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

Heritage Impact Report

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Executive Summary

PGS Heritage (PGS) was appointed by SiVest Environmental Division to undertake a Heritage Impact Assessment Report (HIA) that forms part of the Basic Environmental Impact Assessment (BA) and Environmental Management Plan (EMPr) for proposed Surya Power – SSS1 5MW Solar Photovoltaic (PV) Power Plant on the western part of Portion 6 (Portion of Portion 5) of farm Spes Bona 2355, approximately 12km west of Bloemfontein, Free State Province.

The field work and assessment of the impact of the proposed PV facility and power line has identified no heritage resources during the field work, however the following recommendations regarding palaeontology needs to be implemented:

Palaeontology

The Spes Bona Study area is mainly underlain by Permian aged rocks of the Adelaide Subgroup, with a portion of the study area study area underlain by Jurassic aged dolerite intrusions. Both alternatives A and B fall on rocks of the Adelaide Subgroup and will have the same palaeontological sensitivity.

Although the high fossiliferous potential of the Adelaide Subgroup strata warrants an allocation of a High palaeontological sensitivity, the fact that all the alternative sites are falling in presently ploughed fields, will make it less likely that fossils will be exposed. Remote sensing indicates that most of the study areas are presently part of ploughed fields, with relatively deep soils. For this reason, areas underlain by these units have been allocated a Medium palaeontological sensitivity, which might be upgraded to a High palaeontological sensitivity, following exposure of the bedrock during the construction phase. In areas where topsoil has been removed by erosion, fossils will most likely be exposed. The areas underlain by dolerite have been allocated a Low palaeontological sensitivity as a result of their igneous nature.

Recommendations:

1. The EAP as well as the ECO for this project must be made aware of the fact that the Adelaide Subgroup is extremely rich in fossil remains. Several types of fossils have been recorded from this subgroup in the Karoo Basin of South Africa.
2. A qualified palaeontologist must be appointed to assess and record the extent of erosion and outcrop of the Adelaide Subgroup during the construction phase of the project. All the alternative sites have been allocated a Medium palaeontological sensitivity rating and the rating must be upgraded to High if fossils are recorded during the construction phase.
3. If fossils are recorded during deep excavations for infrastructure such as road developments, the palaeontologist must apply for a collection permit to collect the fossils according the SAHRA specifications.

The overall impact on the heritage resources by both alternatives is seen as low through the implementation of the recommended mitigation measures. No alternative carries a higher preference with regards to lesser impacts on heritage resources.

SURYA POWER (PTY) LTD

HERITAGE IMPACT REPORT

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1 INTRODUCTION

PGS Heritage (PGS) was appointed by SiVest Environmental Division to undertake a Heritage Impact Assessment Report (HIA) that forms part of the Basic Environmental Impact Assessment (BA) and Environmental Management Plan (EMPr) for proposed Surya Power – SSS1 5MW Solar Photovoltaic (PV) Power Plant on the western part of Portion 6 (Portion of Portion 5) of farm Spes Bona 2355, approximately 12km west of Bloemfontein, Free State Province.

1.1 Scope of the Study

The aim of the study is to identify possible heritage sites and finds that may occur in the impact areas identified for the EIA study. The Heritage Impact Assessment 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

This Heritage Impact Report was compiled by PGS Heritage (PGS). The staff at PGS has a combined experience of nearly 60 years in the heritage consulting industry. PGS will only undertake heritage assessment work where their staff has the relevant expertise and experience to undertake that work competently. Wouter Fourie, the Principal Heritage Specialist, is registered with the Association of Southern African Professional Archaeologists (ASAPA) as a Professional Archaeologist and is accredited as Principal Investigator; he is further an Accredited Professional Heritage Practitioner with the Association of Professional Heritage Practitioners – Western Cape (APHP).

Dr Gideon Groenewald, the appointed external Palaeontologist for this project, has a PhD in Geology from the Nelson Mandela Metropolitan University (1996) and the National Diploma in Nature Conservation from the University of South Africa (1990). He specialises in research on South African Permian and Triassic sedimentology and macrofossils with an interest in biostratigraphy, and palaeontological aspects. He has extensive experience in the locating of fossil material in the Karoo Supergroup and has more than 20 years of experience in locating, collecting and curating fossils, including exploration field trips in search of new localities in the southern, western, eastern and north-eastern parts of the country. His publication record includes multiple articles in internationally recognized journals. Dr Groenewald is accredited by the Palaeontological Society of Southern Africa (society member for 25 years).

1.3 Assumptions and Limitations

Not subtracting in any way from the comprehensiveness of the fieldwork undertaken, it is necessary to realise that the heritage resources located during the fieldwork do not necessarily represent all the possible heritage resources present within the area. Various factors account for this, including the subterranean nature of some archaeological sites and the current dense vegetation cover. As such, should any heritage features and/or objects not included in the present 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 had 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. In the event that any graves or burial places are located during the development the procedures and requirements pertaining to graves and burials will apply as set out in this document.

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:

- National Environmental Management Act (NEMA), Act 107 of 1998
- National Heritage Resources Act (NHRA), Act 25 of 1999
- Mineral and Petroleum Resources Development Act (MPRDA), Act 28 of 2002
- Development Facilitation Act (DFA), Act 67 of 1995

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

- National Environmental Management Act (NEMA) Act 107 of 1998
    - Basic Environmental Assessment (BEA) – Section (23)(2)(d)
    - Environmental Scoping Report (ESR) – Section (29)(1)(d)
    - Environmental Impact Assessment (EIA) – Section (32)(2)(d)
    - Environmental Management Plan (EMPr) – Section (34)(b)
- National Heritage Resources Act (NHRA) Act 25 of 1999
    - Protection of Heritage Resources – Sections 34 to 36; and
    - Heritage Resources Management – Section 38
- Mineral and Petroleum Resources Development Act (MPRDA) Act 28 of 2002
- Section 39(3)
- Development Facilitation Act (DFA) Act 67 of 1995
    - The GNR.1 of 7 January 2000: Regulations and rules in terms of the Development Facilitation Act, 1995. Section 31.

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 and the DFA 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 Section 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 for further information on the interpretation of heritage Appendix B.

1.5 Terminology

ABBREVIATIONS	DESCRIPTION
AIA	Archaeological Impact Assessment
ASAPA	Association of South African Professional Archaeologists
CRM	Cultural Resource Management
DEA	Department of Environmental Affairs
DWA	Department of Water Affairs
ECO	Environmental Control Officer

EIA practitioner	Environmental Impact Assessment Practitioner
EIA	Environmental Impact Assessment
ESA	Early Stone Age
GPS	Global Positioning System
HIA	Heritage Impact Assessment
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 Authority
PSSA	Palaeontological Society of South Africa
SADC	Southern African Development Community
SAHRA	South African Heritage Resources Agency

- **Archaeological resources**

This includes:

- 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;
- 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;

- 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;
- 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:

  - construction, alteration, demolition, removal or change in use of a place or a structure at a place;
  - carrying out any works on or over or under a place;
  - subdivision or consolidation of land comprising a place, including the structures or airspace of a place;
  - constructing or putting up for display signs or boards;
  - any change to the natural or existing condition or topography of land; and
  - 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

- **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.

