MAINSTREAM RENEWABLE POWER SOUTH AFRICA

CONCENTRATED SOLAR POWER EIA - KAALSPRUIT

Heritage Impact Assessment

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For:	▪ SiVEST Environmental Division

Declaration of Independence

This report has been completed by PGS Heritage & Grave Relocation Consultants, an appointed Heritage Specialist for SiVest. The views stipulated in this report are purely objective and no other interests are displayed during the decision making processes discussed in the Heritage Impact Assessment Process that includes the Scoping as well as this final report

HERITAGE CONSULTANT: PGS Heritage & Grave Relocation Consultants

CONTACT PERSON: Wouter Fourie

SIGNATURE: ______________________________

Executive Summary

PGS Heritage & Grave Relocation Consultants was appointed by Sivest Environmental Division to undertake a Heritage Impact Report that forms part of the Environmental Impact Assessment (EIA) and Environmental Management Plan (EMP) for the Concentrated Solar Project for Mainstream Renewable Power South Africa, on the farm Kaalspruit 283 close to Loeriesfontein in the Northern Cape Province.

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

Although the archaeological field work did not identify any historical, archaeological or graves sites, the possibility always exist that such site can be uncovered during the life of the project.

The Palaeontological desktop study found that the impact of the proposed development on local fossil heritage is considered to be low and specialist palaeontological mitigation is not considered necessary.

The following general mitigation measures are recommended:

a. A monitoring plan must be agreed upon by all the stakeholders for the different phases of the project. The developer undertakes to give the archaeologist sufficient time to identify and record any archaeological finds and features.
b. If during construction any finds are made, the operations must be stopped and the archaeologist be contacted for an assessment of the find.
c. Should substantial fossil remains (e.g. well-preserved fossil fish, reptiles or petrified wood) however be exposed during construction, the ECO should carefully safeguard these, preferably in situ, and alert SAHRA as soon as possible so that appropriate action (e.g. recording, sampling or collection) can be taken by a professional palaeontologist.
d. A management plan must be developed for managing the heritage resources in the surface area impacted by operations during construction and operation of the development. This includes basic training for construction staff on possible finds, action steps for mitigation measures, surface collections, excavations, and communication routes to follow in the case of a discovery.

MAINSTREAM RENEWABLE POWER SOUTH AFRICA

HERITAGE IMPACT ASSESSMENT

Contents **Page**

Appendices

1 INTRODUCTION

PGS Heritage & Grave Relocation Consultants was appointed by Sivest Environmental Division to undertake a Heritage Impact Assessment that forms part of the Environmental Impact Assessment (EIA) and Environmental Management Plan (EMP) for the Concentrated Solar Project for Mainstream Renewable Power South Africa, on the farm Kaalspruit 283 close to Loeriesfontein in the Northern Cape 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 proposed development area. 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

There Heritage Impact Assessment (Including the Scoping and this Report) was compiled by PGS Heritage & Grave Relocation Consultants (PGS).

The staff at PGS has a combined experience of nearly 40 years in the heritage consulting industry. PGS and its staff have extensive experience in managing HIA processes. PGS will only undertake heritage assessment work where they have the relevant expertise and experience to undertake that work competently.

Wouter Fourie, Principal Archaeologist for this project, and the two field archaeologist, Henk Steyn and Marko Hutton are registered with the Association of Southern African Professional Archaeologists (ASAPA) and has CRM accreditation within the said organisation.

Dr. Almond has since 2002 carried out Palaeontological Impact Assessments for developments and conservation areas in the Western, Eastern and Northern Cape under the aegis of his Cape Town-based company Natura Viva cc. He is a long-standing member of the Archaeology, Palaeontology and Meteorites Committee for Heritage Western Cape (HWC) and an advisor on palaeontological conservation and management issues for the Palaeontological Society of South Africa (PSSA), HWC and SAHRA. He is currently compiling technical reports on the provincial palaeontological heritage of Western, Northern and Eastern Cape for SAHRA and HWC. Dr.

Almond is an accredited member of PSSA and APHAP (Association of Professional Heritage Assessment Practitioners – Western Cape).

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. 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 also applies to graves and cemeteries. In the event that any graves or burial places are located during the development the procedures and requirements pertaining to graves and burials as set out below will apply.

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. Minerals and Petroleum Resources Development Act (MPRDA) Act 28 of 2002
iv. 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.

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 Impacts 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. Minerals and Petroleum Resources Development Act (MPRDA) Act 28 of 2002

a. Section 39(3)

iv. Development Facilitation Act (DFA) Act 67 of 1995

a. 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 NEMA (No 107 of 1998) states that an integrated environmental management plan should (23:2 (b)) "…identify, predict and evaluate the actual and potential impact on the environment, socio-economic conditions and cultural heritage". In accordance with legislative requirements and EIA rating criteria, the regulations of SAHRA and Association of Southern African Professional Archaeologists (ASAPA) have also been incorporated to ensure that a comprehensive legally compatible AIA report is compiled.

Terminology

Acronyms	***Description***
AIA	Archaeological Impact Assessment
ASAPA	Association of South African Professional Archaeologists
CRM	Cultural Resource Management
DEAT	Department of Environmental Affairs and Tourism
DWAF	Department of Water Affairs and Forestry
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 Agency
PSSA	Palaeontological Society of South Africa
ROD	Record of Decision
SADC	Southern African Development Community
SAHRA	South African Heritage Resources Agency

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 the 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

Heritage resources

This means any place or object of cultural significance

2 TECHNICAL DETAILS OF THE PROJECT

2.1 Site Location and Description

Kaalspruit - Polar photovoltaic (PV)

Location	(Lat -30.8410; Long 19.4814) The land is 12km North of Loeriesfontein in the Northern Cape
Land	1713 Hectares of land under option, expect to subdivide areas as needed. The land owner is a private farmer
Land Description	The land is greenfield field (bush) type, zoned for agricultural use however not used at present. There are small bushes on site which may need to be cleared. The land is generally flat slope on-site does not exceed 2 degrees.

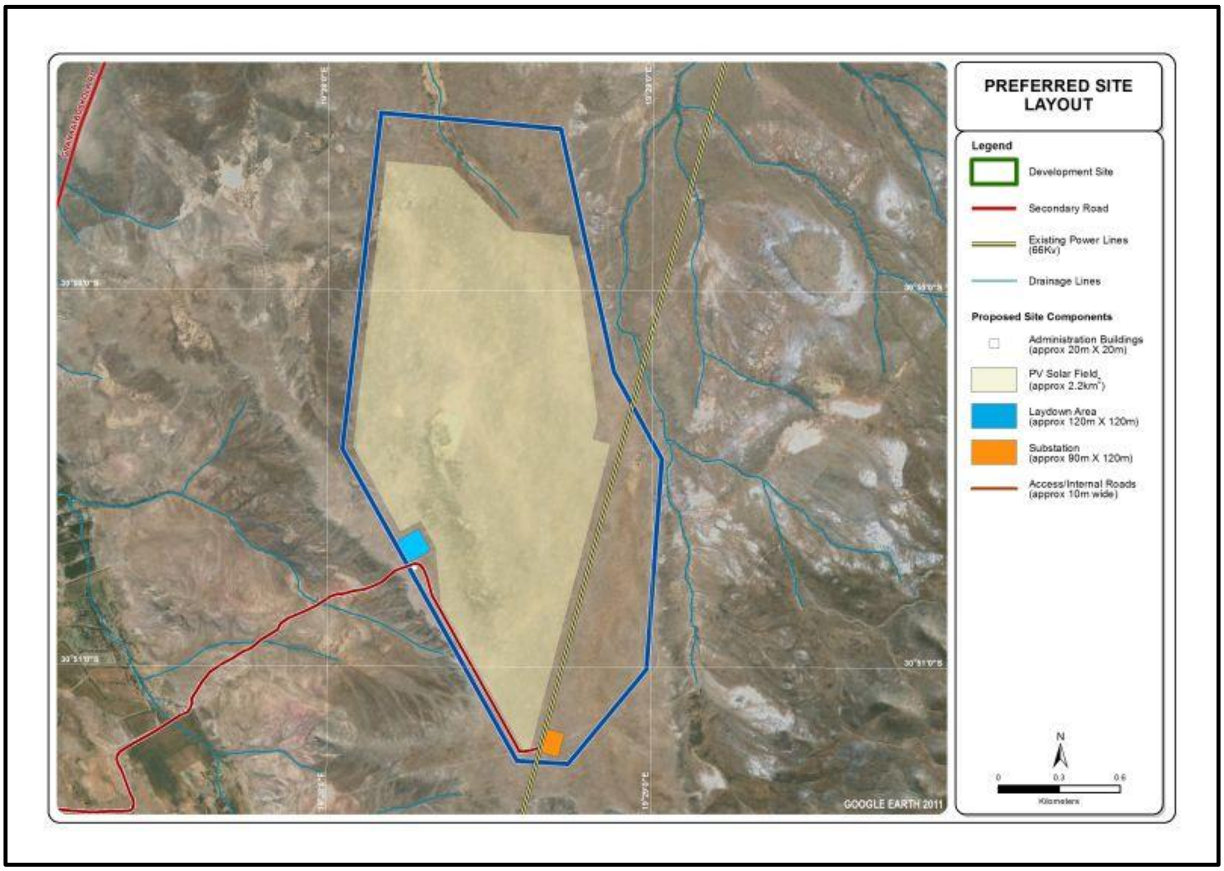

Figure 1 - Kaalspruit Solar Park Locality and Layout

2.2 Technical Project Description

The project will consist of two components:

a. CPV/PV Power Plant
b. Associated infrastructure

- CPV/PV Solar Power Plant

  The CPV/ PV plant will consist of the following infrastructure

  a. Solar field
  b. Buildings

These are described in detail below:

a. Solar field

Concentrated Photovoltaic (CPV) or Photovoltaic (PV) panel arrays with approximately 160 000 panels will be installed. An area of approximately $2km^2$ is likely to be required for the CPV/PV. The area required does not need to be cleared or graded, however no tall vegetation such as trees can remain on the site.

