C: IMPACT ASSESSMENT MATRIX
D: HERITAGE MAPS

1 INTRODUCTION

PGS Heritage was appointed by SiVEST Environmental Division to undertake a Heritage Impact Assessment (HIA) Study that forms part of the Environmental Impact Assessment (EIA) and Environmental Management Plan (EMP) for the proposed development of Helena 1 Solar 75MWsolar photovoltaic (PV) energy facilities near Copperton, Northern Cape Province.

1.1 Scope of the Study

The aim of the study is to identify possible heritage sites, finds and sensitive areas that may occur in the study area for the EIA study. The Heritage Impact Assessment (HA) aims to inform the Environmental Impact Assessment in the development of a comprehensive Environmental Management Plan to assist the developer in managing the discovered heritage resources in a responsible manner, in order to protect, preserve, and develop them within the framework provided by the National Heritage Resources Act of 1999 (Act 25 of 1999) (NHRA).

1.2 Specialist Qualifications

PGS Heritage (PGS) compiled this Heritage Impact Assessment Report.

The staff at PGS has a combined experience of nearly 70 years in the heritage consulting industry. PGS and its staff have extensive experience in managing the HIA processes. PGS will only undertake heritage assessment work where they have the relevant expertise and experience to undertake that work competently.

Wouter Fourie, Project manager for this project, is registered as a Professional Archaeologist with the Association of Southern African Professional Archaeologists (ASAPA) and has CRM accreditation within the said organisation, as well as being accredited as a Professional Heritage Practitioner with the Association of Professional Heritage Practitioners – Western Cape (APHP).

1.3 Assumptions and Limitations

Not detracting in any way from the fieldwork undertaken, it is necessary to realise that the heritage sites located during the fieldwork do not necessarily represent all the heritage sites present within the area. Should any heritage features or objects not included in the inventory be located or observed, a heritage specialist must immediately be contacted. Such observed or located heritage features and/or objects may not be disturbed or removed in any way, until such time that the heritage specialist has been able to make an assessment as to the significance of the site (or material) in question. This applies to graves and cemeteries as well.

The survey was conducted over 3 days over the extent of the total footprint area. It must be stressed that the extent of the fieldwork was based on the available field time and was aimed at determining the heritage character of the area.

The fieldwork that covered the Helena 1 Solar site as well as the proposed power line corridors covered approximately 45km in total with an evaluation field of 20 meters for small finds (10 meters either side of the archaeologist) and 100 meters for larger finds such as marked cemeteries and historical structures (50 meters either side of the archaeologist).

1.4 Legislative Context

The identification, evaluation and assessment of any cultural heritage site, artefact or find in the South African context is required and governed by the following legislation:

i. National Environmental Management Act (NEMA), Act 107 of 1998
ii. National Heritage Resources Act (NHRA), Act 25 of 1999
iii. Mineral and Petroleum Resources Development Act (MPRDA), Act 28 of 2002

The following sections in each Act refer directly to the identification, evaluation and assessment of cultural heritage resources.

i. National Environmental Management Act (NEMA) Act 107 of 1998
   a. Basic Environmental Assessment (BEA) – Section (23)(2)(d)
   b. Environmental Scoping Report (ESR) – Section (29)(1)(d)
   c. Environmental Impact Assessment (EIA) – Section (32)(2)(d)
   d. Environmental Management Plan (EMP) – Section (34)(b)
ii. National Heritage Resources Act (NHRA) Act 25 of 1999
   a. Protection of Heritage Resources – Sections 34 to 36; and
   b. Heritage Resources Management – Section 38
iii. Mineral and Petroleum Resources Development Act (MPRDA) Act 28 of 2002
   a. Section 39(3)

The NHRA stipulates that cultural heritage resources may not be disturbed without authorization from the relevant heritage authority. Section 34(1) of the NHRA states that, "no person may alter or demolish any structure or part of a structure which is older than 60 years without a permit issued by the relevant provincial heritage resources authority…". The NHRA is utilized as the basis for the identification, evaluation and management of heritage resources and in the case of CRM those resources specifically impacted on by development as stipulated in Section 38 of NHRA, and those developments administered through NEMA, MPRDA legislation. In the latter cases, the feedback from the relevant heritage resources authority is required by the State and Provincial Departments managing these Acts before any authorizations are granted for development. The last few years have seen a significant change towards the inclusion of heritage assessments as a major component of Environmental Impacts Processes required by NEMA and MPRDA. This change requires us to evaluate the Sections of these Acts relevant to heritage (Fourie, 2008).

The NEMA 23(2)(b) states that an integrated environmental management plan should, "…identify, predict and evaluate the actual and potential impact on the environment, socio-economic conditions and cultural heritage".

A study of subsections (23)(2)(d), (29)(1)(d), (32)(2)(d) and (34)(b) and their requirements reveals the compulsory inclusion of the identification of cultural resources, the evaluation of the impacts of the proposed activity on these resources, the identification of alternatives and the management procedures for such cultural resources for each of the documents noted in the Environmental Regulations. A further important aspect to be taken account of in the Regulations under NEMA is the Specialist Report requirements laid down in Section 33 of the regulations (Fourie, 2008).

Refer to **Appendix A** for further discussions on heritage management and legislative frameworks

1.5 Terminology

Archaeological resources

This includes:

i. material remains resulting from human activity which are in a state of disuse and are in or on land and which are older than 100 years including artefacts, human and hominid remains and artificial features and structures;

ii. rock art, being any form of painting, engraving or other graphic representation on a fixed rock surface or loose rock or stone, which was executed by human agency and which is older than 100 years, including any area within 10m of such representation;

iii. wrecks, being any vessel or aircraft, or any part thereof, which was wrecked in South Africa, whether on land, in the internal waters, the territorial waters or in the maritime culture zone of the republic as defined in the Maritimes Zones Act, and any cargo, debris or artefacts found or associated therewith, which is older than 60 years or which SAHRA considers to be worthy of conservation;

iv. features, structures and artefacts associated with military history, which are older than 75 years and the site on which they are found.

Cultural significance

This means aesthetic, architectural, historical, scientific, social, spiritual, linguistic or technological value or significance

Development

This means any physical intervention, excavation, or action, other than those caused by natural forces, which may in the opinion of the heritage authority in any way result in a change to the nature, appearance or physical nature of a place or influence its stability and future well-being, including:

i. construction, alteration, demolition, removal or change in use of a place or a structure at a place;
ii. carrying out any works on or over or under a place;
iii. subdivision or consolidation of land comprising a place, including the structures or airspace of a place;
iv. constructing or putting up for display signs or boards;
v. any change to the natural or existing condition or topography of land; and
vi. any removal or destruction of trees, or removal of vegetation or topsoil

Early Stone Age

The archaeology of the Stone Age, between 700 000 and 2 500 000 years ago.

Fossil

Mineralised bones of animals, shellfish, plants and marine animals. A trace fossil is the track or footprint of a fossil animal that is preserved in stone or consolidated sediment.

Heritage

That which is inherited and forms part of the National Estate (historical places, objects, fossils as defined by the National Heritage Resources Act 25 of 1999).

Heritage resources

This means any place or object of cultural significance, such as the caves with archaeological deposits identified close to both development sites for this study.

Holocene

The most recent geological time period which commenced 10 000 years ago.

Late Stone Age

The archaeology of the last 20 000 years associated with fully modern people.

Late Iron Age (Early Farming Communities)

The archaeology of the last 1000 years up to the 1800's, associated with iron-working and farming activities such as herding and agriculture.

Middle Stone Age

The archaeology of the Stone Age between 20-300 000 years ago, associated with early modern humans.

Palaeontology

Any fossilised remains or fossil trace of animals or plants which lived in the geological past, other than fossil fuels or fossiliferous rock intended for industrial use, and any site which contains such fossilised remains or trace.

1.6 Abbreviations

Acronyms	***Description***
AIA	Archaeological Impact Assessment
ASAPA	Association of South African Professional Archaeologists
CRM	Cultural Resource Management
CCS	Cryptocrystalline silicate
DEA	Department of Environmental Affairs
DoE	Department of Energy
DWS	Department of Water and Sanitation
EA	Environmental Authorisation
EIA practitioner	Environmental Impact Assessment Practitioner
EIA	Environmental Impact Assessment
ESA	Early Stone Age
GPS	Global Positioning System
HIA	Heritage Impact Assessment
HV	High Voltage
I&AP	Interested & Affected Party
LSA	Late Stone Age
LIA	Late Iron Age
MSA	Middle Stone Age
MIA	Middle Iron Age
NEMA	National Environmental Management Act
NHRA	National Heritage Resources Act

PHRA	Provincial Heritage Resources Agency
PSSA	Palaeontological Society of South Africa
PV	Photovoltaic
ROD	Record of Decision
SPV	Special Purpose Vehicle
SADC	Southern African Development Community
SAHRA	South African Heritage Resources Agency
SAHRIS	South African Heritage Resources Information System

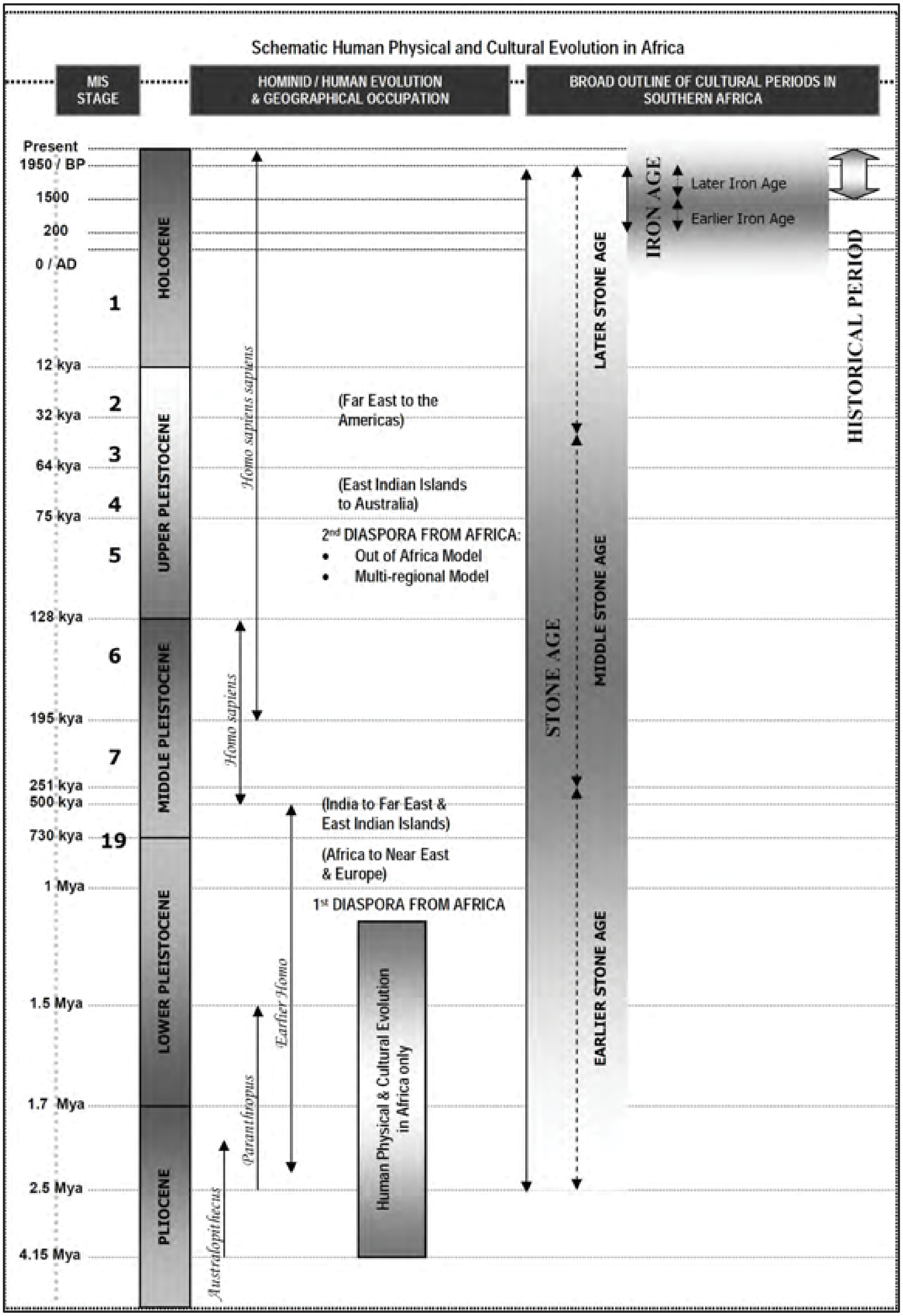


Figure 1 – Human and Cultural Timeline in Africa (Morris, 2008)

2 TECHNICAL DESCRIPTION

The proposed project will encompass the installation of a solar PV field and associated components, in order to generate electricity that is to be fed into the Eskom grid. The facility will have a maximum export capacity of 75MW. The proposed development area is approximately 430 ha, however it is envisaged that the 75MW energy facility layout will only require approximately 250 ha. The voltage of the connection lines from the solar PV energy facility substation to the grid is likely to be 132kV.

2.1 PV Project Components

This proposed PV energy facility forms one of three PV energy facilities with a 75MW export capacity that BioTherm are proposing to develop on Portion 3 of the farm Klipgats Pan No 117 (Figure 2). In order to accommodate the Department of Energy's (DoE) competitive bidding process for procuring renewable energy from Independent Power Producers in South Africa each PV energy facility will be developed under a separate Special Purpose Vehicle (SPV) and therefore each requires a separate Environmental Authorisation. However, the possibility to allow shared associated infrastructure will be considered.

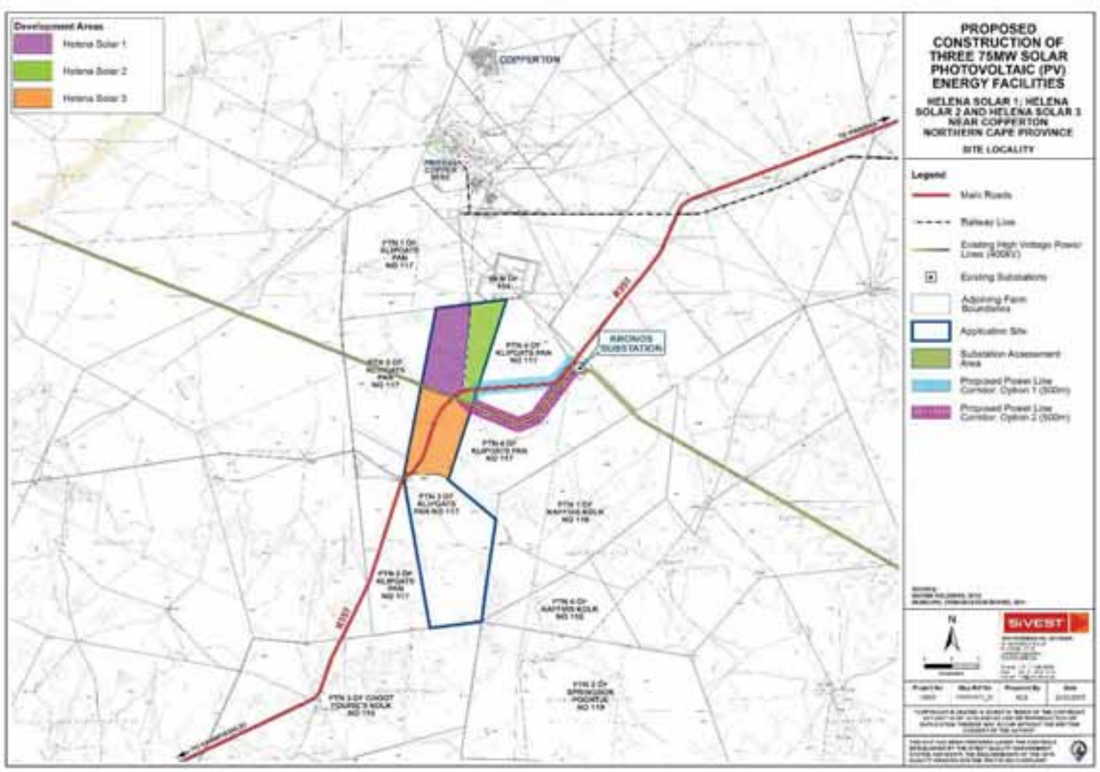


Figure 2: Proposed solar PV energy facility study area

The key technical details and infrastructure required is presented in the table below (Table 3).

Table 3: Helena Solar 1 phase summary

Phase Name	**DEA Reference**	**Farm name and area**	**Technical details and infrastructure necessary for each phase**
Helena Solar 1	14/12/16/3/3/2/765	Portion 3 of Klipgats Pan No 117 (PV site) and Portion 4 of Klipgats Pan No 117 (power lines) PV Site Area: 427.56 ha	▪ Approximately 300 000 **solar PV panels** with a total export capacity of 75MW; ▪ Panels will be either **fixed axis mounting or single axis tracking solutions**, and will be either crystalline silicon or thin film technology; ▪ Onsite **switching station**, with the transformers for voltage step up from medium voltage to high voltage; ▪ The panels will be connected in strings to inverters, approximately **43 inverter stations** will be required throughout the site. Inverter stations will house 2 x 1MW inverters and 1 x 2MVA transformers; ▪ DC power from the panels will be converted into AC power in the inverters and the voltage will be stepped up to 22-33kV (medium voltage) in the transformers. ▪ The **22-33kV cables** will be run underground in the facility to a common point before being fed to the **onsite substation** where the voltage will typically be stepped up to 132kV. ▪ Grid connection is to the Kronos substation. A **power line** with a voltage of 132kV is proposed and will run from the onsite substation to the Kronos substation. The distance will be about 4km. The final grid connection voltage will be below 275kV. ▪ A **laydown area** for the temporary storage of materials during the construction activities; ▪ **Access roads and internal roads**; ▪ Construction of a **car park and fencing** around the project; and ▪ **Administration, control and warehouse buildings**

2.2 Solar Field

Solar PV panels are usually arranged in rows or ‘arrays’ consisting of a number of PV panels. The area required for the PV panel arrays will likely need to be entirely cleared or graded. Where tall vegetation is present, this vegetation will be removed from the PV array area.

Approximately 300 000 solar PV panels will be required per project for a total export capacity of 75MW. Support structures will be either fixed axis mounting or single axis tracking solutions and the modules will be either crystalline silicon or thin film technology. The solar PV panels are variable in size, and are affected by advances in technology between project inception and project realisation. The actual size of the PV panels to be used will be determined in the final design stages of the project. The PV panels are mounted onto metal frames which are usually aluminium. Rammed or screw pile foundations are commonly used to support the panel arrays (Figure 3).

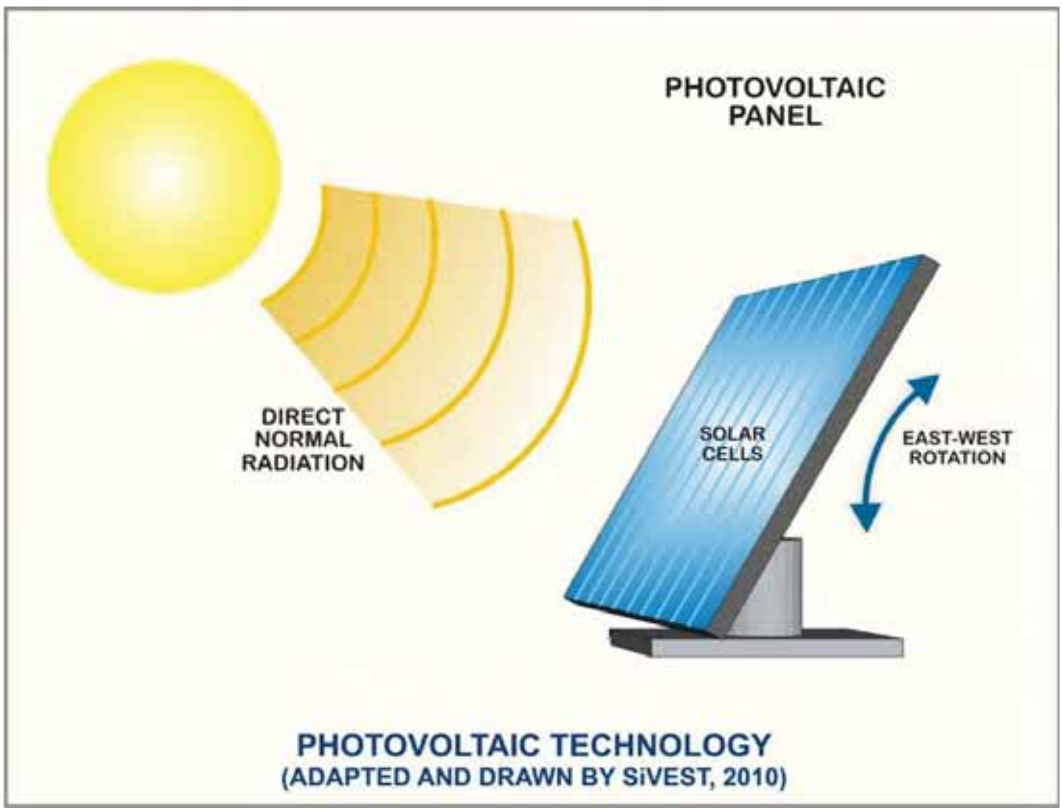


Figure 3: Example of a Photovoltaic Panel with tracking capability.

2.3 Associated Infrastructure

2.3.1 Electrical Infrastructure

The solar PV panel arrays are connected to each other in strings, which are in turn connected to inverters. For a 75MW size facility, typically 2MW inverter stations which are containerised stations housing 2x1MW inverters and 1x2MVA transformers will be used; therefore approximately 43 inverter stations will be required throughout the site for the proposed solar PV energy facility (Figure 4). DC power from the panels will be converted into AC power in the inverters and the voltage will be stepped up to 22-33kV (medium voltage) in the transformers. The 22-33kV cables will be run underground in the facility to a common point before being fed to the onsite substation and switching station where the voltage will typically be stepped up to 132kV. A Power line with a voltage of up to 132kV will run from the onsite substation to the existing Kronos substation. The distance will be about 4km.

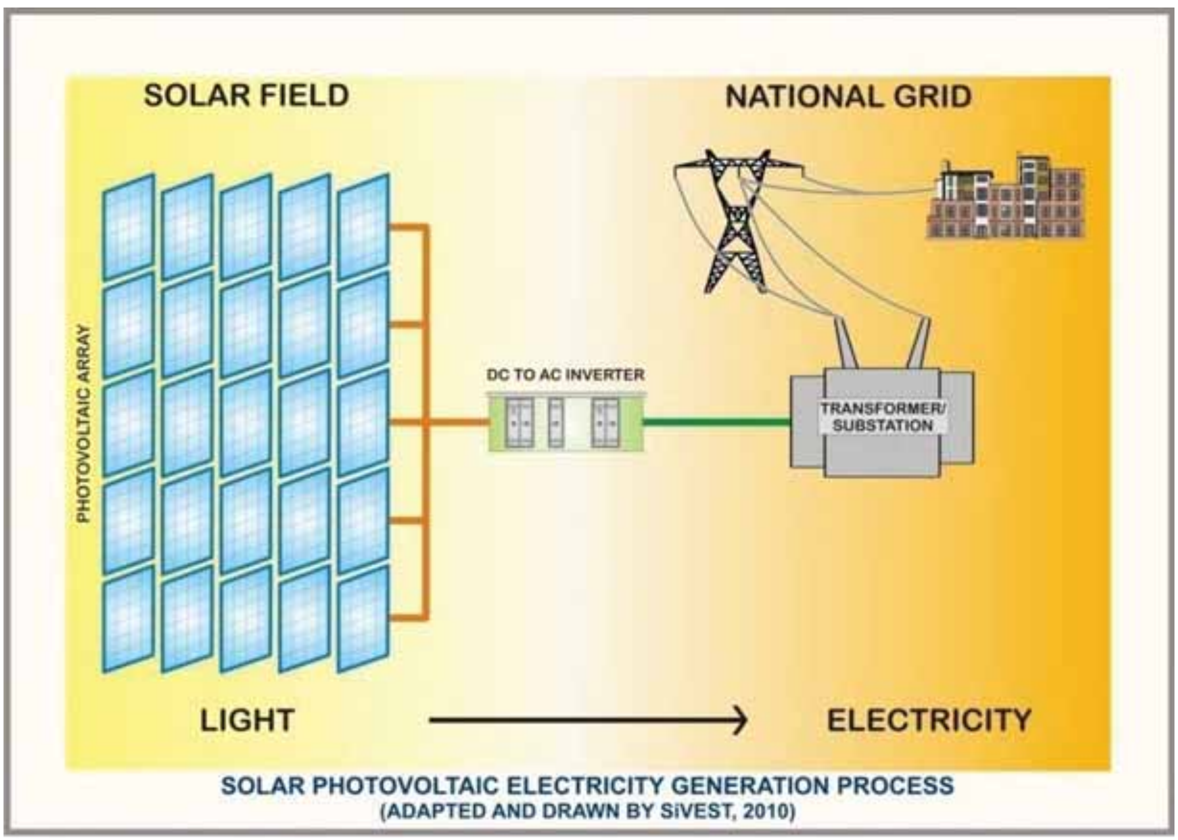


Figure 4: PV process

2.3.2 Buildings

The solar field will require onsite buildings, which will be used in the daily operation of the plant and includes an administration building (office). The buildings will likely be single storey buildings, which will be required to accommodate the following:

- Control room
- Workshop
- High Voltage (HV) switchgear
- Mess Room
- Toilets
- Warehouse for storage
- Car park and fencing around the project

2.3.3 Construction Lay-down Area

A general construction lay-down area will be required for the construction phase of the proposed solar PV energy facility. The size of this area is yet to be determined, but 3 to 5 hectares is likely.

2.3.4 Other Associated Infrastructure

Other associated infrastructure includes the following:

- Access roads and internal roads;
- A car park; and
- Fencing around the project.

2.4 Alternatives

Due to the limited space available as well as the constraints of the sensitive areas, no alternative PV panel layouts were identified. It was felt that it would be environmentally preferable to assess one viable panel layout rather than two panel layouts that are not technically or environmentally viable. Other design or layout alternatives have been identified. Two alternative site locations for the substation were also proposed, as well as two alternative route corridors for the proposed power line. Additionally, two road and cabling layout alternatives were identified. Based on the scoping phase specialist findings the substation assessment area was eliminated as an appropriate area for the proposed substation as most of this site was found to be potentially sensitive by the specialists. As such, two alternative substation sites that cover an area of 3 ha each were proposed to be assessed in the EIA phase. Should the other two PV projects that are being proposed by BioTherm on the same farm also be granted Environmental Authorisations (EA) and be awarded preferred bidder status by the DoE the possibility of sharing the substation site to reduce the environmental impact will be considered.

These layouts for the proposed PV facility are presented in Figure 5.

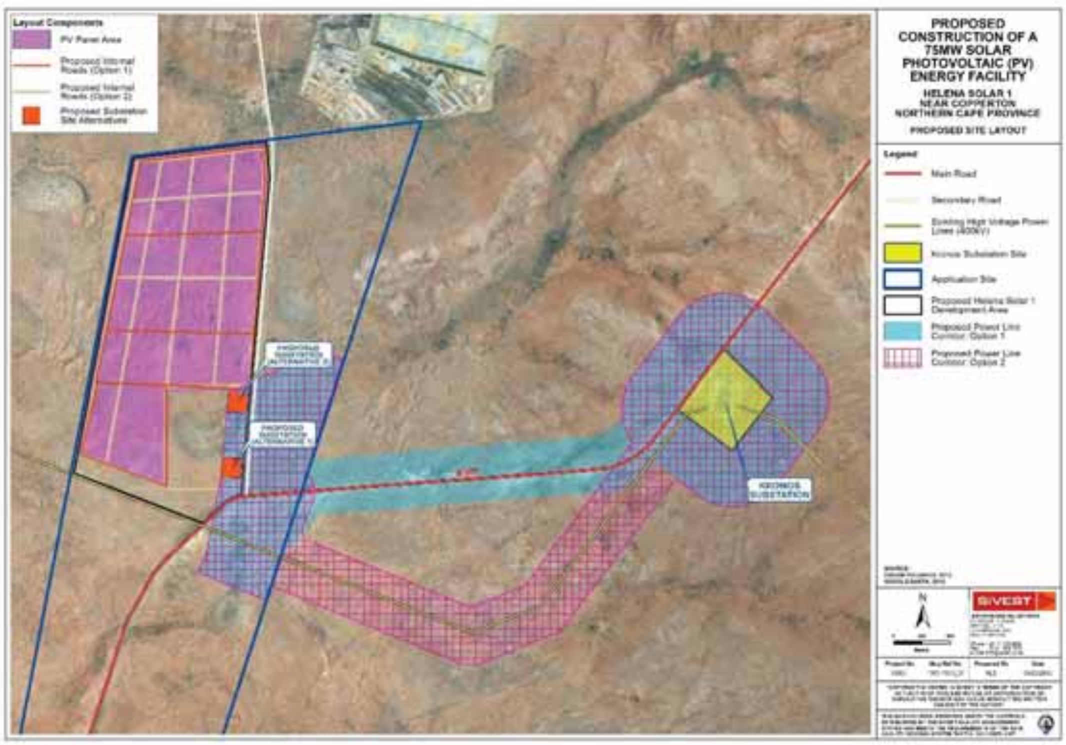


Figure 5: Proposed Layout Alternatives

3 ASSESSMENT METHODOLOGY

The section below outlines the assessment methodologies utilised in the study.

3.1 Methodology for Assessing Heritage Site significance

PGS Heritage (PGS) compiled this Heritage Assessment Document as part of the Heritage Impact Assessment (HIA) report for the proposed Helena 1 Solar facilities. The applicable maps, tables and figures, are included as stipulated in the NHRA (no 25 of 1999), the National Environmental Management Act (NEMA) (no 107 of 1998). The HIA process consisted of three steps:

3.1.1 Scoping Phase

Step I – Literature Review: The background information to the field survey relies greatly on the Heritage Background Research.

3.1.2 Impact Assessment Phase

Step II – Physical Survey: A physical survey was conducted on foot through the proposed project area by a qualified archaeologist, which aimed at locating and documenting sites falling within and adjacent to the proposed development footprint.

Step III – The final step involved the recording and documentation of relevant archaeological resources, the assessment of resources in terms of the HIA criteria and report writing, as well as mapping and constructive recommendations.

Appendix B, outlines the Plan of study for the Heritage Impact Assessment process, while **Appendix C** provides the guidelines for the impact assessment evaluation that was used during the EIA phase of the project.

4 BACKGROUND RESEARCH

The examination of heritage databases, historical data and cartographic resources represents a critical additional tool for locating and identifying heritage resources and in determining the historical and cultural context of the study area. Therefore an Internet literature search was conducted and relevant archaeological and historical texts were also consulted. Relevant topographic maps and satellite imagery were studied.

4.1 Previous Studies

Researching the SAHRIS online database (http://www.sahra.org.za/sahris), it was determined that a number of other archaeological or historical studies have been performed within the wider vicinity of the study area. Previous studies listed for the area in the APM Report Mapping Project included a number of surveys within the area listed in chronological order below:

VAN RYNEVELD, K. 2006. Phase 1 Archaeological Impact Assessment - Vogelstruisbult 104, Prieska District, Northern Cape, South Africa. National Museum Bloemfontein

KAPLAN, J.M. 2010. Archaeological Scoping Study and Impact assessment of a proposed photovoltaic power generation facility in Copperton Northern Cape. Agency for Cultural Resource Management

KAPLAN, J.M. & WILTSHIRE, N. 2011. Archaeological Impact Assessment of a proposed wind energy facility, power line and landing strip in Copperton, Siyathemba municipality, Northern Cape. Agency for Cultural Resource Management

ATWELL, M. 2011. Heritage Assessment Proposed Wind Energy Facility And Related Infrastructure, Struisbult: (Farm 103, Portions 4 And 7), Copperton, Prieska, Atwell & Associates

ORTON, JAYSON. 2012a. Heritage Impact assessment for a proposed photovoltaic energy plant on the farm Klipgats Pan near Copperton, Northern Cape. Archaeology Contracts Office Department of Archaeology. University of Cape Town

ORTON, JAYSON. 2012b. Heritage Impact Assessment for a proposed photovoltaic energy plant on the farm Hoekplaas near Copperton, Northern Cape. Archaeology Contracts Office Department of Archaeology. University of Cape Town

ORTON, J & WEBLEY, L. 2013. Heritage Impact Assessment for Multiple Proposed Solar Energy Facilities on the Remainder of Farm Klipgats Pan 117, Copperton, Northern Cape

ORTON, J. 2014. Archaeological Mitigation of Later Stone Age Sites on the Remainder of Portion 4 of Klipgats Pan 117, Prieska Magisterial District, Northern Cape. ASHA Consulting (Pty) Ltd

Van der Walt, Jaco. 2012. Archaeological Impact Assessment Report for the proposed Garob Wind Energy Facility Project, located close to Copperton in the Northern Cape. Heritage Contracts and Archaeological Consulting CC (HCAC)

FOURIE, W. 2012. Heritage Impact Assessment for the proposed Eskom Cuprum to Kronos Double Circuit 132kv Power line and Associated Infrastructure, Prieska, Northern Cape.

ALMOND, J.E. 2011. Palaeontological Specialist Assessment: Combined Desktop & Field Assessment Study. Proposed Photovoltaic Energy Plant on Farm Klipgats Pan (Portion 4 of Farm 117) near Copperton, Northern Cape Province

4.1.1 Findings from the studies

Palaeontology

The following map (**Figure 6**) is an extract from the palaeontological desktop study completed by Almond (2012) for the proposed solar project on the farm Klipgatspan, bordering to the study area. The map indicates the main geological units as:

The main geological units mapped within the PV4 study region are:

1. Precambrian (Mid Proterozoic / Mokolian) basement rocks (igneous / metamorphic): Reddish-brown (Mg) = granitic and associated intrusive rocks

2. Late Carboniferous / Early Permian Karoo Supergroup sediments:
   Grey (C-Pd) = Mbizane Formation (Dwyka Group)
3. Early Jurassic dolerite intrusions
   Pink (Jd) = Karoo Dolerite Suite
4. Cretaceous kimberlite intrusions
   Black line (Kk) = kimberlite dykes (not all mapped)
5. Late Caenozoic (Quaternary to Recent) superficial deposits:
   Pale yellow with flying bird symbol = Quaternary to Recent alluvium, pan sediments (N.B. calcrete hardpan extensively present in the subsurface and superficial soils gravels are not mapped at this scale)

Almond (2012), indicated that the, "*poorly-exposed upper Dwyka Group bedrocks in the Klipgats Pan study area do not contain rich trace fossil assemblages, petrified wood or other fossil material, and are therefore of low palaeontological sensitivity. The only fossils recorded from the Dwyka succession here are ice-transported erratic boulders of Precambrian limestone or dolomite that contain small stromatolites (microbial mounds or columns). The study area is largely mantled by Pleistocene to Recent superficial sediments (soils, alluvium, calcretes, gravels etc) that are likewise generally of* ***low palaeontological sensitivity***."