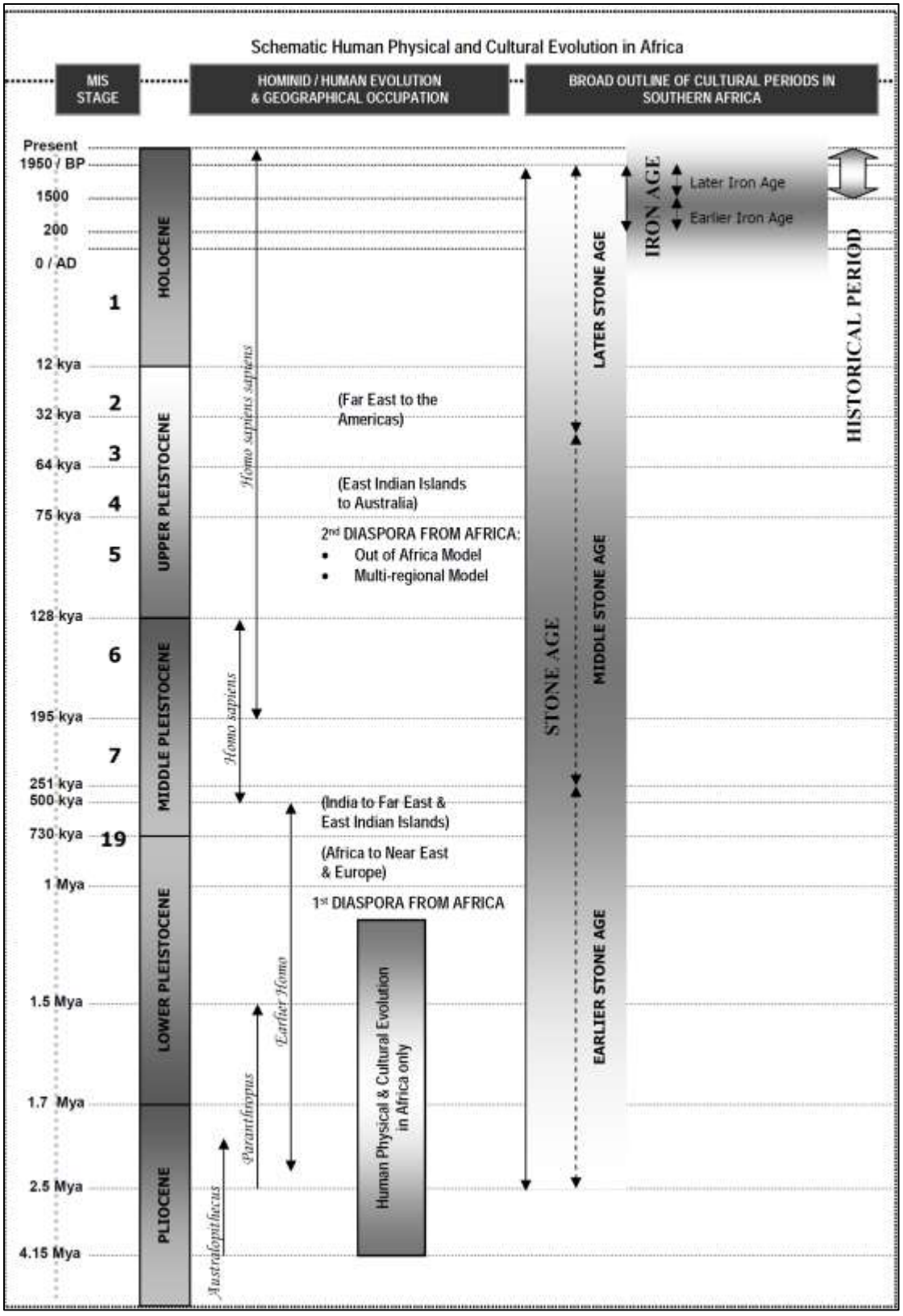

Figure 1 – Human and Cultural Timeline in Africa (Morris, 2008)

2 TECHNICAL DETAILS OF THE PROJECT

2.1 Site Location and Description

Location	S29 06 21.3 E26 05 06.0 The site is situated on the western part of Portion 6 (Portion of Portion 5) of Farm Spes Bona 2355, approximately 12km west of Bloemfontein, Free State Province
Land	75 Hectares of land under option.

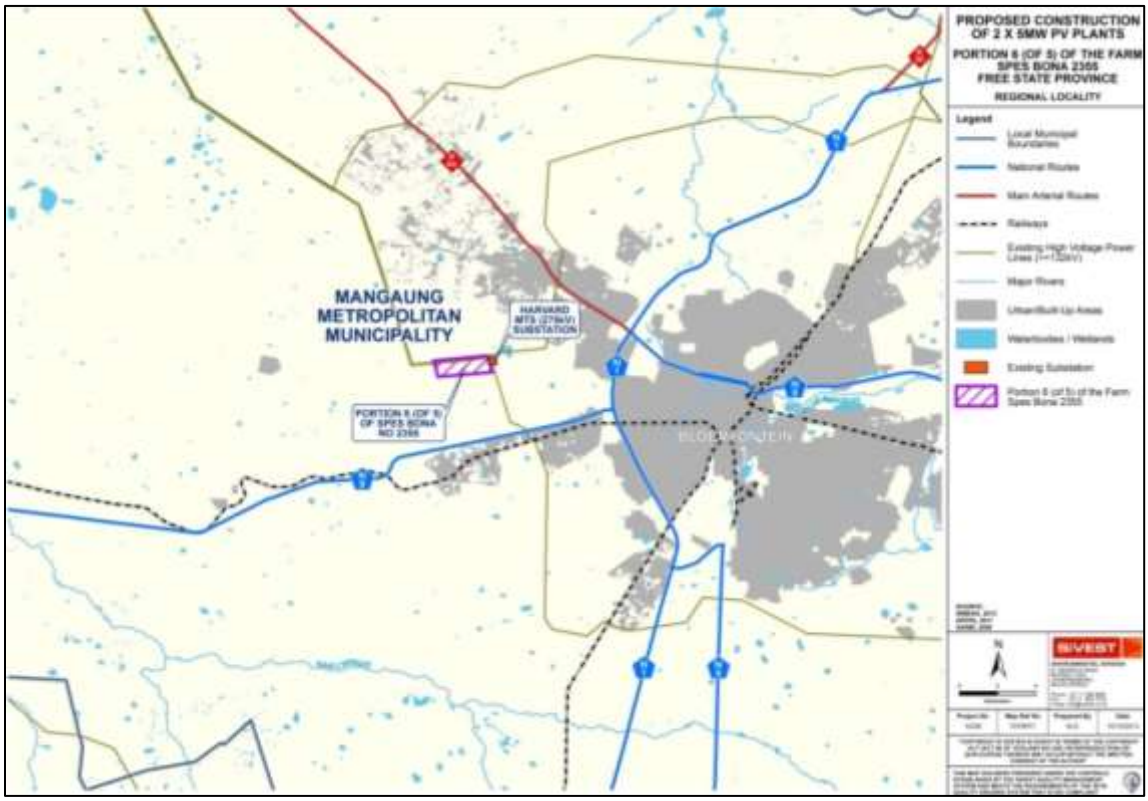

Figure 2 –PV Project locality

2.2 Technical Project Description

Refer to **Appendix C** for description of the PV technical details.

3 ARCHIVAL FINDINGS

The aim of the archival background research is to identify possible heritage resources that could be encountered during the field work. The archival research included in this report covers the larger study area.

3.1 Previous historical studies

The following archaeological and historical studies were conducted in the vicinity of the study area:

- Dreyer, J.2007. First phase archaeological and cultural heritage assessment of the proposed light industrial developments at Plot 38 Kwaggafontein, Bloemfontein.
  - **Findings: None**

- Dreyer, J.2005. First phase heritage / archaeological assessment of the proposed residential developments at the Farm Wolfkop 2353, Bloemfontein.
  - **Findings:** Early farming community stone walled settlements found on the farm Wolfkop 5km to the southwest of the Spes. Bona study area.

- Dreyer, J. 2008. Archaeological and historical investigation of the proposed township establishment on a Portion of the Farm Bloemfontein 654, Bloemfontein, Free State.
  - **Findings: None**

- Dreyer, J. 2007. Archaeological and historical investigation of the proposed township establishment on Portions of the Farms Cecilia 2352, Kwaggafontein 2300 and Bloemfontein 654, Bloemfontein, Free State.
  - **Findings: None**

- Dreyer, J. 2007. First phase archaeological and cultural heritage assessment of the proposed residential developments at Subdivision 3, Kwaggafontein 2300, Bloemfontein.
  - **Findings:** the farm Kwaggafontein was associated with Cornelius Hermanus Wessels, the second Administrator of the Free State (1915-1924). He bought the farm in 1892 and was buried on the farm in 1924. Other remains on the farm are the original farmstead, family cemetery and farm workers cemetery.

3.2 Archival findings

The aim of the archival background research is to identify possible heritage resources that could be encountered during the field work, as summarised in **Table 1**.

Table 1: Summary of History of Spes Bona and surrounds

DATE	DESCRIPTION
2.5 million to 250 000 years ago	The Earlier Stone Age (ESA). No recorded sites were located during the desktop study.
250 000 to 40 000 years ago	The Middle Stone Age (MSA). No recorded sites were located during the desktop study.
40 000 years ago to the historic past	The Later Stone Age (LSA). No recorded sites were located during the desktop
AD 200 - 900	Early Iron Age (EIA). No recorded sites were located during the desktop study.
AD 900 - 1300	Middle Iron Age (MIA). No recorded sites were located during the desktop study.
AD 900 - 1840	Late Iron Age (LIA). Early farming community stone walled settlements found on the farm Wolfkop 5km to the southwest of the Spes. Bona study area (Dreyer, 2005)
AD 1840-1902	Historical period. Bloemfontein was officially founded in 1846 as military outpost by Major Henry Douglas Warden. Warden bought the farm from the original owner Johannes Nicolas Brits in the early 1840's for the specific establishment of a military outpost in the Transoranje region. Bloemfontein becomes the capital of the Orange River Sovereignty (1848-1854) and then the Orange Free State Republic (1854-1902). Bloemfontein hosts the Bloemfontein Conference of 1899, with the aim of negotiating a peaceful settlement between President Kruger of the Transvaal Republic and the British High commissioner Alfred Milner on the status of British migrant mine workers, however the conference fails and South African War starts alter in the same year. 13 March 1900, Bloemfontein is capture by British forces. Bloemfontein town is largely concentrated between Naval Hill to the north and Fort Hill to the south during the South African War

3.3 Palaeontology of the area

The following section is an extract from the Palaeontological Desktop Study, attached as Appendix D.

The portions of the study area where the PV power plants are expected to be constructed are underlain by Upper Permian aged rocks of the Adelaide Subgroup, Beaufort Group, Karoo Supergroup. Portions towards the center of the study area are underlain by Jurassic aged Dolerite (Figure 3).