The panel arrays are approximately 15m x 4m in area. These are mounted into metal frames which are usually aluminium. Concrete or screw pile foundations are used to support the panel arrays. The arrays are either fixed on a tracking system (CPV is always on a tracking system and contains a slightly different panel) or tilted at a fixed angle equivalent to the latitude at which the site is located in order to capture the most sun (Figure 2). Arrays usually reach up to between 5m and 10m above ground level. Either a CPV or PV plant will be installed.

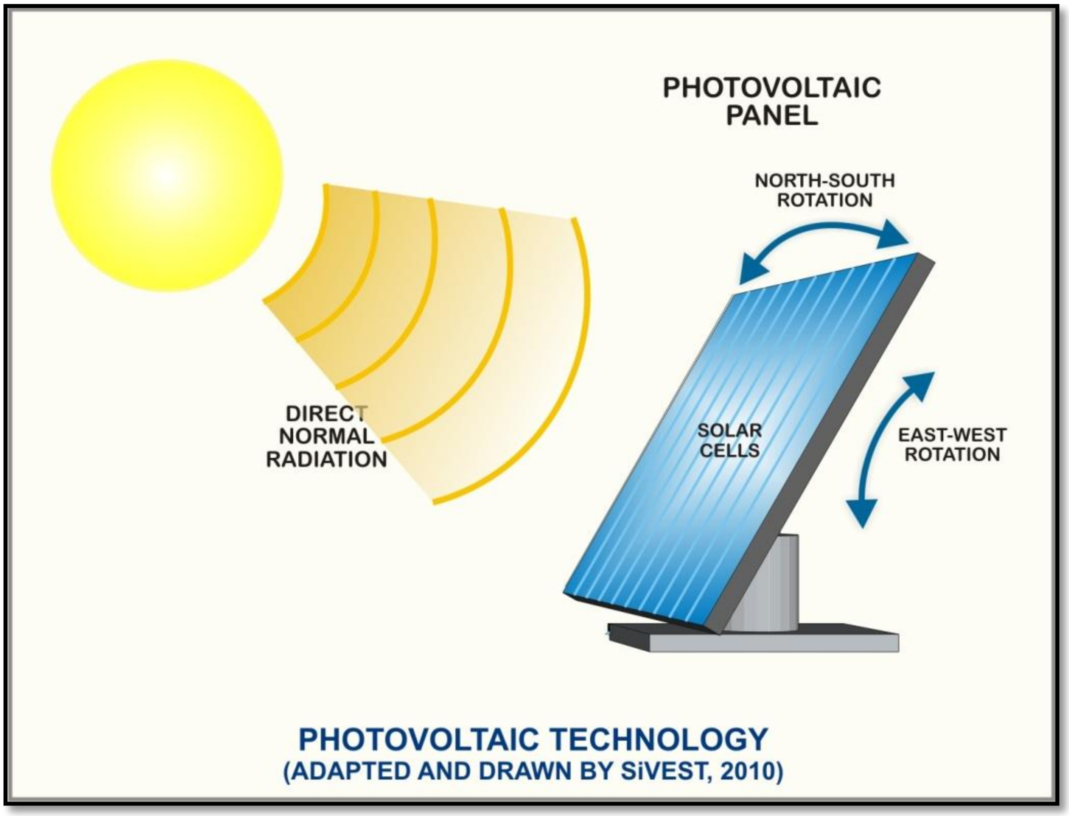

Figure 2: Illustration of how a CPV panel operates

b. Building infrastructure

The solar field will require on site buildings which will relate to the daily operation of the plant. The plant will require administration buildings (office) and possibly a warehouse for storage. The buildings will likely be a single storey building with warehouse / workshop space & access (e.g. 5m high, 20m long, 20m wide). The office will be used for telecoms and ablution facilities will be included. Security will be required.

- Associated infrastructure

a. Electrical Infrastructure

The PV arrays are typically connected to each other in strings and the strings connected to DC to AC inverters (Figure 3). The DC to AC inverters may be mounted on the back of the panel's support substructures / frames or alternatively in a central inverter station. The strings are connected to the inverters by low voltage DC cables. Power from the inverters is collected in medium voltage transformers through AC cables. Cables may be buried or pole-mounted depending on voltage level and site conditions.

The medium voltage transformers can be compact transformers distributed throughout the solar field or alternatively located in a central sub-station. It is likely to be a central substation in this instance.

The substation will be approximately 90m x 120m in size and will ideally be located in close proximity to the existing power lines that traverse a part of the site. The substation will be a distribution substation and will include transformer bays which will contain transformer oils. Bunds will be constructed to ensure that any oil spills are suitably attenuated and not released into the environment. The substation will be securely fenced.

If the substation is beside the existing power line the connection to the line will be via drop-down conductors. If the line is remote from the substation the connection will be by a newly constructed overhead power line, using either pole or pylon construction depending on the voltage.

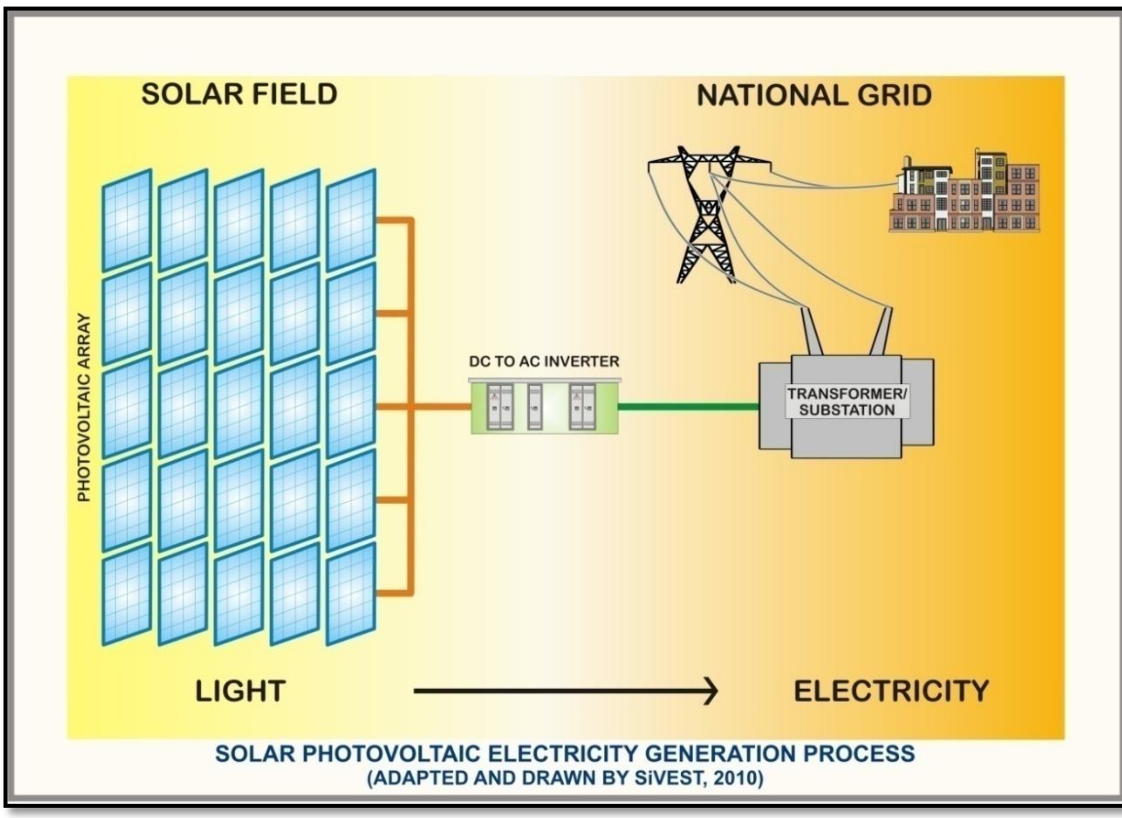

Figure 3: CPV/PV process

b. Roads

Upgrading of certain existing public roads along the equipment transport route may take place. An access road with a gravel surface from the public road onto the site will be required. An internal site road network to provide access to the solar field, power block & other infrastructure (substation & buildings) will also be required. Existing farm roads will be used where possible.