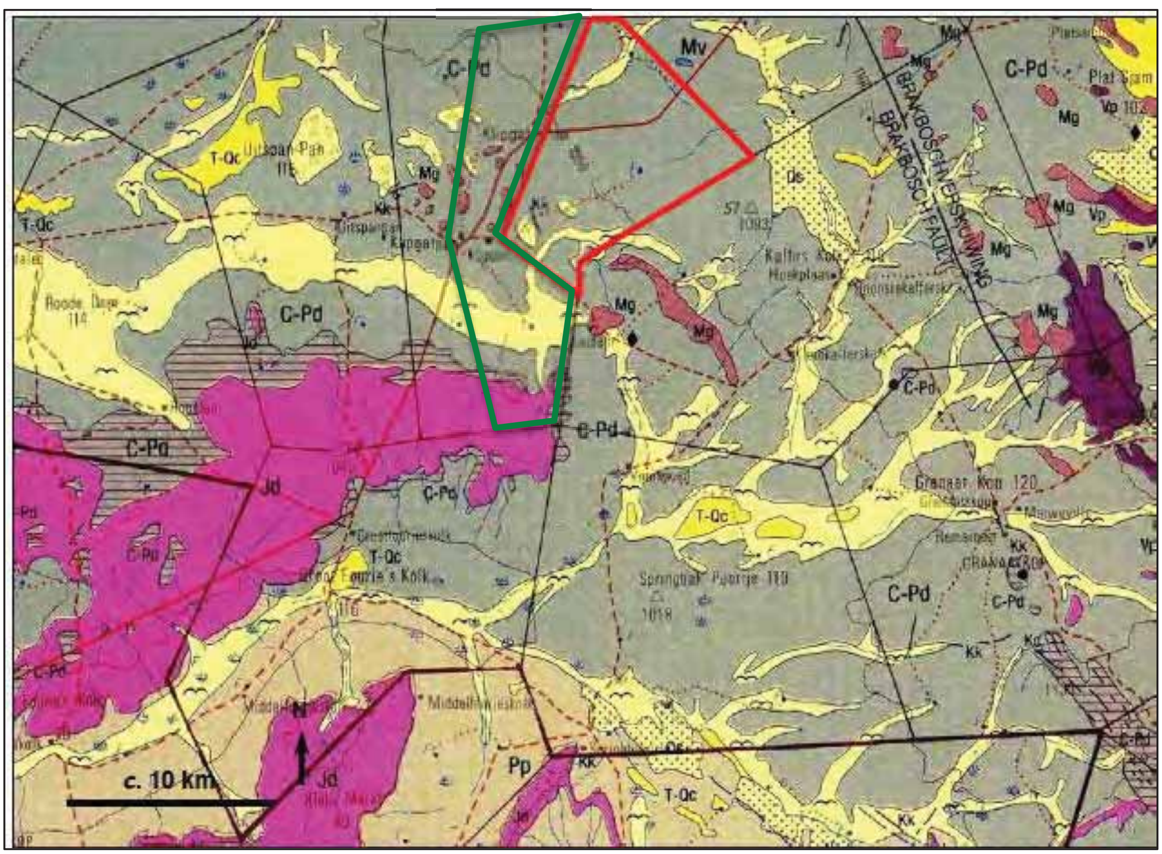


Figure 6 – 1: 250 000 geology sheet 3022 Britstown (Council for Geoscience, Pretoria). The Outline of the current study in green

4.1.2 Archaeology

Most archaeological material in the Northern Cape is found near water sources such as rivers, pans and springs, as well as on hills and in rock shelters. Sites usually comprise of open sites where the majority of evidence of human occupation is scatters of stone tools (Parsons 2003). Evaluation of the alignment has identified possible sensitive areas.

The areas marked in blue and red (Figure 9**)** shows drainage lines and pans in the proposed development areas.

Since Sept 2011 a large number of Heritage and Archaeological Impact Assessments were completed in the vicinity of the proposed development area **(**Figure 9**).** Most notably the work of Orton (2011, 2012 and 2013), Kaplan (2010) and Kaplan and Wiltshire (2011) and Van der Walt (2012), has confirmed the statement by Parsons (2003), as noted earlier.

Figure 7: Early Stone Age stone tools found close to Kronos substation, just east of the study area

Orton (2012) notes that literature has shown that the Bushmanland area is littered by low density lithic scatters, with well weathered Early (ESA) and Middle Stone Age (MSA) artefacts dominating the assemblages. Orton's (2012 and 2013) and Fourie's (2012) work on the Klipgats Pan and

Hoekplaas, that was done in the closest proximity to the study area has produced numerous find spots as well as clusters of site located on elevated terraces overlooking pan-like areas (identified as the drainage area as indicated in(Figure 9**)**, noted by Orton as being of LSA origin.

Figure 8: Close-up view of quartzite flakes and debitage at Kr_Cu/2012/003 (Debitage and lithics indicate by dots) a site situated some 500 meters to the east of the study area (Fourie, 2013)

Kaplan and Wiltshire's (2011) work to the north of the study area has confirmed the presence of Stone Age Sites with a high local significance rating with the sites at Modderpan and Saaipan covering ESA, MAS and LSA finds. A number of knapping occurrences and find spots were also made during the fieldwork.

4.1.3 Historical structures and history

Some structures (green areas in Figure 9) identified during map analysis was investigated during the fieldwork and found to be watering holes for livestock and of no significance.

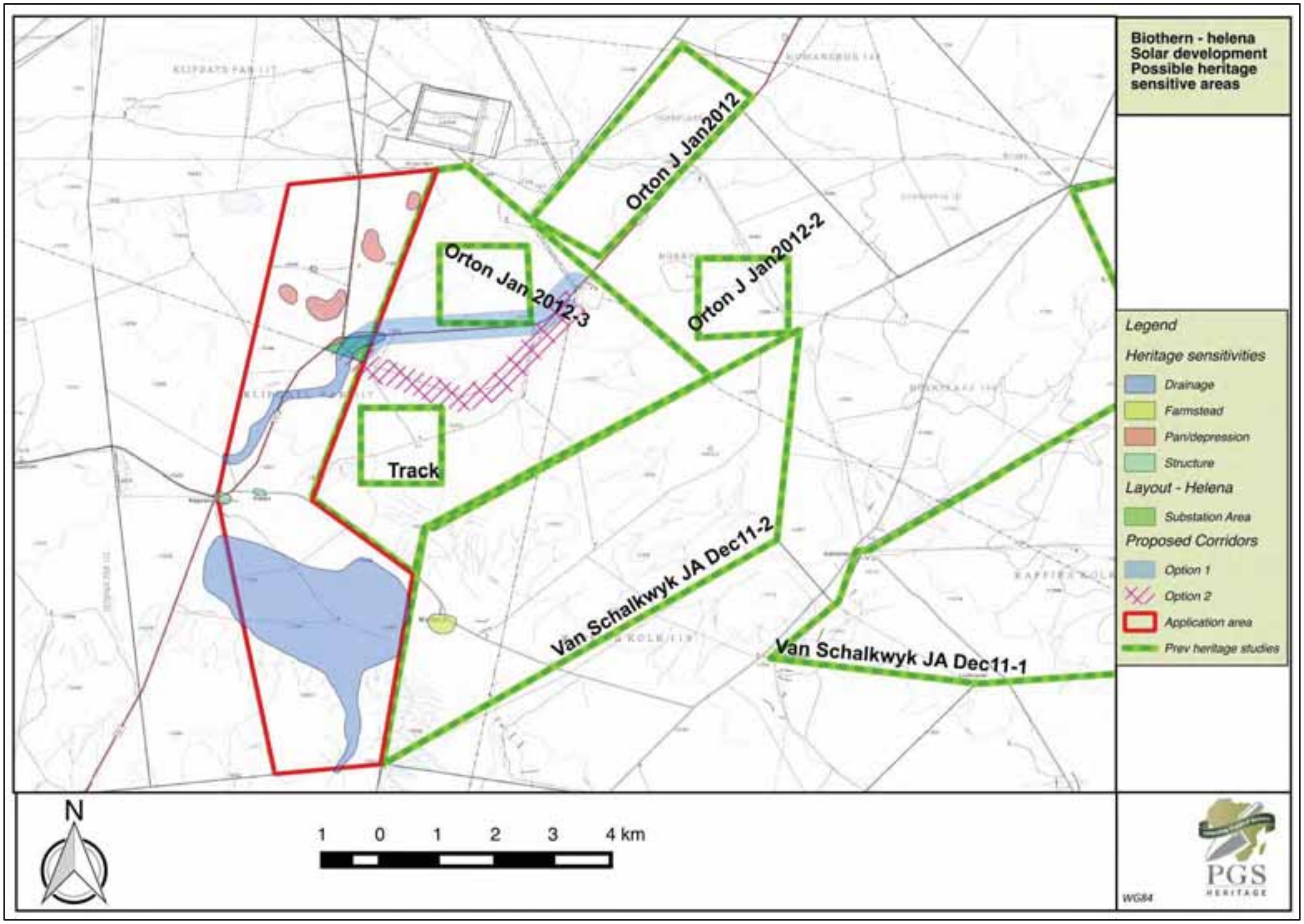


Figure 9 – Possible heritage sensitive areas

4.1.4 Possible finds

Evaluation of aerial photography has indicated the following area that may be sensitive from an archaeological perspective (**Figure 9**). The analysis of the studies conducted in the area assisted in the development of the following landform type to heritage find matrix in **Table 4**.

Table 4: Landform to heritage matrix

LAND FROM TYPE	HERITAGE TYPE
Crest and foot hill	LSA and MSA scatters
Crest of small hills	Small LSA sites – scatters of stone artefacts, ostrich eggshell, pottery and beads
Pans	Dense LSA sites
Dunes	Dense LSA sites
Outcrops	Occupation sites dating to LSA, MSA and ESA
Farmsteads	Historical archaeological material

To be able to compile a heritage management plan to be incorporated into the Environmental Management Plan the following further work will be required for the EIA.

- Archaeological walk through of the areas where the project will be impacting;
- Palaeontological desktop assessment of the area will not be required based on the findings of other palaeontological studies (Almond, 2011) in the same area, with the

5 IMPACT ASSESSMENT

5.1 Field work findings

5.1.1 Methodology

Fieldwork was conducted on the three proposed PV developments of the Helena Project from 22-24 July 2015. The methodology focused of a tracked walkthrough of the foot print areas of proposed PV projects as well as the two proposed power line corridors from the site to the Kronos substation. An accredited professional archaeologist, Mr Wouter Fourie, completed the fieldwork. All the fieldwork was done on foot and consisted of 60 kilometres of tracked field walking through the proposed development areas.

It must be stressed that the extent of the fieldwork was based on the available field time and was aimed at determining the heritage character of the area.

The fieldwork that covered the Helena 1 Solar site as well as the proposed power line corridors covered approximately 45km in total with an evaluation field of 20 meters for small finds (10 meters either side of the archaeologist) and 100 meters for larger finds such as marked cemeteries and historical structures (50 meters either side of the archaeologist).

A total of a 116 find spots were logged of which 14 can be described as archaeological sites.

The numerous Stone Age artefacts (lithics) occurring over the extent of the area, required a refinement of the methodology and the defining of what constitutes an archaeological site as appose to a findspot.

It was decided to use the density of lithics present on the ground to be the guiding rule towards elaborating on a findspot and defining it as an archaeological site. A findspot was classified as and area containing a density of more than 10 lithics per square meter, while a density of or than 20 lithics per square meter was deemed to be the trigger mechanism for converting a findspot to an archaeological site.

5.1.2 Description of area

The study area and surrounds is characterised by low vegetation growth dispersed over fairly flat terrain. Dominating the surface area are vast exposed pebble layers usually associated with low rises in the landscape. Drainage lines and flat surface are characterised by red sand cover in between the exposed pebble layers.

Figure 10 – General view of southern power line corridor

Figure 11 – Kraal with cement dam on Helena 1

Figure 12 – Characteristic deflation between pebble scatters

Figure 13 – View of northern corridor alignment with the Kronos substation in background

5.1.3 Finds

A total of 120 findspots were marked over the extent of the fieldwork. The findspots were mostly characterised by three types of setting, deflated red sands, and pebble concentrations associated with a calcrete exposure and non-deflated red sand exposures in between low-density vegetation.

The findspots varied from Later Stone Age (LSA) scatters consisting of flakes, chips and some cores manufactured from fine-grained quartzite, chalcedony, and cryptocrystalline (ccs) material; Middle Stones Age (MSA) lithics consisting of cores, chips and flakes with a low occurrence of formal tools. The majority of the material utilised were either lideanite that occur in the form of medium sized boulders or round washed pebbles in the area or coarse-grained quartzite that occur as sporadic outcrops.

Earlier Stone Age (ESA) lithics found at some of these finds spots consisted of hand axes, cleavers and large flakes. Most of the lithics were either rolled or heavily weathered with patination evident on 95% of the lithics.

All these site have a low significance, however the possibility of sub-surface deposits cannot be discounted and was kept in mind with the development of the mitigation recommendations.

Mitigation:

- The final alignment and pylon positions of the power line needs to be walked down and heritage features demarcated;
- Where required the sites identified during the walkdown will then need mitigation measures developed that will need to be completed before construction can commence;
- Such mitigation measures will require a permit from SAHRA before mitigation can be done as well as a final destruction permit on completion of the mitigation work.

- Due to the large amount of Stone Age material present on site it is recommended that an archaeologist be appointed to monitor construction activity as part of a watching brief. The aim being the identification and mitigation of any newly discovered sites.

Figure 14 – Heavily weathered ESA material

Figure 15 – MSA lithics (jasper, silcrete and quartzite)

Figure 16 – Backed flake with retouch (jasper)

Figure 17 – Heavily weathered ESA lithics (radial core: top)

Figure 18 – ESA lithic with heavy patination (lideanite)

Figure 19 – MSA flakes and cores (silcrete and fine-grained quartzite)

Figure 20 – MSA flakes and cores (silcrete and fine-grained quartzite)

Figure 21 – Late ESA lithic (quartzite)

5.1.4 Sites

During the fieldwork 13 archaeological sites were identified (Table 5 **and** Table 6**).** Refer to Appendix D for distribution map

Table 5: Sites – Power line corridor

Site number	Type	Longitude	Latitude	Description	Heritage Significance	Alternative
001-004	MSA site	22.33514	-30.02119	Medium density scatter of ESA and MSA lithics over an area of approximately 20 $m^{2.}$ The site is characterised by a large pebble concentration. The lithics assemblage is characterised by a large number of flakes and chips, while a small percentage of the material on site can be described as cores.	Grade 3C	**Northern Alignment**
014	ESA/MSA site	22.32953	-30.02752	Medium density scatter of heavily weathered (rolled) ESA artefact. The site is characterised by low vegetation growth and a red soil matrix with little or no pebble deposit. Site size is approximately 5 m^2.	Grade 3C	**Northern Alignment**
016	ESA site	22.32890	-30.02798	Medium density scatter of heavily weathered (rolled) ESA artefact. The site is characterised by low vegetation growth and a red soil matrix with little or no pebble deposit. Site size is approximately 10 m^2. Most of the material utilised is coarse-grained quartzite.	Grade 3C	**Northern Alignment**
017	Structure	22.32866	-30.02785	Site is characterised b y a small stone packed pile. No associated artefacts could be seen. The possibility does exist that it could be a Stone Age grave.	Grade 3C	**Northern Alignment**

Site number	Type	Longitude	Latitude	Description	Heritage Significance	Alternative
029	ESA/MSA site	22.30943	-30.02943	The site is situated in a deflated area of approximately 50m². The site consists of a medium density scatter of heavily weathered ESA cores and hand axes. A few MSA silcrete cores and flakes also occur in the deflation.	Grade 3C	**Northern Alignment**
032	MSA site	22.30197	-30.03105	The site is situated in a deflated area of approximately 20m2. The site consists of a medium density scatter of MSA silcrete and quartzite cores with a low density of flakes in the deflation.	Grade 3C	**Northern Alignment**
036	MSA site	22.30114	-30.02586	The site is situated in a deflated area of approximately 40m2. The site consists of a medium density scatter of predominantly MSA flakes. Some of the flakes do show traces of usage and retouch.	Grade 3C	**Northern Alignment**
037a and b	MSA site	22.30147	-30.02546	The site is situated in a deflated area of approximately 40m2. The site consists of a medium density scatter of predominantly MSA flakes. Some of the flakes do show traces of usage and retouch.	Grade 3C	**Northern Alignment**
045	MSA site	22.29749,	-30.02695	Site can be described as knapping site, characterised by a large number of flakes and chips as well as large quartzite cores occurring around the site. The site is however small not more than 5m².	Grade 3	**Northern Alignment**

Mitigation:

- The final alignment and pylon positions of the power line needs to be walked down and heritage features demarcated;
- Where required the sites identified during the walkdown will then need mitigation measures developed that will need to be completed before construction can commence;
- Such mitigation measures will require a permit from SAHRA before mitigation can be done as well as a final destruction permit on completion of the mitigation work.

Figure 22 – MSA flakes and cores (silcrete and fine-grained quartzite)

Figure 23 –Stone structure at site 017

Figure 24 –ESA site 018

Figure 25 – ESA lithics in situ

Figure 26 – Worked material at site 045

Table 6: Sites – Helena 1 Solar footprint

Site number	Type	Longitude	Latitude	Description	Heritage Significance	Alternative
029	MSA site	22.28943	-30.01093	Medium density scatter of MSA lithics scattered over an area of 100m^2. Most of the MSA material consist of silcrete and CCS flakes and cores	Grade 3C	**Internal roads Option 1**
033	MSA site	22.32953	-30.02752	Quartzite outcrop occurs at this site. The outcrop was used as manufacturing and quarry site as is evident from the large amount of flakes and chips occurring over the area. The outcrop shows clear marks of flaking Site size is approximately 100 m^2.	Grade 3C	**Internal roads Option 1**
034	ESA site	22.29579	-30.01100	Medium to high density scatter of MSA material with some reworked blades, cores and flakes. Material utilised on site stem from some quartzite outcrops as well as CCS, jasper and lideanite. Site size is approximately 100 m^2.	Grade 3B	**Internal roads Option 1**
046	LSA Site	22.29439	-30.00586	High density scatters of LSA material consisting of cores, bladelette cores, and retouched flakes from CCS and silcrete.	Grade 3B	**PV footprint area**

Mitigation:

- All four site will require mitigation work before construction can commence;
- The mitigation work will be at a minimum:
  - a controlled surface collection of the material;
  - test excavations at site 034 and 046;
  - analysis of material and final report;
- Such mitigation measures will require a permit from SAHRA before mitigation can be done as well as a final destruction permit on completion of the mitigation work.

Figure 27 – View of site 034

Figure 28 – Quartzite outcrop at site 034

Figure 29 – Flake scaring evident on outcrop at site 034

Figure 30 – Lithics present on site (large quartzite flakes, lideanite) – Site 034

Figure 31 – Flakes, and broken blades from site 046

5.2 Assessment

The fieldwork findings have shown that the study area is characterised by a background scatter of Stone Age artefact. The methodology utilised in the identification and classification of finds between find spots and sites enable a clear distinction between groupings.

It must be kept in mind that the fieldwork could in no way identify all archaeological sites within the development footprint and as such the fieldwork has shown that the possibility of encountering other Stone Age archaeological site is extremely high.

The following set of tables provide an assessment of the impact on heritage resources within the development foot print

Table 7: Rating of impacts – Chance finds

IMPACT TABLE	
Environmental Parameter	*Heritage Resources*
Issue/Impact/Environmental Effect/Nature	*The possibility of encountering previously unidentified heritage resources and specifically Stone Age archaeological sites. As well as the impact on the identified archaeological sites*
Extent	*Will impact on the footprint area of the development*
Probability	*The fieldwork has shown that such a predicted impact will definitely occur*
Reversibility	*Due to the nature of archaeological sites the impact is seen as irreversible, however mitigation could enable the collection of enough information to preserve the data from such a site*
Irreplaceable loss of resources	*The development could lead to significant losses in unidentified and unmitigated site*
Duration	*The impact on heritage resources such as archaeological sites will be permanent*
Cumulative effect	*As the type of development impact on a large area, and other similar development in the area will also impact on archaeological sites the cumulative impact is seen as having a medium negative impact.*

Intensity/magnitude	*The large scale impact on archaeological sites and will require mitigation work.*	
Significance Rating	*The overall significance rating for the impact on heritage resources is seen as high pre-mitigation. This can be attributed to the very definite possibility of encountering more archaeological sites as shown through fieldwork. The implementation of the recommended heritage mitigation measures will address the envisaged impacts and reduce the overall rating to a low impact rating.*	
	Pre-mitigation impact rating	Post mitigation impact rating
Extent	1	1
Probability	4	4
Reversibility	2	2
Irreplaceable loss	2	2
Duration	4	4
Cumulative effect	3	2
Intensity/magnitude	3	2
Significance rating	-51 (high negative)	-24 (low negative)
Mitigation measures	*Monitoring during construction by and archaeologist* *Mitigation through archaeological excavations and collection* *Walkdown of final power line route*	

5.3 Cumulative Assessment

A large number of solar projects are proposed and some have been approved and is currently in construction around the study area. Section 4 identified finds and conclusions made by other HIA's from other project that has shown the vast distribution of Stone Age sites over the larger area around Copperton. Although some studies has proposed mitigation work only one report on mitigation work (Orton, 2014) for the Mulilo Prieska PV (Pty) Ltd development just east of the study area, has been completed at this stage.

The need for the implementation of the recommended mitigation measures is of great importance and must be seen in the context of the large areas to be impacted by the construction activity. By implementing the mitigation measures the cumulative effect will be reduce from a Medium to a Low negative impact rating.

5.4 Impact Summary

Table 8 provides a summary of the projected impact rating for this project on heritage resources.

Table 8: Comparison of summarised impacts on environmental parameters

Environmental parameter	Issues	Rating prior to mitigation	Average	Rating post mitigation	Average
Heritage resources	Impact during construction	51		24	
			High Negative Impact		Low Negative Impact

5.5 Comparative Assessment for Helena Solar 1

Key

PREFERRED	The alternative will result in a low impact / reduce the impact
FAVOURABLE	The impact will be relatively insignificant
NOT PREFERRED	The alternative will result in a high impact / increase the impact
NO PREFERENCE	The alternative will result in equal impacts

Alternative	Preference	Reasons
SUBSTATION		
Substation Site Alternative 1	NO PREFERENCE	No heritage resources identified
Substation Site Alternative 2	NO PREFERENCE	No heritage resources identified
INTERNAL ROADS		
Internal Road Alternative 1	NOT PREFERRED	Some heritage resources identified close by
Internal Road Alternative 2	PREFERRED	No resources identified in close vicinity
POWER LINES		
Power Line Corridor Alternative 1	FAVOURABLE	More heritage sites identified in this corridor
Power Line Corridor Alternative 2	PREFERRED	Less heritage sites identified in this corridor

6 MANAGEMENT GUIDELINE

6.1 Heritage Management Plan for EMP implementation

No.	Mitigation Measures	Phase	Timeframe	Responsible Party For Implementation	Monitoring Party (Frequency)	Target	Performance Indicators (Monitoring Tool)	Cost
A	Include section on possible heritage finds in induction prior to construction activities take place – Refer to Section 9 of this report	Planning /Pre-Construction	Prior to constructio n	Applicant ECO Heritage Specialist	ECO (Monthly)	Ensure compliance with relevant legislation and recommendations from SAHRA under Section 36 and 38 of NHRA	No legal directives Legal compliance audit scores (Legal register) (ECO Monthly Checklist/Report)	**R5 000**
B	Implement chance find procedures in case where possible heritage finds area made	Construction	During constructio n	Applicant ECO Heritage Specialist	ECO (weekly)	Ensure compliance with relevant legislation and recommendations from SAHRA under Section 35and 38 of NHRA	ECO Monthly Checklist/Report	**Possibly R10 000**
C	Implement walk down of final alignment on power line alignment	Pre-Construction	Pre-Constructio n	Applicant ECO Heritage Specialist	Once off	Ensure compliance with relevant legislation and recommendations from SAHRA under Section 36 and 38 of NHRA	Completion and development of mitigation measures	**R30 000**

No.	Mitigation Measures	Phase	Timeframe	Responsible Party For Implementation	Monitoring Party (Frequency)	Target	Performance Indicators (Monitoring Tool)	Cost
D	Monitoring of construction activities by archaeologist	Construction	During constructio n	Applicant ECO Archaeologist	Archaeologist (weekly)	Ensure compliance with relevant legislation and recommendations from SAHRA under Section 35 and 38 of NHRA	Archaeologist Monthly Checklist/Report	**Monthly R40-50 000**
E	Implement mitigation for identified sites	Pre-construction	Pre-Constructio n	Applicant ECO Archaeologist	Once off	Ensure compliance with relevant legislation and recommendations from SAHRA under Section 35 and 38 of NHRA	Completion of mitigation measures and obtain destruction permit	**Approximate ly R300 000**

7 HERITAGE MANAGEMENT GUIDELINES

7.1 General Management Guidelines

1. The National Heritage Resources Act (Act 25 of 1999) states that, any person who intends to undertake a development categorised as-
   - (a) the construction of a road, wall, transmission line, pipeline, canal or other similar form of linear development or barrier exceeding 300m in length;
   - (b) the construction of a bridge or similar structure exceeding 50m in length;
   - (c) any development or other activity which will change the character of a site-
     - (i) exceeding 5 000 m^2 in extent; or
     - (ii) involving three or more existing erven or subdivisions thereof; or
     - (iii) involving three or more erven or divisions thereof which have been consolidated within the past five years; or
     - (iv) the costs of which will exceed a sum set in terms of regulations by SAHRA or a provincial heritage resources authority;
   - (d) the re-zoning of a site exceeding 10 000 m^2 in extent; or
   - (e) any other category of development provided for in regulations by SAHRA or a provincial heritage resources authority, must at the very earliest stages of initiating such a development, notify the responsible heritage resources authority and furnish it with details regarding the location, nature and extent of the proposed development.

In the event that an area previously not included in an archaeological or cultural resources survey is to be disturbed, the SAHRA needs to be contacted. An enquiry must be lodged with them into the necessity for a Heritage Impact Assessment.

2. In the event that a further heritage assessment is required it is advisable to utilise a qualified heritage practitioner, preferably registered with the Cultural Resources Management Section (CRM) of the Association of Southern African Professional Archaeologists (ASAPA).

   This survey and evaluation must include:
   - (a) The identification and mapping of all heritage resources in the area affected;
   - (b) An assessment of the significance of such resources in terms of the heritage assessment criteria set out in section 6 (2) or prescribed under section 7 of the National Heritage Resources Act;
   - (c) An assessment of the impact of the development on such heritage resources;
   - (d) An evaluation of the impact of the development on heritage resources relative to the sustainable social and economic benefits to be derived from the development;
   - (e) The results of consultation with communities affected by the proposed development and other interested parties regarding the impact of the development on heritage resources;

(f) If heritage resources will be adversely affected by the proposed development, the consideration of alternatives; and

(g) Plans for mitigation of any adverse effects during and after the completion of the proposed development.

3. It is advisable that an information section on cultural resources be included in the SHEQ training given to contractors involved in surface earthmoving activities. These sections must include basic information on:

   a. Heritage;
   b. Graves;
   c. Archaeological finds; and
   d. Historical Structures.

   This module must be tailor made to include all possible finds that could be expected in that area of construction.

   Possible finds include:

   a. Open air Stone Age scatters, disturbed during vegetation clearing. This will include stone tools.
   b. Palaeontological deposits such as bone, and teeth in fluvial riverbank deposits.

4. In the event that a possible find is discovered during construction, all activities must be halted in the area of the discovery and a qualified archaeologist contacted.
5. The archaeologist needs to evaluate the finds on site and make recommendations towards possible mitigation measures.
6. If mitigation is necessary, an application for a rescue permit must be lodged with SAHRA.
7. After mitigation, an application must be lodged with SAHRA for a destruction permit. This application must be supported by the mitigation report generated during the rescue excavation. Only after the permit is issued may such a site be destroyed.
8. If during the initial survey sites of cultural significance are discovered, it will be necessary to develop a management plan for the preservation, documentation or destruction of such a site. Such a program must include an archaeological/palaeontological monitoring programme, timeframe and agreed upon schedule of actions between the company and the archaeologist.
9. In the event that human remains are uncovered, or previously unknown graves are discovered, a qualified archaeologist needs to be contacted and an evaluation of the finds made.
10. If the remains are to be exhumed and relocated, the relocation procedures as accepted by SAHRA need to be followed. This includes an extensive social consultation process.

Table 9: Roles and responsibilities of archaeological and heritage management when heritage resources are discovered during operations

ROLE	RESPONSIBILITY	IMPLEMENTATION
A responsible specialist needs to be allocated and should attend all relevant meetings, especially when changes in design are discussed, and liaise with SAHRA.	The client	Archaeologist and a competent archaeology support team
If chance finds and/or graves or burial grounds are identified during construction or operational phases, a specialist must be contacted in due course for evaluation.	The client	Archaeologist and a competent archaeology support team
Comply with defined national and local cultural heritage regulations on management plans for identified sites.	The client	Environmental Consultancy and the Archaeologist
Consult the managers, local communities and other key stakeholders on mitigation of archaeological sites, when discovered.	The client	Environmental Consultancy and the Archaeologist
Implement additional programs, as appropriate, to promote the safeguarding of our cultural heritage. (i.e. integrate the archaeological components into the employee induction course).	The client	Environmental Consultancy and the Archaeologist,
If required, conservation or relocation of burial grounds and/or graves according to the applicable regulations and legislation.	The client	Archaeologist, and/or competent authority for relocation services
Ensure that recommendations made in the Heritage Report are adhered to.	The client	The client
Provision of services and activities related to the management and monitoring of significant archaeological sites (when discovered). The client with the specialist needs to agree on the scope and activities to be performed	The client	Environmental Consultancy and the Archaeologist
When a specialist/archaeologist has been appointed for mitigation work on discovered heritage resources, comprehensive feedback reports should be submitted to relevant authorities during each phase of development.	Client and Archaeologist	Archaeologist

7.2 All phases of the project

7.2.1 Archaeology

The project will encompass a range of activities during the construction phase, including ground clearance, establishment of construction camps area.

It is possible that cultural material will be exposed during operations and may be recoverable, but this is the high-cost front of the operation, and so any delays should be minimised. Development surrounding infrastructure and construction of facilities results in significant disturbance, but construction trenches do offer a window into the past and it thus may be possible to rescue some of the data and materials. It is also possible that substantial alterations will be implemented during this phase of the project and these must be catered for. Temporary infrastructure is often changed or added to during the subsequent history of the project. In general these are low impact developments as they are superficial, resulting in little alteration of the land surface, but still need to be catered for.

During the prospecting phase, it is important to recognise any significant material being unearthed, and to make the correct judgment on which actions should be taken. In the event that possible heritage resources are identified a qualified archaeologist/palaeontologist must be contacted to evaluate the finds and make recommendations on the mitigation required.

In addition, feedback reports can be submitted by the archaeologist to the client and SAHRA to ensure effective monitoring. This archaeological monitoring and feedback strategy should be incorporated into the Environmental Management Plan (EMP) of the project. Should an archaeological/palaeontological site or cultural material be discovered during construction (or operation), such as burials or grave sites, the project needs to be able to call on a qualified expert to make a decision on what is required and if it is necessary to carry out emergency recovery. SAHRA would need to be informed and may give advice on procedure. The developers therefore should have some sort of contingency plan so that operations could move elsewhere temporarily while the material and data are recovered. The project thus needs to have an archaeologist/palaeontologist available to do such work. This provision can be made in an archaeological monitoring programme.

In the case where archaeological material is identified during construction the following measures must be taken:

- Upon the accidental discovery of archaeological material, a buffer of at least 20 meters should be implemented.
- If archaeological material is accidentally discovered during construction, activities must cease in the area and a qualified archaeologist be contacted to evaluate the find. To remove the material permit must be applied for from SAHRA under Section 35 of the NHRA.

7.2.2 Graves

In the case where a grave is identified during construction the following measures must be taken:

- Upon the accidental discovery of graves, a buffer of at least 50 meters should be implemented.
- If graves are accidentally discovered during construction, activities must cease in the area and a qualified archaeologist be contacted to evaluate the find. To remove the remains a permit must be applied for from SAHRA (Section 36 of the NHRA) and other relevant authorities (National Health Act and its regulations). The local South African Police Services must immediately be notified of the find.
- Where it is recommended that the graves be relocated, a full grave relocation process that includes comprehensive social consultation must be followed.

The grave relocation process must include:

i. A detailed social consultation process, that will trace the next-of-kin and obtain their consent for the relocation of the graves, that will be at least 60 days in length;
ii. Site notices indicating the intent of the relocation;
iii. Newspaper notices indicating the intent of the relocation;
iv. A permit from the local authority;
v. A permit from the Provincial Department of Health;
vi. A permit from the South African Heritage Resources Agency, if the graves are older than 60 years or unidentified and thus presumed older than 60 years;
vii. An exhumation process that keeps the dignity of the remains intact;
viii. The whole process must be done by a reputable company that is well versed in relocations;
ix. The exhumation process must be conducted in such a manner as to safeguard the legal rights of the families as well as that of the developing company.

8 CONCLUSIONS AND RECOMMENDATIONS

Heritage resources are unique and non-renewable and as such any impact on such resources must be seen as significant.

The Heritage Scoping Report has shown that the proposed Helena Solar projects may have heritage resources present on the property. This has been confirmed through archival research and evaluation of aerial photography of the sites.

Evaluation of aerial photography has indicated the following area that may be sensitive from an archaeological perspective (**Figure 9**). The analysis of the studies conducted in the area assisted in the development of the following landform type to heritage find matrix in **Table 4**.

Table 10: Landform to heritage matrix

LAND FROM TYPE	HERITAGE TYPE
Crest and foot hill	LSA and MSA scatters
Crest of small hills	Small LSA sites – scatters of stone artefacts, ostrich eggshell, pottery and beads
Pans	Dense LSA sites
Dunes	Dense LSA sites
Outcrops	Occupation sites dating to LSA
Farmsteads	Historical archaeological material

The fieldwork that covered the Helena 1 Solar site as well as the proposed power line corridors covered approximately 45km in total with an evaluation field of 20 meters for small finds (10 meters either side of the archaeologist) and 100 meters for larger finds such as marked cemeteries and historical structures (50 meters either side of the archaeologist).

A total of a 116 find spots were logged of which 13 (9 in proposed power line corridors and 4 in Helena 1 footprint area) can be described as archaeological sites.

8.1 Find spots

A total of 103 findspots were marked over the extent of the fieldwork. The findspots were mostly characterised by three types of setting, deflated red sands, and exposed pebble concentrations associated with a calcrete exposure and non-deflated red sand exposures in between low-density vegetation.

The findspots varied from Later Stone Age (LSA) scatters consisting of flakes, chips and some cores manufactured from fine-grained quartzite, chalcedony, and cryptocrystalline (ccs) material; Middle Stones Age (MSA) lithics consisting of cores, chips and flakes with a low occurrence of formal tools. The majority of the material utilised were either lideanite that occur in the form of medium sized boulders or round washed pebbles in the area or coarse-grained quartzite that occur as sporadic outcrops.

Earlier Stone Age (ESA) lithics found at some of these finds spots consisted of hand axes, cleavers and large flakes. Most of the lithics were either rolled or heavily weathered with patination evident on 95% of the lithics.

All these site have a low significance, however the possibility of subsurface deposits cannot be discounted and was kept in mind with the development of the mitigation recommendations.

Mitigation:

- The final alignment and pylon positions of the power line needs to be walked down and heritage features demarcated;
- Where required the sites identified during the walkdown will then need mitigation measures developed that will need to be completed before construction can commence;
- Such mitigation measures will require a permit from SAHRA before mitigation can be done as well as a final destruction permit on completion of the mitigation work.

Due to the large amount of Stone Age material present on site it is recommended that an archaeologist be appointed to monitor construction activity as part of a watching brief. The aim being the identification and mitigation of any newly discovered sites.

8.2 Sites

During the fieldwork 13 archaeological sites were identified of which all were archaeological sites representing the Earlier, Middle and Later Stone Age. The sites are all rated as medium to low local heritage significance. Al the sites will require mitigation prior to construction.

Power line sites - *Mitigation:*

- The final alignment and pylon positions of the power line needs to be walked down and heritage features demarcated;
- Where required the sites identified during the walkdown will then need mitigation measures developed that will need to be completed before construction can commence;
- Such mitigation measures will require a permit from SAHRA before mitigation can be done as well as a final destruction permit on completion of the mitigation work.

PV footprint - *Mitigation:*

- All four site will require mitigation work before construction can commence
- The mitigation work will be at a minimum:
    - a controlled surface collection of the material,
    - test excavations at site 034 and 046,;
    - analysis of material and final report;
- Such mitigation measures will require a permit from SAHRA before mitigation can be done as well as a final destruction permit on completion of the mitigation work.

8.3 Impact Summary

Table 11 provides a summary of the projected impact rating for this project on heritage resources.

Table 11: Comparison of summarised impacts on environmental parameters

Environmental parameter	Issues	Rating prior to mitigation	Average	Rating post mitigation	Average
Heritage resources	Impact during construction	51		24	
			High Negative Impact		Low Negative Impact

8.4 Comparative Assessment for Helena Solar 1

Key

PREFERRED	The alternative will result in a low impact / reduce the impact
FAVOURABLE	The impact will be relatively insignificant
NOT PREFERRED	The alternative will result in a high impact / increase the impact
NO PREFERENCE	The alternative will result in equal impacts

Alternative	Preference	Reasons
SUBSTATION		
Substation Site Alternative 1	NO PREFERENCE	No heritage resources identified
Substation Site Alternative 2	NO PREFERENCE	No heritage resources identified
INTERNAL ROADS		
Internal Road Alternative 1	NOT PREFERRED	Some heritage resources identified close by
Internal Road Alternative 2	PREFERRED	No resources identified in close vicinity
POWER LINES		
Power Line Corridor Alternative 1	FAVOURABLE	More heritage sites identified in this corridor
Power Line Corridor Alternative 2	PREFERRED	Less heritage sites identified in this corridor

9 REFERENCES

ALMOND, J.E. 2011. Palaeontological Specialist Assessment: Combined Desktop & Field Assessment Study. Proposed Photovoltaic Energy Plant on Farm Klipgats Pan (Portion 4 of Farm 117) near Copperton, Northern Cape Province

FOURIE, W 2008. Archaeological Impact Assessments within South African Legislation: Paper Presented at the Archaeological Resources Management Workshop, 17 May 2007. The South African Archaeological Bulletin Vol. 63, No. 187 (Jun., 2008), pp. 77-79

FOURIE, W. 2012. Heritage Impact Assessment for the proposed Eskom Cuprum to Kronos Double Circuit 132kv Power line and Associated Infrastructure, Prieska, Northern Cape.