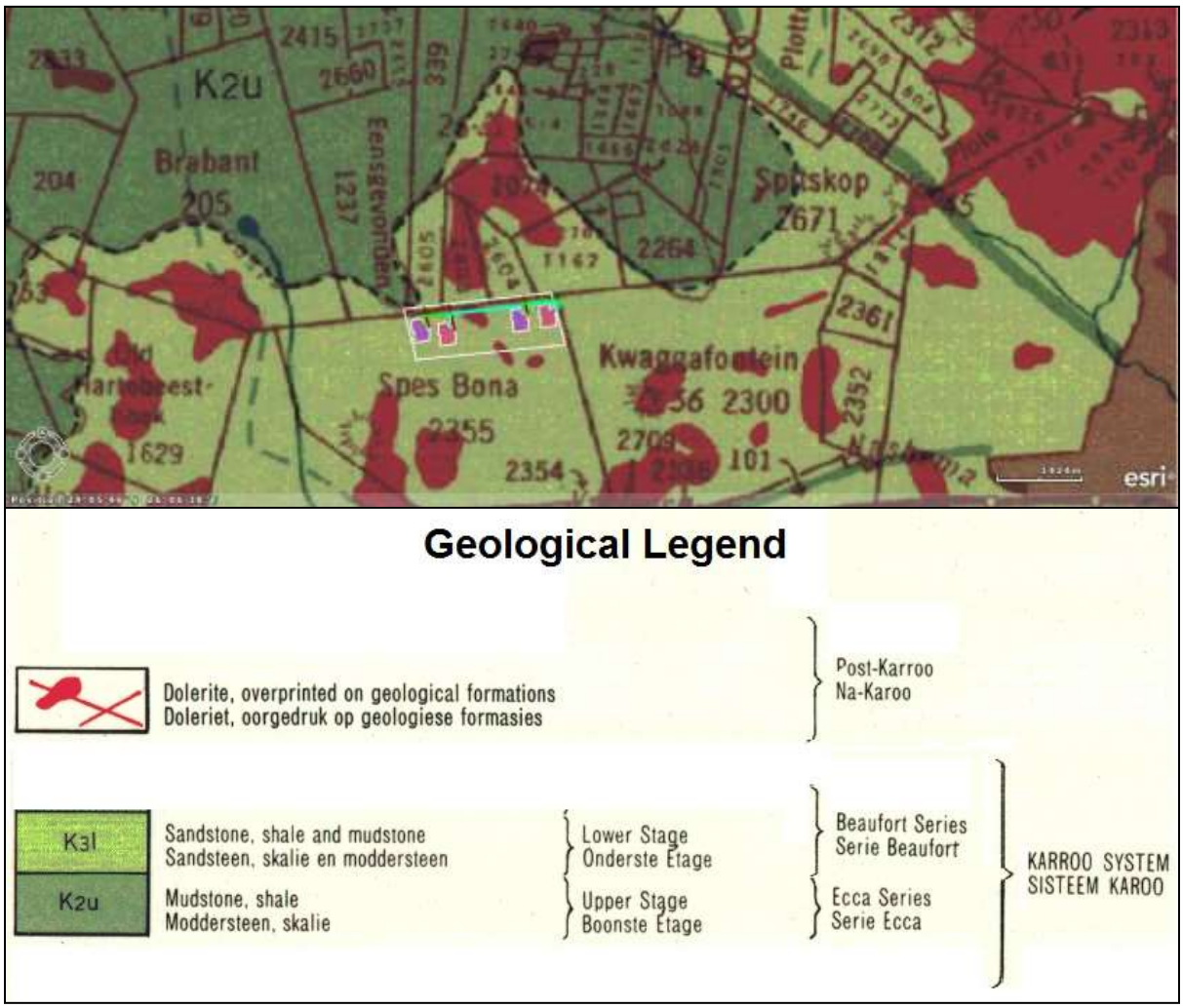

Figure 3 - Geology of the study area of the proposed PV sites

3.3.1 Adelaide Subgroup (K3l)

The Adelaide Subgroup (K3l) is interpreted as fluvial sediments with channel sandstones

(meandering rivers), thin mudflake conglomerates interbedded with floodplain mudrocks (green and maroon), pedogenic calcretes, playa lake and pond deposits and occasional reworked volcanic ashes (Johnson et al, 2006). Rocks belonging to the Adelaide Subgroup in this region can be best correlated with the Normandien Formation in the North-eastern Free State (Groenewald 1989). The upper part of the Subgroup is interpreted as mostly shallow lacustrine deposits and is represented by brightly coloured (greenish grey and maroon) siltstones (Groenewald, 1996).

The Permian aged Adelaide Subgroup is well-known as a productive fossil-bearing unit in the Beaufort Group of the Karoo Supergroup. The study area is underlain by rocks of the lower Adelaide Subgroup that can best be correlated with the Normandien Formation to the east of the study area (Groenewald, 1989). This sequence of rock correlates with the Dicynodon Assemblage Zone and also contains the remains of Glossopteris plants

3.3.2 3.Dolerite (Jd)

Dolerite is a mafic intrusive igneous rock and occurs as dykes or sills in the study area. The Jurassic aged dolerite in the study area is associated with the “koppies” or high-lying areas in the region.

The rock units of the Adelaide Subgroup have a high potential to yield fossils. The extent of erosion and outcrops of these units in the study area is however not known. The excavations for infrastructure such as roads and trenches for electric cables and foundations for solar panel foundations might expose fresh bedrock. As a result, areas underlain by rocks of the Adelaide Subgroup have been allocated a Medium Palaeontological Sensitivity, although this may be increased to High Sensitivity following the recording of palaeontological information during the construction phase.

4 IMPACT ASSESSMENT

4.1 Assessment Methodology

The section below outlines the assessment methodologies utilised in the study.

This Heritage Impact Assessment (HIA) report was compiled by PGS Heritage (PGS) for the proposed SSS1 5MW PV project. 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) and the Minerals and Petroleum Resources Development Act (MPRDA) (28 of 2002). The HIA process consisted 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 in September 2010.

- Step II – Physical Survey: A physical survey was conducted on foot through the proposed project area by qualified archaeologists (February 2011), 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

Impacts on these sites by the development will be evaluated as follows

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 2: 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

4.2 Methodology for Impact Assessment

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.

4.2.1 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.

4.2.2 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.

- 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 3: Description

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.

4.3 Field work findings and assessment

The footprint area for this proposed project covers approximately 75 hectares that will encompass the installation of a solar field and their associated components as well as a further 2.5 kilometres of power line that will link the PV plant with the Harvard Substation to the east. Due to the nature of cultural remains, with the majority of artefacts occurring below surface, a controlled-exclusive surface survey of the footprint area as well as centre line of the provided power line alignment was conducted over a period of 1days\ on foot by a heritage specialist / archaeologist from PGS. Field work was conducted on 26 November 2013. Refer to **Appendix A** for Heritage Maps and tracklogs.

The site assessed averages at 1380 meters above mean sea level and is characterised ploughed agricultural land utilised or planting maize and grazing. Alternative A has a gentle slope from east to west and levels out towards Alternative B (**Figure 5** and **Figure 4**).

Figure 4 – General view of the proposed alternative A

Figure 5 – General view of the proposed alternative B

No heritage resources were identified on any of the two alternative PV plant options or power line alignments for the project.

4.4 Impact Matrix

Note that the impact assessment tables all refer to impacts during construction and not operational, as the foreseen impacts on the heritage resources will primarily be during the construction phase.

Table 4: Impact Assessment table for chance finds

IMPACT TABLE		
Environmental Parameter	*Discovery of previously unidentified heritage sites (archaeological, historical or grave sites)*	
Issue/Impact/Environmental Effect/Nature	*During construction activity and earthmoving archaeological material could be unearthed that was previously unidentified due to its position.*	
Extent	*In most cases confined to small areas on the site*	
Probability	*Due to the close proximity to water course, localised archaeological finds may possibly occur*	
Reversibility	*In most cases where such finds are made damaged is irreversible*	
Irreplaceable loss of resources	*Significant loss but in most cases the scientific data recovered will mitigate such losses*	
Duration	*Permanent*	
Cumulative effect	*Low cumulative impact*	
Intensity/magnitude	*Medium*	
Significance Rating	*The impact is anticipated as being low and localised but will vary due to type of heritage find that could be made*	
	Pre-mitigation impact rating	Post mitigation impact rating
Extent	1	1
Probability	2	1
Reversibility	4	2
Irreplaceable loss	4	3
Duration	4	4
Cumulative effect	2	1
Intensity/magnitude	2	1
Significance rating	-24(Low negative)	-11 (low negative)
Mitigation measures	*A heritage monitoring program that will identify finds during construction will be able to mitigate the impact on the finds through scientific documentation of finds and provide valuable data on any finds made.*	

4.4.1 Palaeontology

The likely impact of the proposed development on local fossil heritage is determined on the basis of the palaeontological sensitivity of the rock units concerned and the nature and scale of the development itself, most notably the extent of fresh bedrock excavation envisaged. The different sensitivity classes used are explained in Table 1 above. The Palaeontological sensitivity of the Geological units present within the study area is summarised in **Table 5** below. Based on the interpretation of the Google image, both alternative sites for the development (Alternatives A and B) are situated in ploughed fields and therefore most probably underlain by relatively deep soils on rocks of the Permian aged Adelaide Subgroup of the Karoo Supergroup.

The rock units of the Adelaide Subgroup have a high potential to yield fossils. The extent of erosion and outcrops of these units in the study area is however not known. The excavations for infrastructure such as roads and trenches for electric cables and foundations for solar panel foundations might expose fresh bedrock. As a result, areas underlain by rocks of the Adelaide Subgroup have been allocated a Medium Palaeontological Sensitivity, although this may be increased to High Sensitivity following the recording of palaeontological information during the construction phase.

Due to the igneous nature of dolerite, no fossils will be found and areas underlain by dolerite have been allocated a Low palaeontological sensitivity.

Table 5: Palaeontological sensitivity of the Geological units present within the study area

Geological Unit	**Rock Type and Age**	**Fossil Heritage**	**Vertebrate Biozone**	**Palaeontological Sensitivity**
Jurassic dolerite	Dolerite JURASSIC	None	None	Low sensitivity
Adelaide Subgroup	Green-grey mudstone and grey sandstone PERMIAN	*Dicynodon lacerticeps* Gorgonopsians *Glossopteris* plants	*Dicynodon* Assemblage zone	Medium sensitivity

The palaeontological sensitivity of the study area is shown in **Figure 6** below.