The site road network will include turning circles for large trucks, passing points and where necessary, may include culverts over gullies and rivers/ drainage lines. All site roads will require a width of approximately 10m. Drainage trenches along the side of the internal road network will be installed. In addition, silt traps at the outfall of the drainage trenches to existing watercourses will be installed.

c. Fencing

For health & safety and security reasons, the plant will be required to be fenced off from the surrounding farm.

d. Solar Resource Measuring Station

A permanent solar resource measuring station which will measure $100m^2$ and which will be 5m in height will be required on site to measure incoming solar radiation levels on the site.

e. Temporary work areas / activities during construction

A lay down area of a maximum of 10 $000m^2$, adjacent to the site or access route will be required. This will be temporary in nature (unless the property owner wishes to continue using it in the long term). Associated with this will be a contractors site offices which will require a maximum of $5000m^2$.

f. Borrow pits

Borrow pits may be required, which are subject to appropriate permits via a separate process. These would be distributed around the site. Existing borrow pits will be used as far as possible. The size of these pits will be dependent on the terrain and need for granular fill material for use in construction.

At this stage these are not required however this will be determined prior to construction and the correct procedure followed.

At the end of construction these pits will be backfilled as much as possible using surplus excavated material from the foundations and vegetation will be rehabilitated as indicated in the EMPR

3 ASSESSMENT METHODOLOGY

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

This Heritage Impact Assessment (HIA) report was compiled by PGS Heritage and Grave Relocation Consultants (PGS) for the proposed Kaalspruit Polar photovoltaic 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) and requested by Heritage Western Cape (HWC). The AWD 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 1: 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)	-	High / Medium Significance	Mitigation before destruction
Generally Protected B (GP.B)	-	Medium Significance	Recording before destruction
Generally Protected C (GP.A)	-	Low Significance	Destruction

3.1 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.

3.1.1 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 **Error! Reference source not found.**.

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.

3.1.2 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 2: 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.

The 2010 regulations also specify that alternatives must be compared in terms of impact assessment.

4 CURRENT STATUS QUO

4.1.1 Site Description

The Kaalspruit site is characterised by a large flat sandy stretch sparsely vegetated by low karoo bush (**Figure 4 and 5**). The area indicated as the preferred locality for the placement of the solar park is bordered on the east by a dry river bed (**Figure 6**) and the west by a sloping erosion plane.

Figure 4 - View of Kaalspruit from low ridge in north of site

Figure 5 - View of preferred area at Kaalspruit from west

Figure 6 - View of dry riverbed at Kaalspruit

4.1.2 Archival findings

Archival research produced the following reference:

- Palaeontology

  Dr Brian Kensley (1975) makes reference to palaeontological finds of Pygocephalomorphic Crustacea in the Loeriesfontein area. The coordinate reference indicates approximate find spots to the north west of the Kaalspruit area.

  The Palaeontological desktop study found that, the proposed Kaalspruit PV solar plant is largely underlain by Palaeozoic mudrocks of the Ecca Group, although in many areas these are mantled by largely unfossiliferous superficial deposits. Of the two Ecca Group rock units present the Prince Albert Formation is of low palaeontological sensitivity in this area. In contrast, the Whitehill Formation around Loeriesfontein is well known for its rich record of fossil fish, crustaceans and marine reptiles. However, field data including material excavated from test pits demonstrated that the Whitehill Formation at Kaalspruit is highly weathered near-surface. Since substantial bedrock excavations are not envisaged here, fresh (i.e. unweathered), potentially fossiliferous Whitehill bedrocks are unlikely to be directly affected by construction of the PV solar plant. The impact of the proposed development on local fossil heritage is considered to be low and specialist palaeontological mitigation is not considered necessary.

- Archaeology

  Although a study conducted by Morris (2007) have indicated minimal finds of archaeological sites in the vicinity of the upgrade of Loop 7A of the Sishen-Saldanha ore line to the north of the study area, discussions with local framers have indicated the occurrence of some archaeological sites.

  Morris (2010) notes that previous studies have indicated that substantial MSA scatters is fairly uncommon in the Bushmanland/.Namaqualand areas. While herder sites where more limited to sheltered and dune areas close to water sources such as pans and rivers.

  The owner, Mr. Adrie Husselman, indicated the presence of San rock art in the Kibuskou Mountains 7 kilometers to the west of the study area. He further indicated some historical rock engravings on a northern portion of Kaalspruit outside the study area.
  Mr. Hussleman, further related a story on how one of his herders found a cache of ostrich eggs washing out in a donga. This type of ostrich egg cache is indicative of the finds made through out of the Northern Cape found at places like Thomas' Farm, Saratoga, Spuigslangfontein, Vaalbos (Henderson, 2002; Morris, 2002).

- Historical structures and history
  The closest building structures found on Kaalspruit falls outside the preferred areas and include one site with a single building and farms dam, and a second farmstead with main house and sheds.

4.1.3 Possible finds

Evaluation of aerial photography has indicated the following area that may be sensitive from an archaeological perspective (**Figure 7**). Archaeological surveys and studies in the Northern Cape have shown rocky outcrops, dry riverbeds, riverbanks and confluences to be prime localities for archaeological finds and specifically Stone Age sites.

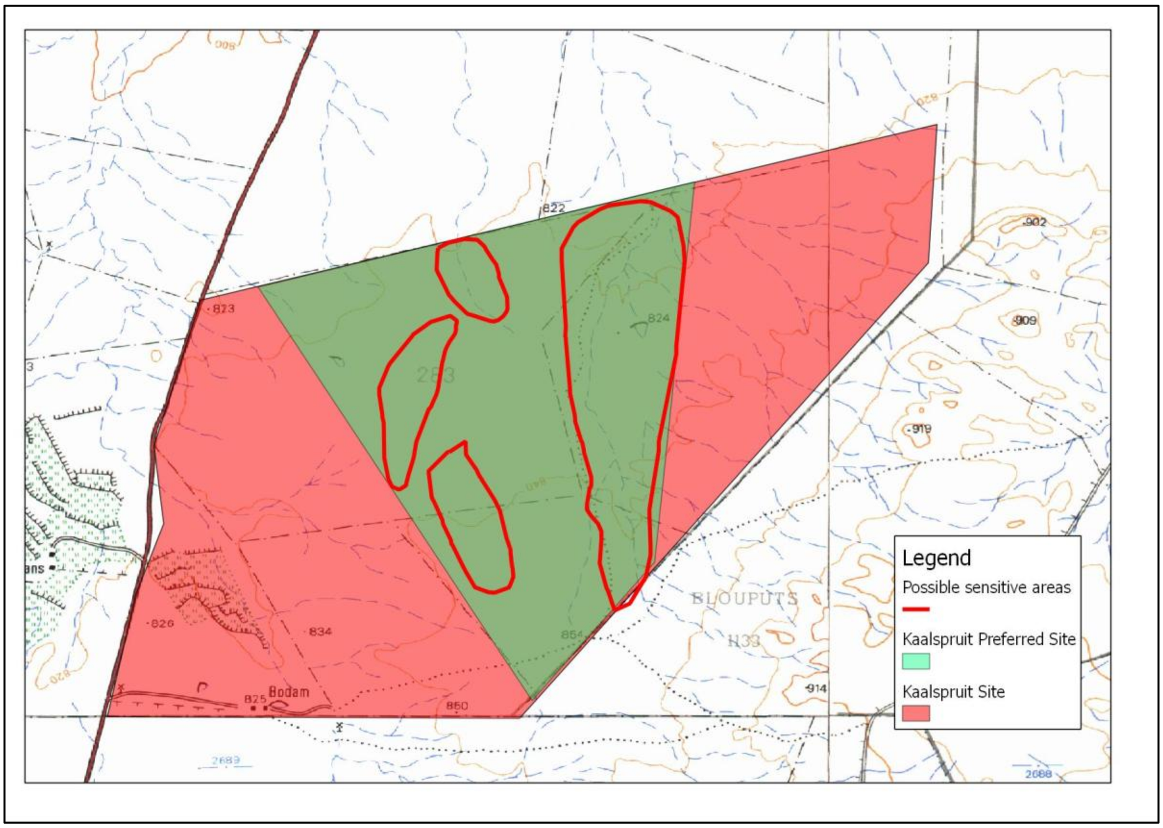

Figure 7 – Sensitivity map created from Scoping findings

4.1.4 Findings during Heritage Scoping Report

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 assessment of the areas identified a low probability of finds and only management measures during construction required;

4.1.5 Field work findings

A follow up visit to the study area was conducted in February 2011 with the aim of conducting an archaeological survey of the development area and giving particular attention to the areas identified during the Scoping phase as being potentially sensitive.

The study area for this project covers approximately 1700 hectares with a central impact area of approximately 600 hectares. Due to the nature of cultural remains, with the majority of artefacts occurring below surface, an intensive foot-survey that covered the study area was conducted. A controlled-exclusive surface survey was conducted over a period of 2 days on foot by two archaeologists of PGS.

During the field survey no sites of heritage value was identified, it must however be noted that the field survey did not cover any palaeontological field work as this study is still continuing and will be incorporated into the EMP for the site.