MORRIS, D. 2008. Archaeological and Heritage Impact Assessment on Remainder of Carter Block 458, near Lime Acres, Northern Cape. McGregor Museum

PARSONS, I. 2003. Lithic expressions of Later Stone Age lifeways in the Northern Cape. South African Archaeological Bulletin 58: 33-37.

KAPLAN, J.M. 2010. Archaeological Scoping Study and Impact assessment of a proposed photovoltaic power generation facility in Copperton Northern Cape. Agency for Cultural Resource Management

KAPLAN, J.M. & WILTSHIRE, N. 2011. Archaeological Impact Assessment of a proposed wind energy facility, power line and landing strip in Copperton, Siyathemba municipality, Northern Cape. Agency for Cultural Resource Management

ORTON, JAYSON. 2012a. Heritage Impact assessment for a proposed photovoltaic energy plant on the farm Klipgats Pan near Copperton, Northern Cape. Archaeology Contracts Office Department of Archaeology. University of Cape Town

ORTON, JAYSON. 2012b. Heritage Impact Assessment for a proposed photovoltaic energy plant on the farm Hoekplaas near Copperton, Northern Cape. Archaeology Contracts Office Department of Archaeology. University of Cape Town

ORTON, J. 2014. Archaeological Mitigation of Later Stone Age Sites on the Remainder of Portion 4 of Klipgats Pan 117, Prieska Magisterial District, Northern Cape. ASHA Consulting (Pty) Ltd

Van der Walt, Jaco. 2012. Archaeological Impact Assessment Report for the proposed Garob Wind Energy Facility Project, located close to Copperton in the Northern Cape. Heritage Contracts and Archaeological Consulting CC (HCAC).

Appendix A

LEGISLATIVE PRINCIPLES

LEGISLATIVE REQUIREMENTS – TERMINOLOGY AND ASSESSMENT CRITERIA

3.1 General principles

In areas where there has not yet been a systematic survey to identify conservation worthy places, a permit is required to alter or demolish any structure older than 60 years. This will apply until a survey has been done and identified heritage resources are formally protected.

Archaeological and palaeontological sites, materials, and meteorites are the source of our understanding of the evolution of the earth, life on earth and the history of people. In the new legislation, permits are required to damage, destroy, alter, or disturb them. People who already possess material are required to register it. The management of heritage resources are integrated with environmental resources and this means that before development takes place heritage resources are assessed and, if necessary, rescued.

In addition to the formal protection of culturally significant graves, all graves, which are older than 60 years and are not in a cemetery (such as ancestral graves in rural areas), are protected. The legislation protects the interests of communities that have interest in the graves: they may be consulted before any disturbance takes place. The graves of victims of conflict and those associated with the liberation struggle will be identified, cared for, protected and memorials erected in their honour.

Anyone who intends to undertake a development must notify the heritage resource authority and if there is reason to believe that heritage resources will be affected, an impact assessment report must be compiled at the developer's cost. Thus, developers will be able to proceed without uncertainty about whether work will have to be stopped if an archaeological or heritage resource is discovered.

According to the National Heritage Act (Act 25 of 1999 section 32) it is stated that:

An object or collection of objects, or a type of object or a list of objects, whether specific or generic, that is part of the national estate and the export of which SAHRA deems it necessary to control, may be declared a heritage object, including –

- objects recovered from the soil or waters of South Africa, including archaeological and palaeontological objects, meteorites and rare geological specimens;
- visual art objects;
- military objects;
- numismatic objects;
- objects of cultural and historical significance;
- objects to which oral traditions are attached and which are associated with living heritage;
- objects of scientific or technological interest;
- books, records, documents, photographic positives and negatives, graphic material, film or video or sound recordings, excluding those that are public records as defined in section 1 (xiv) of the National Archives of South Africa Act, 1996 (Act No. 43 of 1996), or in a provincial law pertaining to records or archives; and
- any other prescribed category.

Under the National Heritage Resources Act (Act No. 25 of 1999), provisions are made that deal with, and offer protection, to all historic and pre-historic cultural remains, including graves and human remains.

3.2 Graves and cemeteries

Graves younger than 60 years fall under Section 2(1) of the Removal of Graves and Dead Bodies Ordinance (Ordinance no. 7 of 1925) as well as the Human Tissues Act (Act 65 of 1983) and are the jurisdiction of the National Department of Health and the relevant Provincial Department of Health and must be submitted for final approval to the Office of the relevant Provincial Premier. This function is usually delegated to the Provincial MEC for Local Government and Planning, or in some cases the MEC for Housing and Welfare. Authorisation for exhumation and reinterment must also be obtained from the relevant local or regional council where the grave is situated, as well as the relevant local or regional council to where the grave is being relocated. All local and regional provisions, laws and by-laws must also be adhered to. In order to handle and transport human remains the institution conducting the relocation should be authorised under Section 24 of Act 65 of 1983 (Human Tissues Act).

Graves older than 60 years, but younger than 100 years fall under Section 36 of Act 25 of 1999 (National Heritage Resources Act) as well as the Human Tissues Act (Act 65 of 1983) and are the jurisdiction of the South African Heritage Resource Agency (SAHRA). The procedure for Consultation Regarding Burial Grounds and Graves (Section 36(5) of Act 25 of 1999) is applicable to graves older than 60 years that are situated outside a formal cemetery administrated by a local authority. Graves in the category located inside a formal cemetery administrated by a local authority will also require the same authorisation as set out for graves younger than 60 years over and above SAHRA authorisation.

If the grave is not situated inside a formal cemetery but is to be relocated to one, permission from the local authority is required and all regulations, laws and by-laws set by the cemetery authority must be adhered to.

Appendix C

Heritage Assessment Methodology

The section below outlines the assessment methodologies utilised in the study.

The Heritage Impact Assessment (HIA) report compiled by PGS Heritage (PGS) for the proposed Helena 1 Solar projects will assess the heritage resources found on site. This report will contain the applicable maps, tables and figures as stipulated in the NHRA (no 25 of 1999), the National Environmental Management Act (NEMA) (no 107 of 1998) and the Minerals and Petroleum Resources Development Act (MPRDA) (28 of 2002). The HIA process consists of three steps:

- Step I – Literature Review: The background information to the field survey leans greatly on the Heritage Scoping Report completed by PGS for this site.

- Step II – Physical Survey: A physical survey was conducted on foot through the proposed project area by qualified archaeologists, aimed at locating and documenting sites falling within and adjacent to the proposed development footprint.

- Step III – The final step involved the recording and documentation of relevant archaeological resources, as well as the assessment of resources in terms of the heritage impact assessment criteria and report writing, as well as mapping and constructive recommendations

The significance of heritage sites was based on four main criteria:

- **site integrity** (i.e. primary vs. secondary context),
- **amount of deposit, range of features** (e.g., stonewalling, stone tools and enclosures),
  - Density of scatter (dispersed scatter)
    - Low - <10/50m^2
    - Medium - 10-50/50m^2
    - High - >50/50m^2
- **uniqueness** and
- **potential** to answer present research questions.

Management actions and recommended mitigation, which will result in a reduction in the impact on the sites, will be expressed as follows:

A - No further action necessary;
B - Mapping of the site and controlled sampling required;
C - No-go or relocate pylon position
D - Preserve site, or extensive data collection and mapping of the site; and
E - Preserve site

Site Significance

Site significance classification standards prescribed by the South African Heritage Resources Agency (2006) and approved by the Association for Southern African Professional Archaeologists (ASAPA) for the Southern African Development Community (SADC) region, were used for the purpose of this report.

Table 12: Site significance classification standards as prescribed by SAHRA

FIELD RATING	GRADE	SIGNIFICANCE	RECOMMENDED MITIGATION
National Significance (NS)	Grade 1	-	Conservation; National Site nomination
Provincial Significance (PS)	Grade 2	-	Conservation; Provincial Site nomination
Local Significance (LS)	Grade 3A	High Significance	Conservation; Mitigation not advised
Local Significance (LS)	Grade 3B	High Significance	Mitigation (Part of site should be retained)
Generally Protected A (GP.A)	Grade 4A	High / Medium Significance	Mitigation before destruction
Generally Protected B (GP.B)	Grade 4B	Medium Significance	Recording before destruction
Generally Protected C (GP.A)	Grade 4C	Low Significance	Destruction

Appendix C

Impact Assessment Methodology to be utilised during EIA phase

The EIA Methodology assists in evaluating the overall effect of a proposed activity on the environment. The determination of the effect of an environmental impact on an environmental parameter is determined through a systematic analysis of the various components of the impact. This is undertaken using information that is available to the environmental practitioner through the process of the environmental impact assessment. The impact evaluation of predicted impacts was undertaken through an assessment of the significance of the impacts.

9.1 Determination of Significance of Impacts

Significance is determined through a synthesis of impact characteristics which include context and intensity of an impact. Context refers to the geographical scale i.e. site, local, national or global whereas Intensity is defined by the severity of the impact e.g. the magnitude of deviation from background conditions, the size of the area affected, the duration of the impact and the overall probability of occurrence. Significance is calculated as shown in Table 3.

Significance is an indication of the importance of the impact in terms of both physical extent and time scale, and therefore indicates the level of mitigation required. The total number of points scored for each impact indicates the level of significance of the impact.

9.2 Impact Rating System

Impact assessment must take account of the nature, scale and duration of effects on the environment whether such effects are positive (beneficial) or negative (detrimental). Each issue / impact is also assessed according to the project stages:

- planning
- construction
- operation
- decommissioning

Where necessary, the proposal for mitigation or optimisation of an impact should be detailed. A brief discussion of the impact and the rationale behind the assessment of its significance has also been included.

9.2.1 Rating System Used To Classify Impacts

The rating system is applied to the potential impact on the receiving environment and includes an objective evaluation of the mitigation of the impact. Impacts have been consolidated into one rating. In assessing the significance of each issue the following criteria (including an allocated point system) is used:

NATURE		
Include a brief description of the impact of environmental parameter being assessed in the context of the project. This criterion includes a brief written statement of the environmental aspect being impacted upon by a particular action or activity.		
GEOGRAPHICAL EXTENT		
This is defined as the area over which the impact will be expressed. Typically, the severity and significance of an impact have different scales and as such bracketing ranges are often required. This is often useful during the detailed assessment of a project in terms of further defining the determined.		
1	Site	The impact will only affect the site
2	Local/district	Will affect the local area or district
3	Province/region	Will affect the entire province or region
4	International and National	Will affect the entire country
PROBABILITY		
This describes the chance of occurrence of an impact		
1	Unlikely	The chance of the impact occurring is extremely low (Less than a 25% chance of occurrence).
2	Possible	The impact may occur (Between a 25% to 50% chance of occurrence).
3	Probable	The impact will likely occur (Between a 50% to 75% chance of occurrence).
4	Definite	Impact will certainly occur (Greater than a 75% chance of occurrence).
REVERSIBILITY		
This describes the degree to which an impact on an environmental parameter can be successfully reversed upon completion of the proposed activity.		
1	Completely reversible	The impact is reversible with implementation of minor mitigation measures
2	Partly reversible	The impact is partly reversible but more intense mitigation measures are required.
3	Barely reversible	The impact is unlikely to be reversed even with intense mitigation measures.
4	Irreversible	The impact is irreversible and no mitigation measures exist.
IRREPLACEABLE LOSS OF RESOURCES		
This describes the degree to which resources will be irreplaceably lost as a result of a proposed activity.		
1	No loss of resource.	The impact will not result in the loss of any resources.
2	Marginal loss of resource	The impact will result in marginal loss of resources.
3	Significant loss of resources	The impact will result in significant loss of resources.
4	Complete loss of resources	The impact is result in a complete loss of all resources.

DURATION		
This describes the duration of the impacts on the environmental parameter. Duration indicates the lifetime of the impact as a result of the proposed activity		
1	Short term	The impact and its effects will either disappear with mitigation or will be mitigated through natural process in a span shorter than the construction phase (0 – 1 years), or the impact and its effects will last for the period of a relatively short construction period and a limited recovery time after construction, thereafter it will be entirely negated (0 – 2 years).
2	Medium term	The impact and its effects will continue or last for some time after the construction phase but will be mitigated by direct human action or by natural processes thereafter (2 – 10 years).
3	Long term	The impact and its effects will continue or last for the entire operational life of the development, but will be mitigated by direct human action or by natural processes thereafter (10 – 50 years).
4	Permanent	The only class of impact that will be non-transitory. Mitigation either by man or natural process will not occur in such a way or such a time span that the impact can be considered transient (Indefinite).
CUMULATIVE EFFECT		
This describes the cumulative effect of the impacts on the environmental parameter. A cumulative effect/impact is an effect which in itself may not be significant but may become significant if added to other existing or potential impacts emanating from other similar or diverse activities as a result of the project activity in question.		
1	Negligible Cumulative Impact	The impact would result in negligible to no cumulative effects
2	Low Cumulative Impact	The impact would result in insignificant cumulative effects
3	Medium Cumulative impact	The impact would result in minor cumulative effects
4	High Cumulative Impact	The impact would result in significant cumulative effects
INTENSITY / MAGNITUDE		
Describes the severity of an impact		
1	Low	Impact affects the quality, use and integrity of the system/component in a way that is barely perceptible.
2	Medium	Impact alters the quality, use and integrity of the system/component but system/ component still continues to function in a moderately modified way and maintains general integrity (some impact on integrity).
3	High	Impact affects the continued viability of the system/component and the quality, use, integrity and functionality of the system or component is severely impaired and may temporarily cease. High costs of rehabilitation and remediation.

4	Very high	Impact affects the continued viability of the system/component and the quality, use, integrity and functionality of the system or component permanently ceases and is irreversibly impaired (system collapse). Rehabilitation and remediation often impossible. If possible rehabilitation and remediation often unfeasible due to extremely high costs of rehabilitation and remediation.

SIGNIFICANCE

Significance is determined through a synthesis of impact characteristics. Significance is an indication of the importance of the impact in terms of both physical extent and time scale, and therefore indicates the level of mitigation required. This describes the significance of the impact on the environmental parameter. The calculation of the significance of an impact uses the following formula:

(Extent + probability + reversibility + irreplaceability + duration + cumulative effect) x magnitude/intensity.

The summation of the different criteria will produce a non weighted value. By multiplying this value with the magnitude/intensity, the resultant value acquires a weighted characteristic which can be measured and assigned a significance rating.

Points	Impact Significance Rating	Description
6 to 28	Negative Low impact	The anticipated impact will have negligible negative effects and will require little to no mitigation.
6 to 28	Positive Low impact	The anticipated impact will have minor positive effects.
29 to 50	Negative Medium impact	The anticipated impact will have moderate negative effects and will require moderate mitigation measures.
29 to 50	Positive Medium impact	The anticipated impact will have moderate positive effects.
51 to 73	Negative High impact	The anticipated impact will have significant effects and will require significant mitigation measures to achieve an acceptable level of impact.
51 to 73	Positive High impact	The anticipated impact will have significant positive effects.
74 to 96	Negative Very high impact	The anticipated impact will have highly significant effects and are unlikely to be able to be mitigated adequately. These impacts could be considered "fatal flaws".
74 to 96	Positive Very high impact	The anticipated impact will have highly significant positive effects.

The table below is to be represented in the Impact Assessment section of the report.

IMPACT TABLE FORMAT		
Environmental Parameter	*A brief description of the environmental aspect likely to be affected by the proposed activity e.g. Surface water*	
Issue/Impact/Environmental Effect/Nature	*A brief description of the nature of the impact that is likely to affect the environmental aspect as a result of the proposed activity e.g. alteration of aquatic biota The environmental impact that is likely to positively or negatively affect the environment as a result of the proposed activity e.g. oil spill in surface water*	
Extent	*A brief description of the area over which the impact will be expressed*	
Probability	*A brief description indicating the chances of the impact occurring*	
Reversibility	*A brief description of the ability of the environmental components recovery after a disturbance as a result of the proposed activity*	
Irreplaceable loss of resources	*A brief description of the degree in which irreplaceable resources are likely to be lost*	
Duration	*A brief description of the amount of time the proposed activity is likely to take to its completion*	
Cumulative effect	*A brief description of whether the impact will be exacerbated as a result of the proposed activity*	
Intensity/magnitude	*A brief description of whether the impact has the ability to alter the functionality or quality of a system permanently or temporarily*	
Significance Rating	*A brief description of the importance of an impact which in turn dictates the level of mitigation required*	
	Pre-mitigation impact rating	Post mitigation impact rating
Extent	4	1
Probability	4	1
Reversibility	4	1
Irreplaceable loss	4	1
Duration	4	1
Cumulative effect	4	1
Intensity/magnitude	4	1
Significance rating	-96 (high negative)	-6 (low negative)
Mitigation measures	*Outline/explain the mitigation measures to be undertaken to ameliorate the impacts that are likely to arise from the proposed activity. Describe how the mitigation measures have reduced/enhanced the impact with relevance to the impact criteria used in analyzing the significance. These measures will be detailed in the EMP.*	

Table 13: Rating of impacts

9.3 Impact Summary

The impacts will then be summarized and a comparison made between pre and post mitigation phases as shown in Table 4 below. The rating of environmental issues associated with different parameters prior to and post mitigation of a proposed activity will be averaged. A comparison will then be made to determine the effectiveness of the proposed mitigation measures. The comparison will identify critical issues related to the environmental parameters.

The table below is to be represented in the Executive Summary of the report.

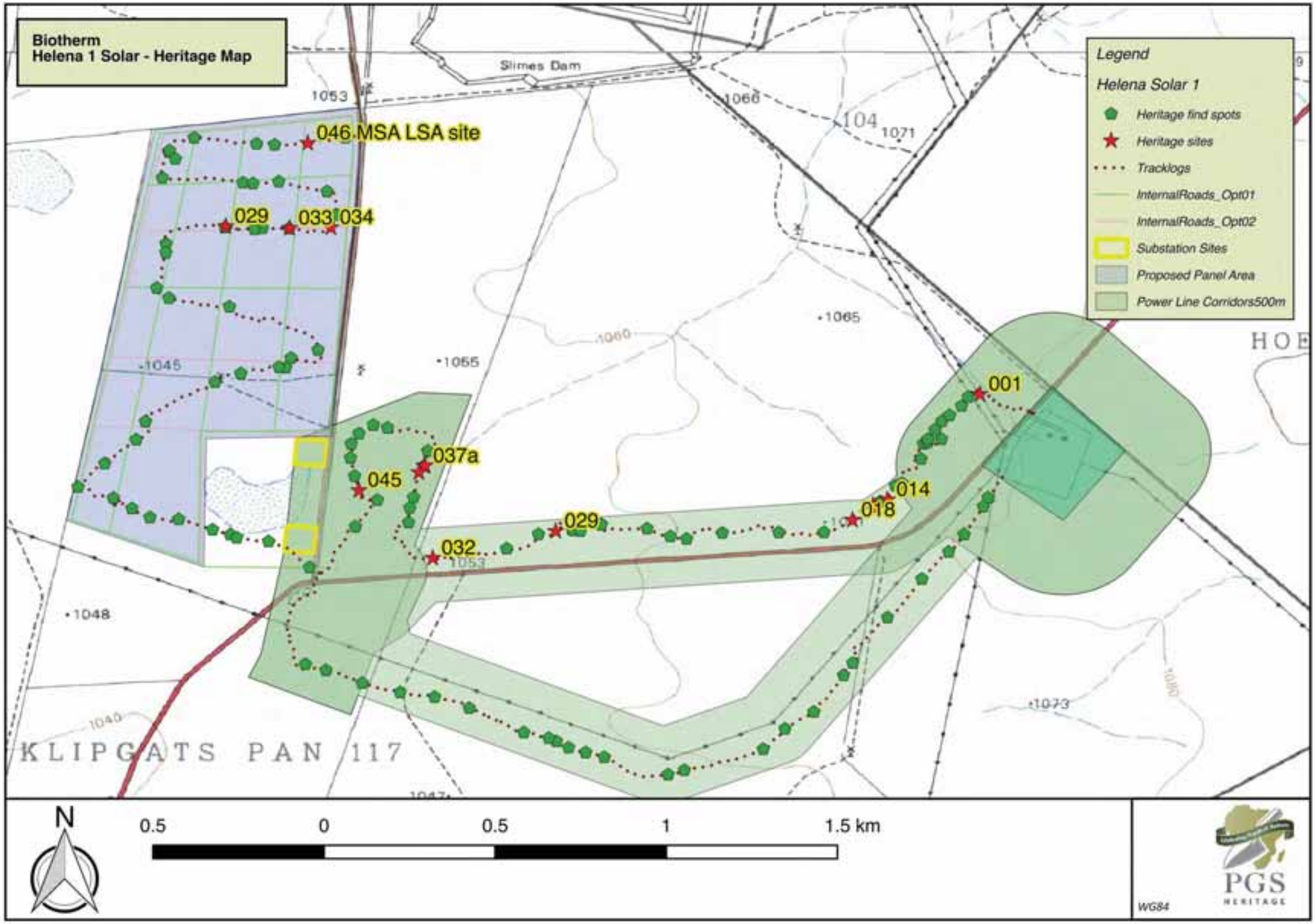
Environmental parameter	**Issues**	**Rating prior to mitigation**	**Average**	**Rating post mitigation**	**Average**
Surface water	Erosion	43		16	
	Oil spills	22		22	
	Alteration of aquatic biota	16		3	
			- 0,0		**-0,0**
			Low Negative Impact		Low Negative Impact

Table 14: Comparison of summarised impacts on environmental parameters

Finally, the 2010 regulations also specify that alternatives must be compared in terms of impact assessment. Hence all alternatives will need to be comparatively assessed.

Appendix D

Heritage Maps


Biotherm
Helena 1 Solar - Heritage Map
Legend
Helena Solar 1
Heritage find spots
Heritage sites
Tracklogs
InternalRoads_Opt01
InternalRoads_Opt02
Substation Sites
Proposed Panel Area
Power Line Corridors500m
046 MSA LSA site
029
033
034
037a
045
032
029
018
014
001
Slimes Dam
KLIPGATS PAN 117
HOE
N
0.5
0
0.5
1
1.5 km
WG84
PGS
HERITAGE

Appendix 6G:

Socio-economic Assessment

ENVIRONMENTAL IMPACT ASSESSMENT FOR THE PROPOSED HELENA 1 SOLAR PHOTOVOLTAIC (PV) ENERGY FACILITY, NEAR COPPERTON, NORTHERN CAPE

July 2015

Socio-Economic Impact Assessment Study
Final Report

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EXECUTIVE SUMMARY

Urban-Econ Development Economists (Urban-Econ) was appointed by SiVest Environmental Division (SiVest) to undertake a Socio-Economic Impact Assessment (SEIA) Study for the proposed Helena 1 Solar Photovoltaic (PV) Energy Facility near Copperton, Northern Cape Province. The SEIA forms part of the Environmental Impact Assessment process managed by SiVest. The SEIA provides an assessment of the economic impacts associated with the development of the solar PV facility and associated infrastructure.

This report details the results of the Socio-Economic Impact Assessment (EIA) specialist study undertaken by Urban-Econ Development Economists as part of the overall Environmental Impact Assessment (EIA) process undertaken by SiVest. The SEIA documented in this report builds on the Socio-Economic Impact Assessment: Scoping Phase Inputs Report compiled as part of the Scoping Phase of the EIA process.

Economic impact refers to the effect on the level of economic activity and the welfare of households in a given area because of some form of external intervention in the economy. The intervention can be in the form of new investment in infrastructure (as in the case of the current assessment), new development, adoption of a new policy or service, expansion of the current operations, etc. The types of economic impact stimulated by the intervention are generally positive and include creation of additional jobs, generation of business sales and value-added, improved quality of life, increase in disposable income, and growth of government revenue.

Any type of intervention does not only create direct benefits experienced by the investor, but has spill over effects on the other economic agents through a multiplier effect. Two types of multiplier effects can be distinguished, i.e. production induced effects or indirect effects and consumption induced effects or induced impacts.

Economic impacts can also be viewed in terms of their duration, or the stage of the project's lifecycle that is being analysed. Generally two phases are subjected to the economic impact assessment namely the construction phase and the operational phase. The construction phase economic impacts are of a temporary nature, they have; therefore, a temporary effect. On the other hand, the operational phase of the project usually takes place over a long-term; hence, the impacts during this stage are generally of a sustainable nature.

After collecting the relevant data for the project and delineating the study area, potential socio-economic impacts of the construction and the operational phases on the local and regional economies were identified and analysed. The results of the impact assessment found that the construction and operation activities will result in various positive economic impacts which are summarised in the table below.

Impact	Nature	Pre-mitigation significance	Post-mitigation significance
Construction phase			
Temporary increase in production	Positive	High	High
Temporary increase in GDP	Positive	Medium	Medium
Temporary increase in employment	Positive	Medium	Medium
Impact on skills development	Positive	Medium	Medium

Temporary increase in household income	Positive	Medium	Medium
Increase in government revenue	Positive	Low	Low
Impact on balance of payment	Negative	Low	Low
Sterilisation of agricultural land	Negative	Low	Low
Increased pressure on basic services	Negative	Low	Low
Increase in social pathologies	Negative	Low	Low
Operational phase			
Sustainable increase in production	Positive	Medium	Medium
Sustainable increase in GDP	Positive	Medium	Medium
Impact on employment	Positive	Medium	Medium
Impact on skills development	Positive	Medium	Medium
Increase in household income	Positive	Low	Low
Increase in government revenue	Positive	Low	Low
Investment in local communities	Positive	Low	Low
Impact on sense of place	Negative	Low	Low

Aside from the improvement of energy security which is key to sustaining and growing the economy, the solar PV facility has the potential to improve the standard of living of households. The project will also assist with the reduction of greenhouse gas emissions that indirectly affect the livelihoods of the global population. Amongst the most prominent socio-economic benefits of solar PV technology, is the project's potential to stimulate local industries and generate new and sustainable employment opportunities. Therefore, from an economic perspective, the project should be approved for development, under the condition that the proposed mitigations are implemented.

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ACRONYMS

CSP	Concentrated Solar Power
DM	District Municipality
DoE	Department of Energy
EA	Environmental Authorisation
ED	Enterprise Development
EIA	Environmental Impact Assessment
FTE	Full-Time Equivalent
GDP	Gross Domestic Product
GDP-R	Gross Domestic Product per Region
GWh	Gigawatt hour
IPAP	Industrial Policy Action Plan
IRP	Integrated Resource Plan
kV	Kilovolts
LM	Local Municipality
MW	Megawatt
NDP	National Development Plan
NGP	National Growth Plan
NGPF	New Growth Path Framework
PV	Photovoltaic
REIPPP	Renewable Energy Independent Power Procurement Producer
SED	Socio-Economic Development
SEIA	Socio-Economic Impact Assessment

1. INTRODUCTION

This document was prepared by **Urban-Econ Development Economists** in response to a request by **SiVest Environmental Division** (SiVest) on behalf of **BioTherm Energy (Pty) Ltd** to undertake a Socio-Economic Impact Assessment (SEIA) Study for the **proposed Helena 1 Solar Photovoltaic (PV) Energy Facility** near Copperton. The SEIA is conducted as part of the Environmental Impact Assessment (EIA) process managed by SiVest. This document provides an assessment of the socio-economic impacts associated with the development of the Helena 1 Solar plant which is one of the three plants proposed for development.

1.1 Project background and description

The Integrated Resource Plan for Electricity 2010-2030 (IRP 2010-2030) promulgated on 6 May 2011 projected that an additional uncommitted capacity of 42 539 megawatts (MW) will be required to support the development in the country over the next twenty years and ensure adequate reserves. About 75% of the required capacity will be generated through the use of renewable energy sources to reduce carbon emissions involved in generating electricity. Specifically, 19.7% or 8 400 MW of the new uncommitted capacity is allocated towards solar Photovoltaic (PV) projects.

In the wake of the IRP targets, government set in motion the Renewable Energy Independent Power Procurement Producer (REIPPP) Programme with the publication of the South African Renewable Energy (RE) IPP Request for Proposals in August 2011. The South African RE IPPP Programme follows a competitive bid process and aims to procure 3 725 MW of renewable energy projects and to contribute towards socio-economic and environmentally sustainable growth, job creation and to stimulate the renewable energy industry in South Africa. In order to submit a bid, the proponent is required to have obtained an Environmental Authorisation (EA) in terms of the Environmental Impact Assessment (EIA) Regulations as well as several additional authorisations or consents. Compliant bids are evaluated on the basis of price and economic development, with allocations of 70 and 30 points out of 100 respectively.

The REIPPP programme was to be broken down into five bidding windows and the progress thus far is shown below:

- The first bid window closed on 4 November 2011 with a total of 53 applications for all renewable energy projects. On 7 December of the same year, Round 1 preferred bidders were announced with 18 PV projects being chosen with a total of 631.5MW of installed capacity.
- The second bid window closed on 5 March 2012 with the submission of 79 renewable energy project bids. On 21 May 2012, government announced the preferred bidders for round two including nine PV projects equating to 417.1MW of installed capacity.
- The third bid window closed on 19 August 2013 with the submission of 93 renewable energy project bids. On 4 November 2013, government announced the preferred bidders for round three which include six PV projects equating to 431MW of installed capacity.
- The fourth bid window closed on 18 August 2014 with the submission of 77 renewable energy project bids. The preferred bidders for round four were announced on 16 April 2015 and include six PV projects equating to 415MW of installed capacity.
- The fifth bid window RFP is planned to be released in the second quarter of 2016.

The Minister of Energy, Ms Tina Joemat-Pettersson, also announced that bidding window 4 of the REIPPP will be extended by a further 1 800 MW to reconsider unsuccessful project bids from windows 1 to 4 (Forder, 2015).

In line with the IRP 2010-2030, BioTherm are proposing the construction of a photovoltaic (PV) power generating facility that will have an installed capacity of 75 MW. The facility is planned to be located on Portion 3 of the farm Klipgats Pan No 117 in the Northern Cape Province.

1.2 Terms of reference and project scope

The terms of reference for the Socio-Economic Impact Assessment require:

- A description of the environment that may be affected by the activity and the manner in which the environment may be affected by.
- A description and assessment of the potential social-economic issues associated with the proposed facility.
- Identification of enhancement and mitigation aimed at maximising opportunities and avoiding and or reducing negative impacts.

The purpose of the socio-economic impact assessment is to determine the potential socio-economic implications of the project activities and associated infrastructure and to compare its effects with the "no-go" alternative. The "no-go" alternative assumes that the proposed 75 MW solar PV plant is not established, which means that it represents the current status of the environment, including the socio-economic situation.

The scope of the socio-economic impact study is thus understood as follows:

- Delineate of the primary, secondary, and tertiary study areas.
- Undertake a policy review and assess the alignment of the proposed project with the national, provincial, and local socio-economic policies.
- Create a socio-economic profile for the study area using primary and secondary data.
- Identify, analyse and interpret potential negative and positive socio-economic impacts that could be created by the proposed project during its life cycle.
- Provide recommendations with respect to possible mitigation measures that could be implemented to reduce potential negative impacts and capitalise on the possible positive economic effects of the project.
- Evaluate potential impacts following a selected methodology for the cases before and after mitigations.

1.3 Project Content, Location and Study Area Delineation

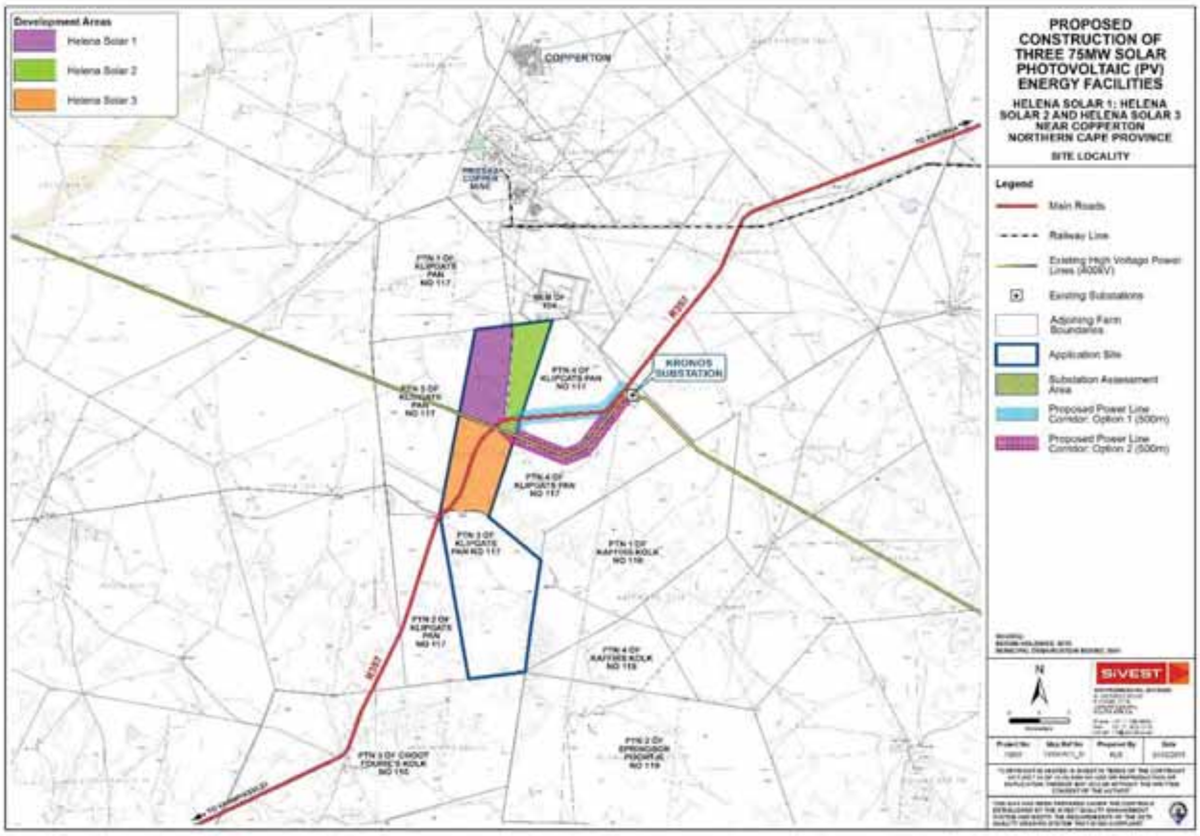
The proposed solar photovoltaic facility will accommodate an array of approximately 300 000 solar PV panels with a generating capacity of 75MW. The total area earmarked for the development of the facility is approximately 430 ha, however, it is envisaged that the 75MW energy facility layout will only require approximately 250 ha. The facility will be linked to the grid via a 132kV power line.

The basic infrastructure associated with the establishment of the Helena 1 Solar PV facility will include:

- Solar PV panels with a generating capacity of 75 MW;
- Onsite substation and transformer to step up power from medium voltage to high voltage;
- 22-33 kV underground cabling in order to feed power to the on-site substation;
- A 132 kV power line linking the on-site substation to the Kronos substation;
- Inverter stations;
- Laydown area for temporary storage of materials;
- Internal access roads;
- Car park and fencing around the project; and
- Administration, control and warehouse buildings.

It should be noted that the possibility to allow shared associated infrastructure will be considered should the other two PV projects that are being proposed by BioTherm on the same farm also be granted EAs and be awarded preferred bidder status (SiVest, 2015).

The proposed project is to be located near Copperton in the Siyathemba Local Municipality (LM), which is part of the Pixley ka Seme District Municipality (DM) situated in the Northern Cape Province. It is envisaged that the solar panels will be set up on Portion 3 of Klipgats Pan No 117 while the power line will run on Portion 4 of Klipgats Pan No 117 as illustrated in Map 1-1.