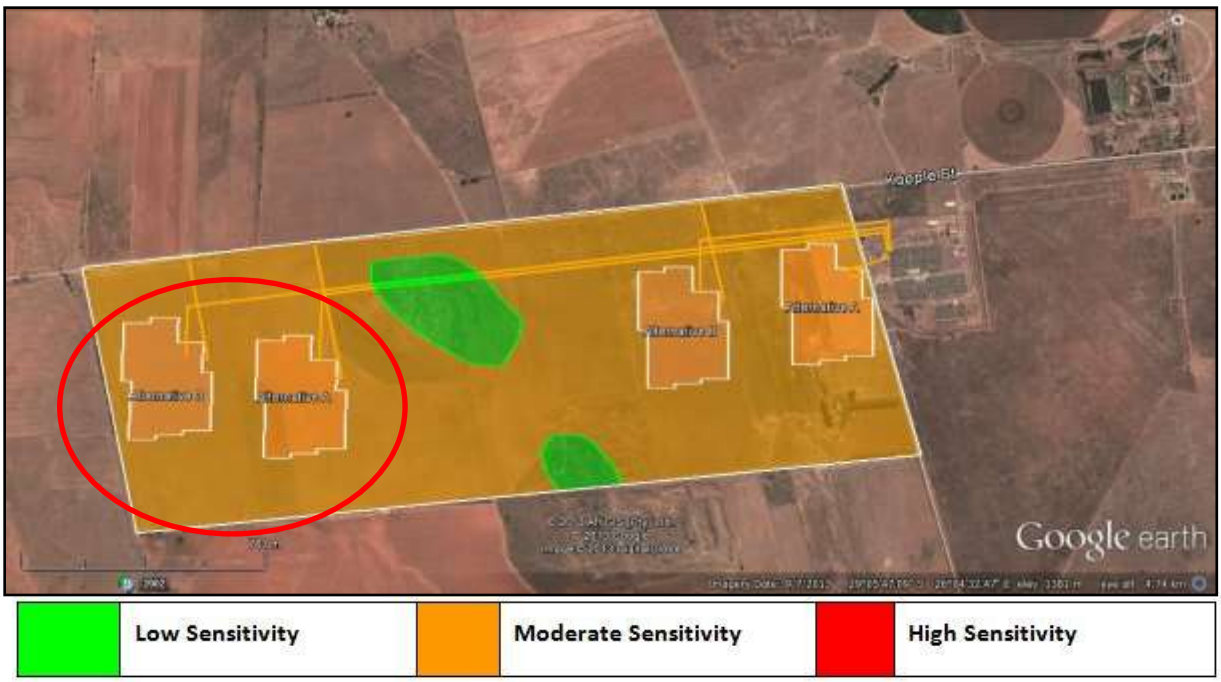

Figure 6 – Palaeontological sensitivity of the study area (SSS1 circled in red)

Table 6: Impact Assessment table for palaeontology

IMPACT TABLE		
Environmental Parameter	*Impact on palaeontological resources*	
Issue/Impact/Environmental Effect/Nature	*The possibility of uncovering significant subsurface palaeontological deposits*	
Extent	*In most cases confined to small areas on the site*	
Probability	*Low probability of impact on palaeontology*	
Reversibility	*In most cases where a site cannot be excluded and needs to be destructed the impact is irreversible*	
Irreplaceable loss of resources	*Significant loss but in most cases the scientific data recovered will mitigate such losses*	
Duration	*Permanent*	
Cumulative effect	*Low cumulative impact*	
Intensity/magnitude	*Low*	
Significance Rating	*The impact is anticipated as being low and localised*	
	Pre-mitigation impact	Post mitigation impact

IMPACT TABLE		
	rating	rating
Extent	1	1
Probability	3	1
Reversibility	4	2
Irreplaceable loss	2	3
Duration	4	4
Cumulative effect	2	2
Intensity/magnitude	1	1
Significance rating	-16 (Medium negative)	-13 (low negative)
Mitigation measures	*Refer to Section 4.8.1*	

4.5 Confidence in Impact Assessment

It is necessary to realise that the heritage resources located during the fieldwork do not necessarily represent all the possible heritage resources present within the area. Various factors account for this, including the subterranean nature of some heritage sites.

The impact assessment conducted for heritage sites assumes the possibility of finding heritage resources during the project life and has been conducted as such.

4.6 Cumulative Impacts

None foreseen

4.7 Reversibility of Impacts

Although heritage resources are seen as non-renewable the mitigation of impacts on possible finds through scientific documentation will provided sufficient mitigation on the impacts on possible heritage resources.

4.8 Site specific management measures

4.8.1 Palaeontology

1. The EAP as well as the ECO for this project must be made aware of the fact that the Adelaide Subgroup is extremely rich in fossil remains. Several types of fossils have been recorded from this subgroup in the Karoo Basin of South Africa.
2. A qualified palaeontologist must be appointed to assess and record the extent of erosion and outcrop of the Adelaide Subgroup during the construction phase of the project. All the alternative sites have been allocated a Medium palaeontological sensitivity rating and the rating must be upgraded to High if fossils are recorded during the construction phase.
3. If fossils are recorded during deep excavations for infrastructure such as road developments, the palaeontologist must apply for a collection permit to collect the fossils according the SAHRA specifications.

5 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 South African Heritage Resources Agency (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 Cultural 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.

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 is 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 needs to be followed. This includes an extensive social consultation process.

The definition of an archaeological/palaeontological monitoring programme is a formal program of observation and investigation conducted during any operation carried out for non-archaeological reasons. This will be within a specified area or site on land, inter-tidal zone or underwater, where there is a possibility that archaeological deposits may be disturbed or destroyed. The programme will result in the preparation of a report and ordered archive.

The purpose of an archaeological/palaeontological monitoring programme is:

- To allow, within the resources available, the preservation by record of archaeological/palaeontological deposits, the presence and nature of which could not be established (or established with sufficient accuracy) in advance of development or other potentially disruptive works
- To provide an opportunity, if needed, for the watching archaeologist to signal to all interested parties, before the destruction of the material in question, that an archaeological/palaeontological find has been made for which the resources allocated to the watching brief itself are not sufficient to support treatment to a satisfactory and proper standard.
- A monitoring is not intended to reduce the requirement for excavation or preservation of known or inferred deposits, and it is intended to guide, not replace, any requirement for contingent excavation or preservation of possible deposits.
- The objective of the monitoring is to establish and make available information about the archaeological resource existing on a site.

Table 7: Roles and responsibilities of archaeological and heritage management

ROLE	RESPONSIBILITY	IMPLEMENTATION
A responsible specialist needs to be allocated and should sit in at all relevant meetings, especially when changes in design are discussed, and liaise with SAHRA.	The client	Archaeologist and a competent archaeology supportive 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 supportive team
Comply with defined national and local cultural heritage regulations on	The client	Environmental Consultancy and the

management plans for identified sites.		Archaeologist/Palaeontologist
Consult the managers, local communities and other key stakeholders on mitigation of archaeological/palaeontological sites.	The client	Environmental Consultancy and the Archaeologist/Palaeontologist
Implement additional programs, as appropriate, to promote the safeguarding of our cultural heritage. (i.e. integrate the archaeological components into employee induction course).	The client	Environmental Consultancy and the Archaeologist/Palaeontologist
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/palaeontological sites.	The client	Environmental Consultancy and the Archaeologist/Palaeontologist
After the specialist/archaeologist/palaeontologist has been appointed, comprehensive feedback reports should be submitted to relevant authorities during each phase of development.	Client and Archaeologist	Archaeologist/Palaeontologist

5.1 All phases of the project

5.1.1 Graves

In the case where a grave is identified during construction the following measures must be taken.

Mitigation of graves will require a fence around the cemetery with a buffer of at least 20 meters.

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 rescue permit must be applied for with SAHRA and the local South African Police Services must be notified of the find.

Where it is then 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 Notice 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. An exhumation process that will safeguard the legal implications towards the developing company;
ix. The whole process must be done by a reputable company that are well versed in relocations;
x. The 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.

6 CONCLUSIONS AND RECOMMENDATIONS

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

The field work and assessment of the impact of the proposed PV facility and power line has identified no heritage resources during the field work, however the following recommendations regarding palaeontology needs to be implemented.

6.1 Palaeontology

The Spes Bona Study area is mainly underlain by Permian aged rocks of the Adelaide Subgroup, with a portion of the study area study area underlain by Jurassic aged dolerite intrusions. Both alternatives A and B fall on rocks of the Adelaide Subgroup and will have the same palaeontological sensitivity.

Although the high fossiliferous potential of the Adelaide Subgroup strata warrants an allocation of a High palaeontological sensitivity, the fact that all the alternative sites are falling in presently ploughed fields, will make it less likely that fossils will be exposed. Remote sensing indicates that most of the study areas are presently part of ploughed fields, with relatively deep soils. For this reason, areas underlain by these units have been allocated a Medium palaeontological sensitivity, which might be upgraded to a High palaeontological sensitivity, following exposure of

the bedrock during the construction phase. In areas where topsoil has been removed by erosion, fossils will most likely be exposed. The areas underlain by dolerite have been allocated a Low palaeontological sensitivity as a result of their igneous nature.

Recommendations:

4. The EAP as well as the ECO for this project must be made aware of the fact that the Adelaide Subgroup is extremely rich in fossil remains. Several types of fossils have been recorded from this subgroup in the Karoo Basin of South Africa.
5. A qualified palaeontologist must be appointed to assess and record the extent of erosion and outcrop of the Adelaide Subgroup during the construction phase of the project. All the alternative sites have been allocated a Medium palaeontological sensitivity rating and the rating must be upgraded to High if fossils are recorded during the construction phase.
6. If fossils are recorded during deep excavations for infrastructure such as road developments, the palaeontologist must apply for a collection permit to collect the fossils according the SAHRA specifications.