5 IMPACT ASSESSMENT

5.1 Potential Impacts during Construction

ISSUE	**Impact on archaeological sites**
POTENTIAL IMPACTS	Unidentified archaeological sites and the discovery of such sites during construction can seriously hamper construction timelines.
EMP	Management measures to be included in the EMP for chance finds

ISSUE	**Impact on palaeontological sites**
POTENTIAL IMPACT	Unidentified palaeontological sites and the discovery of such sites during construction can seriously hamper construction timelines.
EMP	Management measures to be included in the EMP for chance finds

ISSUE	**Impact on historical sites**
PREDICTED IMPACT	No sites identified during field work
EMP	Management measures to be included in the EMP for chance finds.

ISSUE	**Impact on graves and cemeteries site**
POSSIBLE IMPACT	Unidentified graves and cemeteries and the discovery of such structures during construction can seriously hamper construction timelines.
EMP	In the event that these graves and cemeteries could not be avoided a grave relocation proses needs to be started. Such a process impacts on the spiritual and social fabric of the next of kin and associated communities. Management measures for such finds must be included in the EMP

5.2 Potential Impacts during Operation

Same as construction

5.3 Impact Matrix

Table 3: Rating Matrix for impacts in the Construction phase

IMPACT TABLE FORMAT	
Environmental Parameter	*Discovery of previously unidentified heritage sites (archaeological, palaeontological, 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*

IMPACT TABLE FORMAT		
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.*	

Table 4: Rating Matrix for impacts on Decommissioning phase

IMPACT TABLE FORMAT	
Environmental Parameter	*Discovery of previously unidentified heritage sites (archaeological, palaeontological, historical or grave sites)*
Issue/Impact/Environmental Effect/Nature	*During decommissioning 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	*Magnitude dependent on type of finds made – however in most cases Medium*

IMPACT TABLE FORMAT		
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 decommissioning will be able to mitigate the impact on the finds through scientific documentation of finds and provide valuable data on any finds made.*	

5.4 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.

5.5 Cumulative Impacts

None foreseen

5.6 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.

6 MITIGATION MEASURES

6.1 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.

PGS can be contacted on the way forward in this regard.

Table 5: 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 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.	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 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.	The client	Environmental Consultancy and the Archaeologist
After the specialist/archaeologist has been appointed, comprehensive feedback reports should be submitted to relevant authorities during each phase of development.	Client and Archaeologist	Archaeologist

6.2 All phases of the project

6.2.1 Archaeology and Palaeontology

Based on the findings of the HIA, all stakeholders and key personnel should undergo an archaeological/palaeontological induction course during this phase. Induction courses generally form part of the employees' overall training and the archaeological/palaeontological component can easily be integrated into these training sessions. Two courses should be organised – one aimed more at managers and supervisors, highlighting the value of this exercise and the appropriate communication channels that should be followed after chance finds, and the second targeting the actual workers and getting them to recognize artefacts, features and significant sites. This needs to be supervised by a qualified archaeologist. This course should be reinforced by posters reminding operators of the possibility of finding archaeological/palaeontological sites.

The project will encompass a range of activities during the construction phase, including ground clearance, establishment of construction camps area and small scale infrastructure development associated with the project.

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 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 construction phase, it is important to recognize any significant material being unearthed, making and to make the correct judgment on which actions should be taken. A responsible archaeologist/palaeontologist must be appointed for this commission. This person does not have to be a permanent employee, but needs to sit in at relevant meetings, for example when changes in design are discussed, and notify SAHRA of these changes. The archaeologist would inspect the site and any development recurrently, with more frequent visits to the actual workface and operational areas.

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/palaeontological monitoring programme.

6.2.2 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.

7 CONCLUSIONS AND RECOMMENDATIONS

Although the archaeological field work did not identify any historical, archaeological or graves sites the possibility always exist that such site can be uncovered during the life of the project.

The Palaeontological desktop study found that the proposed Kaalspruit PV solar plant is largely underlain by Palaeozoic mudrocks of the Ecca Group, although in many areas these are mantled by largely unfossiliferous superficial deposits. Of the two Ecca Group rock units present, the Prince Albert Formation is of low palaeontological sensitivity in this area. In contrast, the Whitehill Formation around Loeriesfontein is well known for its rich record of fossil fish, crustaceans and marine reptiles. However, field data including material excavated from test pits demonstrated that the Whitehill Formation at Kaalspruit is highly weathered near-surface. Since substantial bedrock excavations are not envisaged here, fresh (i.e. unweathered), potentially fossiliferous Whitehill bedrocks are unlikely to be directly affected by construction of the PV solar plant. The impact of the proposed development on local fossil heritage is considered to be low and specialist palaeontological mitigation is not considered necessary.

The following general mitigation measures are recommended:

a. A monitoring plan must be agreed upon by all the stakeholders for the different phases of the project. The developer undertakes to give the archaeologist sufficient time to identify and record and archaeological finds and features.
b. If during construction any possible finds are made, the operations must be stopped and the qualified archaeologist be contacted for an assessment of the find.
c. Should substantial fossil remains (e.g. well-preserved fossil fish, reptiles or petrified wood) be exposed during construction, however, the ECO should carefully safeguard these, preferably in situ, and alert SAHRA as soon as possible so that appropriate action (e.g. recording, sampling or collection) can be taken by a professional palaeontologist.
d. A management plan must be developed for managing the heritage resources in the surface area impacted by operations during construction and operation of the development. This includes basic training for construction staff on possible finds, action steps for mitigation

measures, surface collections, excavations, and communication routes to follow in the case of a discovery.

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Appendix A

PALAEONTOLOGICAL DESKTOP STUDY

PALAEONTOLOGICAL DESKTOP STUDY

Proposed Kaalspruit Solar Photovoltaic Project near Loeriesfontein, Northern Cape Province

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1. SUMMARY

The proposed 50 MW PV solar plant on the Farm Kaalspruit 283, situated some 12km north of Loeriesfontein in the Northern Cape, is largely underlain by Palaeozoic mudrock sediments of the Ecca Group. In many areas these older bedrocks are mantled by largely unfossiliferous superficial deposits (*e.g.* alluvium sheetwash, soil). Of the two Ecca Group rock units present in the study area the Prince Albert Formation here is of low palaeontological sensitivity. In contrast, the Mid Permian Whitehill Formation around Loeriesfontein is well known for its rich record of fossil fish, crustaceans and marine reptiles. However, field data including material excavated from test pits demonstrates that the Whitehill Formation at Kaalspruit is highly weathered near-surface. Since substantial bedrock excavations are not envisaged for this project, fresh (*i.e*. unweathered), potentially fossiliferous Whitehill bedrocks are unlikely to be directly affected by construction of the PV solar plant. The impact of the proposed development on local fossil heritage is considered to be *low* and specialist palaeontological mitigation is not considered necessary.

Should substantial fossil remains (*e.g.* well-preserved fossil fish, reptiles or petrified wood) be exposed during construction, however, the ECO should carefully safeguard these, preferably *in situ*, and alert SAHRA as soon as possible so that appropriate action (*e.g.* recording, sampling or collection) can be taken by a professional palaeontologist.

2. INTRODUCTION & BRIEF

The company Mainstream Renewable Power South Africa (MRP) is proposing to construct a solar photovoltaic (PV) plant on agricultural land on the farm Kaalspruit 283, situated approximately 12km north of the town of Loeriesfontein in the Northern Cape Province (Fig. 1). The capacity of the power plant will be approximately 50 MW.

Components of the PV solar plant of relevance to the present study include:

- a photovoltaic (PV) panel array comprising *c*. 160 000 panels over an area of approximately 2km^2. Each array is 15m x 4m in area and supported by concrete or screw pile foundations.
- building infrastructure including an office and a warehouse.
- electrical infrastructure including buried or pole-mounted cables and a central substation (*c*. 90m x 120m) or new overhead powerline or poles or pylons to an existing power line.
- new or upgraded gravels roads for access to the site as well as an internal road network. Site roads will be 10m wide and there will be drainage trenches along their sides with silt traps at the outfall of the drainage trenches into existing watercourses.
- a solar resource monitoring station (100m^2).
- a temporary lay down area of *c*. 10 000m^2 adjacent to the site or access route.
- possible new borrow pits (to be separately permitted); existing borrow pits are to be used as far as possible. Borrows will be backfilled after construction of the PV plant.

The proposed PV power plant overlies potentially fossiliferous sediments of the Ecca Group (Karoo Supergroup). Fossils preserved within the bedrock or superficial deposits may be disturbed, damaged or destroyed during the construction phase of the proposed project. The extent of the proposed development (over 5000 m^2) falls within the requirements for a Heritage Impact Assessment (HIA) as required by Section 38 (Heritage Resources Management) of the South African Heritage Resources Act (Act No. 25 of 1999). The various categories of heritage resources recognised as part of the National Estate in Section 3 of the Heritage Resources Act include, among others:

- geological sites of scientific or cultural importance
- palaeontological sites
- palaeontological objects and material, meteorites and rare geological specimens

This desktop palaeontological study has accordingly been commissioned by PGS - Heritage & Grave Relocation Consultants.

Minimum standards for the palaeontological component of heritage impact assessment reports are currently being developed by SAHRA. The latest version of the SAHRA guidelines is dated May 2007.