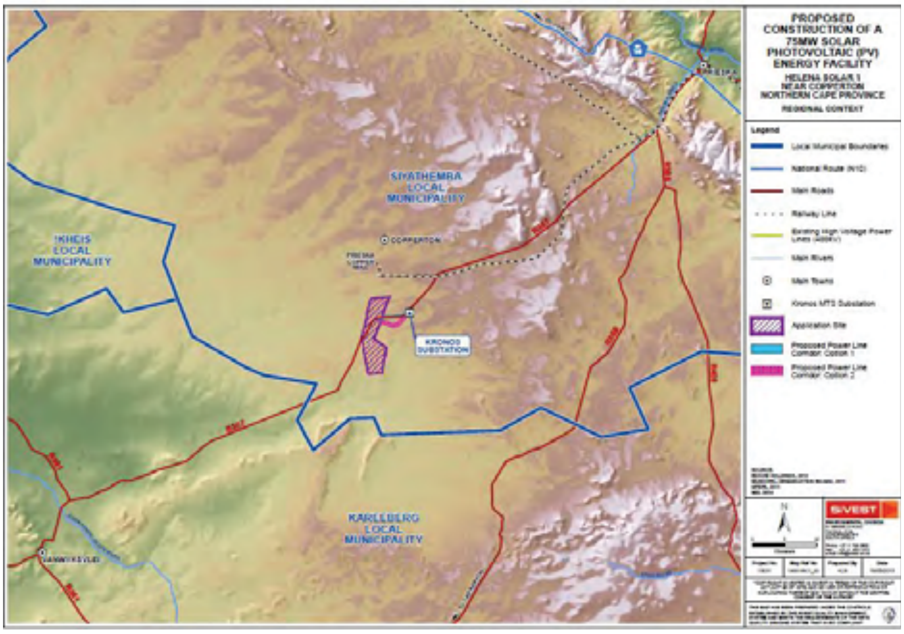
Map 1-1: Project location (SiVest, 2015)

In order to delineate the study area, it is important to understand the concept of socio-economic impacts. The socio-economic impacts on the project area and surrounds are dependent on the activity and the structure and composition of the locality. The more diversified the immediate locality of the project is in terms of its socio-economic variables, the more concentrated the impact will be in that area. Understanding the potential distribution and concentration of impacts is important to determine the magnitude and significance of these impacts in the context of spatial units.

The project area is characterised by a largely dispersed settlement pattern. The closest major town to Copperton is Prieska, which is situated in the Siyathemba LM about 60 km north-east from the project site by road. According to Census 2011 data, the Siyathemba LM population is 21 593. However, only a small percentage of the people in this municipality have some form of higher education, which means that many skilled and high-skilled workers will most likely be sourced from other parts of the country and possibly even from other countries; while those positions requiring little or no skill would be available for the locals. Aside from the above, the proposed project could be associated with a number of social, economic and environmental impacts. These might impact people and economic activities situated in close proximity to the site.

Given the above, the study areas for the analysis have been defined as follows:

- Primary study area refers to the locality where direct economic impacts of the proposed activity are to be concentrated. The primary study area was chosen to be the site as well as adjacent farms which form the immediate zone of influence, Prieska and the Siyathemba LM.
- Secondary study area includes the Northern Cape Province. The proposed project is to be located about 60km away from Prieska and about 280km away from Kimberley; which is a major urban centre of the Northern Cape Province. Thus it is safe to assume that some of the inputs required for the establishment and operations would be sourced from the Northern Cape, i.e. the same province where the project is located.
- Tertiary study area is South Africa. The indirect effects of the construction and operation of the facility will be distributed throughout the country and will not be concentrated in a particular municipality. At the same time certain inputs will be sourced from outside South Africa and would have a macro-level negative effect, again highlighting the need to look at the country's profile.



Map 1-2: Regional context of project site (SiVest, 2015)

1.4 Methodology

The methodology employed in conducting the study comprised of three main steps as described below:

Step 1: Study area profiling

Profiling involved the description of the study area in terms of selected economic variables. It included the analysis of parameters such as population size and household numbers, structure and growth of the economy, labour force, and employment situation. Profiling for the study was done making use of the Quantec Research database and selected Stats SA statistics, such as Census 2011.

Step 2: Impact identification

This step included the identification of the potential sensitive receptors and beneficiaries of the project and description of socio-economic impacts that could be expected during various phases of the project's life cycle. The identification of potential socio-economic issues associated with proposed facility is based on interviews with directly affected and adjacent land owners, review of relevant documentation, and experience with similar projects.

Step 3: Impact evaluation and recommendations

The purpose of this step was to interpret the identified socio-economic impacts in the context of their effects on the local communities and economies. Where applicable, measures to reduce or eliminate negative impacts and enhance positive impacts were proposed.

All impacts identified were rated according to the evaluation methodology prescribed by the environmental consultant. The following table outlines various ratings used to determine different levels of severity, spatial scale, duration, and probability during evaluation.

Table 1-1: Criteria options and associated rating

NATURE		
This criterion includes a brief written statement of the environmental aspect being impacted upon by a particular action or activity.		
GEOGRAPHICAL EXTENT		
This is defined as the area over which the impact will be expressed.		
1	Site	The impact will only affect the site
2	Local/district	Will affect the local area or district
3	Province/region	Will affect the entire province or region
4	International and National	Will affect the entire country
PROBABILITY		
This describes the chance of occurrence of an impact		
1	Unlikely	The chance of the impact occurring is extremely low (Less than a 25% chance of occurrence).
2	Possible	The impact may occur (Between a 25% to 50% chance of occurrence).
3	Probable	The impact will likely occur (Between a 50% to 75% chance of occurrence).
4	Definite	Impact will certainly occur (Greater than a 75% chance of occurrence).
REVERSIBILITY		
This describes the degree to which an impact on an environmental parameter can be successfully reversed upon completion of the proposed activity.		
1	Completely reversible	The impact is reversible with implementation of minor mitigation measures

2	Partly reversible	The impact is partly reversible but more intense mitigation measures are required.
3	Barely reversible	The impact is unlikely to be reversed even with intense mitigation measures.
4	Irreversible	The impact is irreversible and no mitigation measures exist.
IRREPLACEABLE LOSS OF RESOURCES		
This describes the degree to which resources will be irreplaceably lost as a result of a proposed activity.		
1	No loss of resource.	The impact will not result in the loss of any resources.
2	Marginal loss of resource	The impact will result in marginal loss of resources.
3	Significant loss of resources	The impact will result in significant loss of resources.
4	Complete loss of resources	The impact is result in a complete loss of all resources.
DURATION		
This describes the duration of the impacts on the environmental parameter. Duration indicates the lifetime of the impact as a result of the proposed activity		
1	Short term	The impact and its effects will either disappear with mitigation or will be mitigated through natural process in a span shorter than the construction phase (0 – 1 years), or the impact and its effects will last for the duration of a relatively short construction period and a limited recovery time after construction, thereafter it will be entirely negated (0 – 2 years).
2	Medium term	The impact and its effects will continue or last for some time after the construction phase but will be mitigated by direct human action or by natural processes thereafter (2 – 10 years).
3	Long term	The impact and its effects will continue or last for the entire operational life of the development, but will be mitigated by direct human action or by natural processes thereafter (10 – 50 years).
4	Permanent	The only class of impact that will be non-transitory. Mitigation either by man or natural process will not occur in such a way or such a time span that the impact can be considered transient (Indefinite).
CUMULATIVE EFFECT		
This describes the cumulative effect of the impacts on the environmental parameter. A cumulative effect/impact is an effect which in itself may not be significant but may become significant if added to other existing or potential impacts emanating from other similar or diverse activities as a result of the project activity in question.		
1	Negligible Cumulative Impact	The impact would result in negligible to no cumulative effects
2	Low Cumulative Impact	The impact would result in insignificant cumulative effects
3	Medium Cumulative impact	The impact would result in minor cumulative effects
4	High Cumulative Impact	The impact would result in significant cumulative effects

INTENSITY / MAGNITUDE		
Describes the severity of an impact		
1	Low	Impact affects the quality, use and integrity of the system/component in a way that is barely perceptible.
2	Medium	Impact alters the quality, use and integrity of the system/component but system/ component still continues to function in a moderately modified way and maintains general integrity (some impact on integrity).
3	High	Impact affects the continued viability of the system/component and the quality, use, integrity and functionality of the system or component is severely impaired and may temporarily cease. High costs of rehabilitation and remediation.
4	Very high	Impact affects the continued viability of the system/component and the quality, use, integrity and functionality of the system or component permanently ceases and is irreversibly impaired (system collapse). Rehabilitation and remediation often impossible. If possible rehabilitation and remediation often unfeasible due to extremely high costs of rehabilitation and remediation.

Significance is determined through a synthesis of impact characteristics. Significance is an indication of the importance of the impact in terms of both physical extent and time scale, and therefore indicates the level of mitigation required. This describes the significance of the impact on the environmental parameter. The calculation of the significance of an impact uses the following formula:

(Extent + probability + reversibility + irreplaceability + duration + cumulative effect) x magnitude/intensity.

The summation of the different criteria will produce a non-weighted value. By multiplying this value with the magnitude/intensity, the resultant value acquires a weighted characteristic which can be measured and assigned a significance rating.

Table 1-2: Impact significance thresholds

Points	Impact Significance Rating	Description
6 to 28	Negative Low impact	The anticipated impact will have negligible negative effects and will require little to no mitigation.
6 to 28	Positive Low impact	The anticipated impact will have minor positive effects.
29 to 50	Negative Medium impact	The anticipated impact will have moderate negative effects and will require moderate mitigation measures.
29 to 50	Positive Medium impact	The anticipated impact will have moderate positive effects.

51 to 73	Negative High impact	The anticipated impact will have significant effects and will require significant mitigation measures to achieve an acceptable level of impact.
51 to 73	Positive High impact	The anticipated impact will have significant positive effects.
74 to 96	Negative Very high impact	The anticipated impact will have highly significant effects and are unlikely to be able to be mitigated adequately. These impacts could be considered "fatal flaws".
74 to 96	Positive Very high impact	The anticipated impact will have highly significant positive effects.

2. POLICY REVIEW

A policy review plays an integral role in the early stages of a project. The review provides a high level indication of whether a project is aligned with the goals and aspirations of the developmental policy within a country and at a local level. Furthermore, the analysis signposts any red-flags or developmental concerns that could jeopardise the development of the project; thus, assisting in making an informed decision with respect to the proposed project's location.

The following government strategic documents applicable to the delineated study areas were examined:

- National (South Africa):
  - New Growth Path Framework (NGPF) (2011)
  - White Paper on Renewable Energy (2003)
  - Integrated Resource Plan (IRP) 2010-2030 promulgated in 2011
  - Integrated Resource Plan (IRP) 2010-2030: Update Report 2013
  - National Development Plan (NDP) 2030 (2011 – 2030)
  - Industrial Policy Action Plan (IPAP) (2014/2015 – 2016/2017)
- Regional (Limpopo Province and Mpumalanga Province):
  - Northern Cape Provincial Spatial Development Framework (2012)
  - Northern Cape Provincial Growth and Development Strategy
- Local (Pixley ka Seme district Municipality and Siyathemba LM):
  - Pixley Ka Seme District Municipality Integrated Development Plan (2011-2016)
  - Siyathemba Local Municipality Integrated Development Plan
  - Siyathemba Local Municipality Local Economic Development Strategy

The **New Growth Path Framework** (Department of Economic Development, 2010) and the **National Development Plan 2030** (National Planning Commission , 2011) confer that all regions are to seize the advantages of the natural resources endowed to them towards achieving accelerated economic growth, poverty alleviation and job creation. This however, should be done in a sustainable and equitable manner. The NGP identifies the green economy as one of the key sectors for job creation which will be achieved through expansions in construction and the production of technologies for solar, wind and biofuels, clean manufacturing and environmental services. The NDP 2030 sets a target of creating approximately 11 million new jobs and achieving an annual average economic growth rate of 5.4% by 2030. The National Development Plan 2030 seeks to ensure that half of all new electricity generating capacity is provided through renewable energy resources. Related to this objective, is the importance of transitioning towards a low carbon economy, which is in line with international protocols and ambitions.

In its **White Paper on Renewable Energy** (Department of Minerals and Energy, 2003) the South African government sets out its vision, policy principles, strategic goals and objectives for promoting and implementing renewable energy in the country. One of these is the "target of 10 000 GWh (0.8 Mtoe) renewable energy contribution to final energy consumption by 2013, to be produced mainly from biomass, wind, solar and small-scale hydro." It also outlines the need for government to create an enabling environment; i.e. fiscal and financial mechanisms within an appropriate legal and regulatory framework, to allow renewable energy technologies to compete with fossil-based technologies. Furthermore, the **Integrated Resource Plan (IRP) 2010 – 2030** (Department of Energy , 2011) explicitly spells out the need to support the development of a local industry for renewable technologies, with a particular focus on wind and solar. The IRP provides for a diversified energy mix, in terms of new generation capacity, that will comprise inter alia, renewable energy carriers, which include hydro at 6,1%, wind at 19,7%, concentrated solar power at 2,4% and photovoltaic at 19,7%.To this end, the government has set up the Renewable Energy Independent Power Producer Procurement Programme (REIPPP) which "provides an ideal vehicle to support the development of a competitive renewable energy manufacturing sector and related support industries" and announced in December 2012 an additional 3 200 MW available for procurement by 2020 (Department of Trade and Technology, 2013).

It was indicated at the time of promulgation that the IRP should be a "living plan", which would be revised by the Department of Energy (DoE) every two years; to this end the update report was formulated in 2013. According to the **IRP 2010-2030 Update Report** the economic situation in South Africa has changed and the energy sector in the country has undergone some developments since the promulgation of the IRP in 2011. The electricity demand outlook has been downgraded, which reduced the targeted installed capacity by 2030 from 67 800 MW to 61 200 MW (Department of Energy, 2013). In addition, certain developments and uncertainties in the energy sector such as change in technology cost, potential for shell gas and future cost of fuel necessitated the revision of the future path taken to build up necessary electricity generating capacities in the country. As a result, the allocation of installed capacities among various technologies has changed and would depend on the scenario chosen. For the base case, the nuclear capacity is planned to be reduced, while the gas capacity increases and CSP increases substantially at the expense of wind capacity. However, PV capacity remains important and even increases slightly; from 8 400 MW in the original IRP 2010 policy adjusted plan to 9 770 MW in the IRP update report.

The **IPAP 2014/2015 – 2016/2017** represents the sixth annual iteration of the first IPAP launched in the 2007/8 financial year. It represents a significant step forward in scaling up the country's efforts to promote long term industrialisation and industrial diversification beyond the current reliance on traditional commodities and non-tradable services and also to promote sustainable development. The IPAP identifies green industries as one of the key sectors in which to strengthen industrial policy interventions. To further the country's development of and transition to a green economy. The IPAP focuses on improving opportunities in the market and strengthening capacity in solar and wind power generation and therefore increasing the local content of renewable energy projects in South Africa.

The **Northern Cape Provincial Spatial Development Framework** makes reference to renewable energy sources, stating that, "there is considerable potential for wind energy … along the Namaqualand area and in certain parts of the interior of the province". Feasibility and desirability of a large scale wind energy plant on the coastland therefore, needs to be assessed and, if desirable, promote the development thereof. It also makes reference to the energy targets as set out in the White Paper for Renewable Energy and the impacts associated with achieving the target, which include, among others, adding 1 667MW new renewable energy capacity, creation of additional government revenue, creation of jobs and a contribution towards water saving. To this end the document notes that energy supply schemes need to be developed and instituted so as to contribute to the targets as set out.

The importance of developing the renewable energy sector is further corroborated by the **Northern Cape Provincial Growth and Development Strategy (NCPGDS).** The NCPGDS makes reference to the need to ensure availability of affordable energy. It notes, "in order to promote economic growth in the Northern Cape the availability of electricity to key industrial users at critical localities at rates that enhance the competitiveness of their industries must be ensured." At the same time, the development of new sources of energy through the promotion of the adoption of energy applications that display a synergy with the province's natural resource endowments must be encouraged. In this regard the NCPGDS notes that, "development of energy sources such as solar energy, the natural gas fields, bio-fuels, etc.; could be some of the means by which economic opportunity and activity is generated in the Northern Cape". The NCPGDS also notes that "sustainable utilisation of the natural resource base on which agriculture depends is critical in the Northern Cape with its fragile eco-systems and vulnerability to climatic variation". In this regard, care needs to be taken to ensure that renewable energy facilities do not impact negatively on the region's natural environment. The document further indicates the planned solar corridor stretching from the Pixley ka Seme region to the //Khara Hais Municipality in ZF Mgcawu (Siyanda) District Municipality

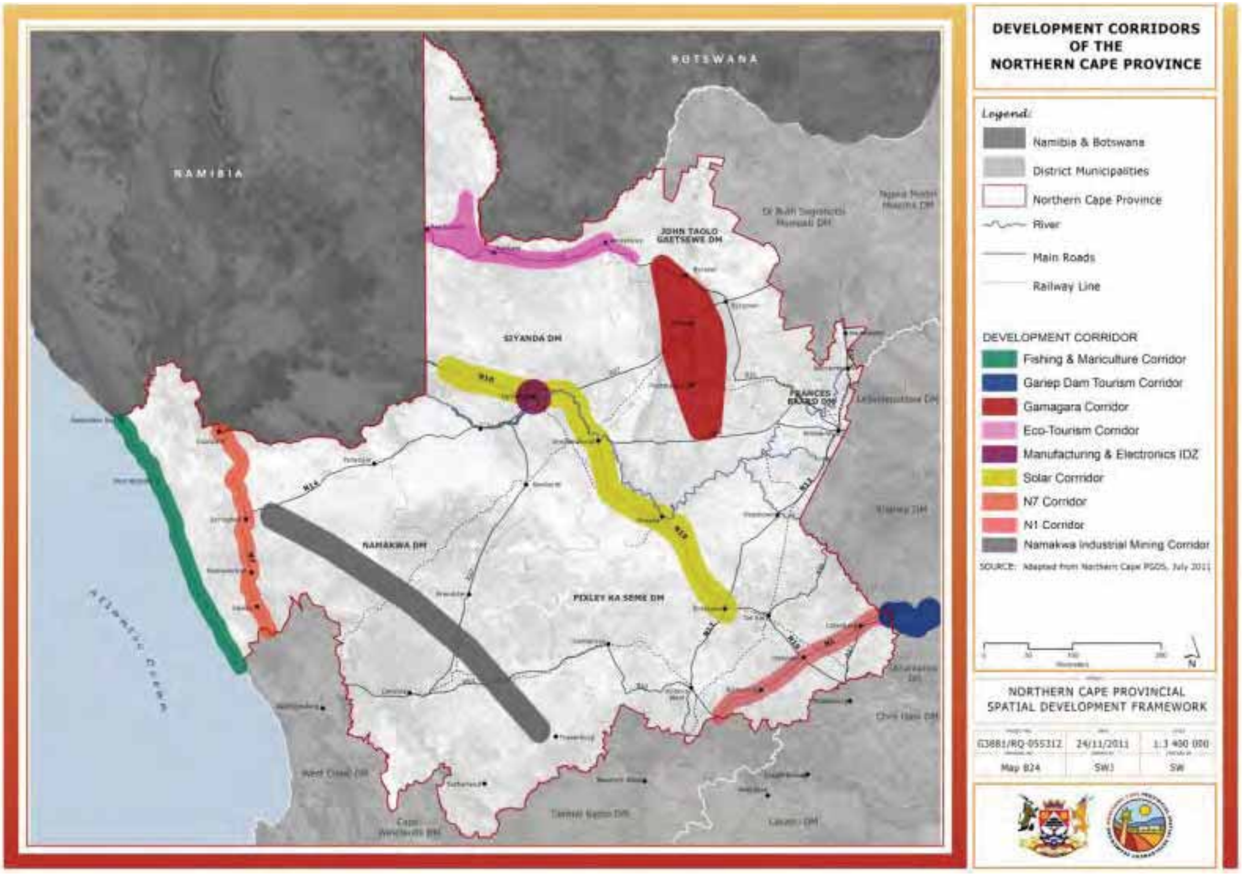


Figure 2-1: Development corridors of the Northern Cape (Dennis Moss Partnership, 2012)

With the recognition of the potential in the Northern Cape and the construction of large solar and wind power stations, it is no surprise that the province is fast becoming the country's renewable energy hub through the construction of large solar and wind power stations. The Renewable Energy Independent Producers Procurement Programme, directed by the Department of Energy, has so far approved 31 projects for the province. The fast growing renewable energy and green economy sector in the province concentrates mainly on solar energy and is expected to attract massive investments.

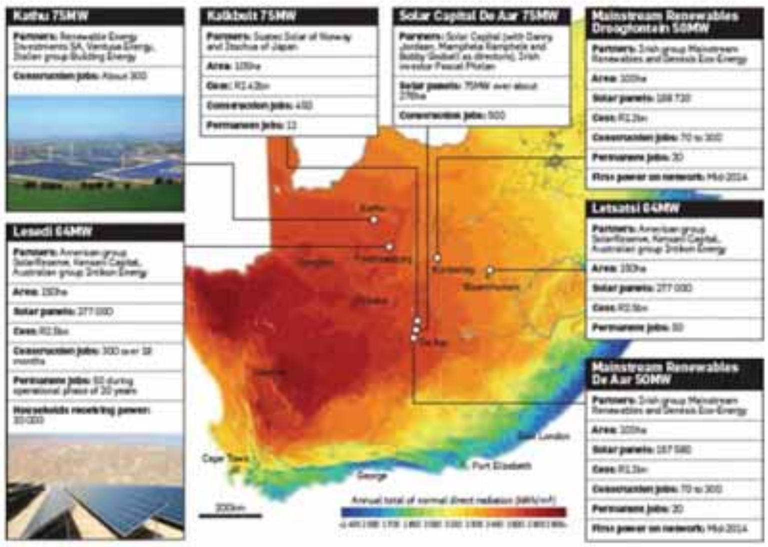


Figure 2-2: Large solar PV project in the Northern Cape

The **Pixley ka Seme DM IDP** has identified the need for attraction and retention of investors in the region. Renewable energy projects have the potential to attract a number of investors. With regard to energy/electricity, the district municipality is currently in the process of promoting the use of renewable energy (solar, wind, gas, biomass and bio-digestion) as an alternative source of energy for industrial, agricultural and domestic uses (Pixley ka Seme District Municipality, 2011). The IDP also recognises renewable energy projects as being in line with identified local economic development objectives and strategies, and notes that their promotion could reverse the current trends of decline and lack in diversity of the economy. The Siyathemba Local Municipality believes that renewable energy development is an opportunity for economic development in the municipality and further states in the **Siyathemba LM IDP** that "electricity shortages could be alleviated through local production, which could justify investment in a local solar power plant" (Siyathemba Local Municipality, 2014).

The **Siyathemba LM LED Strategy** is focused on developing the economic and natural resources of the area. Its goals are to promote agricultural and rural development, tourism, industrial development and creating a safe environment for business. One of the development opportunities identified in the agricultural sector is investment in a local solar power plant in order to alleviate electricity shortages. The local production of solar panels that could supply the utilities sector of the Northern Cape is also a development opportunity identified by the LED strategy for the manufacturing sector (Siyathemba Local Municipality, 2012).

To summarise, this project will assist in achieving some of the governmental objectives which include, increased energy security, transitioning to a low carbon economy, development of a competitive renewable energy manufacturing sector and job creation. The project will also aid the efforts to diversify and reverse the declining trend of the local municipality's economy. The policies also guard against unsustainable use of natural resources citing that care needs to be taken to ensure that renewable energy facilities do not impact negatively on the region's natural environment. However considering that the site is located in an abandoned town with low agricultural potential and a low population density, it can be argued that the project will not disturb the natural environment significantly. It therefore appears that the project is not in conflict with any of the key policies and strategies reviewed but it is rather aligned with key economic development priorities.

3. BASELINE INFORMATION

This chapter examines key socio-economic characteristics of the study area. This is essential as it provides both qualitative and quantitative data related to the communities and economies under observation, creating a baseline against, which the impacts can be assessed.

3.1 Study area's composition

Spatial context and regional linkages

The proposed Copperton Solar PV Plant is located in the Siyathemba Local Municipality, which is one of the eight local municipalities making up the Pixley ka Seme District Municipality. The other seven local municipalities are Thembelihle Local Municipality, Emthanjeni Local Municipality, Siyancuma Local Municipality, Umsobomvu Local Municipality, Ubuntu Local Municipality, Kareeberg Local Municipality and Renosterberg Local Municipality.

The **Northern Cape Province** is geographically the largest province in South Africa covering an area of 372 889 km^2, which constitutes approximately 30% of the country's total area. Despite having the largest surface area, the Northern Cape Province is the least populated of all nine provinces. According to Census 2011, the province's population was 1 145 859 or 2.2% of the national population. The province is bordered by Namibia and Botswana in the north, while domestically, the North West Province borders it in the north-east, the Free State Province in the east, the Eastern Cape Province in the south-east and the Western Cape Province to the south and south-west. The Northern Cape consists of five districts, namely Frances Baard, Pixley ka Seme, Namakwa, ZF Mgcawu (previously known as Siyanda) and John Taolo Gaetsewe.

Pixley ka Seme DM which lies in the south-east of the Northern Cape Province is geographically the second largest of the five district municipalities and covers a surface area of 103 410 km^2. It is bordered by the Free State in the east, ZF Mgcawu District in the north, the Eastern Cape Province to the south, and Namakwa District in the west. The total population of the district, according to the 2011 Census, was approximately 186 349; making it the municipality with the second lowest population in the Province.

The **Siyathemba LM** is located within the central eastern parts of the Northern Cape Province and is traversed from the east to west by the Orange River, the country's largest river. The municipality covers a geographic area of 14 725 km^2. Prieska functions as the administrative seat of the local municipality. Other settlements include Marydale, Nierkerkshoop and Copperton.

Spatially, Siyathemba is very distant from South Africa's largest consumer markets. The area is traversed by the R357 which links the site to Prieska. Prieska has easy access to the main railway line to Namibia, good tarred road connections to Upington, Kimberly and De Aar. It is located some 182 km from De Aar (administrative seat of the Pixley ka Seme DM) and 236 km from Kimberley.

Towns and Settlements

Copperton was once a populated town, providing accommodation for the mine workers and their families. It was then sold to a private owner after the closing of the Copperton Mine and is currently on a long-term lease by the Request Trust. Some of the houses were initially demolished but after the lease agreement was signed with the Request Trust, an agreement was reached that the rest of the houses could be retained (Siyathemba Local Municipality, 2014). According to the Census 2011 results, the population of Copperton was 55 with 33 households. A few of these houses are used by Denel SOC Ltd,which operates a missile testing centre in the area (Wikipedia, 2014).

Figure 3-1: Settlements and towns near the project site

The site is located in a rural area and as such, the population density is very low, with major towns located kilometres away. The closest major town to Copperton is Prieska, which is approximately 60 km away in the same local municipality. Prieska is home to 14 248 people LM (Stats SA, 2014). Marydale, situated 60km north-west of Copperton, is also a rural service centre near the site also located in the Siyathemba LM. Nierkerkshoop, another rural service centre, is approximately 80 km north-east.

Siyathemba LM has a population of 21 593 people, comprising of 5 830 households. The most dominant population group is coloured. This group represents 80% of the total population in the municipal area; other groups are black (12%) and white (8%). Education levels in the municipality are low, with approximately 1 500 people out of the adult population having no schooling all, while only 2 200 people have completed high school and 720 people have a higher education qualification.

In 2011, the unemployment rate in Siyathemba LM was 24.7%. The main employment industry is farming, followed by mining. The level of unemployment in the area is low with 7.5% having no income at all, and a further 58.6% earning less than R3 200 per month. The land uses in the area are mainly agriculture, consisting mostly of sheep farming and production of wheat, maize, lucerne, cotton, beans and peanuts.

Prieska is the administrative seat of the Siyathemba Local Municipality and is located on the Southern Bank of the Orange River, approximately 50km northeast of the proposed site. While relatively isolated, Prieska has good access to the main railway line to Namibia, good tarred road connections to Upington, Kimberley and De Aar, and two landing strips for light aircrafts. The Prieska area is also known for its high quality semi-precious stones, specifically tiger's eye.

Resources and land capability

Generally, the area does not have any significant mineral deposits. To the south of Prieska, on the farm Doornfontein, a medium-sized mineral deposit of Phosphate can be found. Various small mineral deposits can be found near Niekerkshoop. These include Tiger's-eye and Crocidolite (Asbestos). Small deposits of

Alluvial Diamonds can be found in the Orange River. Other small mineral deposits within the Municipal boundary include Salt, Gypsum, Iron and Uranium (Siyathemba Local Municipality, 2012).

The Orange River runs through the Municipality and provides ideal conditions for irrigation farming in Siyathemba, especially the cultivation of grains and vegetables.

The town of Prieska is located on the south bank of the Orange River at the foot of the Doringberg. It was originally named Prieskap, a Khoisan word meaning, “lace of the lost she-goat”. The following are the main Tourism attractions in the region (Siyathemba Local Municipality, 2014):

- Die Bos Nature Reserve
- British Fort
- Green Valley Nuts
- The Oranjezicht and Keikamspoort Hiking Trails
- Khoisan Rock Art
- Memorial Garden
- Prieska Museum
- Ria Huysamen Aloe Garden Schumann Rock Collection
- Wonderdraai Island

Land-uses within the affected zone of influence

The surrounding land uses are mainly agriculture, consisting mostly of sheep grazing. The main livestock farming in the region include cattle, sheep and goat farming (Siyathemba Local Municipality, 2014).

The interviews with the farm owners within the affected zone of influence corroborates the fact that the area is mainly used for sheep farming. Land-use information for some the farms where various components of the project will be established is discussed in detail in section four.

3.2 Demographic Profile and Income Levels

The population of any geographical area is the cornerstone of the development process, as it affects the economic growth through the provision of labour and entrepreneurial skills, and determines the demand for the production output. Examining population dynamics is essential in gaining an accurate perspective of those who are likely to be affected by any prospective development or project.

The Siyathemba LM is home to approximately 21 593 people, with a total of 5 830 households (Stats SA). The population has increased by 14.9% from 18 376 in 2001. A large portion (87.2%) of the population in the LM resides in urban areas, while the rest (12.8%) lives in on farms. Both urban to urban migration, and rural to urban migration are relevant in the Pixley ka Seme region, including the Siyathemba LM. Rural to urban migration is perceived as the dominant migration type at present (Pixley ka Seme District Municipality, 2011). The large proportion of people living in the urban area can be explained by the ease of access to opportunities and services within the larger urban centres, in this case Prieska. The majority (72.2%) of the people in the municipality are Coloured with 18.5% of the population being Black, followed by White 8.4%), and Indians/Asians (0.5%). Afrikaans is the language most spoken in the LM. The municipality’s gender ratios are not very skewed, the female population (50.1%) accounts for slightly more of the LM's population compared to the male population (49.9%).

The youth (age 15-34) make up the majority of the people living in the Siyathemba LM with 31.7%, followed by the group between the ages of 35 and 64 years with 31.4%. Considering the working age group that is between the ages of 15 and 64 years, the municipality has a slightly bigger percentage of working age males than females (refer to Figure 3-2). The population in the area is characterised by a high dependency ratio (58.5%) with a total of 36.8% of the population within the ages of 0 to 14 years (30.6%) and over 65 years old (6.2%). According to the district municipality's IDP, the implications of this population structure are a higher demand on the provision of social and physical facilities, like schools, primary health care centres, etc.

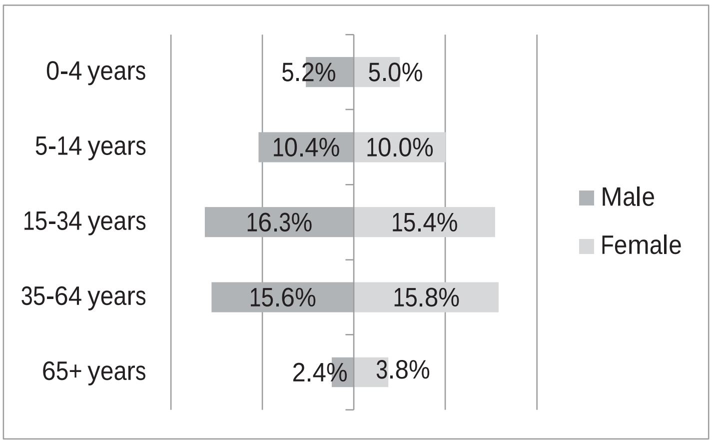


Figure 3-2: Age and gender profile (Quantec, 2015)

In terms of education levels in the LM, 11.5% of the adult population (over 20 years of age) had no education at all, while 64% have primary or secondary education (Stats SA, 2015).Those with higher educational qualifications accounted for 5.5% of the population. These figures indicate an increase in all categories since 2001, except for the no schooling, some primary, and some secondary categories. In general, there has been an improvement in the educational qualifications of the labour force in the local municipality. The no schooling category decreased by 10%, indicating a higher percentage of people attending school. While the share of people with no schooling at district level is 14.1%, the percentage of people with no schooling is notably lower at provincial (11.1%) and LM (11.5%) level. Additionally, the number of people who have completed matric in Siyathemba is 17.3%, which is lower than the 20% and 22.1% at district and provincial levels, respectively.

The average monthly household income in the Siyathemba LM was R6 858 in 2014 prices. This was less than the national, provincial and district levels which had average household incomes of R9 743, R8 116, and R7 030. Overall, approximately two thirds of the population in the Siyathemba LM earns up to R3 400 a month; this is larger than the same group at district and provincial level. According to the Pixley ka Seme IDP, the cut-off monthly household income for indigence in the Siyathemba LM is R1 500. This means those households who, due to a number of socio-economic factors are unable to afford basic services such as water, basic sanitation, basic energy, health care, housing, food and clothing. From income data obtained in the 2011 Census, approximately 39.4% of the households would qualify as indigent in the local municipality.

3.3 Structure of the Economy

The structure of the economy and the composition of its employment provide valuable insight into the dependency of an area on specific sectors and its sensitivity to fluctuations of global and regional markets. Knowledge of the structure and the size of each sector are also important for the economic impact results' interpretation, as it allows the assessment of the extent to which the proposed activity would change the economy, its structure, and trends of specific sectors.

The Northern Cape Province contributes the least percentage (2.3%) to the country's Gross domestic Product (GDP). However, although the Northern Cape Province has the smallest economy of the nine provinces, Gross Domestic Product of the Region (GDPR) per capita is higher than national average which is R59 917 and R58 533, respectively. The Siyathemba LM economy was valued at R 796 million in current prices. The LM contributed 10.9% to the economy of the Pixley ka Seme District and made a contribution of 1.2% to the province's economy. Over a period of ten years (2003-2013), the municipality's economy grew at a Compounded Average Growth Rate (CAGR) of 2.4% per year. This was slightly higher than the district and provincial average growth rates of 1.8% and 2.3%, respectively.

In terms of economic activities, the economy of the Northern Cape Province depends heavily on the primary sectors of the economy (agriculture and mining) which made up 36.5% of GDP-R in 2013. The largest sector is mining, which has been fluctuating between periods of growth and decline in contribution to the GDP-R. Agriculture, on the other hand has declined in contribution from 8.7% in 2002 to 5.4% in 2013. A worrying characteristic of the Northern Cape Province is the limited amount of processing of the primary commodity output in agriculture and mining. This is evident in the fact that the manufacturing sector contributes only 2.4% towards GDP-R. All industries in the secondary sector have shown very little growth if any. The tertiary sector was the largest contributor to the economy of the Northern Cape Province, making up 56.8% of GDP-R. General government services (15.2%) were the second largest industry contributors after mining (31.2%).

Contrary to the province's economy, mining and quarrying continues to be a small contributor to the economy of the LM, making a meagre 3.1% contribution compared to the province's 31.2%. The mining sector historically played a major role in the local economy, with asbestos and copper mining the key activities. Currently, mining activities are mainly related to alluvial diamond mining activities along the Orange River. The closure of the asbestos mines as well as the Copperton mine, has had a major lasting negative impact on the Siyathemba LM economy. On the other hand, the agricultural sector makes a significant contribution of 16.7%, making it the second largest single contributor after finance and business services. The most extensively cultivated crops in the municipality are maize, wheat, peanuts, lucerne and table grapes. Stock farming activities are mainly based on sheep and goats. Overall, the economy of Siyathemba LM is a service economy with the tertiary sector contributing 70% to the municipality's GDP-R.

3.4 Labour Force and Employment Structure

Employment is the primary means by which individuals who are of working age may earn an income that will enable them to provide for their basic needs and improve their standard of living. As such, employment and unemployment rates are important indicators of socio-economic well-being.

The Census 2011 data indicates that the Siyathemba LM had about 13 656 people in the working-age population. This amounts to 63% of the total population. Of these, 7 113 people were economically active; while roughly 48% of the working age population were not economically active (NEA), that is, persons aged 15–64 years who are neither employed nor unemployed at the time of the survey, including discouraged job seekers . The employed labour in the LM was estimated at 5 356; while the unemployed population was estimated at 1 757, reflecting an unemployment rate of 24.7%. This was lower than the country's unemployment rate of 29.7% and lower than the provincial unemployment rate that was recorded at 27.4%.