The overall impact on the heritage resources by both alternatives is seen as low through the implementation of the recommended mitigation measures. No alternative carries a higher preference with regards to lesser impacts on heritage reosurces.

7 REFERENCES

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7.1 Web resources

Bloemfontein - http://en.wikipedia.org/wiki/Bloemfontein
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7.2 Supporting documentation

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STANDARD AND GUIDANCE FOR ARCHAEOLOGICAL DESK-BASED ASSESSMENT. 1994.

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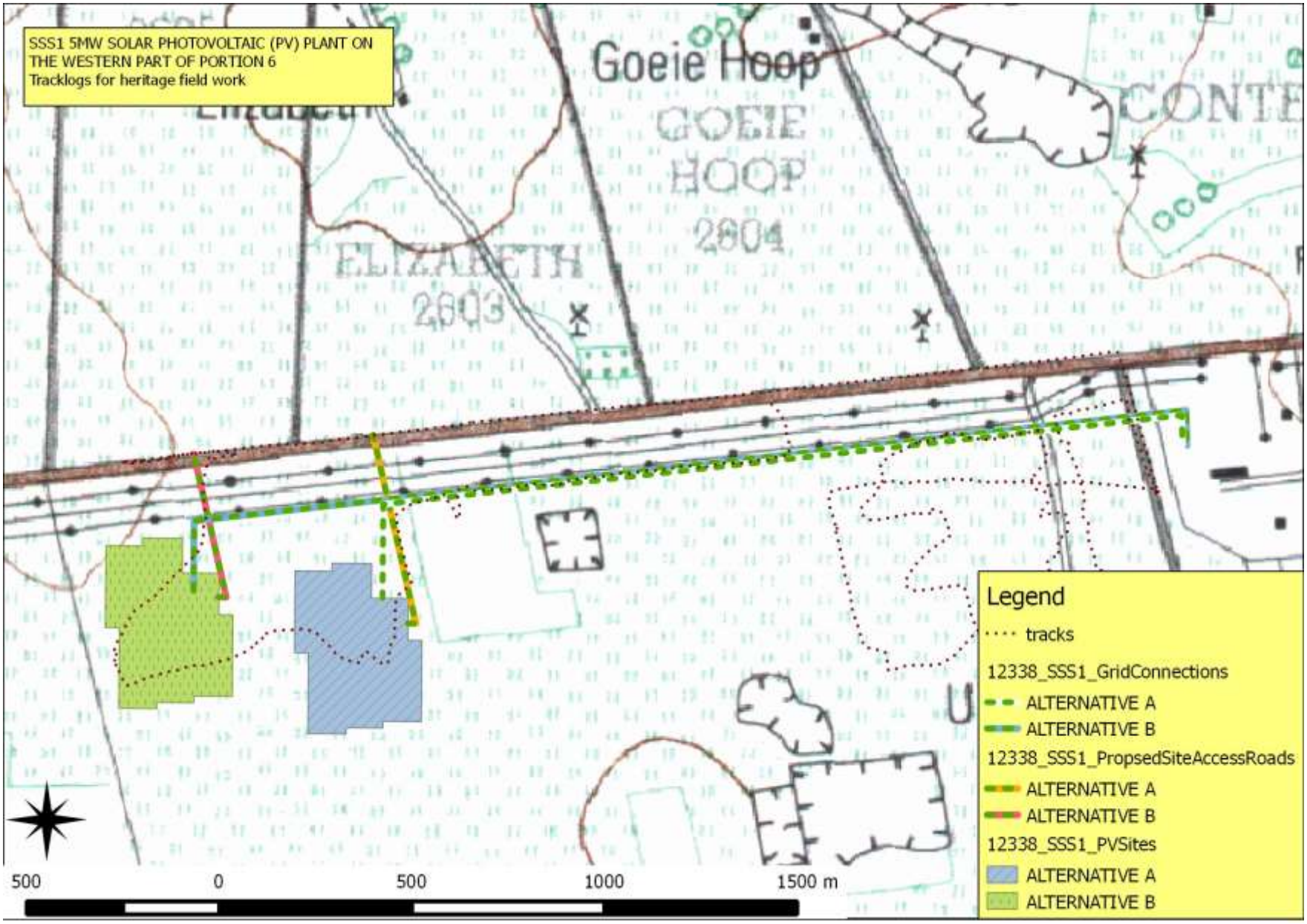
Appendix A

HERITAGE MAP


SSS1 5MW SOLAR PHOTOVOLTAIC (PV) PLANT ON THE WESTERN PART OF PORTION 6
Tracklogs for heritage field work
Goeie Hoop
GOEIE HOOP
2604
ELIZABETH
2603
Legend
tracks
12338_SSS1_GridConnections
ALTERNATIVE A
ALTERNATIVE B
12338_SSS1_PropsedSiteAccessRoads
ALTERNATIVE A
ALTERNATIVE B
12338_SSS1_PVSites
ALTERNATIVE A
ALTERNATIVE B
500
0
500
1000
1500 m

Appendix B

LEGISLATIVE PRINCIPLES

LEGISLATIVE REQUIREMENTS – TERMINOLOGY AND ASSESSMENT CRITERIA

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.

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

PROJECT DESCRIPTIONS

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

Surya Power (Pty) Ltd. (hereafter referred to as Surya Power) are proposing to construct the SSS1 5MW Solar Photovoltaic (PV) Power Plant on the western part of Portion 6 (Portion of Portion 5) of Farm Spes Bona 2355, approximately 12km west of Bloemfontein, Free State Province. Surya Power has appointed SiVEST, as the independent Environmental Assessment Practitioner (EAP), to undertake the required Basic Assessment process for the above-mentioned proposed project.

Project Description

The following key components are to be constructed for the PV Power Plant:

- Solar PV Field;
- PV solar panels and arrays (Jinko polycrystalline 290W panels, five subfields);
- PV Panel mountings (terrafix single axis tracking system east/west - 5200 points for foundations 1,2 m deep);
- DC-AC current inverters and transformers (10 x 500 kVA (2.5m x 1m) within the PV field);
- Mini Substations (3m x 2 m within the PV field).

A conceptual illustration of a typical solar PV panel is displayed in Figure 7 below.

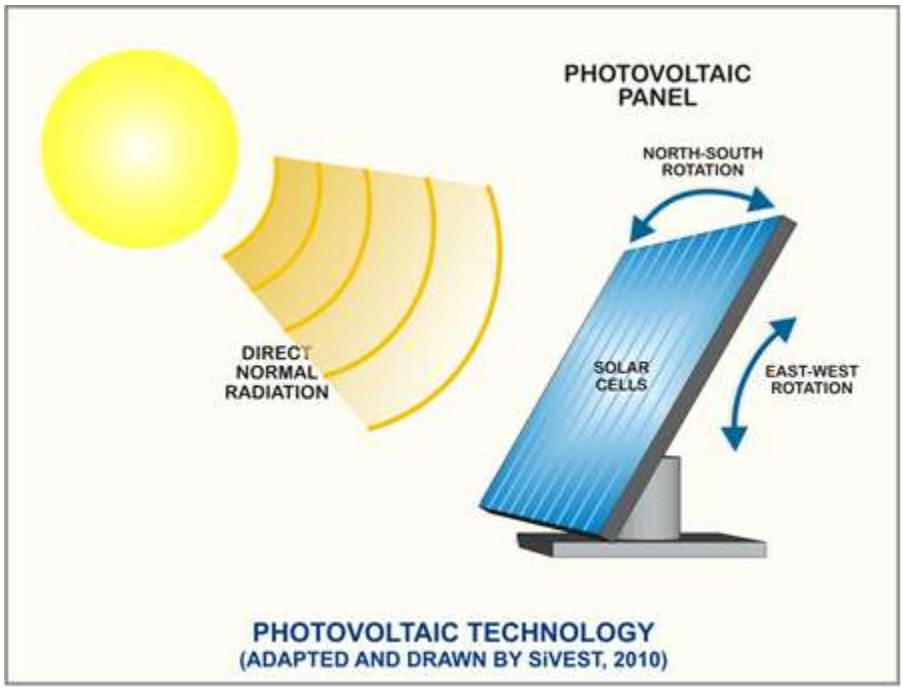


Figure 7: Typical Solar PV Panel

In terms of the associated infrastructure required for the proposed development, the following is to be constructed:

- Substation (approximately 10m x 10m);
- Coupling station (approximately 10m x 10m);

- Underground cabling (approximately 0,8 m x 0,6 wide);
- Overhead power lines (11-22kV);
- Small site office and storage facility (approximately 10m x 10m) - including security and associated facilities;
- Internal gravel roads (4m width);
- Site fencing.

The proposed development is located directly west of the Harvard Substation, where existing supply is taken. The proposed developments will link into Harvard Substation.

Location of the proposed solar PV plant

As previously stated, the study area is located in the Free State Province approximately 12km west of Bloemfontein within the Mangaung Metropolitan Municipality. It is proposed that the 5MW PV Solar Power Plant is to be located on the western part of Portion 6 (Portion of Portion 5) of Farm Spes Bona 2355.