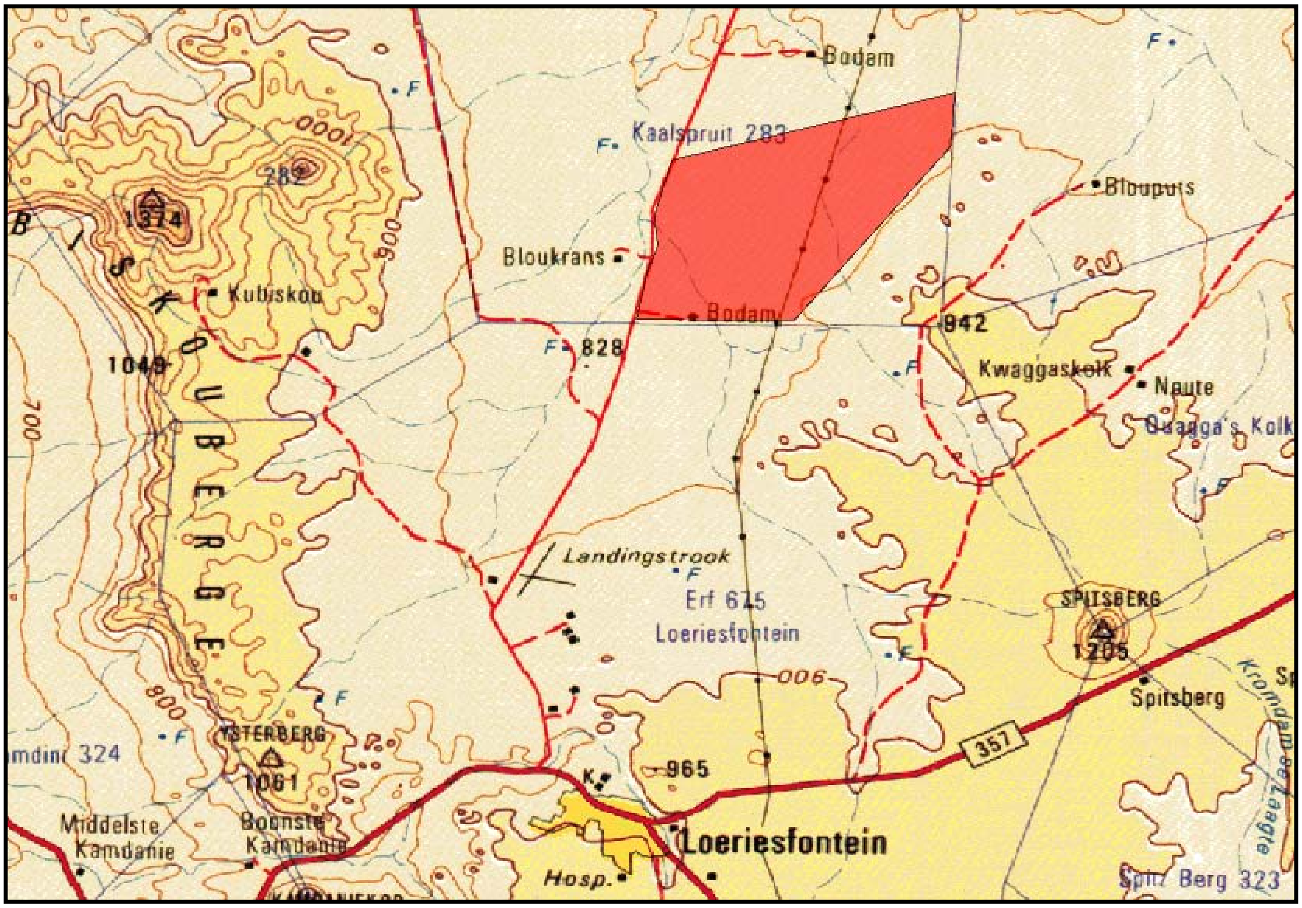

Fig. 1. Extract from 1: 250 000 topographical map 3018 Loeriesfontein (Courtesy of the Chief Directorate of Surveys & Mapping, Mowbray) showing location of the proposed Kaapspruit Solar PV project *c.* 12km north of Loeriesfontein, Northern Cape Province (red polygon).

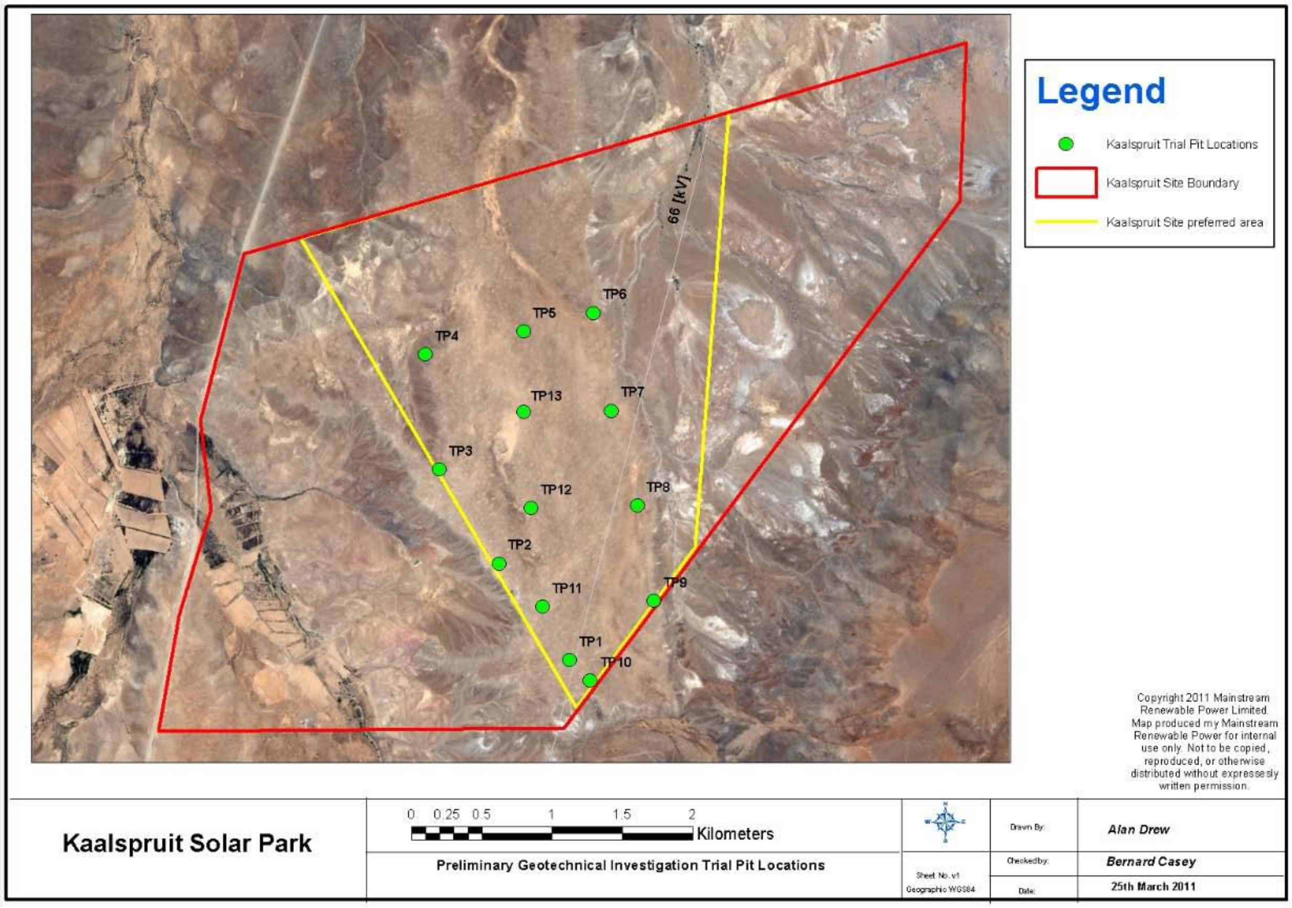

Fig. 2. Satellite image of the proposed Kaalspruit Solar Park north of Loeriesfontein (Image abstracted from geotechnical report by Mainstream renewable Power, Engineering & Construction). Green points mark test pits (*cf* Fig. 6).

2.2. General approach used for palaeontological desktop studies

In preparing a palaeontological desktop study the potentially 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, previous palaeontological impact studies in the same region, and the author's field experience (Consultation with professional colleagues as well as examination of institutional fossil collections may play a role here, or later during the compilation of the final report). This data is then used to assess the palaeontological sensitivity of each rock unit to development (Provisional tabulations of palaeontological sensitivity of all formations in the Western, Eastern and Northern Cape have already been compiled by J. Almond and colleagues; *e.g.* Almond & Pether 2008). The likely impact of the proposed development on local fossil heritage is then determined on the basis of (1) the palaeontological sensitivity of the rock units concerned and (2) the nature of the development itself, most notably the extent of fresh bedrock excavation envisaged.