In the town of Prieska, 3 094 of the working age population was employed, with 1 212 of them unemployed. This means that 28.1% of the labour force in Prieska was unemployed. On the other hand, 4 672 of the working age population was not economically active. In the smaller towns, the unemployment situation was worse, with unemployment rates 41% and 33.6% in Marydale and Nierkerkshoop, respectively (Stats SA, 2014). The Copperton community is very small and isolated from employment opportunities and amenities.

More than three quarters of the employed individuals in the Siyathemba LM were employed in the formal sector, and only 10.8% were employed in the informal sector. Private households provided for 11.8% of the employment opportunities in the municipality. In Prieska, 74.4% of the employment opportunities were provided by the formal sector and only 8.6% came from the informal sector. In Marydale, 86.5% of the population is employed in the formal sector while only 52.3% of the Nierkerkshoop employment opportunities come from the formal sector. A significant percentage (43.4%) of Nierkerkshoop's employment opportunities come from the informal sector, while the same sector contributes only 7.7% towards employment in Marydale (Stats SA, 2014).

In terms of the structure of employment, the agricultural sector was the most important economic sector not only in the LM but in the district as well. In the Siyathemba LM, this sector contributed 27.8% of the total employment opportunities, while creating 27.1% of employment opportunities in the Pixley ka Seme District. This was followed by personal services and general government. These figures are almost similar to those of the province, but general government is the largest contributor to employment in the Northern Cape Province. Table 3-1below indicates the contribution of economic sectors to employment in the district and the LM.

Table 3-1: Employment by economic sectors in Ehlanzeni DM and Siyathemba LM

Economic Sector	Pixley ka Seme DM Employment		Siyathemba LM Employment	
	Employment	%	Employment	%
Agriculture	12 587	27.1%	1 637	27.8%
Mining and quarrying	342	0.7%	32	0.6%
Manufacturing	1 354	2.9%	219	3.7%
Electricity, gas and water	358	0.8%	24	0.4%
Construction	2 813	6.1%	596	10.1%
Trade	6 491	14.0%	774	13.1%
Transport and communication	839	1.8%	50	0.8%
Finance and business services	5 357	11.6%	751	12.8%
Personal services	8 489	18.3%	921	15.6%
General government	7 756	16.7%	888	15.1%
TOTAL	**46 387**	**100%**	**22 3232**	**100%**

Source: (Quantec, 2015)

3.5 Access to housing and basic services

Access to shelter, water, electricity, sanitation, and other services are indicators that assist to determine the standard of living of the people in the area under investigation. Infrastructure and the state of local infrastructure are other indicators to contemplate when considering living standards. The availability of social and economic infrastructure including roads, educational facilities, and health facilities, further indicates the nature of the study area that is valuable in developing a complete profile of the circumstances in which communities are living. These measurements create a baseline against; which the potential impacts of the proposed project can be assessed.

- **Housing:** Approximately 85% of the households in the Siyathemba LM reside in formal housing in the form of a house or other brick structures on a separate stand or yard. 14.3% of the households live in informal dwellings. Furthermore, 0.7% of the municipality's households live in traditional dwellings. These numbers are similar to those of Prieska with about 85.3% households living in formal dwellings, while 14.5% live in informal structures.
- **Access to water**: In terms of access to piped water, 88.7% of the households in the municipality have access to piped water either inside the dwelling or in the yard. The picture improves in Prieska, where 94.9% of the households have access to piped water inside their dwellings or yard. Only 1.2% of the households in the town do not have access to piped water at all. In terms of the supply, the bulk of the water in the LM is supplied by the municipality or other service providers. In Prieska, close to 97% of the households' water is supplied by the municipality or other water service providers, while in the non-urban areas of the municipality only 1.1% of water is supplied by bulk water infrastructure connections. Two thirds of the households in non-urban areas used boreholes (Stats SA, 2014). The district's IDP note that water provision and availability is one of the issues that will have to be addressed in order to improve the economic activity in most towns situated within the Pixley ka Seme District Municipal area (Pixley ka Seme District Municipality, 2011).
- **Access to sanitation**: If not properly managed and monitored, sewerage and sanitation are basic needs of communities which can pose serious health and hygiene risks. 71.2% of the households in the Siyathemba LM had access to a flushing toilet while 16.8% of the households used pit latrines. 7.7% of families have no access to toilet facilities and 3.8% is still using the bucket system. According to the Siyathemba LM IDP the municipality has a sanitation backlog of 470 households.
- **Access to electricity:** The indicator "energy for lighting" was used as a proxy for measuring households' access to electricity. The majority of households (86.3%) in the municipality have access to electricity, while 13.7% use alternative forms of energy for lighting; mainly candles (11%).

3.6 Social and recreational infrastructure

The Siyathemba LM has the following social and recreational infrastructure available:

- Where education facilities are concerned, the municipality has one crèche, 6 primary schools and 3 combined schools, and one secondary school.
- The municipality has five community halls.

- There are four libraries in the municipality.
- Recreational facilities are available in each of the three towns.
- There is a police station in each of the three towns (Marydale, Prieska and Nierkerkshoop)
- There are five health facilities in the municipality; i.e. one hospital, three clinics and a mobile clinic in Prieska. It is indicated that the main challenge is the lack of ambulance services in Nierkerkshoop (Siyathemba Local Municipality, 2014)

3.7 Conclusion

The Siyathemba LM, where the proposed activity is to take place, comprises of 21 593 people and 5 830 households. Over the last decade, the size of the municipality from a population perspective has grown by 14.9%; with a large portion of the population in the municipality residing in urban areas.

Households residing in the local municipality have a relatively lower income as compared to the average household in the Northern Cape Province, but it is significantly lower than the average household income in South Africa. This means that the households in the LM do not have the same level of access to economic opportunities as the rest of South Africa.

The labour market in the primary study area comprises of 5 356 employed and 1 757 unemployed people. It has a smaller labour participation rate (52%) than in South Africa and the Northern Cape, which explains a lower average household income earned by Siyathemba LM households versus the rest of South African households. The unemployment rate in the local municipality is lower than in any of the analysed areas. Overall, the economy of the Siyathemba LM is a service economy. However, the agricultural sector also makes a significant contribution both in terms employment and GDP-R.

The situation with housing and service delivery is above average. About 85% of the households reside in formal dwellings. With respect to water and sanitation, a significant portion of households have access to water inside their dwellings and yards while 71% of the households have access to a flushing toilet.

Given all of the above, it can be concluded that the primary study area is in need of investment to stimulate its economy and create new jobs. Ideally, such investment should focus on diversification of local economic activities and create new value chains within the local economy. Any new developments in the municipality should also take into account the local housing and service delivery situation, and, if possible, put interventions in place that would assist in improving access to formal dwellings as well as access to basic services.

4. IMPACT ASSESSMENT ASSUMPTIONS

This chapter provides assumptions related to the proposed project and the activities in the zone of influence.

4.1 Proposed project related assumptions

Cost related and employment assumptions for the construction and operational phases are based on information provided by the client. Some assumptions are also based on information reported by the Department of Energy (DoE) for the approved Bid Window 4 projects.

Construction-phase assumptions

It is envisaged that the construction phase will last for a period of about 18 to 21 months. Based on the information provided, it is estimated that about R1 500 million will be spend during the construction period and 129 skilled and unskilled employment opportunities will be created

The majority of the employment opportunities, specifically for unskilled and semi-skilled individuals are likely to be available to local community members. Employment opportunities for skilled individuals are likely to be associated with contractors appointed during the construction phase. It is thus assumed, that 80% of the positions will be filled by local people.

Operational-phase assumptions

It is expected that the proposed Helena Solar 1 PV facility will be in operation for 20 years. The average annual electricity generated by the proposed 75 MW plant will amount to about 140 000 MWh per annum. The annual revenue generated by the plant could amount to up to R50 million. Furthermore, it is expected that 43 jobs per annum will be created at the plant.

4.2 Assumptions regarding affected land uses and economic activities

The proposed development area covers an area of 430 ha on Portion 3 of the farm Klipgats Pan No 117, however it is envisaged that the project footprint will only require an area of about 250 ha. The proposed power line corridor runs on Portion 4 of the farm Klipgats Pan No 117.

In order to obtain baseline information on the socio-economic conditions characterising the potentially affected land parcels in terms of current and predicted future changes with and without the project, telephonic interviews were conducted.

Out of the list of eleven farms that were included in the zone of influence, eight farmers were engaged with. No contact details were available for the owners of Portions 1, 2 and 5 of Klipgats Pan 117 and hence they could not be contacted for comment. Owners of the Remainder of Slimes Dam 154, Portion 2 of Springbok Poortje 119, Portion 2 of Kaffirs Kolk 118 and Portion 1 of Kaffirs Kolk 118 did not wish to be engaged with.

Table 4-1 summarises information that was obtained during the interviews. All respondents were of the view that the proposed development would bring about positive socio-economic benefits to the area and would not be a threat to existing activities.

Table 4-1: Land-uses – site and adjacent land

Farm	Land use	Demographics	Sensitivity
Portion 3 of Klipgats Pan 117	• Small private sheep farm	• 4 people living on the farm • 1 labourer	Directly affected (PV site)
Portion 4 of Klipgats Pan 117	• No activities currently taking place	• No one lives on the land	Directly affected (power lines)
Portion 3 of Groot	• Commercial sheep	• 4 people living on	Adjacent

Fouries Kolk 116	farming	the farm • 4 labourers	

Source: Telephonic interviews with landowners

5. Comparative assessment of alternatives

The study requires an assessment of the alternatives, however, from a socio-economic perspective no alternative takes preference over the other as the impacts remain the same for whichever alternative is chosen. Therefore, all impacts analysed in this chapter will be equally applicable to the three site alternatives.

Alternative	Preference	Reasons
SUBSTATION		
Substation Site Alternative 1	No preference	Impact is the same
Substation Site Alternative 2	No preference	Impact is the same
INTERNAL ROADS		
Internal Road Alternative 1	No preference	Impact is the same
Internal Road Alternative 2	No preference	Impact is the same
POWER LINES		
Power Line Corridor Alternative 1	No preference	Impact is the same
Power Line Corridor Alternative 2	No preference	Impact is the same

6. SOCIO-ECONOMIC IMPACT ASSESSMENT AND EVALUATION

6.1 Construction phase assessment results

The analysis of the expected impacts from the construction phase of the development of the proposed project is presented in the following paragraphs. The assessment covers a number of aspects including the impact on production, GDP, employment, household income, and government revenue of the local and regional economies. It includes the assessment of both positive and potential negative economic impacts.

Temporary increase in production

One of the most important objectives of the South African government is to enhance local manufacturing through the REIPP. The programme obliges bidders to meet varying minimum local content requirements depending on the technology with a threshold of 45% set for solar PV projects.

During the construction phase, the demand for necessary goods, services, and materials will induce production amongst the supporting industries and their supply value chains. Total local expenditure during the development phase is estimated to be about R675 million which represents the direct impact of the proposed project on the economy. Therefore, the development of the solar PV facility will have a positive impact on the regional, as well as the national economy. The direct impact will be wholly absorbed by the construction sector through companies that will be directly involved in the construction activities, i.e. construction contractors and engineering firms.

Based on experience and knowledge of other solar PV studies undertaken by Urban-Econ, it is envisaged that a significant portion of new business sales in the economy during construction will be stimulated though indirect effects or production-induced effects, i.e. by companies that will be supplying inputs and services to the contractors and engineering firms operating on site. Aside from the building and construction sector that will benefit from sub-contracting activities, the manufacturing sector will also benefit from the development of the solar PV plant.

In addition to the direct and indirect impacts resulting from the initial capital investment, construction of the solar PV plant will result in significant consumption induced increases in new business sales. Construction activities will lead to the creation of new temporary employment opportunities through both direct and indirect effects which will in turn increase the household income and consequently stimulate sales in a variety of sectors through household consumption. Considering the distribution of consumption induced impacts, the manufacturing industry, real estate, trade, and transport will be the biggest beneficiaries from the temporary increase in household spending. Although the majority of new business sales stimulated through consumption induced effects will be distributed throughout the country, some of it will be captured in the local economy (within the Siyathemba LM) and will most likely benefit businesses within the tertiary sectors such as trade, transport, and personal services.

Environmental Parameter	*Economic production is defined as any activity that uses inputs such as labour and capital to produce outputs in the form of services or goods.*
Issue/Impact/Environmental Effect/Nature	*The impact takes place due to the investment on the project that will be spent in the country. Besides the direct impact, it involves the indirect and induced effects that are created when either suppliers of goods and services to the project experience an increase in demand or when businesses servicing households experience an increase in demand for their products.*
Extent	*The national economy will experience an increase in production.*
Probability	*It is most likely that there will be a temporary increase in production during construction.*
Reversibility	*The impact is irreversible, as the capital spent on the project cannot be paid back.*
Irreplaceable loss of resources	*No loss of resource.*
Duration	*Short term*
Cumulative effect	*High, as there are a number of planned renewable energy developments in the area.*
Intensity/magnitude	*Considering multiplier effects, the total impact on the national economy's output could be more than three times more than the expenditure of R0.7 billion.*

Significance Rating	*This is a positive high impact. Mitigation measures will maximise benefits to the local economy but will not change the significance of the rating.*	
	Pre-mitigation impact rating	Post mitigation impact rating
Extent	4	4
Probability	3	3
Reversibility	4	4
Irreplaceable loss	1	1
Duration	1	1
Cumulative effect	3	3
Intensity/magnitude	4	4
Significance rating	+64(high positive)	+64 (high positive)
Mitigation measures	*In order to optimise the stimulation of the local economy through direct, indirect, and induced effects, the following should be applied where possible:* - *Procure construction materials, goods, and products from local suppliers if feasible.* - *Employ local contractors where possible.* *The proposed mitigation measures will possibly increase the positive impact in the local economy; however, this will not affect the rating.*	

Temporary increase in GDP-R

A country's gross domestic product (GDP) is the total value of all "final" goods and services, which were produced within the borders of the country, during a year. Most of the investment activities in the country are associated with a value-adding activity, which has a positive impact on the Gross Domestic Product per Region (GDP-R). The capital investment into the establishment of the proposed solar PV facility will generate some value added. Again, increase in employment will lead to increase in household income and consequently result in an increase of household consumption and expenditure on goods and services. This will result in an increase in GDP-R in the country due to consumption induced effects in addition to the direct and indirect impacts. Sectors that will experience the largest temporary growth in value added as a result of this investment will include the manufacturing industry, as well as the trade, transport, finance, and business services sectors.

Environmental Parameter	*Gross domestic product (GDP) is the total value of all "final" goods and services, which were produced within the borders of the country during a year.*
Issue/Impact/Environmental Effect/Nature	*The impact is generated through capital expenditure that shocks the economy. It results in growth of sectors that include businesses supplying goods and services required for the establishment of the*

	facility and businesses that benefit from the increased consumer expenditure.	
Extent	*The national economy will experience an increase in GDP-R.*	
Probability	*It is most likely that there will be a temporary increase in GDP-R during construction.*	
Reversibility	*The impact is irreversible, as the capital spent on the project cannot be paid back.*	
Irreplaceable loss of resources	*No loss of resource.*	
Duration	*Short term*	
Cumulative effect	*High, as there are a number of planned renewable energy developments in the area.*	
Intensity/magnitude	*There will be a significant increase in the country's GDP.*	
Significance Rating	*This is a positive medium impact. Mitigation measures will maximise benefits to the local economy but will not change the significance of the rating.*	
	Pre-mitigation impact rating	Post mitigation impact rating
Extent	4	4
Probability	3	3
Reversibility	4	4
Irreplaceable loss	1	1
Duration	1	1
Cumulative effect	3	4
Intensity/magnitude	3	3
Significance rating	+48 (medium positive)	+48 (medium positive)
Mitigation measures	❑ *Recruit local labour.* ❑ *Sub-contract to local construction companies.* ❑ *Use local suppliers where viable and arrange with the local Small and Medium Enterprises to provide transport, catering, and other services for the construction crew.* *The proposed mitigation measures will possibly increase the positive impact in the local economy; however, this will not affect the rating.*	

Temporary increase in employment

The establishment of the solar PV plant is expected to create 129 skilled and unskilled jobs over the construction period. It is not possible to state at this stage of the development where the workers will come from; however, it can be expected that a relatively notable share will come from the immediate and surrounding areas, i.e. from within the Northern Cape Province. Besides the employment that will be temporarily created by the construction of the facility directly, an increase in labour demand as a result of production and consumption induced effects is also expected.

According Census 2011 data, the Siyathemba LM had 1 757 unemployed individuals in 2011. It is envisaged that about 80%, or 103 job opportunities will be made available to individuals from within the municipality. This means that the project will have the potential to reduce unemployment in the municipality by about 6% for a temporary period provided that the local unemployed individuals will be suitable and willing to work on site.

It is expected that the sectors with the largest expected growth in temporary employment during the construction period will be the construction and manufacturing industries.

Environmental Parameter	*Employment impacts are calculated in terms of the Full-Time Equivalent (FTE) employment positions, which is the same as a FTE job or one man-year of work.*	
Issue/Impact/Environmental Effect/Nature	*The impact is generated through capital expenditure that shocks the economy. It involves the creation of direct new job opportunities related to the construction of the proposed development and employment opportunities that will be indirectly created through the increased expenditure in sectors supplying goods and services to the construction activity and in sectors benefiting from the increase of consumer expenditure.*	
Extent	*Increase in employment will affect the entire country depending on the areas where inputs required are sourced.*	
Probability	*It is most likely that there will be a temporary increase in employment during construction.*	
Reversibility	*Irreversible as employment created, albeit for a temporary period, cannot be undone.*	
Irreplaceable loss of resources	*No loss of resource.*	
Duration	*Short term.*	
Cumulative effect	*High, as there are a number of planned renewable energy developments in the area.*	
Intensity/magnitude	*There will be a notable reduction in unemployment within the Siyathemba LM.*	
Significance Rating	*This is a positive high impact. Mitigation measures will maximise benefits to the local economy but will not change the significance of the rating.*	
	Pre-mitigation impact rating	Post mitigation impact rating
Extent	4	4
Probability	3	3
Reversibility	4	4
Irreplaceable loss	1	1
Duration	1	1
Cumulative effect	3	3
Intensity/magnitude	3	3
Significance rating	+48 (medium positive)	+48 (medium positive)

Mitigation measures	- *Employ labour-intensive measures in construction.* - *Employ local residents.* - *Sub-contract to local construction companies.* - *Utilise local suppliers.* - *Set-up a skills desk at the local municipal office and in the nearby communities to identify skills available in the community and assist in recruiting local labour during both construction and operation.*

Impact on skills development

The construction of the proposed solar PV facility will require general construction experience as well as expert knowledge. It is expected that where specialist training can be provided, candidates from local communities will be trained. People involved in the project will have opportunities to further perfect and develop the skills within their own fields of expertise or acquire new skills. This could particularly be relevant to the unskilled and semi-skilled people engaged in the construction.

The creation of jobs through indirect and induced effects, although for a short-term, will create another opportunity for people to develop and acquire new skills. Given that the impact during construction will affect almost all sectors, although at different levels, it could be argued that the project will stimulate the creation of a comprehensive set of new skills in the country. Most importantly, unlike employment opportunities during construction, skills developed during that period will not expire once the phase is complete. Thus, the impact on skills development is much more sustainable and has a positive impact on the employability of the affected people. This means that although employment will be temporary, people benefiting from skills developed during that employment will have a far greater chance of finding permanent jobs than they had before the project.

Environmental Parameter	*Skills development: employment creation gives way to a host of skills transfer and development opportunities in terms of honing an existing skill or acquiring a new skill.*
Issue/Impact/Environmental Effect/Nature	*The impact takes place during the creation of new employment opportunities, and unlike the actual employment created is sustainable.*
Extent	*People across the country will have the opportunity to develop their skills.*
Probability	*Possible – one cannot be certain that people gaining employment during the construction phase will be able to develop or acquire new skills.*
Reversibility	*Barely reversible - skills obtained cannot be lost unless they are not being used and/or become outdated*
Irreplaceable loss of resources	*No loss of resource.*
Duration	*Short term.*

Cumulative effect	*High, as there are a number of planned renewable energy developments in the area.*	
Intensity/magnitude	*High impact on local employees' skills - 11.5% of the adult population in the Siyathemba LM had no education at all, while 64% have primary or secondary education and only 5.5% have higher educational qualifications. In the context of the national economy, though this impact will be of a lower magnitude.*	
Significance Rating	*This is a medium positive impact.*	
	Pre-mitigation impact rating	Post mitigation impact rating
Extent	4	4
Probability	2	3
Reversibility	3	3
Irreplaceable loss	1	1
Duration	1	1
Cumulative effect	3	3
Intensity/magnitude	3	3
Significance rating	+42 (medium positive)	+45 (medium positive)
Mitigation measures	❑ *Contractors should provide learnerships and on-job training;* ❑ *Where specialist training can be provided, candidates from local communities should be prioritised for training; and* ❑ *Share knowledge with the sub-contracting companies during the construction period.* *These mitigation measures could potentially improve the weighting of the impact in terms of its probability.*	

Temporary increase in household income

Given the temporary increase in production levels across the country as well as the increase in temporary employment, a temporary growth in household income is expected. This increase in household income, although temporarily, will result in an increase in the standard of living of the benefitting households. It is essential to keep in mind that this impact is of a temporary nature and it will not be sustained once the facility has been established. Since some of these construction workers will be recruited from outside the area, not all of that spending will be realised in the local community and nearby towns

In addition to the direct impact on household income, individuals who obtain jobs through indirect and induced effects of the construction activities will also experience growth in their income levels and consequently, more households in the province and other parts of the country will also benefit.

Environmental Parameter	*Household income: the result of a household's member engaging in economic activity; has a direct link to the standard of living of these households.*

Issue/Impact/Environmental Effect/Nature	*The impact takes place during construction as a result of jobs created through direct, indirect and induced impacts.*	
Extent	*Increase in household income will be nationwide since the temporary increase in employment will affect the entire country.*	
Probability	*Probable - the impact will most likely take place.*	
Reversibility	*Irreversible.*	
Irreplaceable loss of resources	*No loss of resource.*	
Duration	*Short term.*	
Cumulative effect	*High, as there are a number of planned renewable energy developments in the area.*	
Intensity/magnitude	*High – The income earned by households located in the LM as a result of the project will be on average higher than the average income of these households. The impact within the national economy, though will be less significant.*	
Significance Rating	*This is a medium positive impact. Mitigation measures could increase the impact on the local economy but would not change the total impact. Therefore, the weights assigned for the impact before mitigations will not be affected.*	
	Pre-mitigation impact rating	Post mitigation impact rating
Extent	4	4
Probability	3	3
Reversibility	4	4
Irreplaceable loss	1	1
Duration	1	1
Cumulative effect	3	3
Intensity/magnitude	3	3
Significance rating	+48 (medium positive)	+48 (medium positive)
Mitigation measures	❑ *Recruit local labour as far as feasible to increase the benefits to the local households.* ❑ *Employ labour-intensive methods in construction.* ❑ *Sub-contract to local construction companies.* ❑ *Use local suppliers where viable and arrange with the local Small and Medium Enterprises to provide transport, catering, and other services for the construction crew.*	

Increase in government revenue

The construction phase of the proposed project will last for about 18 to 21 months. During this period, the construction company and the workers will earn income and pay government taxes including income taxes and payroll taxes. Although the spending of this money by government is difficult to associate with a specific budget item, any revenue received by government is allocated towards certain budget items, provinces, or local municipalities to support and assist with improvement of their service delivery. Thus, without doubt this revenue would be spent on improving socio-economic conditions of the population in some way.

Environmental Parameter	*Government revenue: government obtains its revenue by collecting taxes and rates from the country's residents and business.*	
Issue/Impact/Environmental Effect/Nature	*The impact will take place as a result of local expenditure on construction and will be acquired by government through indirect and direct taxes on the project's activity.*	
Extent	*The fiscal gain will be collected by the national government and used in the national budget; it is not possible to pinpoint exact regions benefitting from this increase.*	
Probability	*Definite - the impact will definitely take place, although one cannot be certain of the exact amount that government will be collecting as a result of this phase of the proposed project.*	
Reversibility	*Irreversible.*	
Irreplaceable loss of resources	*No loss of resource.*	
Duration	*Short term.*	
Cumulative effect	*High, as there are a number of planned renewable energy developments in the area.*	
Intensity/magnitude	*Low – the project will make a small contribution to the national revenue.*	
Significance Rating	*This is a low positive impact.*	
	Pre-mitigation impact rating	Post mitigation impact rating
Extent	4	4
Probability	4	4
Reversibility	4	4
Irreplaceable loss	1	1
Duration	1	1
Cumulative effect	3	3
Intensity/magnitude	1	1
Significance rating	+17 (low positive)	+17 (low positive)
Mitigation measures	*No mitigations.*	

Impact on balance of payment

The balance of payments can be described as a summary of all economic transactions between South Africa and all other countries in the world. Two sections make up the balance of payments, namely the current account and the capital account whereby the former refers to trade in the form of export and imports whereas the latter refers to Foreign Direct Investment (FDI), Investment Portfolio, and other investments which reflect on national accounts.

The establishment of the Helena 1 Solar PV facility will require an investment of approximately R1 500 million, of which about 55% or R825 million will be spent on imported goods and services. Expenditure on imported goods can be regarded as a leakage of money from the national economy, which has a negative impact on the trade balance. Any purchase of imported goods and services in South Africa is accounted for in the Current Account as either ‘merchandise imports" or "payments for services". Thus, the R825 million that is expected to be spent on imported goods will be accounted under "merchandise imports".

Over the last decade, South Africa's trade balance has been at a deficit. Between 2007 and 2014, the deficit fluctuated between 1.5% and 5.8% of the GDP (SARB, 2015). It reached the lowest level in 2010 (1.5% of GDP), which could be associated with the increase in demand for South Africa's goods and services due to the shift in global trade patterns following the global financial crisis in 2009, and increase in travel receipts from South Africa hosting 2010 FIFA World Cup™. Thus the need to import materials, equipment, and services required for the construction of the PV plant would most likely increase the trade deficit in the country. However, the effect will be temporary since the construction period is only about two years. Importantly, though, is that the amount is not significant to have any notable negative effect on macro-economic indicators and government policy.

The negative effect of the balance of payment during the construction period will be negligible. Moreover, a negative balance of payments in a developing economy such as South Africa is generally acceptable as the economy needs to borrow money to allow it to invest in infrastructure, people, and businesses that which will further stimulate economic growth. Care, though, should be taken to ensure that the current account deficit does not grow beyond the means of the country to service its debt.

Mitigations thereof are possible, but only if goods and services required for the establishment of the project can be procured locally at a competitive price.

Environmental Parameter	*Balance of payments: a summary of all economic transactions between South Africa and all other countries in the world.*
Issue/Impact/Environmental Effect/Nature	*The impact takes place during construction as a result of importing goods and services.*
Extent	*Importing will affect the balance of the national and international accounts.*
Probability	*Probable - It is likely that machinery and equipment required for the construction of the plant will be imported.*
Reversibility	*Completely reversible.*
Irreplaceable loss of resources	*No loss of resource.*
Duration	*Short-term.*
Cumulative effect	*High, as there are a number of planned renewable energy developments in the area.*
Intensity/magnitude	*Low – the project will make a small contribution to the national revenue.*
Significance Rating	*The impact is low negative - requires development of the local manufacturing capabilities.*

	Pre-mitigation impact rating	Post mitigation impact rating
Extent	4	4
Probability	3	2
Reversibility	1	1
Irreplaceable loss	1	1
Duration	1	1
Cumulative effect	3	3
Intensity/magnitude	1	1
Significance rating	-13 (low negative)	-12 (low negative)
Mitigation measures	❑ *Local goods and services are procured domestically instead of imported.* ❑ *Recruit local labour as far as feasible to increase the benefits to the local households.*	

Potential loss of agricultural land

Activities such as the establishment of access roads, the movement of heavy vehicles, the establishment of lay-down areas and foundations, as well as the establishment of the substation and permanent administration building would potentially damage topsoil and vegetation. The footprint of the project considering the proposed layout will directly affect two farms. One farm is currently being used for private sheep farming, while there are no agricultural activities currently taking place on the other farm. It is assumed that all agricultural activities currently underway at the proposed site will be halted once construction begins.

Since the farms are not being used for commercial agricultural purposes, there will be no significant or meaningful income and employment losses incurred as a result of the construction of the proposed facility.

Environmental Parameter	*Land sterilisation: loss of land to new development.*
Issue/Impact/Environmental Effect/Nature	*The impact will take place as a result of replacement of the low intensity farming activities.*
Extent	*Will affect farms on which project will be developed.*
Probability	*Definite - without the sale/lease of land the project will not go ahead*
Reversibility	*Barely reversible.*
Irreplaceable loss of resources	*Marginal loss of resources.*
Duration	*Long-term.*
Cumulative effect	*High, as there are a number of planned renewable energy developments in the area.*
Intensity/magnitude	*Low – the intensity of agricultural activities is low.*

Significance Rating	*The impact is low negative. Mitigation may reduce intensity of impact*	
	Pre-mitigation impact rating	Post mitigation impact rating
Extent	1	1
Probability	3	2
Reversibility	3	3
Irreplaceable loss	2	2
Duration	3	3
Cumulative effect	3	3
Intensity/magnitude	1	1
Significance rating	-15 (low negative)	-15 (low negative)
Mitigation measures	❑ *Reasonable compensation must be negotiated with the affected farmers.* ❑ *Should resettlement of farm workers be required, a Resettlement Action Plan must be developed and implemented.* ❑ *Implementation of rehabilitation measures.*	

Increased pressure on basic services and social and economic infrastructure

The construction of the solar PV plant will put some pressure on both economic and social infrastructure in the local economy, particularly given the fact that many of the workforce involved in the development would be coming from outside Copperton.

The construction activities will increase the traffic along the R357 road, which could lead to the deterioration of the road infrastructure and require greater expenditure on road maintenance by the municipality. Although the situation regarding access to services in the area appears to be well managed, influx of people to the area and employment of construction workers from outside the local communities will put a strain on the housing and accommodation situation, basic service provision and health facilities during the construction period. Proper mitigation measures need to be put in place to minimise the impact on infrastructure and to ensure that increased pressure does not lead to the deterioration of infrastructure which could reduce the standard of living of the entire community.

Environmental Parameter	*Basic services and social and economic infrastructure: this includes housing, water and sanitation, electricity, roads, clinics, recreational facilities*
Issue/Impact/Environmental Effect/Nature	*The influx of jobseekers to the area and migration of workers will increase the demand for basic services, as well as social and economic infrastructure in the area.*
Extent	*The added pressure on infrastructure will be felt by the local municipality.*
Probability	*Possible.*

Reversibility	*This impact is partly reversible but will require significant investment to provide adequately for the area with a temporary increase in population and straining infrastructure.*	
Irreplaceable loss of resources	*This impact is not associated with any losses of resources; however, deterioration of man-made infrastructure is probable.*	
Duration	*Medium-term - impacts may last post the construction phase until mitigated.*	
Cumulative effect	*High, as there are a number of planned renewable energy developments in the area.*	
Intensity/magnitude	*Low - considering that there are no existing challenges with regards to basic service delivery.*	
Significance Rating	*The impact is low negative.*	
	Pre-mitigation impact rating	Post mitigation impact rating
Extent	2	2
Probability	2	2
Reversibility	2	2
Irreplaceable loss	1	1
Duration	2	2
Cumulative effect	3	3
Intensity/magnitude	1	1
Significance rating	-12 (low negative)	-12 (low negative)
Mitigation measures	❑ *Engage with local authorities and inform them of the development as well discuss with them the ability of the municipality to meet the demands for social and basic services created by the migrant construction workers.* ❑ *Where feasible, assist the municipality in ensuring that the quality of the local social and economic infrastructure does not deteriorate further (especially the local roads).*	

Increase in social pathologies associated with influx of migrant labourers and job seekers to the area (health, crime, prostitution, xenophobia, etc.)

The local area is not sufficiently diversified to provide all skills and workers necessary during construction. The area may thus experience an influx of migrant labourers who may move to the area looking for employment opportunities. The influx of job seekers and migrant construction workers is expected to create social disturbances and conflicts in the local economy, amongst which include crime (stock theft, burglaries, assaults, etc.), and adverse health impacts around the site and elsewhere in the community. The significance of such impacts depends to some extent on the proportion of workers that are recruited from outside the local community.

The findings of this study indicate that the proposed site is located in a sparsely populated rural area with major towns located many kilometres away. There overall numbers of labourers on adjacent farms is small. Given the site lay-out, it appears that no construction camp will be established on the site. The potential for adverse impacts on the relevant rural community is therefore, not rated as significant.

Provided that the stated 80% local recruitment target is met or closely approached, the bulk of construction workers would be from within the Siyathemba LM, particularly Prieska. Given existing skills levels, the majority of the employment opportunities are likely to be filled by semi- and low-skilled workers. Potential social impacts associated with construction workers are usually associated with low-skilled workers, and not the more skilled workers. The fact that the bulk of low skilled workers would potentially be from the local community itself would therefore, serve to neutralise potential impacts as these workers form part of the local social network. It is therefore, unlikely that the remaining fraction of workers recruited from outside the local community will pose a significant risk to the local community.

Environmental Parameter	*Social pathologies - social factors such as deterioration of health; increase in crime; prostitution; and drugs among others.*	
Issue/Impact/Environmental Effect/Nature	*Potential impacts on social factors associated with the presence of construction workers and job seekers.*	
Extent	*The local community.*	
Probability	*Probable.*	
Reversibility	*Partly reversible. However, in the case of HIV and AIDS, the impact is irreversible.*	
Irreplaceable loss of resources	*This impact could be associated with some losses of personal goods and livestock.*	
Duration	*Short-term.*	
Cumulative effect	*High, as there are a number of planned renewable energy developments in the area.*	
Intensity/magnitude	*Low.*	
Significance Rating	*The impact is low negative - requires development of the local manufacturing capabilities.*	
	Pre-mitigation impact rating	Post mitigation impact rating
Extent	2	2
Probability	3	2
Reversibility	2	2
Irreplaceable loss	2	2
Duration	1	1
Cumulative effect	3	3
Intensity/magnitude	1	1
Significance rating	-13 (low negative)	-12 (low negative)
Mitigation measures	*The developers could implement the following measures to limit the occurrence of an increase in social pathologies:*	

	❑ *Employ locals as far as feasible through the creation of the local skills database and recruitment of suitable candidates.* ❑ *Set up a gate or access control to site to limit or completely eliminate the possibility of livestock theft and burglaries at the residential properties.* ❑ *Control the movement of workers between the site and areas of residence to minimise loitering.* ❑ *The contractors should make the necessary arrangements for allowing workers from outside the area to return home over weekends and/ or on a regular basis. This would reduce the risk posed to local family structures and social networks.* ❑ *Implementing health awareness campaigns to curb the potential of spreading disease, use of drugs, or alcohol abuse for example.*

6.2 Operational phase assessment results

The following sections describe the impact of the proposed solar PV plant during the operational phase. The facility is envisaged to have a lifespan of about 20 years. Impacts observed during this phase regardless of whether they are positive or negative will therefore, be long lasting.

Sustainable increase in production

Based on production assumptions made, once operational the proposed facility is expected to generate an annual turnover of R50 million. In addition to the new business sales created each year directly attributable to the proposed project, new business sales will also be generated as a result of indirect and induced effects. However, due to the fact that operational expenditure for the facility is generally small, multiplier effects are expected to be limited and thus the indirect and induced effects stimulated by spending on operations are not expected to be of a significant amount

Given that the Siyathemba LM's economy is quite small (R796 million in current prices) and relatively undiversified it is reasonable to assume that a significant portion of the inputs required will be procured from outside, which means that other local economies in the country will benefit from these expenses. With regard to sectoral benefits, it can be expected that the utilities sector will be the biggest beneficiary. It is also envisaged that local businesses involved in sectors such as manufacturing and financial and business services will experience some increase in annual turnover. Nationwide, industries expected to benefit the most from production induced or indirect impacts include the insurance, business activity, and transport industries; while increased consumer spending as a result of increased household income will benefit agriculture, trade, real estate, and health and social services.