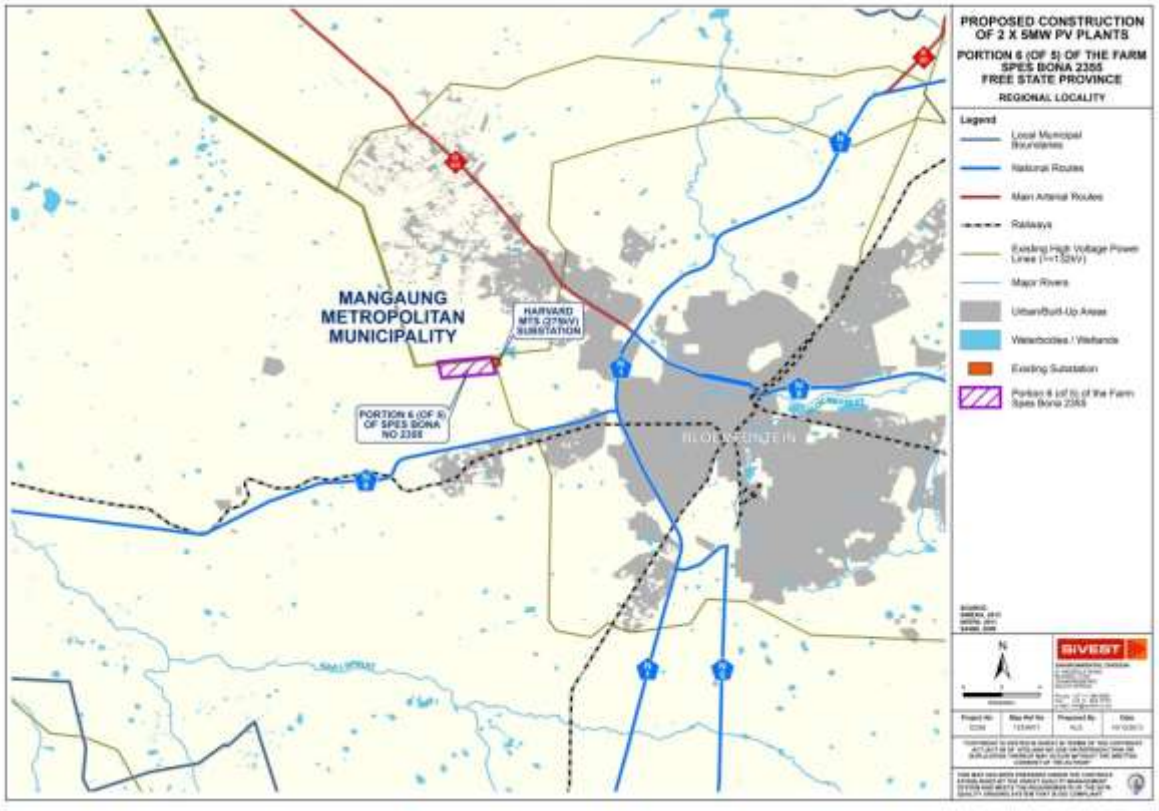


Figure 8: Locality Map

2.1 Proposed site alternatives

Two alternative site locations should be investigated for the proposed Solar PV Power Plant in order to determine the potential impact for the proposed development on the study site. The proposed alternative sites are as follows:

. Layout Alternative A
a. Layout Alternative B

An illustration of the alternatives is provided in Figure 9 below.

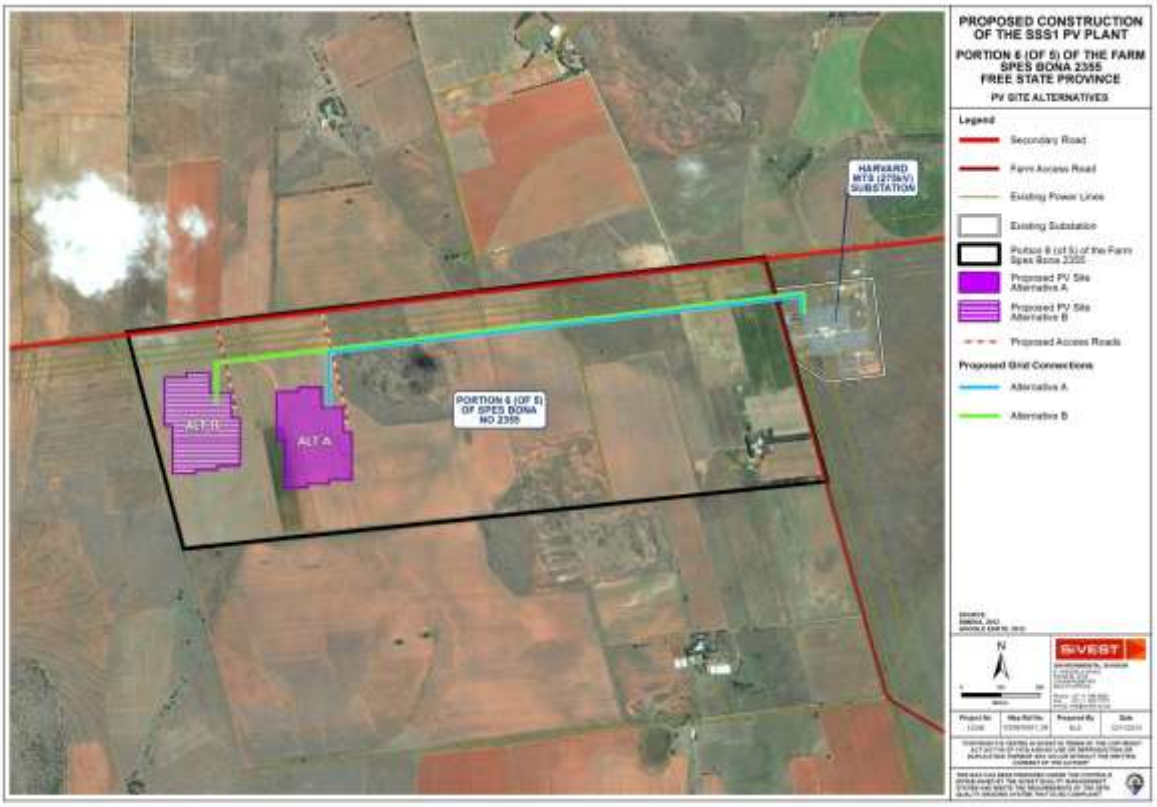


Figure 9: Proposed PV Site Alternatives

Appendix D

PALAEONTOLOGICAL DESKTOP

PALAEONTOLOGICAL DESKTOP ASSESSMENT FOR THE CONSTRUCTION OF TWO 5MW PHOTOVOLTAIC POWER PLANTS ON THE FARM SPES BONA 2355, BLOEMFONTEIN, MANGUANG METRO MUNICIPALITY, FREE STATE PROVINCE

For:

HIA CONSULTANTS

DATE: 29 November 2013

By

Gideon Groenewald
082 339 9202

EXECUTIVE SUMMARY

Gideon Groenewald was appointed by PGS Heritage to undertake a desktop survey, assessing the potential palaeontological impact of the proposed construction of two 5MW Photovoltaic (PV) Powerplants on the farm Spes Bona 2355 located outside Bloemfontein, Mangaung Metro Municipality, Free State Province.

This report forms part of the Basic Environmental Impact Assessment and complies with the requirements of the South African National Heritage Resource Act No 25 of 1999. In accordance with Section 38 (Heritage Resources Management), a Heritage Impact Assessment (HIA) is required to assess any potential impacts to palaeontological heritage within the development footprint of the development.

The likely impact of the proposed development on local fossil heritage is determined on the basis of the palaeontological sensitivity of the rock units concerned and the nature and scale of the development itself, most notably the extent of fresh bedrock excavation envisaged.

The study area is located in the Free State Province approximately 12km west of Bloemfontein within the Mangaung Metropolitan Municipality. It is proposed that both 5MW PV Solar Power Plants are to be located on Portion 6 (Portion of Portion 5) of Farm Spes Bona 2355 as follows:

- SSS1 Solar PV Plant located on the western part of the site; and
- SSS2 Solar PV Plant located on the eastern part of the site.

The portions of the study area where the PV power plants are expected to be constructed are underlain by Upper Permian aged rocks of the Adelaide Subgroup, Beaufort Group, Karoo Supergroup. Portions towards the centre of the study area are underlain by Jurassic aged Dolerite.

The Permian aged Adelaide Subgroup is well-known as a productive fossil-bearing unit in the Beaufort Group of the Karoo Supergroup. The study area is underlain by rocks of the lower Adelaide Subgroup that can best be correlated with the Normandien Formation to the east of the study area (Groenewald, 1989). This sequence of rock correlates with the *Dicynodon* Assemblage Zone and also contains the remains of *Glossopteris* plants.

Due to the igneous nature of dolerite, no fossils will be found in the rock units.

Although the high fossiliferous potential of the Adelaide Subgroup strata warrants an allocation of a High palaeontological sensitivity, the fact that all the alternative sites are falling in presently ploughed fields, will make it less likely that fossils will be exposed. Remote sensing indicates that most of the study areas are presently part of ploughed fields, with relatively deep soils. For this reason, areas underlain by these units have been allocated a Medium palaeontological sensitivity, which might be upgraded to a High palaeontological sensitivity, following exposure of the bedrock during the construction phase. In areas where topsoil has been removed by erosion, fossils will most likely be exposed. The areas underlain by dolerite have been allocated a Low palaeontological sensitivity as a result of their igneous nature.

Recommendations:

1. The EAP as well as the ECO for this project must be made aware of the fact that the Adelaide Subgroup is extremely rich in fossil remains. Several types of fossils have been recorded from this subgroup in the Karoo Basin of South Africa.
2. A qualified palaeontologist must be appointed to assess and record the extent of erosion and outcrop of the Adelaide Subgroup during the construction phase of the project. All the

alternative sites have been allocated a Medium palaeontological sensitivity rating and the rating must be upgraded to High if fossils are recorded during the construction phase.
3. If fossils are recorded during deep excavations for infrastructure such as road developments, the palaeontologist must apply for a collection permit to collect the fossils according the SAHRA specifications.