When rock units of moderate to high palaeontological sensitivity are present within the development footprint, a field-based study by a professional palaeontologist is usually warranted. Most detrimental impacts on palaeontological heritage occur during the construction phase when fossils may be disturbed, destroyed or permanently sealed-in during excavations and subsequent construction activity. Where specialist palaeontological mitigation is recommended, this may take place before construction starts or, most effectively, during the construction phase while fresh, potentially fossiliferous bedrock is still exposed for study. Mitigation usually involves the judicious sampling, collection and recording of fossils as well as of relevant contextual data concerning the surrounding sedimentary matrix. It should be emphasised that, *provided* appropriate mitigation is carried out, many developments involving bedrock excavation actually have a *positive* impact on our understanding of local palaeontological heritage. Constructive collaboration between palaeontologists and developers should therefore be the expected norm

3. GEOLOGICAL BACKGROUND

The geology of the study area north of Loeriesfontein is shown on the unpublished draft of the 1: 250 000 geology map 3018 Loeriesfontein (Council for Geoscience, Pretoria; Fig. 3 herein). The explanation for the Loeriesfontein geological map has only been completed very recently (P. Macey, Council for Geoscience, pers. comm. 2011). Only a draft version of the revised sheet explanation, including a detailed palaeontological section by the present author (Almond 2008a), was available during the preparation of this report.

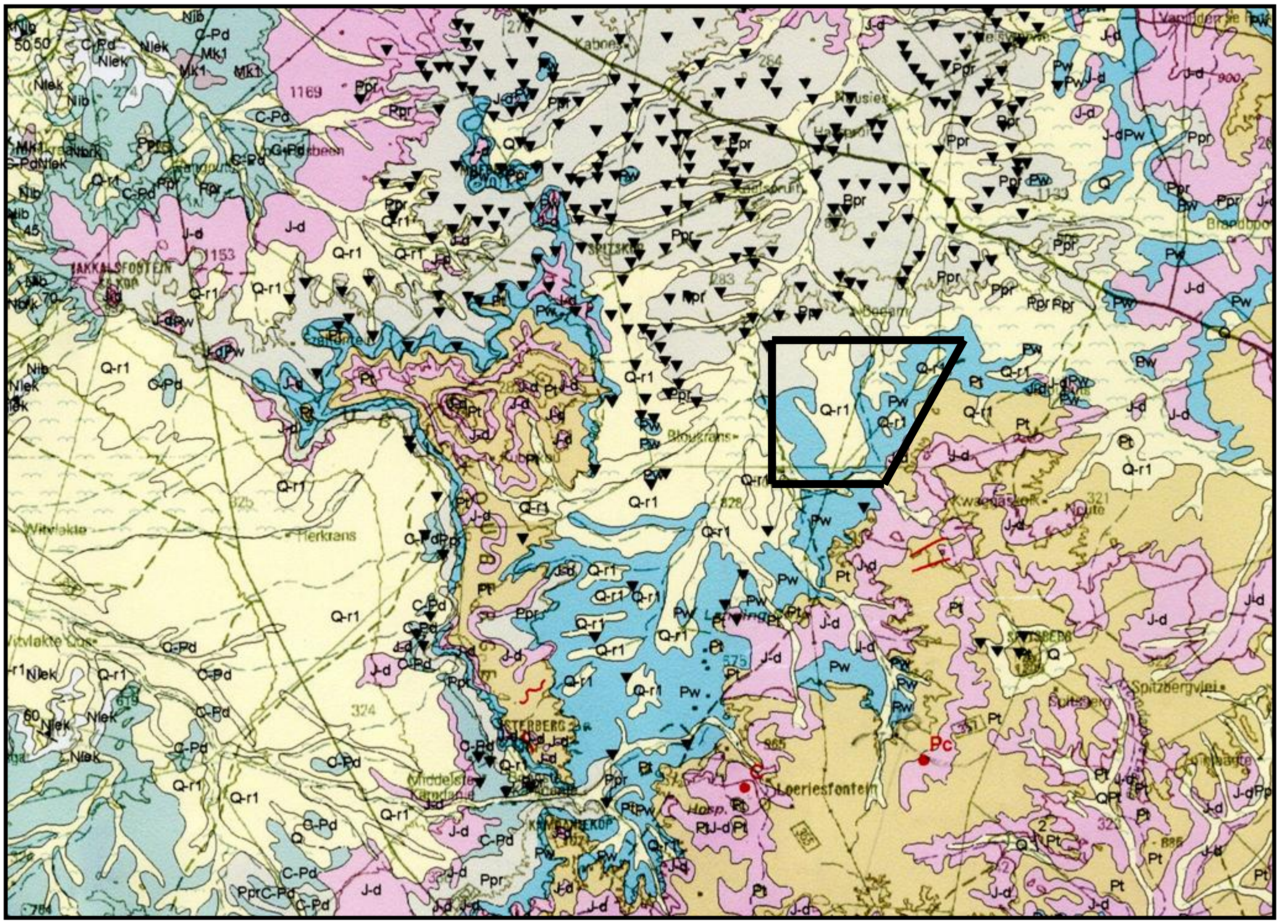

Fig. 3. Extract from unpublished draft of 1: 250 000 geological map 3018 Loeriesfontein (Council for Geoscience, Pretoria) showing location of proposed Kaalspruit Solar Park (black polygon). The geological units represented in the study region include:

Ppr (grey) = Prince Albert Formation (Ecca Group)

Pw (blue) = Whitehill Formation (Ecca Group)

Pt (pale brown) = Tierberg Formation

J-d (pink) = Karoo Dolerite Suite

Q-r1 = superficial Quaternary deposits

Black triangle symbols are breccia pipes relating to Jurassic dolerite intrusion

The study area on the farm Kaalspruit 283, some 12km north of Loeriesfontein town, is on the eastern side of the road to Granatboskolk. It lies within a low-lying, flattish area (c. 820-830m amsl) situated between the Kubiskouberge in the west and a low hilly area with dolerite *koppies* in the east which reach heights of 900-920m amsl. The lowlands are traversed by numerous ephemeral streams that flow northwards to join the Kromrivier drainage system. The whole region is underlain by comparatively readily-weathered basinal mudrocks of the

Ecca Group (Karoo Supergroup) of Early to Middle Permian age. Useful recent geological accounts of the Ecca Group are given by Theron *et al.* (1991), Gresse *et al.* (1992), Johnson *et al.* (2006) and Johnson (2009).

As shown on the new 1: 250 000 geological map (Fig. 3) the northwestern portion of the study area is underlain by mudrocks of the **Prince Albert Formation** (Ppr). These areas usually appear dark on satellite images because the outcrop is mantled in gravels rich in ferromanganese minerals (Gravel clasts often have a shiny-black patina of "desert varnish"). Key geological accounts of this formation are given by Visser (1992) and Cole (2005). This unit of Early Permian (Asselian / Artinskian) age was previously known as "Upper Dwyka Shales". The Prince Albert succession consists mainly of thin-, tabular-bedded mudrocks of blue-grey, olive-grey to reddish-brown colour with occasional thin (dm) buff sandstones and even thinner (few cm), soft-weathering layers of yellowish water-lain tuff (*i.e.* volcanic ash layers). Extensive diagenetic modification of these sediments has led to the formation of thin cherty beds, pearly- blue phosphatic nodules, rusty iron carbonate nodules, as well as beds and elongate ellipitical concretions impregnated with iron and manganese minerals. These last occur within prominent-weathering, metallic-looking beds, some of which display well-developed snuffbox weathering and concentric *Liesegang* rings. Partial cementation of fine-grained siliciclastics by secondary minerals may result in the formation of distinctive "spherulitic" beds that are spotted with small spherical nodules of silica and / or iron minerals. Numerous **breccia pipes** related to dolerite intrusion in the Early Jurassic punctuate the Prince Albert Formation outcrop north of the study area (black triangles in Fig. 3) but are not recorded within the study area itself.

The greater part of Kaalspruit 283 is underlain by the slightly younger, finely-laminated mudrocks of the **Whitehill Formation** (Pw). This is a thin (*c*. 80m) succession of well-laminated, carbon-rich mudrocks of Early / Mid Permian (Artinskian) age that were laid down about 278 Ma (million years ago) in an extensive shallow, brackish to freshwater basin – the Ecca Sea – that stretched across southwestern Gondwana, from southern Africa into South America. Thin volcanic tuffs and large, irregular to oblate dolomitic nodules occur within the laminated mudrocks. Key fossiliferous exposures of the Whitehill Formation are present on the outskirts of Loeriesfontein (McLachlan & Anderson 1973, Oelofsen 1981, 1987, Visser 1992, 1994, 2003, Cole & Basson 1991, Johnson *et al*. 2006) (Fig. 4). Near-surface weathering of these highly-carbonaceous sediments to release gypsum produces pale grey to cream colours that are readily seen in satellite images where the bedrock is exposed (Fig. 2; see also field photo, Fig. 5).

A large portion of the Ecca outcrop area around Loeriesfontein is mantled with various much younger **superficial deposits** such as fine silty alluvium, alluvial, sheet wash and down-wasted gravels as well as calcretes (soil limestones) of probable Quaternary to Recent age (These are grouped as Q-r1 in map Fig. 3 and appear pale buff in satellite images, Fig. 2).

While **Karoo dolerite intrusions** (J-d) are not mapped within the study area itself, the Ecca rocks here have probably been thermally and chemically modified by nearby intrusions, as witnessed by the numerous breccia pipes mentioned earlier. Karoo dolerites crop out both west of the study area (Kubiskouberge) and in hilly terrain immediately to the east. Basinal mudrocks of the Mid Permian **Tierberg Formation** (Pt, Ecca Group; Fig. 3) crop out immediately to the east of the Kaalspruit study area but will not be directly affected by the proposed development and are therefore not considered further here.