Environmental Parameter	*Economic production is defined as any activity that uses inputs such as labour and capital to produce outputs in the form of services or goods.*	
Issue/Impact/Environmental Effect/Nature	*The impact results from sustainable production of the solar PV facility, as well as procurement of goods and services required for its sustainable operations and creation of sustainable employment opportunities through direct and indirect effects.*	
Extent	*The national economy will experience an increase in production*	
Probability	*It is most likely that there will be an increase in production.*	
Reversibility	*The impact is irreversible.*	
Irreplaceable loss of resources	*No loss of resource.*	
Duration	*This impact is rated as long-term since it will be experienced over the entire operational life of the project.*	
Cumulative effect	*High, as there are a number of planned renewable energy developments in the area.*	
Intensity/magnitude	*Medium.*	
Significance Rating	*This is a positive medium impact. Mitigation measures will maximise benefits to the local economy but will not change the significance of the rating.*	
	Pre-mitigation impact rating	Post mitigation impact rating
Extent	4	4
Probability	3	3
Reversibility	4	4
Irreplaceable loss	1	1
Duration	3	3
Cumulative effect	3	3
Intensity/magnitude	2	2
Significance rating	+36 (medium positive)	+36 (medium positive)
Mitigation measures	*The project should aim to benefit the local economy as far as possible and feasible by opting for procurement of local goods and services. However, this will not affect the rating.*	

Sustainable increase in GDP-R

New business sales generated through direct and spin-off effects of operations at the facility will generate value added for the national economy. A significant portion of value added will be created directly by the PV facility operations. The rest will be created through production and consumption induced impacts. Similar to the impact on production, the utilities sector will be the sole beneficiary of the direct value added. In addition, it is expected that the biggest overall stimulus will be experienced by the community and government service, business services, transport, and trade and accommodation sectors.

In 2013, the Siyathemba LM's economy was valued at R796 million. Considering the expected revenue, the project's value added would most likely range between R30 million and R40 million per annum. Assuming that the facility's GDP will be accounted in the local municipality, it will increase the local economy by about 5%. Based on the baseline analysis, the Siyathemba LM's economy is dominated by the tertiary sector with the agricultural sector also playing an important role. It can therefore, be argued that the proposed project will assist in diversifying the local municipality's economy.

Some of the production and consumption induced impacts may also be retained in the Siyathemba LM, suggesting that the facility will benefit the local economy not only through direct impact, but also through the multiplier effect. Importantly, the greater the value of goods and services procured by the mine during its operations from the local economy, the greater the overall economic benefit for the local municipality.

Environmental Parameter	*Gross domestic product (GDP) is the total value of all "final" goods and services, which were produced within the borders of the country during a year.*	
Issue/Impact/Environmental Effect/Nature	*The impact is generated through continuous operation of the solar facility. It stimulates economic activities of directly and indirectly affected businesses, which subsequently leads to the creation of new business sales and generation of value added. Through increased household expenditure, an additional round of value adding is created.*	
Extent	*The national economy will experience an increase in GDP-R.*	
Probability	*It is most likely that there will be an increase in GDP-R during operations.*	
Reversibility	*The impact is irreversible.*	
Irreplaceable loss of resources	*No loss of resource.*	
Duration	*This impact is rated as long-term since it will be experienced over the entire operational life of the project.*	
Cumulative effect	*High, as there are a number of planned renewable energy developments in the area.*	
Intensity/magnitude	*Medium - The direct impact associated with the project will lead to the change in the local economy's structure but will have a diluted effect on the national economy.*	
Significance Rating	*This is a positive medium impact. Mitigation measures will maximise benefits to the local economy but will not change the significance of the rating.*	
	Pre-mitigation impact rating	Post mitigation impact rating
Extent	4	4
Probability	3	3
Reversibility	4	4
Irreplaceable loss	1	1
Duration	3	3
Cumulative effect	3	3
Intensity/magnitude	2	2

Significance rating	+36 (medium positive)	+36 (medium positive)
Mitigation measures	❑ *Investigate local procurement opportunities.* ❑ *Procurement from local suppliers should be encouraged if feasible to the viability of the facility.*	

Impact on employment

The facility will create about 43 skilled and unskilled sustainable employment opportunities per annum. The creation of the unskilled and semi-skilled jobs will provide opportunities for the unemployed people in the local communities to acquire a sustainable source of income and potentially develop skills. This means that the proposed facility will be able to reduce the current unemployment level in the Siyathemba LM, albeit by a small percentage. This positive impact though, will be retained for the entire duration of operational activities at the mine.

Besides the employment opportunities created at the facility itself, the project will stimulate the creation of additional jobs throughout the economy through production and consumption induced impacts. The jobs supported by the solar PV plant operation through the multiplier impact will be distributed among various economic sectors particularly agriculture, utilities, financial and business services, manufacturing and community services sectors.

Environmental Parameter	*Employment impacts are calculated in terms of the Full-Time Equivalent (FTE) employment positions, which is the same as a FTE job or one man-year of work.*
Issue/Impact/Environmental Effect/Nature	*The project is expected to create over 800 person-years throughout its operational lifespan, including 80% from the local communities, and will also create and support additional employment opportunities through multiplier effects.*
Extent	*Increase in employment will affect the entire country depending on the areas where inputs required are sourced.*
Probability	*It is most likely that there will be an increase in employment during operations.*
Reversibility	*The impact is irreversible.*
Irreplaceable loss of resources	*No loss of resource.*
Duration	*Long-term – the created employment opportunities are expected to last for the duration of the project.*
Cumulative effect	*High, as there are a number of planned renewable energy developments in the area.*
Intensity/magnitude	*Low – there will be some reduction in unemployment within the Siyathemba LM*
Significance Rating	*This is a positive low impact. Mitigation measures will maximise benefits to the local economy but will not change the significance of the rating.*

	Pre-mitigation impact rating	Post mitigation impact rating
Extent	4	4
Probability	3	3
Reversibility	4	4
Irreplaceable loss	1	1
Duration	1	1
Cumulative effect	3	3
Intensity/magnitude	1	1
Significance rating	+16 (low positive)	+16 (low positive)
Mitigation measures	❑ *Where possible, the employment of local labour should be practiced to increase the benefit to the local community through prevention of leakage of buying power.* ❑ *Local small businesses should also be approached to investigate the possibility of supplying inputs for maintenance and operations where viable, this should increase local indirect employment creation.*	

Impact on skills development

Establishing and operating the plant will result in improved skills amongst the staff if the facility includes a skills development component. On-the-job training is also a key element of the staff development; many of the required skills during the operational phase will be taught to staff through day-to-day operations. It should, however, be noted that most of the jobs required to support operations of the plant are unskilled and semi-skilled jobs that do not present significant opportunities for skills transfer (i.e. panel cleaners and security personnel).

Environmental Parameter	*Skills development: employment creation gives way to a host of skills transfer and development opportunities in terms of honing an existing skill or acquiring a new skill.*
Issue/Impact/Environmental Effect/Nature	*The impact takes place through the creation of employment opportunities during operations, and unlike the actual employment created is sustainable.*
Extent	*People across the country will have the opportunity to develop their skills.*
Probability	*Possible – one cannot be certain that people gaining employment during the operational phase will be able to develop or acquire new skills.*
Reversibility	*Irreversible; skills once gained cannot be lost.*
Irreplaceable loss of resources	*No loss of resource.*
Duration	*Permanent – the skills transferred will remain after the life of the project*
Cumulative effect	*High, as there are a number of planned renewable energy developments in the area.*

Intensity/magnitude	*Impact is rated as being of low intensity due to the nature of skills required for the operations.*	
Significance Rating	*This impact is given a significance rating of low positive. Enhancement measures exist that can be implemented to ensure that skills development does take place which would improve the probability rating of this impact.*	
	Pre-mitigation impact rating	Post mitigation impact rating
Extent	4	4
Probability	2	3
Reversibility	4	4
Irreplaceable loss	1	1
Duration	4	4
Cumulative effect	3	3
Intensity/magnitude	1	1
Significance rating	+18 (low positive)	+19 (low positive)
Mitigation measures	*In order to improve the chances of skills being developed during the operational period it is recommended that vocational skills transfer/training programmes be developed and knowledge sharing among employees encouraged. This mitigation measure could potentially improve the weighting of the impact in terms of its probability and increase it significance slightly.*	

Increase in household income

The creation of employment opportunities in each year of operation of the Helena 1 facility will positively impact on household income levels and allow these households to improve their standard of living. Furthermore, persons who obtain jobs as an indirect result of the facility's operations will experience growth in their income levels and consequently, more households in the province and other parts of the country will also benefit.

A household in the Siyathemba LM earns on average R6 858 per month with 15% of the households having no income at all. From income data obtained in the 2011 Census approximately 39.4% of the households would qualify as indigent in the local municipality. This means that about four in every ten households are unable to afford basic services such as water, basic sanitation, basic energy, health care, housing, food and clothing. The increase in the local tax base will improve this scenario, leading to the positive effect of the increased employment on living standards of community members being enjoyed by more than just those able to obtain employment at the facility.

Environmental Parameter	*Household income: the result of a household's member engaging in economic activity; has a direct link to the standard of living of these households.*

Issue/Impact/Environmental Effect/Nature	*The impact takes place during operations as a result of jobs created through direct, indirect and induced impacts*	
Extent	*Increase in household income will be nationwide since the sustainable increase in employment will affect the entire country*	
Probability	*Probable - the impact will most likely take place*	
Reversibility	*Irreversible.*	
Irreplaceable loss of resources	*No loss of resource.*	
Duration	*Long-term – the created employment opportunities are expected to last for the duration of the project.*	
Cumulative effect	*High, as there are a number of planned renewable energy developments in the area.*	
Intensity/magnitude	*Medium intensity*	
Significance Rating	*This is a medium positive impact. Mitigation measures could increase the impact on the local economy but would not change the total impact. Therefore, the weights assigned for the impact before mitigations will not be affected.*	
	Pre-mitigation impact rating	Post mitigation impact rating
Extent	4	4
Probability	3	3
Reversibility	4	4
Irreplaceable loss	1	1
Duration	3	3
Cumulative effect	3	3
Intensity/magnitude	2	2
Significance rating	+36 (medium positive)	+36 (medium positive)
Mitigation measures	*Local procurement of labour and required goods and services should be encouraged as far as feasible to increase the benefit to the local households. This, though, will not affect the overall rating.*	

Increase in government revenue

Operations at the facility will contribute to government revenue collection through direct, indirect and payroll taxes during the operational phase. Although the spending of this money by government is difficult to associate with a specific budget item, any revenue received by government is allocated towards certain budget items, provinces or local municipalities to support and assist with improvement of their service delivery. Thus, without doubt, this revenue would be spent on improving socio-economic conditions of the population in some way.

Environmental Parameter	*Government revenue: government obtains its revenue by collecting taxes and rates from the country's residents and business.*

Issue/Impact/Environmental Effect/Nature	*The impact takes place mostly with payment of royalties and corporates taxes, as well as a result of payment of salaries and wages and declaration of dividends.*	
Extent	*The fiscal gain will be collected by the national government and used in the national budget; it is not possible to pinpoint exact regions benefitting from this increase.*	
Probability	*Definite - the impact will definitely take place, although one cannot be certain of the exact amount that government will be collecting as a result of this phase of the proposed project.*	
Reversibility	*Irreversible.*	
Irreplaceable loss of resources	*No loss of resource.*	
Duration	*Long-term*	
Cumulative effect	*High, as there are a number of planned renewable energy developments in the area.*	
Intensity/magnitude	*Low – the project will make a small contribution to the national revenue.*	
Significance Rating	*This is a low positive impact.*	
	Pre-mitigation impact rating	Post mitigation impact rating
Extent	4	4
Probability	4	4
Reversibility	4	4
Irreplaceable loss	1	1
Duration	3	3
Cumulative effect	3	3
Intensity/magnitude	1	1
Significance rating	+19 (low positive)	+19 (low positive)
Mitigation measures	*No mitigations.*	

Investment in the local communities and economic development projects

Any renewable energy project approved by government will need to allocate a certain percentage of its revenue towards socio-economic (SED) and enterprise (ED) development activities in the local communities. The aim is to ensure that the proposed project will contribute to the sustainable development and upliftment of the communities located within a 50 km radius of the proposed site. RE IPPP bidders are required to commit at least 1% of the total revenue earned by each project to be spent on identified socio-economic development initiatives, and at least 0.6% on enterprise development. Given the expected revenue to be generated by the PV facility, the potential benefits of the local communities on an annual basis could amount to R0.8 million on an annual basis for the next 20 years. Proper investigation and planning would allow directing these funds to address the most pertinent challenges faced by the communities, which could substantially improve their livelihoods and standard of living.

Environmental Parameter	*SED and ED initiatives; as part of the RE IPPP programme, project owners are required to spend a portion of their turnover on the upliftment of the community where the project is located.*	
Issue/Impact/Environmental Effect/Nature	*Currently the economic base of Siyathemba LM is small, and the anticipated injection will have a significant positive impact on the standard of living of its community.*	
Extent	*The impact will affect the local municipality; it is envisaged to be geared towards Copperton and nearby villages due to their proximity to the site but could potentially be extended in the future.*	
Probability	*Definite - the impact will definitely take place.*	
Reversibility	*Irreversible.*	
Irreplaceable loss of resources	*No loss of resource.*	
Duration	*Long-term – throughout the operational period*	
Cumulative effect	*High, as there are a number of planned renewable energy developments in the area.*	
Intensity/magnitude	*Low – the project will make an average contribution to the local economy.*	
Significance Rating	*Low positive impact.*	
	Pre-mitigation impact rating	Post mitigation impact rating
Extent	2	2
Probability	4	4
Reversibility	4	4
Irreplaceable loss	1	1
Duration	3	3
Cumulative effect	3	3
Intensity/magnitude	1	1
Significance rating	+17 (low positive)	+17 (low positive)
Mitigation measures	*It is recommended that the project owner develops practical SED and ED programmes throughout the project's lifespan. The plan should be developed in consultation with local authorities and existing strategy documents to identify community projects that would result in the greatest social benefits. With regard to ED initiatives, focus should be on developing plans to support and create sustainable, self-sufficient enterprises. It is important that these plans be reviewed annually and where possible updated.*	

Impact on sense of place

The largest alteration during the operational phase with regard to the sense of place will be through visual impact. However, few people reside in the area and little economic activity is taking place around the development site therefore it is expected that the visual impact will be of little significance.

As mentioned previously, the interviews with the land-owners and residents in the area revealed that they strongly support the proposed solar PV project being built in the area. The land-owners and residents in the area are willing to sacrifice the change in the sense of place that could be brought by the establishment of a PV plant, suggesting that they do not foresee the impact to be of notable significance but rather focus on the benefits of the project for the community. While not a strong concern for the community at present, it is advisable that all efforts be made to address the drivers to the change of the sense of place, such as visual effects, noise, and night illumination to make them less intrusive.

Environmental Parameter	*Sense of place, living and working conditions: these conditions are influenced by a variety of factors and can be quite subjective as each factor has a varying degree of influence for each person depending on what each individual's values are.*	
Issue/Impact/Environmental Effect/Nature	*Operation activities will have a significant visual impact on the areas in close proximity to the development site.*	
Extent	*The biggest impact will be felt close to the project site.*	
Probability	*Definite - the impact will definitely take place.*	
Reversibility	*Completely reversible.*	
Irreplaceable loss of resources	*No loss of resource.*	
Duration	*Long-term – throughout the operational period*	
Cumulative effect	*High, as there are a number of planned renewable energy developments in the area.*	
Intensity/magnitude	*Low*	
Significance Rating	*Low negative impact.*	
	Pre-mitigation impact rating	Post mitigation impact rating
Extent	1	1
Probability	4	4
Reversibility	1	1
Irreplaceable loss	1	1
Duration	3	3
Cumulative effect	3	3
Intensity/magnitude	1	1
Significance rating	-13 (low negative)	-13 (low negative)
Mitigation measures	*The mitigation measures proposed by the visual specialist should be adhered to.*	

7. Cumulative impact assessment

The cumulative impact assessment considers the project within the context of other similar land uses, in the local study area and greater regional context.

The Helena 1 Solar PV facility is one of the 14 renewable energy projects planned for the area. The potential for significant cumulative impacts is therefore likely to be high. Assuming that all the proposed projects are approved, the local, regional and national economies could benefit substantially. Aspects that will potentially be significant include employment creation, and local procurement which will result in an increase in new business sales and value added. The introduction of a number of solar PV facilities could provide opportunities for local component manufacturing, and with an appropriate industrial policy it would be possible to leverage the country's existing industrial capacity. However, the amount of imported goods and services will be initially high, which will result in an increase in the trade deficit.

On the other hand, the cumulative impact in terms of loss of agricultural land could potentially be extensive due to the large land take required for PV power facilities. However, the agricultural potential of the land at the site and in the surrounding area is classified as low for crop production and moderate for grazing and therefore, these impacts are not likely to result in significant cumulative impacts. Overall, should adequate mitigation measures be implemented and adequate regional planning be applied, the cumulative impact on agricultural land is likely to be minor negative.

Table 7-1: Summary of potential cumulative impacts

Positive impacts	Negative impacts
Increase in production and GDP	Increase in crime through influx of workers
Employment creation	Increased pressure on infrastructure
Local economic development through socio-economic and enterprise development initiatives	Loss of agricultural land
Stimulation of the local manufacturing	Impact on rural sense of place
Improved standards of living of households benefiting from the projects	

8. Synopsis

The proposed Helena 1 Solar Photovoltaic Energy Facility is to be located near Copperton in the Siyathemba Local Municipality, Northern Cape Province. The construction of the facility will last for about one year to 18 months and will require an investment of about R1 500million. The facility's operations will generate about R50 million per year in revenue for about 20 years.

The national, provincial, and local government policy and strategy documents analysed in the report support the establishment of renewable energy projects as they have been recognised as potential stimulants of local economic growth, job creation, and also with regards to their contribution to sustainable development. The NCPGDS also notes that "sustainable utilisation of the natural resource base on which agriculture depends is critical in the Northern Cape with its fragile eco-systems and vulnerability to climatic variation". In this regard, care needs to be taken to ensure that renewable energy facilities do not impact negatively on the region's natural environment. However, there will be no significant threats to the natural environment as has been noted during the impact assessment.

The economy of the Siyathemba LM is in need of diversification and the establishment of the solar PV plant in the area will offer such an opportunity. Furthermore, if the other proposed projects are approved, this could contribute to the growth of this sector as well as stimulate economic development further. The project will have the potential to improve the standard of living of the communities located within a 50 km radius given the commitments towards socio-economic and enterprise development.

The construction and operation of the facility will result in various positive economic impacts.

- It is estimated that the capital expenditure on the 75 MW solar facility will be R1 500 million. Approximately, 129 employment opportunities will be created during the construction phase. The majority of the employment opportunities, specifically for unskilled and semi-skilled individuals are likely to be available to local community members. Employment opportunities for skilled individuals are likely to be associated with contractors appointed during the construction phase. It is thus assumed that 80% of the positions will be filled by local people.
- The annual revenue generated by the plant could amount to up to R50 million. Furthermore, it is expected that 43 jobs per annum will be created at the plant.

Table 8-1: Summary of impact assessment

Impact	Nature	Pre-mitigation significance	Post-mitigation significance
Construction phase			
Temporary increase in production	Positive	+64(high)	+64 (high)
Temporary increase in GDP	Positive	+48 (medium)	+48 (medium)
Temporary increase in employment	Positive	+48 (medium)	+48 (medium)
Impact on skills development	Positive	+42 (medium)	+45 (medium)
Temporary increase in household income	Positive	+48 (medium)	+48 (medium)
Increase in government revenue	Positive	+17 (low)	+17 (low)
Impact on balance of payment	Negative	-13 (low)	-12 (low)
Sterilisation of agricultural land	Negative	-15 (low)	-15 (low)
Increased pressure on basic services	Negative	-12 (low)	-12 (low)
Increase in social pathologies	Negative	-13 (low)	-12 (low)
Operational phase			
Sustainable increase in production	Positive	+36 (medium)	+36 (medium)
Sustainable increase in GDP	Positive	+36 (medium)	+36 (medium)
Impact on employment	Positive	+16 (low)	+16 (low)
Impact on skills development	Positive	+32 (medium)	+32 (medium)
Increase in household income	Positive	+18 (low)	+19 (low)
Increase in government revenue	Positive	+19 (low)	+19 (low)
Investment in local communities	Positive	+34 (medium)	+34 (medium)
Impact on sense of place	Negative	-13 (low)	-13 (low)

It is clear from the impact assessment that the proposed solar PV facility will have a significant positive effect on the national economy in terms of stimulation of domestic production, job creation, government revenue, and export earnings. The project has the ability to increase the size of the local economy by about 5%, and reduce local unemployment. Furthermore, the project falls within the developmental priorities of the local municipality that have identified the promotion of the renewable energy sector as one of the means to reverse the current trends of decline and lack in diversity of the economy and alleviate electricity shortages. Based on the above, it can be safely concluded that the proposed project will be highly beneficial for the national economy and local communities. From a socio-economic perspective, it should be approved for development.

9. Bibliography

Dennis Moss Partnership. (2012). *Northern Cape Provincial Spatial Development Framework: First Consultative Draft, March 2012.*

Department of Economic Development. (2010). *New Growth Path: Framework .*

Department of Energy . (2011). *Integrated Resource Plan 2010 - 2030.*

Department of Energy. (2013). *IRP 2010-2030 Update Report.*

Department of Minerals and Energy. (2003). *White paper on Renewable Energy.*

Department of Minerals and Energy. (2003). *White paper on Renewabme Energy.*

Department of Trade and Technology. (2013). *Industrial Policy Action Plan.*

Forder, S. (2015, July 22). *Energy Blog.* Retrieved from http://energy.org.za/reipppp/175-reippp-window-4-preferred-bidders

National Planning Comission . (2011). *National Development Plan: Vision for 2030.*

Northern Cape Government . (2008). *Provincial Growth and Development Strategy.*

Pixley ka Seme District Municipality. (2011). *Pixley ka Seme District Municipality Integrated Development Plan for 2011-2016.*

Public-Private Infrastructure Advisory Facility. (2014). *South Africa's Renewable Energy IPP, Procurement Program: Success Factors and Lessons.*

Quantec. (2015). *Standardised Regional Database.*

SARB. (2015). *Full Quarterly Bulletin – No 276 – June 2015. Statistical tables.*

SiVest. (2015). *Helena 1 Project Description.*

Siyathemba Local Municipality. (2012). *Siyathemba Local Municipality Local Economic Development Strategy.*

Siyathemba Local Municipality. (2014). *Integrated Development Plan 2014/15.*

Siyathemba Local Municipality. (2014). *Siyathemba Municipality Integrated Development Plan 2014/15.*

Stats SA. (2014). *Census 2011.*

Stats SA. (2015). *Census 2011.*

Wikipedia. (2014). Retrieved January 2015, from http://en.wikipedia.org/wiki/Copperton

Appendix 7:
A3 Maps

Appendix 8:
Environmental Management Programme (EMPr)

BIOTHERM ENERGY

Proposed Construction of the Helena 1 75MW Solar Photovoltaic (PV) Energy Facility near Copperton, Northern Cape Province

Draft Environmental Management Programme

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For:	SiVEST Environmental Division

BIOTHERM ENERGY

PROPOSED CONSTRUCTION OF THE HELENA 1 75MW PHOTOVOLTAIC (PV) ENERGY FACILITY NEAR COPPERTON, NORTHERN CAPE PROVINCE

DRAFT ENVIRONMENTAL MANAGEMENT PROGRAMME

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Glossary of Terms:

Construction Phase: The activities pertaining to the preparation for and the physical construction of the proposed development.

Contractor: Persons/organisations contracted by BioTherm to carry out parts of the work for the proposed development.

Decommissioning: Means to take out of active service permanently or dismantle partly or wholly, or closure of a facility to the extent that it cannot be readily recommissioned.

Engineer (E)/ Project Manager (PM): Person/ organisation appointed by BioTherm to oversee the work of all consultants, sub-developers, contractors, residents and visitors.

Environmental Control Officer (ECO): Person/organisation appointed by BioTherm who will provide direction to the Project Manager concerning the activities within the Construction Zone, and who will be responsible for conducting the environmental audit of the project during the construction phase of the project according to the provisions of the Environmental Management Programme.

Environmental Management Programme (EMPr): The EMPr is a detailed plan for the implementation of the mitigation measures to minimise negative environmental impacts during the life-cycle of a project. The EMP contributes to the preparation of the contract documentation by developing clauses to which the contractor must adhere for the protection of the environment. The EMPr specifies how the construction of the project is to be carried out and includes the actions required for the Post-Construction Phase to ensure that all the environmental impacts are managed for the duration of the project's life-cycle.

Operational Phase (Post Construction): The period following the Construction Phase, during which the proposed development will be operational.

Pre-Construction Phase: The period prior to commencement of the Construction Phase, during which various activities associated with the preparation for the Construction Phase will be undertaken.

Rehabilitation: Rehabilitation is defined as the return of a disturbed area to a state which approximates the state (where possible) which it was in before disruption. Rehabilitation for the purposes of this specification is aimed at post-reinstatement re-vegetation of a disturbed area and the insurance of a stable land surface. Re-vegetation should aim to accelerate the natural succession processes so that the plant community develops in the desired way, i.e. promote rapid vegetation establishment.

Site Manager: The person, representing the Contractor, responsible for all the Contractor's activities on the site including supervision of the construction staff and activities associated with the Construction Phase. The Site Manager will liaise with the Project Manager in order to ensure that the project is conducted in accordance with the Environmental Management Programme

Abbreviations:

DEA	Department of Environmental Affairs
EA	Environmental Authorisation
EAP	Environmental Assessment Practitioner
ECO	Environmental Control Officer
EO	Environmental Officer
EHS	Environment, Health and Safety
EIA	Environmental Impact Assessment
EMPr	Environmental Management Programme
EP	Equator Principles
HOD	Head of Department
IFC	International Finance Corporation (World Bank Group)
I&APs	Interested and Affected Parties
MC	Main Contractor
MSDS	Material Safety Data Sheets
NEMA	National Environmental Management Act
OECD	Organisation for Economic Co-operation and Development
PM	Project Manager
SAHRA	South African Heritage Resources Agency

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1 INTRODUCTION

BioTherm Energy (Pty) Ltd (hereafter referred to as BioTherm) has appointed SiVEST to undertake the Environmental Impact Assessment (EIA) process and Environmental Management Programme (EMPr) for the proposed construction of the Helena 1 75MW solar photovoltaic (PV) energy facility near Copperton, Northern Cape Province. The objective of the project is to develop a solar PV energy facility in order to generate electricity to feed into the national grid. The project is also in line with the government's commitment to provide renewable energy as an alternative energy source to those currently utilised.

This EMPr has been compiled in line with the recommendations in the above-mentioned EIA, as well as from issues identified by SiVEST Environmental Division. More details will be provided by the contractors and engineers once the detailed design has been completed.

1.1 Details of the EAP

As per the requirements of the NEMA (2010), the details and level of expertise of the persons who prepared the EMPr are provided in Table 1 below.

Table 1: Consultant Team

Environmental Project Manager	SiVEST (Pty) Ltd – Rebecca Thomas
Contact Details	rebeccat@sivest.co.za
Qualifications	Bachelor of Science (Environmental Science): University of Witwatersrand, 2002, Postgraduate Diploma in Business Management (PDM): Wits Business School, 2011, GIBB's Project Leadership Programme, 2010
Expertise to carry out the EMPr	Rebecca is an Environmental Scientist with 11 years experience. She specialises in the overall management and compilation of Environmental Impact Assessments (EIAs) and Environmental Management Programmes

	(EMPs) primarily related to energy generation and electrical transmission projects. She furthermore has been involved in undertaking and managing Public Participation Processes, Consultation, Environmental Scans and Fatal Flaw / Feasibility Studies and independent review of environmental projects. Some of the projects she has worked on recently include EIAs for the proposed 300 MW Caledon Wind Farm, proposed 30 MW Wind Farm at St. Helena Bay and the Bantamsklip 400 kV Transmission Power Lines all within the Western Cape Province. She was also recently appointed as one of the advisors in strategic environmental matters for ACSA. Rebecca has also completed a Post Graduate Diploma in Business Management (PDM), with the aim of bringing business and project management skills to her projects and division as a whole. From a business administration side, Rebecca is keenly involved in the financial performance, workload and resource planning, quality management and proposal administration for the Johannesburg Environmental Division. **Environmental Impact Assessments and Environmental Management Programmes:** ▪ Moloto Development Corridor (MDC) Project, between the City of Tshwane Local municipality in Gauteng Province and Groblersdal, Limpopo Province, traversing Mpumalanga Province. ▪ Environmental Management Compliance for the Integrated Rapid Transit project for Polokwane Municipality. ▪ Thyspunt Transmission Lines Integration Project (TTLIP) for a conventional nuclear power station and associated infrastructure at the Thyspunt site in the Western Cape. ▪ Proposed 150 MW Renosterberg Wind Energy Company (RWEC) Wind Farm and 75 MW Solar Photovoltaic (PV) Plant, Northern Cape Province. ▪ Basic Assessment (BA) processes for the proposed construction of 132 kV power lines required to connect the Droogfontein 2 and Droogfontein 3 PV Plants to the National Electricity Grid. ▪ Eastside Junction Mixed Use Development near Delmas, Mpumalanga Province ▪ South African Nuclear Energy Corporation (Necsa) Dedicated Isotope Production Reactor (DIPR) at the Pelindaba Site near Hartebeespoort in the North West Province. ▪ Medupi Power Station in Lephalale, Limpopo Province. ▪ 25 MW Community Wind Farm in St Helena Bay, Western Cape Province.

	▪ 300 MW Caledon Wind Farm, Western Cape Province. ▪ PRASA Rail Upgrade Project – Maintenance Depots and Staging Yards – 21 sites across Gauteng, Western Cape and KwaZulu Natal Provinces. ▪ ACSA OR Tambo International Airport Midfield Development Project. ▪ Transmission lines (Bantamsklip – Kappa 765 kV and Bantamsklip – Bacchus, Bacchus - Kappa and Bacchus – Muldersvlei 400 kV) for a conventional nuclear power station and associated infrastructure at the Bantamsklip site in the Western Cape (Nuclear 1). ▪ Watershed Mmabatho 132 kV transmission line, North West Province. ▪ Mulilo Coal Fired Power Station and associated transmission lines near Musina, Limpopo Province. ▪ Mmamantswe Coal Fired Power Station, associated transmission lines and coal mine, Kgatleng District, Botswana. ▪ Upgrade of the Metal Recovery Crushing and Screening Plant at the ArcelorMittal Vanderbijlpark Works, Gauteng Province. ▪ proposed extension of the hydra substation and the proposed construction of a new 765 kV transmission power line between the Hydra and Gamma Substations, Northern Cape Province. ▪ Proposed Mercury – Garona 400 kV transmission power line, traversing the Free State, North West and Northern Cape Province. ▪ Atlantis OCGT Power Station and associated 400 kV power lines, Western Cape Province. ▪ 132 kV sub transmission line from Mayfern Traction Substation to Delta Substation in Nelspruit, Mpumalanga Province. ▪ Proposed 132 kV sub transmission line between Witkloof Substation and the proposed new Thuli Substation, Carolina, Mpumalanga Province. ▪ Proposed 132 kV sub transmission line from Kabokweni Substation to the proposed new Hlau Hlau Substation, Mpumalanga Province. ▪ Proposed 132 kV sub transmission line from Kiepersol Substation to Hazyview Traction Substation and upgrading of Kiepersol Substation, Mpumalanga Province. ▪ Proposed 132 kV sub transmission lines and proposed new substation to Zandfontein, Mpumalanga Province. ▪ Orange Farm Roads Upgrade Project, Gauteng Province. ▪ Driezek Housing Upgrade Project, Gauteng Province. ▪ Proposed Phase 1 and 2 developments of the Gardner Ross Golf and Country Estate project, integrating the current Environmental Management Plan in place for phase 1.

Environmental Assessment Practitioner	SiVEST (Pty) Ltd – Andrea Gibb
Contact Details	andreag@sivest.co.za
Qualifications	BSc (Hons) Environmental Management (University of South Africa 2008-2010), BSc Landscape Architecture (with distinction) (University of Pretoria 2004-2007), ArcGIS Desktop 1 (ESRI South Africa December 2010)
Expertise to carry out the EMPr	Andrea joined SiVEST in August 2010 and holds the position of Environmental Practitioner in the Johannesburg Office. She has 7 years' work experience and specialises in undertaking and managing Environmental Impact Assessments (EIAs) and Basic Assessment (BAs), primarily related to energy generation and electrical distribution projects. She also specialises in undertaking visual impact and landscape assessments, by making use of ArcGIS technology and field surveys. She has extensive experience in overseeing public participation and stakeholder engagement processes and has been involved in environmental baseline assessments, fatal flaw / feasibility assessments and environmental negative mapping / sensitivity analyses. From a business and administrative side, Andrea is actively involved in maintaining good client relationships, mentoring junior staff and maintaining financial performance of the projects she leads. **Environmental Impact Assessments and Environmental Management Programmes:** ▪ EIA for the proposed construction of a 75MW Solar Photovoltaic (PV) Power Plant near Dennilton, Limpopo Province. ▪ EIA for the proposed development of the Dwarsrug Wind Farm near Loeriesfontein, Northern Cape Province. ▪ BA for the proposed construction of two 132kV power lines and associated infrastructure from the Redstone Solar Thermal Power Project site to the Olien MTS near Lime Acres, Northern Cape Province. ▪ BA for the proposed construction of two 132kV power lines and associated infrastructure from Silverstreams DS to the Olien MTS near Lime Acres, Northern Cape Province. ▪ BA for the proposed Construction of the SSS1 5MW Solar Photovoltaic (PV) Plant on the Western Part of Portion 6 (Portion of Portion 5) of Farm Spes Bona 2355 near Bloemfontein, Free State Province. ▪ BA for the proposed Construction of the SSS2 5MW Solar Photovoltaic (PV) Plant on the Eastern Part of Portion 6 (Portion of

	Portion 5) of Farm Spes Bona 2355 near Bloemfontein, Free State Province. ▪ BA for the proposed Mookodi Integration Phase 2: Proposed Construction of a 132kV power line from the proposed Bophirima Substation to the existing Schweizer-Reneke Substation, North West Province. ▪ BA for the proposed Mookodi Integration Phase 2: Proposed Construction of a 132kV power line from the Mookodi Substation to the existing Magopela Substation, North West Province. ▪ BA for the proposed Mookodi Integration Phase 2: Proposed Construction of the Mookodi - Ganyesa 132kV power line, proposed Ganyesa Substation and Havelock LILO, North West Province. ▪ Amendment of the Final Environmental Impact Report for the Proposed Mookodi 1 Integration Project near Vryburg, North West Province. ▪ BA for the proposed 132kV power line and associated infrastructure for the proposed Redstone Solar Thermal Energy Plant near Lime Acres, Northern Cape Province. ▪ BA for the proposed construction of a 132kV power line and substation associated with the 75MW Photovoltaic (PV) Plant on the Farm Droogfontein (PV 3) in Kimberley, Northern Cape Province. ▪ BA for the proposed establishment of a Learning and Development Retreat and an Executive Staff and Client Lodge at Mogale's Gate, Gauteng Province. ▪ Amendment application in order to increase the output of the proposed 40MW PV Facility on the farm Mierdam to 75MW, Northern Cape Province. ▪ BA for the proposed construction of a power line and substation near Postmasburg, Northern Cape Province. ▪ BA for the proposed West Rand Strengthening Project – 400kV double circuit power line and substation extension in the West Rand, Gauteng. ▪ EIA for the proposed construction of a wind farm and PV plant near Prieska, Northern Cape Province. ▪ Public Participation assistance as part of the EIA for the proposed Thyspunt Transmission Lines Integration Project – EIA for the proposed construction of 5 x 400kV transmission power lines between Thyspunt to Port Elizabeth, Eastern Cape Province. ▪ EIA assistance for the proposed construction of three Solar Power Plants in the Northern Cape Province.

	▪ Public Participation as part of the EIA for the proposed Delareyille Kopela Power Line and Substation, North West Province. ▪ Public Participation as part of the EIA for the Middelburg Water Reclamation Project, Mpumalanga Province.
Junior Environmental Consultant	SiVEST (Pty) Ltd – Lynsey Rimbault
Contact Details	lynseyr@sivest.co.za
Qualifications	MSc Biodiversity, Conservation and Management (University of Oxford 2012-2013), BSc (Hons) Geography (University of the Witwatersrand 2011), BA Geography and English (University of the Witwatersrand 2008-2010)
Expertise to carry out the EMPr	Lynsey joined SiVEST in August 2014 and holds the position of Environmental Consultant in the Johannesburg Office. She has 1 year of work experience and is specialising in the management and compilation of Environmental Impact Assessments (EIAs) and Basic Assessment (BAs) primarily related to energy generation and electrical distribution projects. Lynsey has worked previously for Kulima Integrated Development Solutions conducting research for a NEPAD project on Agricultural Adaptations to Climate Change. This involved four different farming sectors in four different provinces of South Africa. Prior to this Lynsey worked at Rayten Engineering Solutions in the field of air quality consulting, primarily in the mining sector. **Environmental Impact Assessments and Environmental Management Programmes:** ▪ Basic Assessment for the Ermelo-Richards Bay Coal Line Upgrade Project: Proposed development of the Madlanzini Main Transmission Station and Associated 88kV and 400kV turn in power lines, Mpumalanga Province. ▪ Environmental Impact Assessment for the proposed development of the Dwarsrug Wind Farm near Loeriesfontein, Northern Cape Province. ▪ Basic Assessment for the proposed Construction of the Mookodi Integration Phase 2 132kV Power Line from the Mookodi MTS to the new proposed Ganyesa Substation, North West Province. ▪ Environmental Impact Assessment for the proposed construction of the Nokukhanya Solar Photovoltaic Power Plant near Dennilton, Limpopo Province.