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1 INTRODUCTION

1.1 Background

Gideon Groenewald was appointed by PGS Heritage ato undertake a desktop survey, assessing the potential palaeontological impact of the proposed construction of two 5MW Photovoltaic (PV) Powerplants on the farm Spes Bona 2355 located outside Bloemfontein, Mangaung Metro Municipality, Free State Province.

This report forms part of the Basic Environmental Impact Assessment and complies with the requirements of the South African National Heritage Resource Act No 25 of 1999. In accordance with Section 38 (Heritage Resources Management), a Heritage Impact Assessment (HIA) is required to assess any potential impacts to palaeontological heritage within the development footprint of the development.

Categories of heritage resources recognised as part of the National Estate in Section 3 of the Heritage Resources Act, and which therefore fall under its protection, include:

- geological sites of scientific or cultural importance;
- objects recovered from the soil or waters of South Africa, including archaeological and palaeontological objects and material, meteorites and rare geological specimens;
- objects with the potential to yield information that will contribute to an understanding of South Africa's natural or cultural heritage.

1.2 Aims and Methodology

Following the *"SAHRA APM Guidelines: Minimum Standards for the Archaeological & Palaeontological Components of Impact Assessment Reports"* the aims of the palaeontological impact assessment are:

- to identify exposed and subsurface rock formations that are considered to be palaeontologically significant;
- to assess the level of palaeontological significance of these formations;
- to comment on the impact of the development on these exposed and/or potential fossil resources and
- to make recommendations as to how the developer should conserve or mitigate damage to these resources.

In preparing a palaeontological desktop study the potential fossiliferous rock units (groups, formations etc.) represented within the study area are determined from geological maps. The known fossil heritage within each rock unit is inventoried from the published scientific literature and previous palaeontological impact studies in the same region.

The likely impact of the proposed development on local fossil heritage is determined on the basis of the palaeontological sensitivity of the rock units concerned and the nature and scale of the development itself, most notably the extent of fresh bedrock excavation envisaged. The different sensitivity classes used are explained in Table 1.1 below.

Table 8 Palaeontological Sensitivity Analysis Outcome Classification

Sensitivity	Description
Low Sensitivity	Areas where a negligible impact on the fossil heritage is likely. This category is reserved largely for areas underlain by igneous rocks. However, development in fossil bearing strata with shallow excavations or with deep soils or weathered bedrock can also form part of this category.
Moderate Sensitivity	Areas where fossil bearing rock units are present but fossil finds are localised or within thin or scattered sub-units. Pending the nature and scale of the proposed development the chances of finding fossils are moderate. A field-based assessment by a professional palaeontologist is usually warranted.
High Sensitivity	Areas where fossil bearing rock units are present with a very high possibility of finding fossils of a specific assemblage zone. Fossils will most probably be present in all outcrops and the chances of finding fossils during a field-based assessment by a professional palaeontologist are very high. Palaeontological mitigation measures need to be incorporated into the Environmental Management Plan

1.3 Scope and Limitations of the Desktop Study

The study will include: i) an analysis of the area's stratigraphy, age and depositional setting of fossil-bearing units; ii) a review of all relevant palaeontological and geological literature, including geological maps, and previous palaeontological impact reports; iii) data on the proposed development provided by the developer (e.g. location of footprint, depth and volume of bedrock excavation envisaged) and iv) where feasible, location and examination of any fossil collections from the study area (e.g. museums).

The key assumption for this scoping study is that the existing geological maps and datasets used to assess site sensitivity are correct and reliable. However, the geological maps used were not intended for fine scale planning work and are largely based on aerial photographs alone, without ground-truthing. There is also an inadequate database for fossil heritage for much of the RSA, due to the small number of professional palaeontologists carrying out fieldwork in RSA. Most development study areas have never been surveyed by a palaeontologist.

These factors may have a major influence on the assessment of the fossil heritage significance of a given development and without supporting field assessments may lead to either:

- an underestimation of the palaeontological significance of a given study area due to ignorance of significant recorded or unrecorded fossils preserved there, or
- an overestimation of the palaeontological sensitivity of a study area, for example when originally rich fossil assemblages inferred from geological maps have in fact been destroyed by weathering, or are buried beneath a thick mantle of unfossiliferous "drift" (soil, alluvium etc.).
-

2 DESCRIPTION OF THE PROPOSED DEVELOPMENT

The study area is located in the Free State Province approximately 12km west of Bloemfontein within the Mangaung Metropolitan Municipality. It is proposed that both 5MW PV Solar Power Plants are to be located on Portion 6 (Portion of Portion 5) of Farm Spes Bona 2355 as follows:

- SSS1 Solar PV Plant located on the western part of the site; and
- SSS2 Solar PV Plant located on the eastern part of the site

Figure 0.1 Locality of the study area.

The proposed development will entail the construction of two 5MW PV Solar Power Plants on Portion 6 (Portion of Portion 5) of Farm Spes Bona 2355. The following key components are to be constructed for each PV Power Plant:

- Solar PV Field;
- PV solar panels and arrays (Jinko polycrystalline 290W panels, five subfields);
- PV Panel mountings (terrafix single axis tracking system east/west - 5200 points for foundations 1,2 m deep);
- DC-AC current inverters and transformers (10 x 500 kVA (2.5m x 1m) within the PV field);
- Mini Substations (3m x 2 m within the PV field).

In terms of the associated infrastructure required for the proposed developments, the following is to be constructed:

- Substation (approximately 10m x 10m);
- Coupling station (approximately 10m x 10m);
- Underground cabling (approximately 0,8 m x 0,6 wide);
- Overhead power lines (11-22kV);
- Small site office and storage facility (approximately 10m x 10m) - including security and associated facilities;
- Internal gravel roads (4m width);
- Site fencing.

The proposed development is located directly west of the Harvard Substation, where existing supply is taken. The proposed developments will link into Harvard Substation

3 GEOLOGY

The portions of the study area where the PV power plants are expected to be constructed are underlain by Upper Permian aged rocks of the Adelaide Subgroup, Beaufort Group, Karoo Supergroup. Portions towards the centre of the study area are underlain by Jurassic aged Dolerite.

3.1 Adelaide Subgroup (K3l)

The Adelaide Subgroup (K3l) is interpreted as fluvial sediments with channel sandstones (meandering rivers), thin mudflake conglomerates interbedded with floodplain mudrocks (green and maroon), pedogenic calcretes, playa lake and pond deposits and occasional reworked volcanic ashes (Johnson et al, 2006). Rocks belonging to the Adelaide Subgroup in this region can be best correlated with the Normandien Formation in the North-eastern Free State (Groenewald 1989). The upper part of the Subgroup is interpreted as mostly shallow lacustrine deposits and is represented by brightly coloured (greenish grey and maroon) siltstones (Groenewald 1996).

3.2 Dolerite (Jd)

Dolerite is a mafic intrusive igneous rock and occurs as dykes or sills in the study area. The Jurassic aged dolerite in the study area is associated with the “koppies” or high-lying areas in the region.