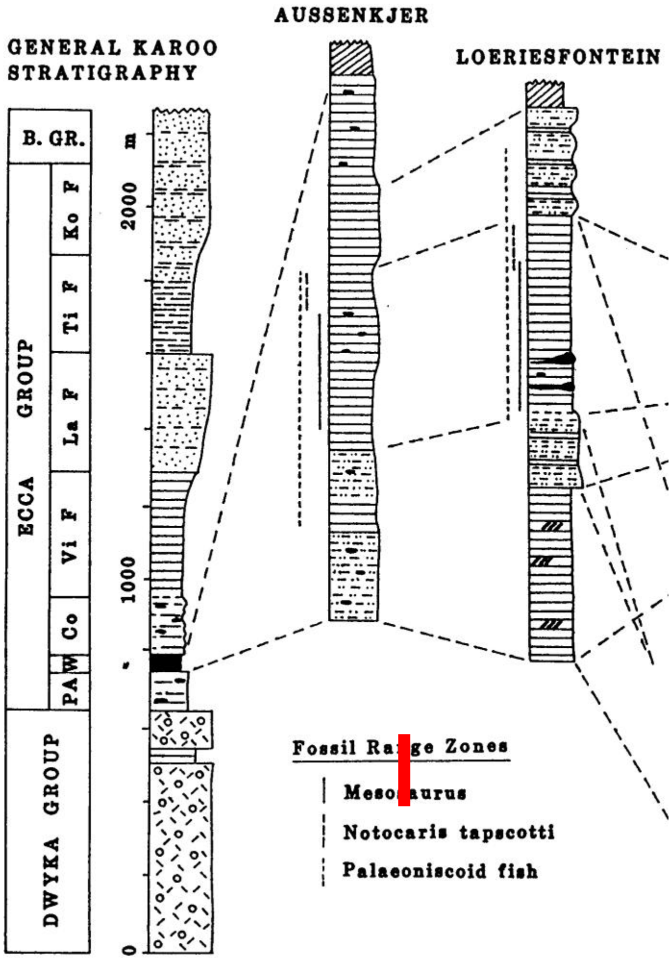

Fig. 4. Stratigraphy of the Ecca Group of the Main Karoo Basin (Modified from Visser 1992) showing the position of the Prince Albert (PA) and Whitehill (W) Formations, emphasized here by the red bar. On the right hand side is presented a detailed section through the Whitehill Formation at Loeriesfontein, showing the range zones of major fossil groups.

Field photographs of the Kaalspruit study site (kindly provided by Mnr Wouter Fourie of PGS Heritage and Grave Relocation Consultants) show that levels of bedrock outcrop in the flat-lying development area are very low. Much of the area is covered in soil, thin surface gravels and karroid bossieveld. Occasional irregular lenticular outcrops of pale, brownish-weathering rock may represent ferruginous surface calcretes, or alternatively ferruginous diagenetic limestone nodules within the Prince Albert Formation (although these are normally darker brown in hue). The banks of ephemeral ("dry") streams expose one or meters of silty alluvium and angular gravels; the latter are also concentrated by down-wasting in the adjacent *veld*. Gravels in the stream beds are fairly sparse and mostly pebble grade or finer, with occasional boulder-sized blocks (*e.g.* fragmentary diagenetic nodules, dolerite). Concentrations of bouldery alluvial gravels perched 1-2m above the modern stream beds are seen locally (Fig. 5), pointing towards stream incision in geological recent times. Ecca bedrock exposed in stream banks here is clearly highly weathered and mantled with thick alluvial and soil deposits.

Fig. 5. Incised ephemeral stream showing modern fine gravelly alluvium derived from local Ecca Group mudrocks. Note pale, chemically weathered nature of the Ecca beds exposed in the lower part of the stream bank, the thick cover of superficial deposits (alluvium / soil) and the perched older bouldery alluvial gravels on the right hand side (Photograph courtesy of Wouter Fourie, PGS).

The nature of the Ecca bedrock beneath the cover of superficial deposits is also clearly illustrated in the geotechnical report for this project produced by Mainstream Renewable Power, Engineering and Construction (Anon, 2011). Trial pits excavated to depths of up to 3m generally reveal some 0.5m of silty soil, with occasional clay or pale calcrete horizons, overlying moderately to highly weathered Ecca Group bedrocks (generally mudrocks, though described in the geotechnical report as "sandstones"). Where chemical weathering is less advanced, the Ecca sediments retain their original shaly (laminated) character and pale grey Whitehill Formation mudrocks (Fig. 6) can be differentiated from darker Prince Albert Formation mudrocks.

Fig. 6. Pale grey shales of the Whitehill Formation excavated from trial pit TP6 in the north-central part of the study area (see Fig. 2). Coherent, moderately weathered mudrocks of this sort may still contain fossil material such as remains of fish, reptiles and crustaceans. Image abstracted from the geotechnical report by Mainstream Renewable Power (Anon, 2011).

4. PALAEONTOLOGICAL HERITAGE

The fossil heritage recorded within each of the main sedimentary rock successions represented within the Kaalspruit study region north of Loeriesfontein is outlined here. See also the summary of fossil heritage provided in Table 1 below.

4.1. Fossils within the Prince Albert Formation

The fossil biota of the post-Dwyka mudrocks of the Prince Albert Formation is summarized by Cole (2005) and Almond (2008a, b). Epichnial (bedding plane) trace fossil assemblages of the non-marine *Mermia* Ichnofacies, dominated by the ichnogenera *Umfolozia* (arthropod trackways) and *Undichna* (fish swimming trails), are commonly found in basinal mudrock facies of the Prince Albert Formation throughout the Ecca Basin. These assemblages have been described by Anderson (1974, 1975, 1976, 1981) and briefly reviewed by Almond (2008a, b). A small range of simple, horizontal to oblique endichnial burrows forming dense monospecific ichnoassemblages have been recorded from the Ceres Karoo, especially from those parts of the Prince Albert succession containing thin volcanic tuffs (Almond 2010). The presence of more diverse, but incompletely recorded, benthic invertebrate fauna in the Early Permian Ecca Sea is suggested by the recent discovery of complex arthropod trails with paired drag marks in the Prince Albert Formation near Matjiesfontein in the southern Great Karoo.These trackways might have been generated by small eurypterids (water scorpions), but this requires further confirmation.

Diagenetic nodules containing the remains of palaeoniscoids (primitive bony fish), sharks, spiral bromalites (coprolites, spiral gut infills *etc* attributable to sharks or temnospondyl amphibians) and petrified wood have been found in the Ceres Karoo (Almond 2008b and refs. therein). Rare shark remains (*Dwykaselachus*) are recorded near Prince Albert on the southern margin of the Great Karoo (Oelofsen 1986). Microfossil remains in this formation include sponge spicules, foraminiferal and radiolarian protozoans, acritarchs and miospores.

The most diverse, as well as biostratigraphically, palaeobiogeographically and palaeoecologically interesting, fossil biota from the Prince Albert Formation is that described from calcareous concretions exposed along the Vaal River in the Douglas area of the Northern Cape (McLachlan and Anderson 1973, Visser *et al.,* 1977-78). The important Douglas biota contains petrified wood (including large tree trunks), palynomorphs (miospores), orthocone nautiloids, nuculid bivalves, articulate brachiopods, spiral and other "coprolites" (probably of fish, possibly including sharks) and fairly abundant, well-articulated remains of palaeoniscoid fish. Most of the fish have been assigned to the palaeoniscoid genus *Namaichthys* but additional taxa, including a possible acrolepid, may also be present here (Evans 2005). The invertebrates are mainly preserved as moulds.

4.2. Fossils within the Whitehill Formation

In palaeontological terms the Whitehill Formation is one of the richest and most interesting stratigraphic units within the Ecca Group. The overall palaeontological sensitivity of this formation has accordingly been rated as very high (Almond & Pether 2008). The rich fossil record of the Whitehill formation in the Loeriesfontein sheet area has been reviewed by Almond (2008a). The biostratigraphic distribution of the most prominent fossil groups – mesosaurid reptiles, palaeoniscoid fishes and notocarid crustaceans – within the Whitehill Formation has been documented by several authors, including Oelofsen (1987), Visser (1992) and Evans (2005), and is shown here in Fig. 4. A non-technical illustrated account of the fossil biota of the Ecca Sea is given in Appendix 1 (See also the accessible illustrated account by MacRae 1999).

In brief, the main groups of Early Permian fossils found within the Whitehill Formation include:

- **aquatic** mesosaurid reptiles **(the earliest known sea-going reptiles)**
- **rare** cephalochordates **(ancient relatives of the living lancets)**
- **a variety of** palaeoniscoid fish **(primitive bony fish)**
- **highly abundant small** eocarid crustaceans **(bottom-living shrimp-like forms)**
- insects **(mainly preserved as isolated wings, but some intact specimens also found)**
- **a low diversity of** trace fossils **(*e.g.* king crab trackways, possible shark coprolites / faeces)**
- palynomorphs **(organic-walled spores and pollens)**

- petrified wood **(mainly of primitive gymnosperms, silicified or calcified)**
- **other sparse** vascular plant remains **(*Glossopteris* leaves, lycopods *etc*).**

Important material of the fossil groups listed above has mainly been collected in the Western Cape Province during the twentieth century by a series of palaeontologists (See, for example, McLachlan & Anderson 1973, Oelofsen 1981, 1987, Almond 1996, 2008a, 2008b, Almond & Pether 2008, Evans 2005, and refs. therein). In the earlier geological literature the Whitehill Formation or "Witband" was included within the Upper Dwyka Shales. Where the Whitehill Formation has been thermally metamorphosed or baked by nearby dolerite intrusions, as may have been the case in the Kaalspruit study area, the preservation of moulds of mesosaurid reptiles and fish may be locally enhanced.