1.2 Site Locality and Description

1.2.1 Regional Locality

The site is located approximately 10km south of Copperton, and 60km south-west of Prieska, and 280km south-west of Kimberley. Copperton is an abandoned town which previously serviced a mine that has subsequently closed. The proposed solar PV energy facility will be accessed by the R357 which transects the site. (Figure 1). The site is located within the Siyathemba Local Municipality of the greater Pixley ka Seme District Municipality.

The site that is proposed for the Helena 1 Solar PV energy facility near Copperton is located on the following farms:

- Portion 3 of Klipgats Pan No 117 (solar PV energy facility); and
- Portion 4 of Klipgats Pan No 117 (power lines).

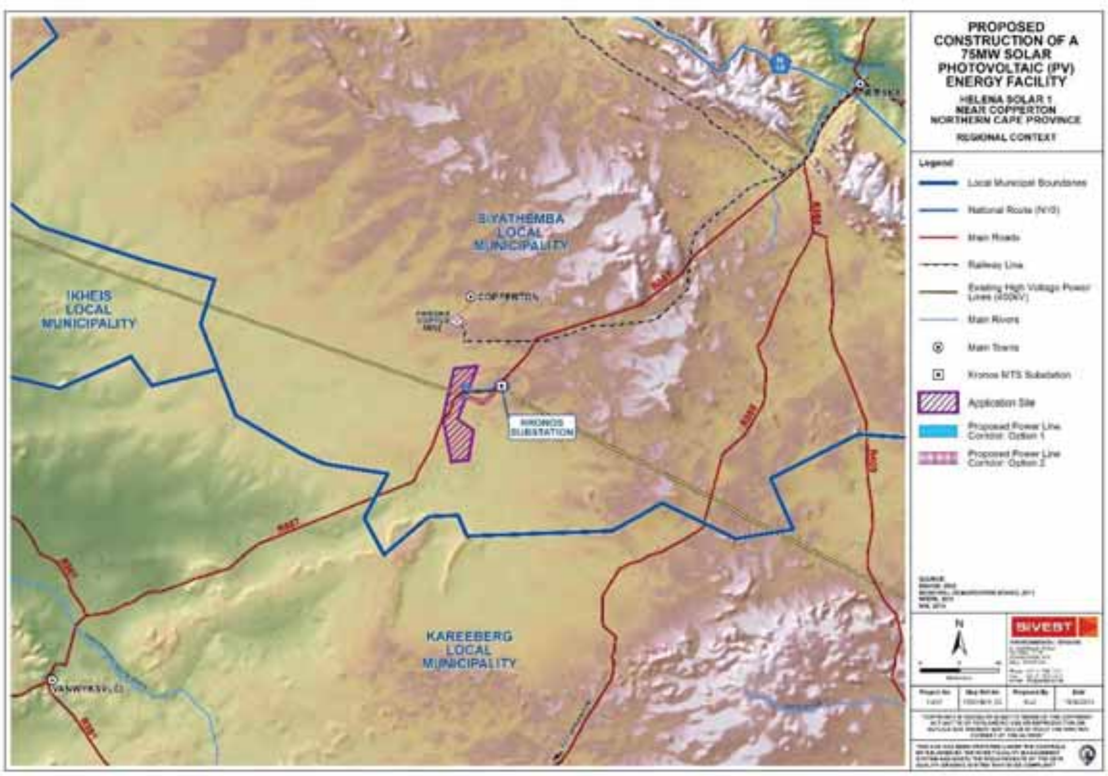


Figure 1: Site locality map

1.2.2 Study Site Description

The prevailing land use in the wider study area is classified as undeveloped low shrubland. The highly arid nature of the area's climate, has resulted in livestock rearing (of sheep) dominating within the area. As such, the typical low, woody shrub, karoo-type communities have been retained across the vast majority of the study area, as sheep graze on natural vegetation.

The nature of the climate and corresponding land use has also resulted in low stocking densities and relatively large farm properties across the area. Therefore the area is very sparsely populated, and little human-related infrastructure exists.

Built form is limited to isolated farmsteads, gravel access roads, ancillary farm buildings, telephone lines, windmills, fences, the remnants of old workers' dwellings and derelict mining infrastructure including a mine dump and slimes dam.

The topography within and in the immediate vicinity of the proposed application site is characterised by a flat to gently undulating landscape (typical of much of the Karoo), that gently slopes down in a south-westerly direction. A slight variation in form can be seen to the north east of the site where an old slimes dam is still present.

The topography in the wider area is characterised by a mix of very flat plains, as well as areas of slightly more undulating relief, including some low ridges and a number of isolated low koppies. A low mountain range also marks a change in topography; the Doringberge form a line of hills to the north-east of the site.

The site falls within the Nama-Karoo Biome and two vegetation types occur within the proposed project site. These are Bushmanland Basin Shrubland and Bushmanland Vloere. Bushmanland Basin Shrubland occurs in the Northern Cape Province on slightly irregular plains. The vegetation is a dwarf shrubland dominated by a mixture of low sturdy, spiny and sometimes succulent shrubs (*Rhigozum, Salsola, Pentzia* and *Eriocephalus*), white grasses and, in years of high rainfall, abundant annuals, such as *Gazania* and *Leysera*. Bushmanland Vloere is the vegetation of the salt pans and broad riverbeds of the central Bushmanland basin. It occurs in areas of flat and very even surfaces of pans and broad bottoms of intermittent dry rivers. Typically, the central parts are devoid of vegetation. Around this is loosely patterned scrub dominated by *Rhigozum trichotomum* and various species of *Salsola* and *Lycium*, with a mixture of karroid dwarf shrubs. In places loose thickets of *Parkinsonia africana*, *Lebeckia linearifolia* and *Acacia karroo* may be found.

1.2.3 Climate

The climate of the study area (Monnik & Malherbe, 2005) can be regarded as warm to hot with occasional rain in summer and dry winters. The long-term average annual rainfall in this region of the Northern Cape is only 198 mm, of which 138 mm, or 69%, falls from November to April. Rainfall is erratic, both locally and seasonally and therefore cannot be relied on for agricultural practices. The average evaporation is over 2 100 mm per year, peaking at over 8.5 mm per day in December.

Temperatures vary from an average monthly maximum and minimum of 31.6ºC and 11.8ºC for January to 15.9ºC and 1.0oC for July respectively. The extreme high temperature that has been recorded is over 42ºC and the extreme low –10.0ºC. Frost occurs most years on 30-40 days on average between early May and mid-September.

1.3 Overview of the proposed project

The proposed project will encompass the installation of a solar PV field and associated components, in order to generate electricity that is to be fed into the Eskom grid. The facility will have a maximum export capacity of 75MW. The total development area of the site for the proposed Helena 1 facility is 420 ha and each substation assessment site comprises of approximately 3 ha. The substation will occupy a footprint area of 2.25 ha. The Helena 1 PV array layout will require approximately 190 ha. The combined laydown areas will require an area less than 8 ha. The final design details are yet to be confirmed and will become available during the detailed design phase of Helena 1. The final preferred layout, including the identified environmentally sensitive areas, is presented in Figure 2 below.

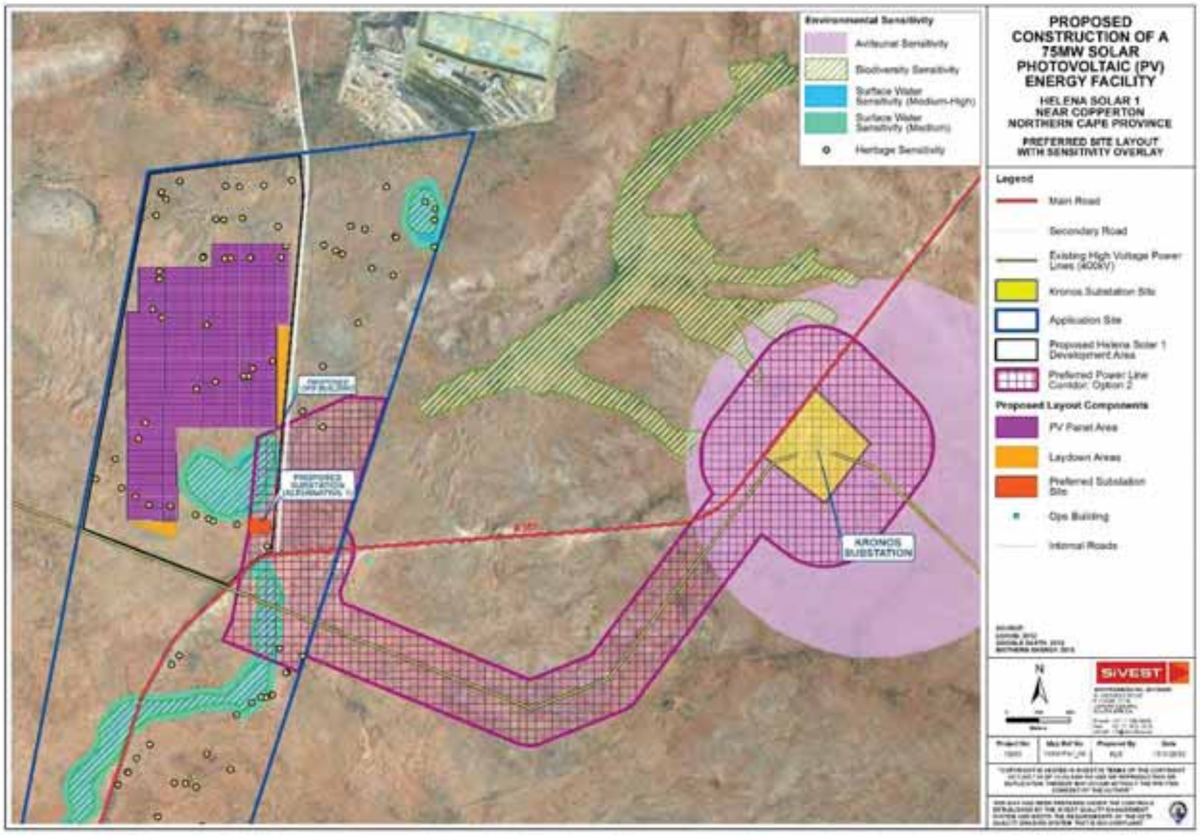


Figure 2: Final preferred layout showing sensitive areas

The generated electricity will be fed into the national distribution network at Kronos Substation via a 132kV power line with a length of approximately 7km. The objective of the solar project is to generate electricity to feed into the national grid.

The key technical details and infrastructure required is presented in the table below (Table 2).

Table 2: Helena Solar 1 summary

Project Name	DEA Reference	Farm name and area	Technical details and infrastructure necessary for each phase
Helena Solar 1	14/12/16/3/3/2/765	Portion 3 of Klipgats Pan No 117 (PV site) and Portion 4 of Klipgats Pan No 117 (power lines)	▪ Approximately 275 000 **solar PV panels** with a total export capacity of 75MW; ▪ Panels will be either **fixed axis mounting or single axis tracking solutions**, and will be either crystalline silicon or thin film technology;

		Development Area: 420 ha	▪ Onsite **switching station**, with the transformers for voltage step up from medium voltage to high voltage; ▪ The panels will be connected in strings to inverters, approximately **43 inverter stations** will be required throughout the site. Inverter stations will house 2 x 1MW inverters and 1 x 2MVA transformers; ▪ DC power from the panels will be converted into AC power in the inverters and the voltage will be stepped up to 22 or 33kV (medium voltage) in the transformers. ▪ The **22 or 33kV cables** will be run underground in the facility to a common point, unless there are environmental or technical concerns that result in the need for an overhead line, before being fed to the **onsite substation** where the voltage will typically be stepped up to 132kV. ▪ Grid connection is to the Kronos substation. A **power line** with a voltage of 132kV is proposed and will run from the onsite substation to the Eskom Kronos substation. The distance will be about 5km. The final grid connection voltage will be below 275kV. ▪ A **laydown area** for the temporary storage of materials during the construction activities; ▪ **Access roads and internal roads**; ▪ Construction of a **car park and fencing** around Helena 1; and ▪ **Administration, control and warehouse buildings**

This proposed PV energy facility forms one of three PV energy facilities with a 75MW export capacity that BioTherm are proposing to develop on Portion 3 of the farm Klipgats Pan No 117. In order to accommodate the Department of Energy's (DoE) competitive bidding process for procuring renewable energy from Independent Power Producers in South Africa each PV energy facility will be developed under a separate

Special Purpose Vehicle (SPV) and therefore each requires a separate Environmental Authorisation. However, the possibility to allow shared associated infrastructure will be considered.

The key components of the project are detailed below.

1.3.1 Solar Field

Solar PV panels are usually arranged in rows or 'arrays' consisting of a number of PV panels. The area required for the PV panel arrays will likely need to be entirely cleared or graded. Where tall vegetation is present, this vegetation will be removed from the PV array area.

Approximately 275 000 solar PV panels will be required for the project for a total export capacity of 75MW. Support structures will be either fixed axis mounting or single axis tracking solutions and the modules will be either crystalline silicon or thin film technology. The solar PV panels are variable in size, and are affected by advances in technology between project inception and project realisation. The actual size of the PV panels to be used will be determined in the final design stages of Helena 1. The PV panels are mounted onto metal frames which are usually aluminium. For foundations, concrete footings or rammed piles are commonly used to support the panel arrays (Figure 3).

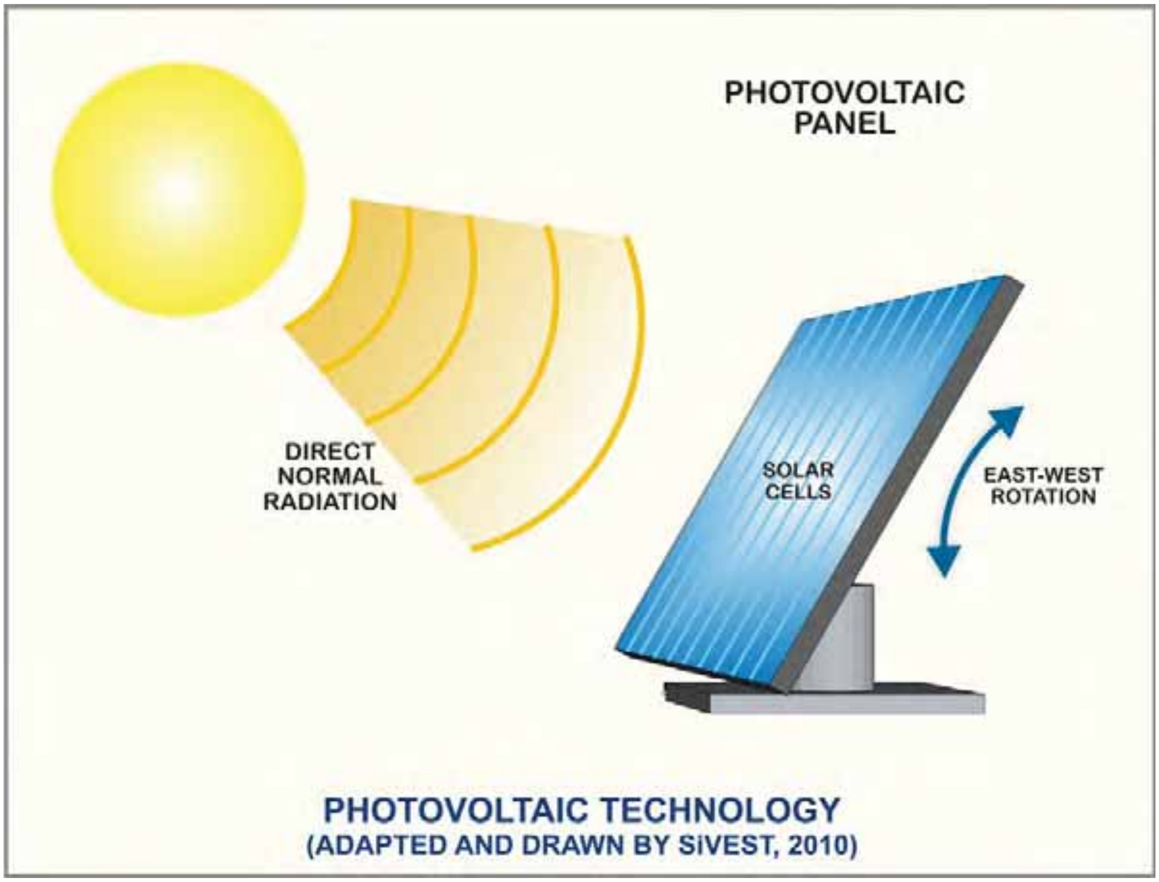


Figure 3: Example of a Photovoltaic Panel with tracking capability.

1.3.2 Electrical Infrastructure

The solar PV panel arrays are connected to each other in strings, which are in turn connected to inverters. For a 75MW size facility, typically 2MW inverter stations which are containerised stations housing 2x1MW inverters and 1x2MVA transformers will be used; therefore approximately 43 inverter stations will be required throughout the site for the proposed solar PV energy facility (Figure 4). DC power from the panels will be converted into AC power in the inverters and the voltage will be stepped up to 22 or 33kV (medium voltage) in the transformers. The 22 or 33kV cables will be run underground in the facility, unless there are environmental or technical concerns that result in the need for an overhead line, to a common point before being fed to the onsite substation and switching station where the voltage will typically be stepped up to 132kV. A Power line with a voltage of up to 132kV will run from the onsite substation to the existing Kronos substation. The distance will be about 5km.

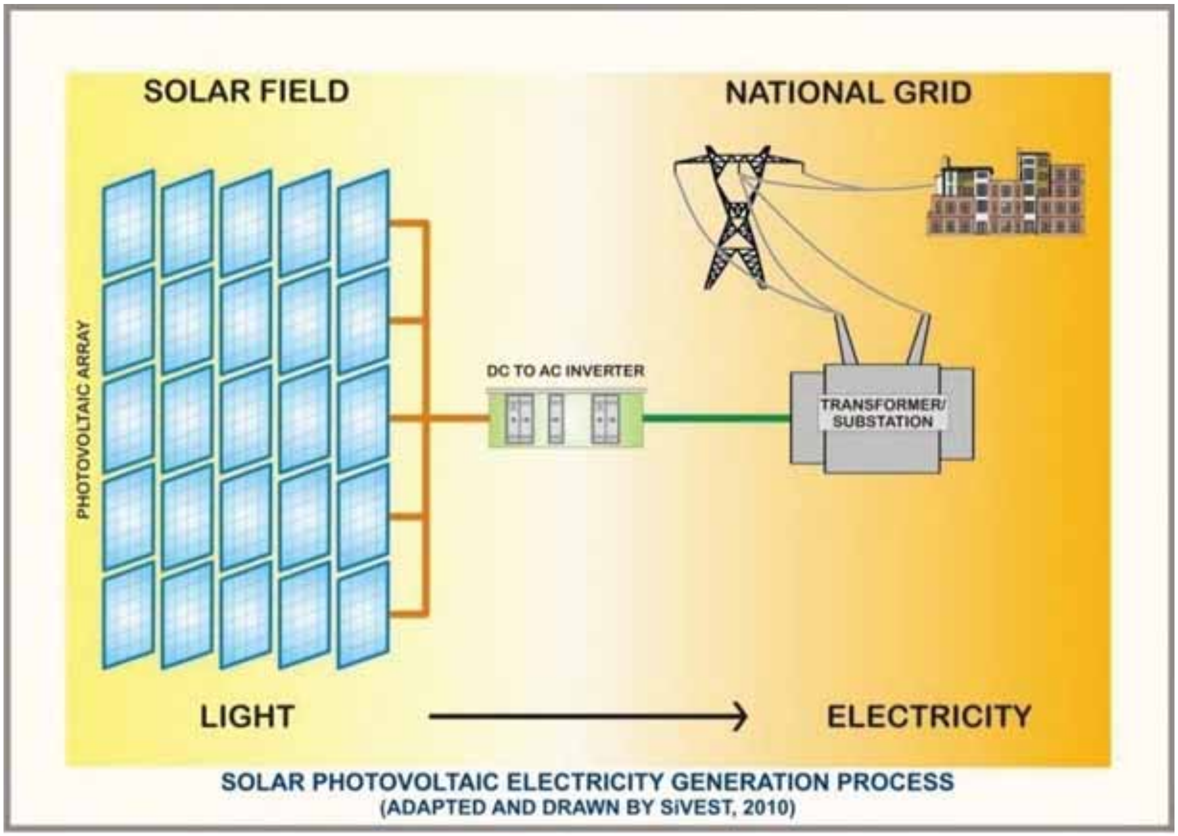


Figure 4: PV process

1.3.3 Buildings

The solar field will require onsite buildings which will be used in the daily operation of the energy facility and includes an administration building (office). The location for the administration building was determined during the EIA process based on environmental constraints identified and design factors that need to be considered. The footprint of the buildings will be approximately 225m^2.The buildings will likely be single storey buildings which will be required to accommodate the following:

- Control room
- Workshop
- High Voltage (HV) switchgear
- Mess Room
- Toilets
- Warehouse for storage

1.3.4 Construction Lay-down Area

A general construction lay-down area will be required for the construction phase of the proposed solar PV energy facility. The size of this area is approximately 8 hectares. The location of the construction lay-down area was determined during the EIA process based on environmental constraints identified and design factors that need to be considered.

1.3.5 Other Associated Infrastructure

Other associated infrastructure includes the following:

- Access roads and internal roads;
- A car park; and
- Fencing around Helena 1.

1.4 Alternatives

As per Chapter 1 of the EIA regulations (2010), feasible and reasonable alternatives are required to be considered during the EIA process. Alternatives are defined at “different means of meeting the general purpose and requirements of the activity” These alternatives may include:

(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.

Each of this alternatives is discussed in relation to the proposed project in the sections below.

1.4.1 The property on which or location where it is proposed to undertake the activity

The placement of solar PV installations is dependent on several factors, all of which are favourable at the proposed site location. These include solar resource, climate, topography, grid connections and access to the site. Prior to site selection a site screening process was undertaken by BioTherm, the entire area around Copperton was assessed due to a high solar resource potential, and grid availability for the PV facility. The assessment included pre-feasibility studies conducted by BioTherm including an estimation of the solar energy resource as well as weather, dust, dirt, and surface albedo. Grid connection and land availability were also important initial considerations Based on the solar resource, grid connection location, topography, available land, and competition, the farm Klipgats was selected as the preferred site. On the farm Klipgats, the southern or northern potions were comparatively assessed as potential sites for the facility. On a high level screening it was decided that the southern portion of the farm had higher environmental sensitivities as it is located further from the grid. The project site has highly advantageous grid connection potential, with the existing Eskom Kronos substation approximately 4km to the east. The site is also easily accessible as the R357 transects the farm. Hence it was decided that the northern portion of the farm would be most suitable. Following the site selection screening process the EIA was initiated on the environmentally preferred northern site. The site is therefore considered highly suitable for the proposed development and no other locations are being considered during the EIA.

1.4.2 The type of activity to be undertaken

. Renewable energy development in South Africa is highly desirable from a social, environmental and development point of view. Prior to project initiation BioTherm considered various renewable energy sources for the development. Wind energy installations were found not to be feasible on the site as there is not enough of a wind resource. Concentrated solar power (CSP) installations are also not feasible because they have a high water requirement and the project site is located in an arid area. Solar PV is therefore the preferred activity being considered for the proposed site. No other activity alternatives are being considered during the EIA.

1.4.3 The design or layout of the activity

Design or layout alternatives are being considered in the EIA process. Various environmental specialists assessed the site during the scoping phase. Their assessments encompassed the entire proposed development site and included the identification of sensitive areas. These sensitive areas were used during the scoping phase to guide layout design for the proposed solar PV energy facility (**Error! Reference source not found.**). These layouts have been extensively investigated in the EIA phase of the project. The design and layout alternatives included; power line routes, internal roads and alternative locations for the substation. The layout alternatives were based on both environmental constraints and design factors.

The alternatives took the sensitive areas identified by the specialists in the Scoping phase into account and these were precluded from the buildable areas. Sensitivity maps were compiled based on the negative mapping / sensitivity assessment exercise that was undertaken by all the specialists.

Due to the elimination of all sensitive areas from the potential buildable area, the proposed layouts were severely constrained in terms of the area available. It was therefore not possible to have two layout alternatives for the PV array area, however the two substation alternatives were positioned as far apart as possible and the two power line alternatives follow entirely different routes. Identifying two relatively similar layouts that are both environmentally feasible was considered more beneficial to the EIA process than only considering one alternative against the option of not implanting the activity or no-go alternative.

1.4.1 The technology to be used in the activity

There are very few technological alternatives for PV technology. For the Helena 1 solar energy facility the mounting structures will be either fixed axis mounting or single axis tracking solutions, and the modules will be either crystalline silicon or thin film technology. The impacts on the environment of the different types of PV technology are the same during construction, operation and decommissioning. Therefore no technology alternatives will be considered during the EIA. The choice of technology used will ultimately be determined by technological and economic factors at a later stage.

1.4.2 The operational aspects of the activity

No operational alternatives were assessed in the EIA, as none are available for solar PV installations.

1.4.3 The option of not implementing the activity

The option of not implementing the activity, or **the 'no-go' alternative, is considered in the EIA**. South Africa is under immense pressure to provide electricity generating capacity in order to reduce the current electricity demand in the country. With the global focus on climate change, the government is under severe pressure to explore alternative energy sources in addition to coal-fired power stations. Although solar power is not the only solution to solving the energy crisis in South Africa, not establishing the proposed solar PV energy facility would be detrimental to the mandate that the government has set to promote the implementation of renewable energy. It is a suitable sustainable solution to the energy crisis and this project could contribute to addressing the problem. Additionally, the project will uplift the community in terms of job creation and local investment into the area, not implementing the activity would remove this positive impact. This project will aid in achieving South Africa's goals in terms of sustainability, energy security, mitigating energy cost risks, local economic development and national job creation.

1.5 Specific Conditions Pertaining to Authorisations

Should the Department of Environmental Affairs (DEA) issue an Environmental Authorisation (EA), this EMPr will be updated to include all the pre-construction, construction, operation and decommissioning conditions stipulated in the EA.

Specific conditions pertaining to regulatory processes, or Licensee / Holder of the Authorisation requirements, have not been included within the EMPr. These conditions are to be undertaken by the Licensee / Holder of the Authorisation prior to the commencement of construction related activities.

1.6 Project Responsibilities

The roles and responsibilities of all the key role players involved in the EMPr are represented below.

1.6.1 The Project Company

The Project Company (BioTherm Energy) will be responsible for the overall control of the project site in environmental terms during the pre-construction, construction, operation, decommissioning and rehabilitation phases of the proposed project. These responsibilities include the following:

- Appointing an independent ECO for the duration of the Contract and notify the DEA of their contact details;
- Being fully familiar with the EIA Report, EA conditions and the EMPr;
- Notifying the DEA of changes in the developments that result in significant environmental impacts;
- Notifying the DEA within 30 days of change of ownership;
- Notifying the DEA of any change of address of the owner/Project Company;
- The overall implementation of the EMPr;
- Ensuring compliance, by all parties, and the imposition of penalties for noncompliance
- Implementing corrective and preventive actions, where required;
- Preventing pollution and actions that will harm or may cause harm to the environment;
- Ensuring the activity does not commence within 30 days of the EA being issued;
- Notifying the DEA within 30 days that construction activity will commence;
- Notifying the DEA in writing within 24 hours if any condition in the EA cannot be or is not adhered to; and
- Notifying the DEA 14 days prior to commencement of the operational phase.

1.6.2 Construction Team

Several professionals will form part of the construction team. The most important from an environmental perspective are the Project Manager (PM), the Contractor Project Manager (CPM), the Main Contractor (MC), the Environmental Control Officer (ECO), the Environmental Officer (EO) and the Social Officer (SO).

The PM is responsible for the implementation of the EMPr on the site during the pre-construction and construction phases of the project.

The CPM is responsible for the establishment and management of contracts for the Main Contractor and the Sub-contractors.

The MC is responsible for abiding by the mitigation measures of the EMPr which are implemented by the Project Manager during the construction phase.

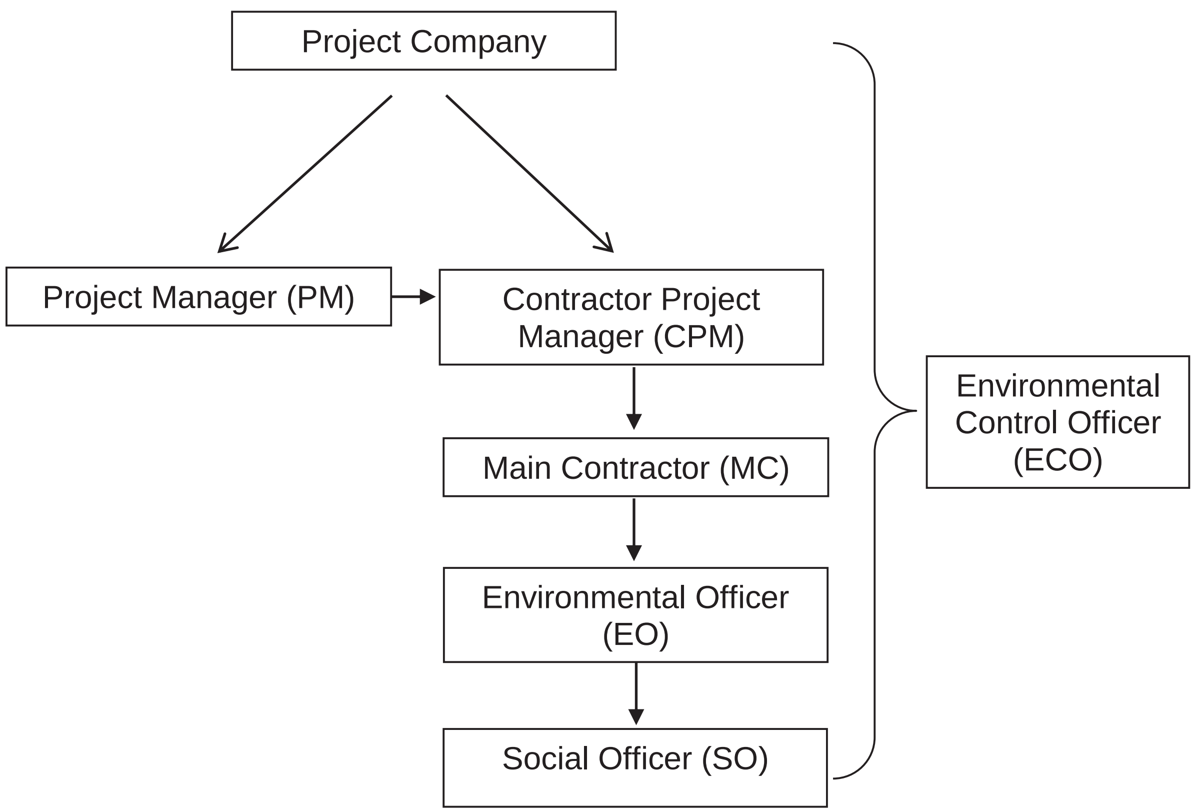
The MC is also responsible for the implementation of the EMPr during the operational and decommissioning phases of the project. However, it must be noted that the MC may change for each phase of the project. The EMPr will therefore be applicable to the relevant MC appointed for each phase of the project.

The ECO is responsible for monitoring the implementation of the EMPr during the design, pre-construction and construction phases of the project.

The EO is responsible for managing the daily onsite implementation of the EMPr.

The SO is responsible for managing the daily on-site implementation of the social aspects of the EMPr.

Basic Organogram:



1.6.3 Project Manager

The PM is responsible for overall construction management of the project as well as the implementation of the EMPr. The following tasks will fall within his / her responsibilities:

- Be aware of the findings and conclusions of the Environmental Impact Assessment and the conditions stated within the Environmental Authorisation;
- Be familiar with the recommendations and mitigation measures of this EMPr, and implement these measures;
- Monitor site activities on a daily basis for compliance;
- Confine the construction site to the demarcated area; and
- Rectify transgressions through the implementation of corrective action.

The Project Manager will assume ultimate responsibility. However, the abovementioned tasks can be delegated to the on-site manager for daily management.

1.6.4 Contractor Project Manager

The CPM will undertake overall project contracts management between of the Main Contractor and the appointed Sub-Contractors. The following tasks will fall within his / her responsibilities:

- Responsible for establishing contractual agreements with the Main Contractor and Sub-Contractors, and ensuring that sub-contractors adhere to the EMPr;
- One of the key contracts will be for the supply, transport, erection and commissioning of the Solar Panel Arrays.

1.6.5 Main Contractor

The MC is responsible for the implementation and compliance with recommendations and conditions set out in the EMPr. This requires that the MC be familiar with the EIA report, EA conditions and the EMPr. This encompasses the following activities:

- Ensuring compliance with the EMPr at all times during construction;
    - Ensuring that all subcontractors have a copy of and understand the contents of the EMPr, to ensure environmental best practice.
- Preventing pollution and avoid actions that will impact or harm the surrounding environment;
- Responsible for the construction activities to be carried out for the duration of the project (will subcontractors and contract workers);
- Implementing corrective and preventive actions, where required;
- Maintain an environmental register which keeps a record of all incidents which occur on the site during construction. These incidents include:
    - Public involvement / complaints;

- Health and safety incidents;
- Hazardous materials stored on site; and
- Non-compliance incidents.

- Development of specific method statements prior to commencment of environmentally sensitive constructions activities as identified in the EMPr.

1.6.6 *Environmental Control Officer*

The ECO is responsible for the implementation of the EMPr during the construction phase and liaison between the Contractor and the Landowners. The ECO should have a minimum of two years of relevant experience as well as a relevant environmental degree or relevant tertiary qualification. The ECO is also to be an independent party. The ECO will liaise and report to the Contractor and authorities, thus the ECO should have effective communication and negotiating skills. The following tasks will fall within his / her responsibilities:

- Be aware of the findings and conclusions of the Environmental Impact Assessment and the conditions stated within the environmental authorisation.
- Work with the construction team to review relevant risk/ method statements from an environmental perspective;
- Be familiar with the recommendations and mitigation measures of this EMPr;
- Conduct monthly audits of the construction site according to the EMPr and EA. A monthly report will be produced detailing the findings of the audit highlighting any non-compliance issues. Positive compliance with the EMPr will also be noted;
- Educate the construction team about the management measures of the EMPr and EA.
- Regular liaison with the construction team and the project leader;
- Recommend corrective action for any environmental non-compliance incidents on the construction site;
- The affected parties shall always be kept informed about any changes to the construction programme should they be involved. If the ECO is not on site the Contractor should keep the affected parties informed. The contact numbers of the Contractor and the ECO shall be made available to the affected parties. This will ensure open channels of communication and prompt response to queries and claims; and
- Liaising with the heritage specialist in the case of unearthing of artefacts and/ or graves.

The ECO is responsible for providing an independent evaluation of compliance with the EMPr and not for enforcement of conditions of the EMPr. The Project Company is responsible for enforcement of the conditions of the EMPr.

The Contractor and the EO are accountable to the ECO for non-compliance with the EMPr. The ECO provides feedback to the Project Company and I&APs, as required. Issues of noncompliance raised by the

ECO must be taken up by the Project Company's Representative and resolved with the Contractor as per the conditions of his/her contract.

The ECO will remain employed for the full duration of the contract until all snag items have been resolved, rehabilitation measures have been completed, and the site is handed over to the Operator, thereby indicating the start of the operational phase.

1.6.7 Environmental Officer

The EO must be appointed by the Contractor and is responsible for managing the daily onsite implementation of the EMPr, and for the compilation of weekly environmental monitoring reports. In addition, the EO must act as liaison and advisor on all environmental and related issues, seek advice from the ECO when necessary, and ensure that any complaints received from I&APs are duly processed and addressed and that conflicts are resolved in an acceptable manner and timely manner. The EO shall be full time dedicated member of the Contractor's team and must be approved by the Project Company.

The following qualifications, qualities and experience are recommended for the individual appointed as the EO:

- A relevant environmental diploma or degree in natural sciences, as well as a minimum of three years' experience in construction site monitoring, excluding health and safety;
- A level-headed and firm person with above-average communication and negotiating skills. The ability to handle and address conflict management situations will be an advantage; and
- Relevant experience in environmental site management and EMPr compliance monitoring.