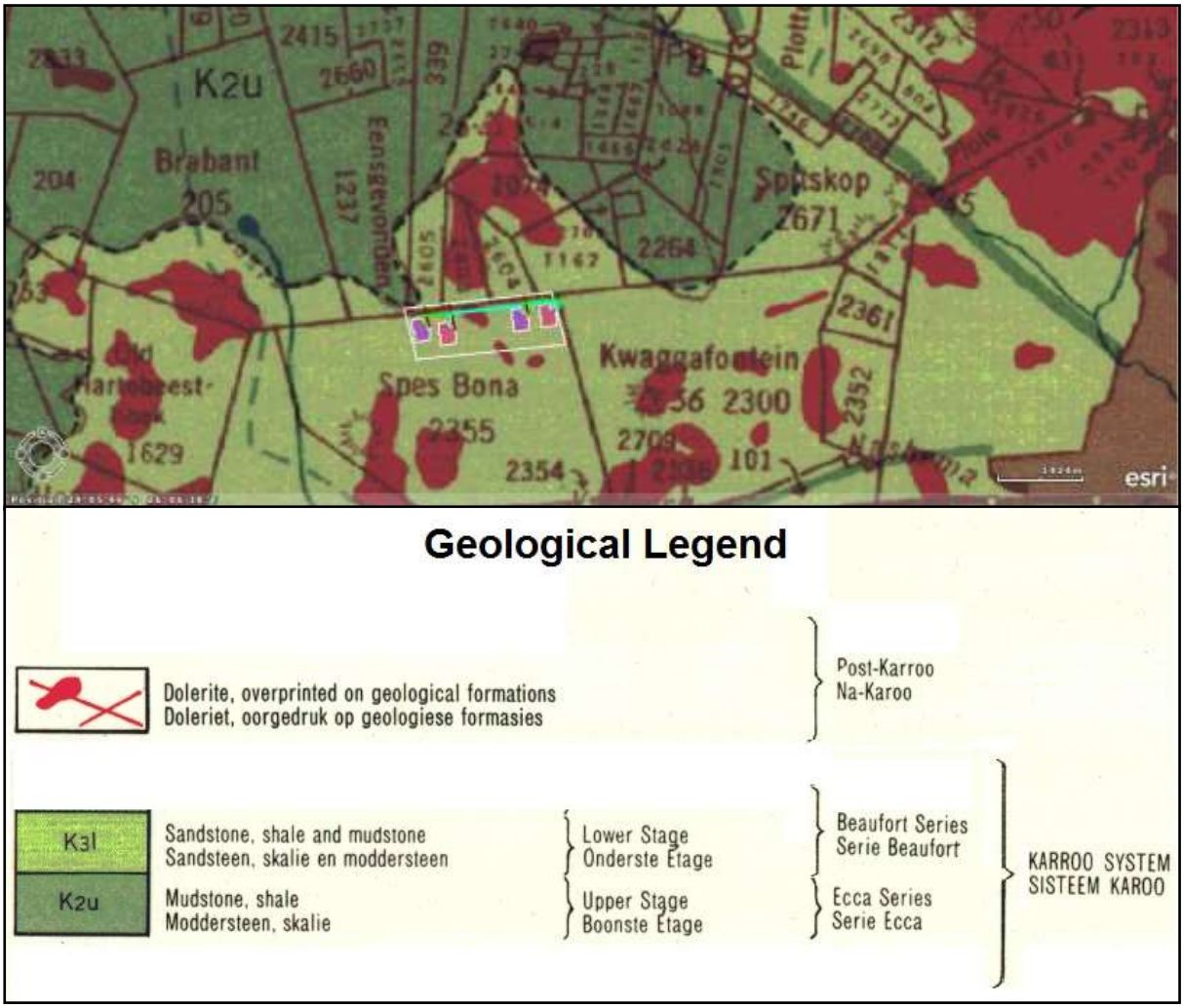

Figure 0.2 Geology of the study area

4 PALAEONTOLOGY OF THE AREA

4.1 Adelaide Subgroup

The Permian aged Adelaide Subgroup is well-known as a productive fossil-bearing unit in the Beaufort Group of the Karoo Supergroup. The study area is underlain by rocks of the lower Adelaide Subgroup that can best be correlated with the Normandien Formation to the east of the study area (Groenewald, 1989). This sequence of rock correlates with the *Dicynodon* Assemblage Zone and also contains the remains of *Glossopteris* plants (Johnson et al, 2006).

4.2 Dolerite

Due to the igneous nature of dolerite, no fossils will be found in the rock units.

5 PALAEONTOLOGICAL SENSITIVITY

The likely impact of the proposed development on local fossil heritage is determined on the basis of the palaeontological sensitivity of the rock units concerned and the nature and scale of the development itself, most notably the extent of fresh bedrock excavation envisaged. The different sensitivity classes used are explained in Table 1 above. The Palaeontological sensitivity of the Geological units present within the study area is summarised in Table 2 below. Based on the interpretation of the Google image, all four alternative sites for the development (Alternatives A and B, Figure 5.1) are situated in ploughed fields and therefore most probably underlain by relatively deep soils on rocks of the Permian aged Adelaide Subgroup of the Karoo Supergroup.

The rock units of the Adelaide Subgroup have a high potential to yield fossils. The extent of erosion and outcrops of these units in the study area is however not known. The excavations for infrastructure such as roads and trenches for electric cables and foundations for solar panel foundations might expose fresh bedrock. As a result, areas underlain by rocks of the Adelaide Subgroup have been allocated a Medium Palaeontological Sensitivity, although this may be increased to High Sensitivity following the recording of palaeontological information during the construction phase.

Due to the igneous nature of dolerite, no fossils will be found and areas underlain by dolerite have been allocated a Low palaeontological sensitivity.

The palaeontological sensitivity of the study area is shown in Figure 5.1 below.

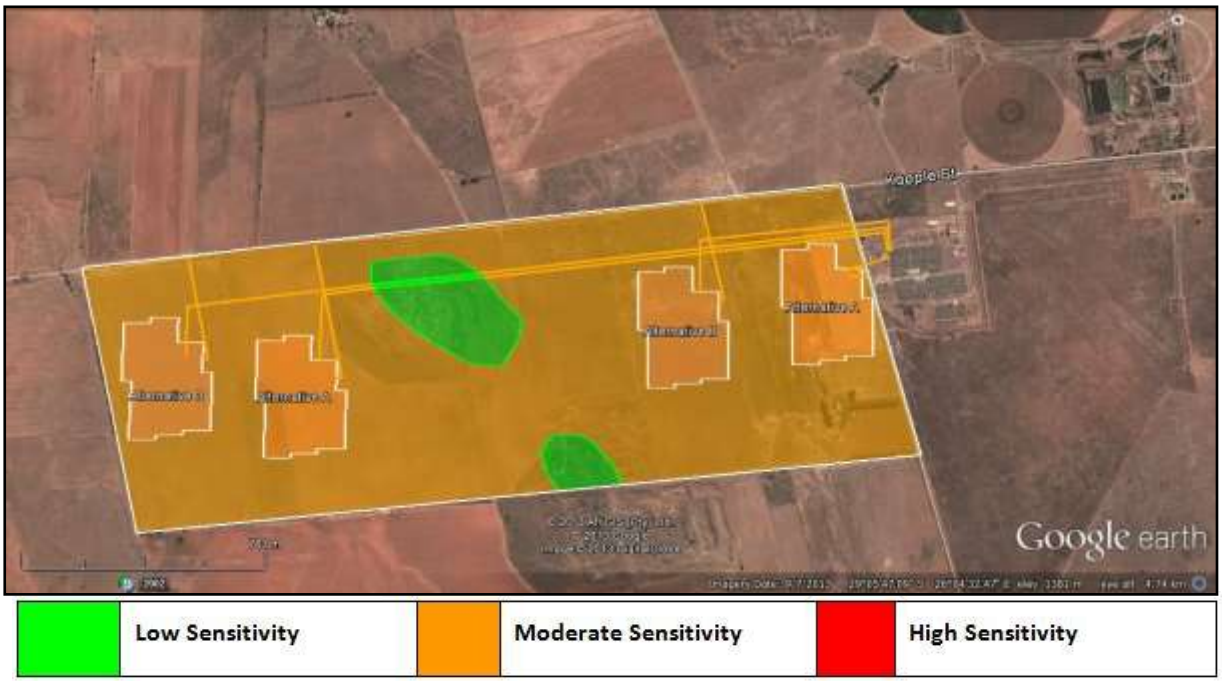

Figure 0.3 Palaeontological sensitivity of the study area

Table 9 Palaeontological sensitivity of the Geological units present within the study area

Geological Unit	Rock Type and Age	Fossil Heritage	Vertebrate Biozone	Palaeontological Sensitivity
Jurassic dolerite	Dolerite JURASSIC	None	None	Low sensitivity
Adelaide	Green-grey	*Dicynodon lacerticeps*	*Dicynodon*	Medium

Subgroup	mudstone and grey sandstone PERMIAN	Gorgonopsians *Glossopteris* plants	Assemblage zone	sensitivity

6 CONCLUSION AND RECOMMENDATIONS

The Spes Bona Study area is mainly underlain by Permian aged rocks of the Adelaide Subgroup, with a portion of the study area study area underlain by Jurassic aged dolerite intrusions. Both alternatives A and B fall on rocks of the Adelaide Subgroup and will have the same palaeontological sensitivity.

Although the high fossiliferous potential of the Adelaide Subgroup strata warrants an allocation of a High palaeontological sensitivity, the fact that all the alternative sites are falling in presently ploughed fields, will make it less likely that fossils will be exposed. Remote sensing indicates that most of the study areas are presently part of ploughed fields, with relatively deep soils. For this reason, areas underlain by these units have been allocated a Medium palaeontological sensitivity, which might be upgraded to a High palaeontological sensitivity, following exposure of the bedrock during the construction phase. In areas where topsoil has been removed by erosion, fossils will most likely be exposed. The areas underlain by dolerite have been allocated a Low palaeontological sensitivity as a result of their igneous nature.

Recommendations:

1. The EAP as well as the ECO for this project must be made aware of the fact that the Adelaide Subgroup is extremely rich in fossil remains. Several types of fossils have been recorded from this subgroup in the Karoo Basin of South Africa.
2. A qualified palaeontologist must be appointed to assess and record the extent of erosion and outcrop of the Adelaide Subgroup during the construction phase of the project. All the alternative sites have been allocated a Medium palaeontological sensitivity rating and the rating must be upgraded to High if fossils are recorded during the construction phase.
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7 REFERENCES

Groenewald, GH. 1989. Stratigrafie en Sedimentologie van die Groep Beaufort in die Noord-Oos Vrystaat. Geol Surv S. Afr. Bull 89.

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8 QUALIFICATIONS AND EXPERIENCE OF THE AUTHOR

Dr Gideon Groenewald has a PhD in Geology from the University of Port Elizabeth (Nelson Mandela Metropolitan University) (1996) and the National Diploma in Nature Conservation from Technicon RSA (the University of South Africa) (1989). He specialises in research on South African Permian and Triassic sedimentology and macrofossils with an interest in biostratigraphy, and palaeoecological aspects. He has extensive experience in the locating of fossil material in the Karoo Supergroup and has more than 20 years of experience in locating, collecting and curating fossils, including exploration field trips in search of new localities in the southern, western, eastern and north-eastern parts of the country. His publication record includes multiple articles in internationally recognized journals. Dr Groenewald is accredited by the Palaeontological Society of Southern Africa (society member for 25 years).

9 DECLARATION OF INDEPENDENCE

I, Gideon Groenewald, declare that I am an independent specialist consultant and have no financial, personal or other interest in the proposed development, nor the developers or any of their subsidiaries, apart from fair remuneration for work performed in the delivery of palaeontological heritage assessment services. There are no circumstances that compromise the objectivity of my performing such work.

Dr Gideon Groenewald
Geologist