4.3. Fossils within the superficial deposits

Porous alluvial sands, silts and gravels are not generally conducive to fossil preservation. However, mummification of soft tissues may play a role here and migrating lime-rich groundwaters derived from the underlying Dwyka Group may lead to the rapid calcretisation of organic structures such as burrows and root casts. Occasional terrestrial fossil remains that might be expected within Pleistocene to Recent alluvial sediments in the Karoo include calcretized rhizoliths (root casts) and termitaria (*e.g. Hodotermes*, the harvester termite), ostrich egg shells (*Struthio*) and shells of land snails (*e.g. Trigonephrus*) (Almond 2008a, Almond & Pether 2008). Other fossil groups such as freshwater bivalves and gastropods (*e.g. Corbula, Unio*) and snails, ostracods (seed shrimps), charophytes (stonewort algae), diatoms (microscopic algae within siliceous shells) and stromatolites (laminated microbial limestones) may be associated with local watercourses and pans. Underlying calcretes might also contain trace fossils such as rhizoliths, termite and other insect burrows, or even mammalian trackways. Mammalian bones, teeth and horn cores (also tortoise remains, and bones of fish, amphibians in wetter depositional settings) may be occasionally expected within river-deposited sediments and calcretes, notably those associated with ancient alluvial gravels.

5. SIGNIFICANCE OF IMPACTS ON PALAEONTOLOGICAL HERITAGE

A brief assessment of the significance of the impact of the Kaalspruit Solar PV development on local fossil heritage resources is presented here.

- **Nature of the impact**

Bedrock excavations for the proposed PV panel supports, buildings, buried cables, electrical substation and monitoring station as well as the access road, drainage channel and powerline infrastructure may adversely affect potential fossil heritage within the study area by destroying, disturbing or permanently sealing-in fossils that are then no longer available for scientific research or other public good. In such flat terrain the lay down area is unlikely to involve bedrock excavation. It is currently unclear if exploitation of potentially fossiliferous bedrock from new or existing borrow pits will be necessary.

- **Extent and duration of the impact**

Significant impacts on fossil heritage are limited to the construction phase when excavations into fresh, potentially fossiliferous bedrock may take place. No further significant impacts are anticipated during the operational phase of the Kaalspruit Solar PV development.

- **Probability of the impact occurring**

Given that the potentially fossiliferous Ecca Group bedrock within the study area is (a) extensively mantled in fossil-poor superficial deposits (*e.g.* alluvium, soil, sheet wash) and (b) often highly weathered, while large scale bedrock excavations are not envisaged for this project, a significant impact on palaeontological heritage is considered unlikely.

- **Degree to which the impact can be reversed**

Impacts on fossil heritage are generally irreversible. Well-documented new records of fossils represent a positive impact from a scientific viewpoint.

- **Degree to which the impact may cause irreplaceable loss of resources**

Well-preserved and locally abundant fossils from the Whitehill Formation, which is present beneath a substantial part of the Kaapspruit study area, are already well-known from good rock exposures in the neighbourhood of Loeriesfontein a few kilometers to the south. In contrast, the Whitehill bedrocks at Kaalspruit are deeply weathered near-surface so the proposed development does not pose a serious threat to local or regional palaeontological heritage. Its impact is therefore rated as of *low significance* in palaeontological terms.

- **Degree to which the impact can be mitigated**

Specialist palaeontological mitigation is *not* regarded as warranted for this project. Should significant fossil remains be exposed during the construction phase of the development, these should be safeguarded, preferably *in situ*, by the ECO and reported to Heritage Western Cape so that appropriate mitigation measures can be considered.

- **Cumulative impacts**

Cumulative impacts cannot be assessed in the absence of reliable data on other development projects approved or proposed in the study region.

6. CONCLUSIONS & RECOMMENDATIONS

The proposed Kaalspruit PV solar plant is largely underlain by Palaeozoic mudrocks of the Ecca Group, although in many areas these are mantled by largely unfossiliferous superficial deposits. Of the two Ecca Group rock units present the Prince Albert Formation is of low palaeontological sensitivity in this area. In contrast, the Whitehill Formation around Loeriesfontein is well known for its rich record of fossil fish, crustaceans and marine reptiles. However, field data including material excavated from test pits demonstrated that the Whitehill Formation at Kaalspruit is highly weathered near-surface. Since substantial bedrock excavations are not envisaged here, fresh (*i.e*. unweathered), potentially fossiliferous Whitehill bedrocks are unlikely to be directly affected by construction of the PV solar plant. The impact of the proposed development on local fossil heritage is considered to be *low* and specialist palaeontological mitigation is not considered necessary.

Should substantial fossil remains be exposed during construction, however (e.g. well-preserved fossil fish, reptiles or petrified wood), the ECO should safeguard these, preferably *in situ*, and alert SAHRA as soon as possible so that appropriate action (*e.g.* recording, sampling or collection) can be taken by a professional palaeontologist.

7. ACKNOWLEDGEMENTS

Mnr Wouter Fourie of PGS - Heritage & Grave Relocation Consultants is thanked for commissioning this study and for kindly providing all the necessary background information, including very useful field photographs of the study site. The geotechnical report by Mainstream Renewable Power was a useful additional resource for this palaeontological study.

TABLE 1: SUMMARY OF FOSSIL HERITAGE IN THE LOERIESFONTEIN AREA				
GEOLOGICAL UNIT	**ROCK TYPES & AGE**	**FOSSIL HERITAGE**	**PALAEONT-OLOGICAL SENSITIVITY**	**RECOMMENDED MITIGATION**
SUPERFICIAL DEPOSITS	mainly silty alluvium *plus* minor coarse fluvial and downwasted gravels, freshwater pan deposits, calcretes soils (often gypsiferous) PLEISTOCENE to RECENT	calcretised rhizoliths & termitaria, ostrich egg shells, land snail shells, rare mammalian and reptile (*e.g.* tortoise) bones, teeth freshwater units associated with diatoms, molluscs, stromatolites *etc*	LOW	none recommended any substantial fossil finds to be reported by ECO to SAHRA
Whitehill Formation ECCA GROUP	finely-laminated carbonaceous mudrocks with large dolomitic nodules, minor tuffs MID PERMIAN	well-preserved mesosaurid reptiles, palaeoniscoid fish, crustaceans, petrified wood, plant remains, palynomorphs, rare insects	GENERALLY HIGH BUT LOW NEAR-SURFACE DUE TO WEATHERING	none recommended any substantial fossil finds to be reported by ECO to SAHRA
Prince Albert Formation ECCA GROUP	basinal mudrocks with carbonate & phosphatic concretions, minor tuffs EARLY PERMIAN	marine invertebrates (esp. molluscs, brachiopods), coprolites, palaeoniscoid fish & sharks, trace fossils, various microfossils, petrified wood	LOW IN THIS AREA	none recommended any substantial fossil finds to be reported by ECO to SAHRA

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QUALIFICATIONS & EXPERIENCE OF THE AUTHOR

Dr John Almond has an Honours Degree in Natural Sciences (Zoology) as well as a PhD in Palaeontology from the University of Cambridge, UK. He has been awarded post-doctoral research fellowships at Cambridge University and in Germany, and has carried out palaeontological research in Europe, North America, the Middle East as well as North and South Africa. For eight years he was a scientific officer (palaeontologist) for the Geological Survey / Council for Geoscience in the RSA. His current palaeontological research focuses on fossil record of the Precambrian - Cambrian boundary and the Cape Supergroup of South Africa. He has recently written palaeontological reviews for several 1: 250 000 geological maps published by the Council for Geoscience and has contributed educational material on fossils and evolution for new school textbooks in the RSA.

Since 2002 Dr Almond has also carried out palaeontological impact assessments for developments and conservation areas in the Western, Eastern and Northern Cape under the aegis of his Cape Town-based company *Natura Viva* cc. He is a long-standing member of the Archaeology, Palaeontology and Meteorites Committee for Heritage Western Cape (HWC) and an advisor on palaeontological conservation and management issues for the Palaeontological Society of South Africa (PSSA), HWC and SAHRA. He is currently compiling technical reports on the provincial palaeontological heritage of Western, Northern and Eastern Cape for SAHRA and HWC. Dr Almond is an accredited member of PSSA and APHAP (Association of Professional Heritage Assessment Practitioners – Western Cape).

Declaration of Independence

I, John E. Almond, declare that I am an independent consultant and have no business, financial, personal or other interest in the proposed development project

, application or appeal in respect of which I was appointed other than fair remuneration for work performed in connection with the activity, application or appeal. There are no circumstances that compromise the objectivity of my performing such work.

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