The EO's responsibilities include:

- Monitoring, on a daily basis, environmental specifications on site and compliance with the conditions of the EA, environmental legislation and EMPr;
- Keeping a register of compliance / non-compliance with the environmental specifications;
- Identifying and assessing previously unforeseen, actual or potential impacts on the environment;
- Ensuring that a brief weekly environmental monitoring report is submitted to the ECO;
- Conducting site inspections during the defects liability period, and bringing any environmental concerns to the attention of the ECO and Contractor;
- Advising the Contractor on the rectification of any pollution, contamination or damage to the construction site, rights of way and adjacent land;
- Attending site meetings (scheduled and *ad hoc*);
- Presenting the environmental awareness training course to all staff, Contractors and Sub contractors, and monitoring the environmental awareness training for all new personnel on-site, as undertaken by the Contractor;
- Ensuring that a copy of the EA and the latest version of the EMPr are available on site at all times;

- Ensuring that the Contractor is made aware of all applicable changes to the EMPr that are approved by the DEA;
- Assisting the Contractor in drafting environmental method statements and/or the Environmental Policy where such knowledge/expertise is lacking;
- Undertaking daily environmental monitoring to ensure the Contractor's activities do not impact upon the receiving environment. Such monitoring shall include dust, noise and water monitoring; and
- Maintaining the following on site:
  - A weekly site diary.
  - A non-conformance register.
  - An I&Ap communications register, and
  - A register of audits.

The EO will remain employed until all rehabilitation measures, as required for implementation due to construction damage, are completed and the site is handed over to the Operator.

1.6.8 Social Officer

The SO shall be employed by the Contractor and will be responsible for managing the daily on-site implementation of the social aspects of the EMPr. The SO shall liaise with landowners and relevant I&APs regarding construction activities for the duration of construction and will ensure that any discussions and complaints received from the public are addressed and that conflicts are resolved in an acceptable manner within 10 days.

The SO(s) shall be full time dedicated member(s) of the Contractor's team and must be accepted by the Project Company. The SO shall report to the Contractor's Project Manager, seeking advice from the ECO when necessary.

The SO may be the same person as the EO, but will assume all the responsibilities of the dual roll.

The following qualifications, qualities and experience are recommended for the individual appointed as the Contractor's SO:

- A person with communication and negotiating skills;
- Report writing skills; and
- Fluency in English, Afrikaans and any other local language as and where required.

The responsibilities and functions of the Construction SO will include:

- Implement and manage the daily social and communication aspects of the construction process according to the EMPr;
- Liaise and maintain good relations with I&APs;
- Monitor social aspects in terms of the specifications;

- Implement mitigation and corrective measures;
- Submit a monthly environmental report to the Contractor's Project Manager;
- Conduct site inspections during the defects notification period, and bring any social concerns to the attention of the Contractor;
- Attend site meetings (scheduled and ad hoc);
- Maintain a filing system meeting the project's quality management plan;
- Assist the Contractor in the drafting of social methods statements where such knowledge/expertise is lacking;
- Maintain the following on site:
    - A daily site diary;
    - A public complaints and communications register; and
    - A register of audits.
- Remain employed until the end of the end of construction.

1.6.9 Responsible Parties and Auditing Process

As described above, Table 3 below provides a summary of the responsible parties and the auditing process to be carried out.

Table 3: Responsible Parties and Auditing Process

TITLE	PARTY	ROLE DURING CONSTRUCTION	ROLE DURING OPERATION
Project Company	BioTherm Energy	Assume ultimate responsibility	Assume ultimate responsibility
Grid Connection Owner	Eskom	N/A	Assume ultimate responsibility
Project Manager	To be appointed by proponent	Construction management	N/A
Contractor's Project Manager	Balance of Plant Contractor	Project management	N/A

Main Contractor/s	There will be multiple contracts placed and managed by the Contractor's Project Manager for the construction phase. These will cover civil earthworks and concrete, structural mechanical and electrical / instrumentation (CI). Then there could also be the construction camp management contract.	Main Contractor will undertake day to day construction activities covering aspects such as civil earthworks and concrete, structural mechanical and electrical / instrumentation (CI).	N/A
Environmental Officer	To be appointed by Main Contractors	Day to day environmental responsibility, point of contact for ECO	N/A
Environmental Control Officer	To be appointed by proponent	Monthly audits	Annual audits
Social Officer	To be appointed by Main Contractors	Day to day environmental responsibility, point of contact for landowners and I&APs's	Monthly Audits
Determining Authority	National Department of Environmental Affairs (DEA)	Conduct site visits when necessary.	Conduct site visits when necessary

The following are the environmental management responsibilities (Table 4) of the various parties during construction and operational phases. Unless otherwise stated, the EMPr will be adhered to as follows:

- The EO will be the responsible party for all daily compliance of this EMPr during the construction phase;
- The monitoring party will be the ECO;
- Method of record keeping will be monthly audits undertaken by the ECO;
- Audit Technique will be the review of records and documentation (including EMPr/EA) that will be kept on site by the EO and/ or site inspections; and
- The Project Company will bear ultimate responsibility.

Table 4: Environmental Management Responsibilities

ITEM	PROJECT COMPONENT AND ACTIVITY	RESPONSIBLE PARTY	MONITORING PARTY	AUDIT TECHNIQUE
1.1	PRE-CONSTRUCTION (SITE ESTABLISHMENT)			
1.1.1	Site preparation	PROJECT COMPANY, MC, EO, ECO	PROJECT COMPANY, ECO	SITE VISIT
1.1.2	Consultation	MC, SO	EO, ECO	SITE VISIT
1.1.3	Cumulative impacts	MC,	EO, ECO	SITE VISIT
1.1.4	Social and Environmental Management Systems	MC,	EO, ECO, SO	SITE VISIT
2.1	CONSTRUCTION ACTIVITIES			
2.1.1	Site Clearing	MC,	EO, ECO	SITE VISIT
2.1.2	Construction traffic and access	MC, EO	ECO	SITE VISIT
2.1.3	Construction Camp	MC, EO, ECO	ECO	SITE VISIT
2.1.4	Environmental Education and Training	PROJECT COMPANY, MC	PROJECT COMPANY	SITE VISIT
2.1.5	Soils and Geology	MC, EO	ECO	SITE VISIT
2.1.6	Erosion Control	EO	ECO	SITE VISIT
2.1.7	Water Use and Quality	EO	ECO	SITE VISIT
2.1.8	Surface and Groundwater	EO	ECO	RECORDS REVIEW
2.1.9	Waste Management	EO	ECO	SITE VISIT
2.1.10	Flora	EO	ECO	SITE VISIT
2.1.11	Fauna	EO	ECO	RECORDS REVIEW, SITE VISIT
2.1.12	Air Quality	EO	ECO	RECORDS REVIEW
2.1.13	Noise and Vibrations	EO	ECO	RECORDS REVIEW
2.1.14	Energy use	EO	ECO	RECORDS REVIEW
2.1.15	Climate Change	EO	ECO	RECORDS REVIEW

2.1.16	Agricultural Potential	EO	ECO	RECORDS REVIEW
2.1.17	Employment	PROJECT COMPANY, MC	ECO	RECORDS REVIEW
2.1.18	Occupational Health and Safety	MC, EO	SO	SITE VISIT
2.1.19	Health and Safety	MC, EO	SO	SITE VISIT
2.1.20	Security	MC, EO	ECO	SITE VISIT
2.1.21	Social Environment	PROJECT COMPANY, MC, SO	ECO	RECORDS REVIEW, SITE VISIT
2.1.22	Community Engagement	SO	ECO	SITE VISIT
2.1.23	Visual Impact	EO	ECO	SITE VISIT
2.1.24	Heritage Impact	PROJECT COMPANY, MC, EO	ECO	SITE VISIT
2.1.25	Avi-fauna Impact	PROJECT COMPANY, MC, EO	ECO	SITE VISIT
3.1	OPERATION ACTIVITIES			
3.1.1	Construction Site Decommissioning	PROJECT COMPANY	ECO	RECORDS REVIEW
3.1.2	Operation and Maintenance	PROJECT COMPANY, ESKOM	ECO	RECORDS REVIEW
3.1.3	Surface and Groundwater	MC	ECO	RECORDS REVIEW
3.1.6	Pollution Control	PROJECT COMPANY, ESKOM, MC	ECO	RECORDS REVIEW
3.1.7	Biodiversity	EO	ECO	RECORDS REVIEW
3.1.8	Waste Management	EO	ECO	RECORDS REVIEW
3.1.9	Health and Safety	MC, EO	ECO	RECORDS REVIEW
3.1.10	Visual Impact	EO	ECO	RECORDS REVIEW
3.1.11	Avi-fauna Impact	EO	ECO	RECORDS REVIEW AND SITE VISIT

4.1	DECOMMISSIONING ACTIVITIES OF PROPOSED DEVELOPMENT			
4.1.1	Ongoing Stakeholder involvement	PROJECT COMPANY, ESKOM, SO	PROJECT COMPANY, ESKOM	SITE VISIT
4.1.2	Community health and safety	PROJECT COMPANY, ESKOM, SO	PROJECT COMPANY, ESKOM	RECORDS REVIEW
4.1.3	Waste management	PROJECT COMPANY, ESKOM, EO	PROJECT COMPANY, ESKOM	RECORDS REVIEW AND SITE VISIT
4.1.4	Surface and groundwater	PROJECT COMPANY, ESKOM, EO	PROJECT COMPANY, ESKOM	RECORDS REVIEW AND SITE VISIT
4.1.5	Biodiversity	PROJECT COMPANY, ESKOM, EO	PROJECT COMPANY, ESKOM	RECORDS REVIEW AND SITE VISIT
4.1.6	Air quality	PROJECT COMPANY, ESKOM, EO	PROJECT COMPANY, ESKOM	RECORDS REVIEW AND SITE VISIT

1.6.10 Environmental Audits

Table 5 below provides an outline of the generic process involved in the auditing process. It briefly describes the activities of the process initially beginning with defining the objectives and scope of the auditing process as well as the responsibilities of the various parties. The procedure for the auditing process is explained through to the production of audit findings and the compliance (or non-compliance) of the audit findings.

Table 5: Example of Procedure for Conducting Audits

Objective	To ensure that formal audits of the EMPr are scheduled and performed so as to verify compliance with the requirements of the EMPr.
Scope	This procedure describes the sequence of events required to perform a compliance audit and the verification of implemented corrective action.
Responsibilities	The ECO or a person authorised and appointed by him, is responsible for the maintenance of the Environmental Audit System

	The ECO is responsible for the scheduling and execution of the audit, as well as the verification of the implementation of corrective action. At his/her discretion, this authority may be delegated to responsible company personnel or to an independent Environmental Auditing Authority to perform the audit on his/her behalf. Auditors shall have no direct responsibility in the area/ system being audited. They will be trained in techniques for auditing environmental management systems. The head of department (HOD)/ supervisor for an area/system to be audited (or a responsible person nominated by him/ her) will assist the audit team in the execution of the audit. The HOD will also be responsible for timely corrective actions based on the findings of the audit.
Planning the audit	The ECO or his authorised delegate, shall plan the audit of a particular environmental area or system as follows: ▪ He shall inform, in writing, the contractor to be audited of the intention to conduct an audit at least two weeks prior to the audit. This notification should include the audit objective, scope and duration and any assistance required from the contractor. ▪ On completion of the audit, an audit findings report shall be prepared and submitted to the Project Company, project manager and construction team. ▪ Corrective actions shall be implemented, within four weeks after the audit, where possible.
Audit Check List	Auditing will be performed by collecting evidence for verification through interviews, relevant documentation and observation of activities and conditions. Instances of non-conformity to EMPr criteria should be recorded. An environmental audit checklist can be used as a guide to address all relevant issues.
Audit Compliance	See below.

Audit Findings and Reporting of non-compliances	The audit team shall review all evidence of their audit findings to decide on non-compliance. Audit findings of non-compliance must be documented and supported by evidence in the Audit Findings Report. The non-compliance findings will be communicated to the Project Manager and his representatives during an audit feedback meeting.

1.7 Layout of Environmental Management Programme

1.7.1 Introduction

This EMPr addresses both generic issues as well as specific issues. The generic and specific issues are each separated into different phases. Each phase has specific issues unique to that period of the development and operation of the solar energy facility as well as associated infrastructure. The impact is identified and given a brief description. The phases of the development are then identified as below:

- Pre-construction (Site Establishment)
- Construction (including associated rehabilitation of affected environment)
- Operation Phase
- Decommissioning

This EMPr seeks to manage and keep to a minimum the negative impacts of a development and at the same time, enhance the positive and beneficial impacts.

The EMPr specifies mitigation measures for the following environmental aspects:

1.7.2 Pre-construction (Site establishment)

- Site preparation
- Consultation
- Site clearing
- Social and Environmental Management Systems

1.7.3 *Construction*

- Construction Camp
- Construction Traffic and Access
- Environmental Education and Training
- Soils and Geology
- Erosion Control
- Water Use and Quality
- Surface and Groundwater
- Waste Management
- Flora
- Fauna
- Air Quality
- Noise and Vibrations
- Energy Use
- Employment
- Occupational Health and Safety
- Security
- Social Environment
- Cultural and Heritage Artefacts
- Community Engagement
- Visual Impact

1.7.4 *Operation*

- Construction Site Decommissioning
- Operation and Maintenance
- Surface and Groundwater
- Biodiversity
- Waste Management
- Health and Safety
- Visual Impact
- Avifauna
- Social

1.7.5 *Decommissioning Phase*

- Ongoing Stakeholder involvement

- Community health and safety
- Waste Management
- Surface and Groundwater
- Biodiversity
- Air Pollution

1.8 Objectives of an EMPr

The objectives of this EMPr are to:

- Identify a range of mitigation measures which could reduce and mitigate the potential impacts to minimal or insignificant levels
- To identify measures that could optimise beneficial impacts
- To create management structures that address the concerns and complaints of I&APs with regards to the development
- To establish a method of monitoring and auditing environmental management practices during all phases of development
- Ensure that the construction and operational phases of the project continues within the principles of Integrated Environmental Management and Environmental Management System (EMS) ISO 14001 Principles
- Detail specific actions deemed necessary to assist in mitigating the environmental impact of the project.
- Ensure that the safety recommendations are complied with.
- Propose mechanisms for monitoring compliance with the EMPr and reporting thereon.
- Specify time periods within which the measures contemplated in the EMPr are implemented, where appropriate.

The EMPr Seeks to highlight the following:

- Avoiding impacts by not performing certain actions
- Minimising impacts by limiting aspects of an action
- Rectifying impacts through rehabilitation, restoration, etc. of the affected environment
- Compensating for impacts by providing substitute resources or environments
- Minimising impacts by optimising processes, structural elements and other design features
- Provide ongoing monitoring and management of environmental impacts of a development and documenting of any digressions /good performances
- The EMPr is a legally binding document that all parties involved in the project must be made aware of.

1.8.1 Environmental monitoring

A monitoring programme will be implemented for the duration of the lifecycle of proposed development. This programme will include:

- Monthly audits according to the EMPr conditions will be conducted by the Environmental Control Officer. These audits can be conducted randomly and do not require prior arrangement with the project manager.
- Compilation of an audit report with a rating of the compliance with the EMPr. This report will be submitted to the relevant authorities.
- An annual audit will also be undertaken by an external specialist.

The ECO shall keep a photographic record of any damage to areas outside the demarcated site area. The date, time of damage, type of damage and reason for the damage shall be recorded in full to ensure the responsible party is held liable. All claims for compensation emanating from damage should be directed to the ECO for appraisal. A register shall be kept of all complaints from the landowner or community (Annexure A). All complaints / claims shall be handled immediately to ensure timeous rectification / payment by the responsible party.

A copy of the EMPr must be kept on site during the life of the solar energy facility. The EMPr will be made binding on all contractors operating on the site and must be included within the Contractual Clauses. Those responsible for environmental damage must pay the repair costs both to the environment and human health and the preventative measures to reduce or prevent further pollution and/or environmental damage (the polluter pays principle).

1.9 Applicable Legislation, Development Strategies and Guidelines

The following legislation applies:

- Constitution of South Africa (Act No. 108 of 1996)
- National Environmental Management Act (Act No 107 of 1998) – NEMA
- Environment Conservation Act (Act No 73 of 1989)
- National Heritage Resources Act (Act No 25 of 1999)
- National Water Act (Act No 36 of 1998)
- Northern Cape Nature Conservation Act, 2009 (Act No. 9 of 2009)
- National Environmental Management: Biodiversity (Act No. 10 of 2004)
- National Forests Act, 1998 (Act No. 84 of 1998)
- Conservation of Agricultural Resources Act No. 43 of 1983)
- Subdivision of Agricultural Land (Act No. 70 of 1970, as amended)

- National Road Traffic (Act No. 93 of 1996, as amended)
- Civil Aviation Act (Act No.13 of 2009)
- Occupational Health and Safety Act No. 85 of 1993
- National Environmental Management: Air Quality Act, 2004 (Act No. 39 of 2004)
- National Environmental Management: Waste Act, 2008 (Act No. 59 of 2008)
- Development Facilitation Act No. 67 of 1995
- National Protected Areas Act (Act No. 25 of 2003)
- Astronomy Geographic Advantage Act No. 21 of 2007

Several regulations will be applicable to the construction phase of the project. These guidelines are mentioned in the EMPr tables. Also of significance in this EMPr are:

- World Bank International Finance Corporation (IFC),
- EHS Guidelines and
- Equator Principles

1.9.1 The Equator Principles

The Equator Principles (2013) are a financial industry benchmark for determining, assessing and managing social & environmental risk in project financing. A number of banks, exchanges and organisations worldwide have adopted the Principles as requirements to be undertaken for project funding on application and approval. Furthermore, certain funding institutions have not formally adopted the Principles, but require clients to be compliant with them in order to qualify for loans.

Under Principle 3, the Equator Principles establish the International Finance Corporations (IFC) Performance Standards (April 30, 2006) and associated General and Sector Specific Environmental, Health and Safety Guidelines as the applicable social and environmental standards that a project should comply with if the project is located in a non-OECD country or OECD country that is not designated as high income.

The social and environmental assessment that is undertaken for a project establishes whether or not the project is in compliance with the IFC Performance Standards[1].

According to these principles, the performance standards relevant to the proposed development are summarised in Table 6.

Table 6: IFC Performance Standards

Performance Standard	Intent and objective

[1] **NB** A project does not seek compliance with the Equator Principles per se but the standards that the EP refers to. A financial institution that has adopted the EP must ensure that any projects it is financing meet the standards referred to and that it adopts an appropriate risk management system to ensure this.

Social & Environmental Assessment Management Systems **(1)**	▪ Adverse and beneficial impacts should be identified within the projects Area of Influence. Emphasis on integrated assessment of social and environmental impacts. ▪ Compliance with national legislation and IFC PS and EHS guidelines as appropriate. ▪ Emphasis on avoidance of impacts wherever practical and where this is not feasible, minimizes, mitigate and compensate. ▪ To ensure effective and ongoing stakeholder engagement ▪ To assess specifically the capacity and commitment of clients to manage risks and opportunities over the course of the transaction.
Labour working conditions **(2)**	▪ Looks at the working conditions by following these principles; ▪ To establish and maintain the worker- management relationship (including specifically a human resources policy). ▪ To promote fair treatment, non-discrimination and equal opportunity of employees (and some contractors) and meet national employment laws. ▪ To protect the workforce by addressing child labour and forced labour. ▪ To promote healthy and safe working conditions.
Pollution, Prevention and Abatement **(3)**	▪ To avoid and minimize adverse impacts on human health and the environment by avoiding or minimizing pollution from project activities. ▪ To promote the reduction of emissions that contributes to climate change.
Community Health, Safety and security **(4)**	▪ To avoid or minimise risks to and impacts on the health and safety of the local community during the project life cycle from both routine and non-routine circumstances. ▪ To ensure that the use of security personnel is carried out in a legitimate manner that avoids or minimizes risks to the community's safety and security.
Land Acquisition & Involuntary Settlement **(5)**	▪ To avoid or at least minimize involuntary resettlement wherever feasible by exploring alternative project designs. ▪ To mitigate adverse social and economic impacts from land acquisition or restrictions on affected persons' use of land by; (i) providing compensation for loss of assets at replacement cost, and (ii) ensuring that resettlement activities are implemented with appropriate disclosure of information,

	consultation, and the informed participation of those affected. ▪ To improve or at least restore the livelihoods and standards of living of displaced persons. ▪ To improve living conditions among displaced persons through provision of adequate housing with security of tenure at resettlement sites.
Biodiversity Conservation & Sustainable Natural Resources Management **(6)**	▪ To promote and conserve biodiversity. ▪ To avoid the introduction of alien invasive species. ▪ To promote sustainable management and use of natural resources (NRM).
Indigenous people **(7)**	▪ To foster full respect for the dignity, human rights, aspirations, cultures and natural resource-based livelihoods of Indigenous Peoples (IP). ▪ To avoid impacts or where avoidance is not feasible, minimize, mitigate and compensate in a culturally appropriate fashion and within the framework of successful good faith negotiation (a form of stakeholder engagement requiring approval of both parties). ▪ To establish and maintain effective relationships with IPs over the course of the project.
Cultural Heritage (**8)**	▪ To protect cultural heritage from adverse impacts of project activities and support its preservation. ▪ To promote the equitable sharing of benefits from the use of cultural heritage in business activities.

(Source; IFC Guidelines, 2006)

2 ENVIRONMENTAL DOCUMENTATION, REPORTING AND COMPLIANCE

2.1 Documentation

The Contractor must ensure the following documentation is kept on the project site for the full duration of the contract:

- Final Environmental Management Programme once approved by the DEA;
- EA issued by the DEA;
- Environmental Policy of the Contractor;
- Environmental method statements compiled by the Contractor;
- Weekly environmental monitoring records;
- Minutes and record of attendance of all environmental meetings;
- Environmental incident book;
- Communications register;
- Register of audits;
- Non-conformance reports; and
- Waste manifests.

2.1.1 Weekly Environmental Monitoring Report

The EO will be required to provide the Main Contractor with a brief weekly environmental monitoring report covering the onsite events which occurred during the past week. This will highlight key performance areas and provide feedback on corrective and preventive actions taken. The EO will have the weekly reports submitted by the Contractor's Manager prior to submission to The Project Company for monthly reporting.

2.1.2 Site Meetings

Weekly site meetings are undertaken which include environmental matters. This meeting shall be chaired by a Senior Site Representative with the Project Company, Contractor(s), the EO (‘s), and SO (’s) in attendance. Where practical or necessary, the ECO will need to attend if possible.

2.1.3 Method Statements

It is a statutory requirement to ensure the wellbeing of employees and of the environment. Therefore, the Contractor shall submit a Method Statement to the Project Company and the ECO for approval prior to the commencement of construction works.

A Method Statement is a document detailing how a particular process will be carried out. It should detail the possible dangers/risks associated with the particular part of the project and the methods of control to be established and to show how the work will be managed in a safe and environmentally responsible manner. The method statement shall also include the following information, where applicable:

- The type of construction activity;
- Timing and location of the activity;
- Construction procedures;
- Materials and equipment to be used;
- Transportation of the equipment to and from site;
- How the equipment/material will be moved while on site;
- Location and extent of construction site office and storage areas;
- Identification of impacts that might result from the construction activity;
- Population impacts;
- Community/institutional arrangements;
- Conflicts between local residents and newcomers;
- Individual and family level impacts;
- Community infrastructure needs;
- Intrusion impacts;
- Methodology and/or specifications for impact prevention or containment and for environmental monitoring;
- Emergency/disaster incident and reaction procedures (required to be demonstrated); and
- Rehabilitation procedures and continued maintenance of the impacted environment.

The Contractor will be accountable for all actions taken in non-compliance of the approved method statements. The Contractor shall keep all the method statements and subsequent revisions on file, copies of which must be distributed to all relevant personnel for implementation.

The Contractor will be required to submit, as a minimum, the relevant method statements as requested by the ECO which are to be compliant with the conditions of the EMPr for review prior to the start of that specific activity.

2.1.4 Communications Register

All complaints or communications that are received from I&APs or any other stakeholder must be recorded in a communications register. These complaints and communications will be brought to the attention of the Project Company, whereupon it will be investigated and a response to the Complainant, I&APs or stakeholder will be given within 10 days. The communications register shall include the following information:

- Record the time and date of the complaint/communication;
- A detailed description of the complaint/communication;
- Action and resources used to correct the complaint;
- Photographic evidence of the complaint (where possible);
- A written response to the complainant indicating rectification of the complaint; and
- Information regarding the relevant authority that was contacted or notified in writing where applicable (person, time and date).

The relevant authorities include:

- Department of Water and Sanitation (e.g. for any incidents involving the contamination of water resources).
- DEA (e.g. for any significant incident of pollution of the soil and air).
- Department of Agriculture, Forestry and Fisheries (e.g. uses of appropriate herbicides for eradication of alien invasive species, and permits for trees of special concern).
- Department of Health (e.g. for incidents such as contamination of water resources, accidental spill of hazardous substances).
- Department of Transport (e.g. for the diversion of traffic due to construction activities).
- Department of Labour (e.g. for labour disputes).

2.1.5 Photographic Record

The EO and SO will be required to compile a photographic record (dated) of all activities on site prior to construction related activities starting, during the construction process and on completion of construction related works. This photographic record will include:

- A pre-construction site record
- Monthly environmental audit reports;
- Weekly environmental monitoring reports;
- Corrective action;
- Progress of environmental works; and
- Incidences of non-conformance.

2.1.6 Waste Manifests

The Contractor shall ensure that all solid (including any hazardous) waste removed from site is disposed of at a registered landfill site or nearby waste transfer station with capacity to accept the project generated waste. The waste manifest shall be kept on record for auditing purposes.

2.1.7 Good Housekeeping

The Contractor is to practice good housekeeping throughout the construction phase. This should eliminate disputes about responsibility, facilitate efficient and timeous running of the project. Over and above practicing accepted construction methods in accordance with SANS 10120, this should include measures to preserve the environment inside the work area. Records of such actions taken to ensure the maintenance and management of housekeeping must be recorded.

The Contractor shall record and report upon environmental management measures undertaken to mitigate assessed impacts upon the environment.

2.1.8 Management and Control

The Contractor is to implement environmental management in a reasonable manner and should such management not prove effective, shall implement measures to the satisfaction of the Project Company. Appropriate measures shall include:

- Appointment of necessary resources to monitor and manage environmental requirements;
- Implement aspect-specific method statements to deal with emergency situations;
- Provision of adequate emergency response equipment to mitigate and manage an incident or emergency; and
- Provision of specific training related to implementation of environmental management requirements.

2.1.9 Recording And Reporting

The Contractor shall maintain detailed records of parameters monitored. These detailed records shall demonstrate the effectiveness of the management actions implemented to mitigate potential impacts. The Contractor shall submit a monthly database/report of management works implemented to the Project Company, as part of the Contractors monthly report.

2.1.10 Monitoring

The Contractor shall submit an Environmental Monitoring Method Statement which details the scope, nature, process, schedule and templates for environmental monitoring. The monitoring results shall be used to determine the effectiveness of the management programme. All complaints, compliments or other comments relating to environmental management parameters are to be recorded in the site issues register of the Contractor for inclusion in the project issues register held by the Project Company.

Monitoring results and the associated required management and mitigation actions for the coming monitoring period are to be presented in the monitoring section of the Contractors monthly report. The daily and weekly reports are to detail observations and information relating to requested management actions and their effectiveness.

The Contractor shall monitor and maintain the following on an ongoing basis:

- Re-growth of alien invasive vegetation;
- Validity of the pest control officer certificate;
- Fire break requirements associated to construction related activities;
- Stormwater systems;
- Topsoil and backfill volumes;
- Access road condition;
- Dust generated from stockpiles;
- Noise;
- Water quality;
- Erosion prevention; and
- Landscaping requirements for rehabilitation.

The Contractor shall submit a monthly database of inter alia the following works to the Project Company. This data base is to include as a minimum:

- Extent of alien invasive clearing operations;
- Volumes of herbicide used on the project;
- Stockpile volumes of chipped material, topsoil, fertile soil and subsoil;
- Volume of recyclable waste removed from site;
- Water volumes recycled and used for dust suppression; and
- Maintenance of chemical toilets.

All complaints, compliments or other comments relating to construction related works are to be recorded by the Contractor in the communications register of the receiving party for inclusion in the project issues register. Site clearance monitoring results and the associated required management and mitigation actions for the coming monitoring period are to be presented in the monitoring section of the Contractors monthly report. The weekly report are to detail observations and information relating to requested management actions and their effectiveness.

2.2 Compliance with the EMPr

The Contractor/s is/are deemed not to have complied with the EMPr if:

- Within the boundaries of the site, site extensions and access roads there is evidence of contravention of clauses;
- If environmental damage ensues due to negligence;
- The contractor fails to comply with corrective or other instructions issued by the ECO or Authorities within a specified time; and
- The Contractor fails to respond adequately to complaints from the public.

The Project Company is deemed not to have complied with the EMPr if:

- Within the boundaries of the site there is evidence of contravention of clauses;
- If environmental damage ensues due to negligence; and
- They fail to respond adequately to complaints from the public.

2.2.1 Non-Conformance Report

A Non-Conformance Report (NCR) will be issued to the Contractor as a final step towards rectifying a failure in complying with a requirement of the EMPr. This will be issued to the Contractor in writing. Preceding the issuing of the NCR, the Contractor will be presented with an opportunity to rectify the outstanding issue in a timely manner.

Preceding requirements to the submitting of the NCR will entail an issue that has been highlighted to the Contractor in the audits for corrective action. Should this issue not be corrected or completed to the satisfaction of the Project Company and ECO, the issue is escalated to an NCR.

Should the ECO assess an incident / issue and find it to be significant (e.g. non-repairable damage upon the environment), it will be reported to the DEA and immediately escalated to the level of an NCR. This will be done in consultation with the Project Company. The following information should be recorded in the NCR:

- Details of non-conformance;
- Any plant or equipment involved;

- Any chemicals or hazardous substances involved;
- Work procedures not followed;
- Any other physical aspects;
- Nature of the risk;
- Actions agreed to by all parties following consultation that should adequately address the identified non-conformance. This may take the form of specific control measures and should take the hierarchy of controls into account. This must accompany the NCR for filing purposes;
- The agreed timeframe by which the Contractor should have implemented the actions documented in the NCR; and
- The ECO should verify that the agreed actions have taken place on or soon after the agreed completion date. Where the actions are complete, the ECO and Contractor should sign the Close Out portion of the Non-Conformance Form and file it with the contract documentation.

2.2.2 Environmental Emergency Response

The Contractor's environmental emergency procedures must ensure that there will be an appropriate response to unexpected or accidental actions or incidents that could cause environmental impacts. Such incidents may include:

- Accidental discharges to water (i.e. into a water resource) and land;
- Accidental spillage of hazardous substances (typically oil, petrol, and diesel);
- Accidental toxic emissions into the air;
- Specific environmental and ecosystem effects from accidental releases or incidents;
- The Environmental Emergency Response Plan is separate to the Health and Safety Plan as it is aimed at responding to environmental incidents and must ensure and include the following:
    - Construction employees shall be adequately trained in terms of incidents and emergency situations;
    - Details of the organisation (manpower) and responsibilities, accountability and liability of personnel;
    - A list of key personnel and contact numbers;
    - Details of emergency services (e.g. the fire department, spill cleanup services) shall be listed;
    - Internal and external communication plans, including prescribed reporting procedures;
    - Actions to be taken in the event of different types of emergencies;
    - Incident recording, progress reporting and remediation measures to be implemented; and
    - Information on hazardous materials, including the potential impact associated with each, and measures to be taken in the event of accidental release.

The Contractor(s) will comply with the environmental emergency preparedness and incident and accident-reporting requirements, as required by the Occupational Health and Safety Act (Act No. 85 of 1993), the National Environmental Management Act (Act No. 107 of 1998), the National Water Act (Act No. 36 of 1998), and/or any other relevant legislation.

2.2.3 Non- compliance

Non-conformance will be issues to the Contractor for incidents of non-compliance. The Contractor (through the Environmental Officer) shall also take the necessary steps (e.g. training) to prevent a recurrence of the infringement. The Contractor is also advised that the imposition of non-conformance does not replace any legal proceedings the authorities, landowners and/or members of the public may institute against the Contractor. The Contractor shall be required to make good any damage caused as a result of the infringement at his own expense. A preliminary list of infringements for which non-conformance will be imposed is as follows:

- Using areas outside the working areas without permission/accessing “no-go areas”;
- Clearing and/or leveling area outside of the working areas;
- Littering of the site and surrounds;
- Burying/burning waste on site and surrounds;
- The undertaking of informal ablutions
- Making fires on site;
- Spillage onto the ground or water bodies of oil, diesel, or any other potential pollutants;
- Picking/damaging plant material, especially that from the residual areas of natural bush on the site;
- Damaging/killing wild or domestic animals/birds;
- Discharging effluent and/or stormwater onto the ground or into surface water;
- Repeated contravention of the specification or failure to comply with instruction

The Senior Site Supervisor, on recommendation from the ECO, may also order the Contractor to suspend part or all the works if the Contractor repeatedly causes damage to the environment by not adhering to the EMPr (i.e. more than 3 cases of infringements). The suspension will be enforced until such time as the offending actions, procedure or equipment is corrected. No extension of time will be granted for such delays and all costs will be borne by the Contractor.

2.2.4 Training and awareness

The Main Contractor is to take responsibility for the management of their staff and subcontractors on the project site during the construction phase and supervise them closely at all times. The onus is on the Contractor to make sure that all their staff and subcontractors fully comprehend the contents of the EMPr. The Contractor shall organise environmental awareness training programmes, which should, be targeted at the two levels of employment: management and labour.

2.2.4.1 Training of construction workers

The construction workers must receive basic training in environmental awareness, including the storage and handling of hazardous substances, minimisation of disturbance to sensitive areas, management of waste, and prevention of water pollution. They must be informed of how to recognise historical / archaeological artefacts that may be uncovered. They must also be appraised of the EMPr's requirements. Environmental awareness training programmes need to be formulated for these levels and must comprise:

- A record of all names, positions and duties of staff to be trained;
- A framework for the training programmes;
- A summarised version of the training course(s); and
- An agenda for the delivery of the training courses.

Such programmes will set out the training requirements, which need to be conducted prior to any construction works occurring and will include:

- Acceptable behaviour with regard to flora and fauna;
- Management and minimising of waste, including waste separation;
- Maintenance of equipment to prevent the accidental discharge or spill of fuel, oil, lubricants, cement, mortar and other chemicals;
- Responsible handling of chemicals and spills;
- Environmental emergency procedures and incident reporting; and
- General code of conduct towards I&APs.

The ECO may be requested to provide additional training (in a first language) on-site regarding environmental aspects that are unclear to the construction personnel. A translator may be required and requested to assist in this additional training. The cost for the translator will be borne by the Contractor.

2.2.4.2 Contractor performance

The Main Contractor must ensure that the conditions of the EMPr are adhered to. Should the Main Contractor require clarity on any aspect of the EMPr, the Main Contractor must contact the Environmental Control Officer for advice.

3 MITIGATION GUIDELINES

3.1 Introduction

Mitigation guidelines are addressed through four phases namely Pre-construction (Site Establishment) Phase; Construction Phase (and associated rehabilitation of affected environment); Operational Phase (Post-Construction) as well as Decommissioning Phase. Each phase has specific issues unique to that period of the development and operation of the solar PV energy facility and the associated infrastructure. The impact is identified and given a brief description. The four phases of the development are then identified as below:

3.2 Pre-construction (Site Establishment)

Requirements for the pre-construction phase

- Proper and continuous liaison between the ECO, the Contractor and Landowners to ensure all parties are appropriately informed at all times.
- The Contractor must adhere to all conditions of the contract including the Environmental Management Programme.
- Adequate planning of the construction programme to allow for disruptions due to rain and very wet conditions.
- Where existing private roads are in a bad state of repair, such roads' condition shall be documented before they are used for construction purposes. This will allow for easy assessment of any damage to the roads which may result from the construction process. If necessary some repairs should be done to prevent damage to equipment. All roads no matter what the condition need to be documented prior to construction.
- Proper documentation and record keeping of all complaints and actions taken.
- Appointment of an Environmental Control Officer to implement this EMPr.
- Regular site inspections by the ECO and good control over the construction process throughout the construction period.
- Independent Environmental Audits to be carried out during and upon completion of construction.
  A formal communications protocol should be set up during the construction phase. The aim of the protocol should be to ensure that effective communication on key issues that may arise during this phase be maintained between key parties such as the ECO, project manager and contractor. The protocol should also ensure that concerns / issues raised by I&APs are formally recorded and considered and where necessary acted upon. If necessary, a forum for communicating with key stakeholders on a regular basis may need to be set up. This could be done through an Environmental Monitoring Committee that would meet on a regular basis. The communications protocol should be maintained throughout the construction phase.