



**DESKTOP PALAEOLOGICAL  
HERITAGE IMPACT ASSESSEMENT  
REPORT ON THE SITE OF A  
PROPOSED SOLAR POWER  
PRODUCTION FACILITY (THE  
TUTUKA SOLAR ENERGY FACILITY)  
TO BE LOCATED ON PORTIONS 4, 10,  
11 AND 12 OF FARM PRETORIUS  
VLEY 374 IS, MPUMALANGA  
PROVINCE**

27 November 2014

Prepared for:  
Heritage Contracts and Archaeological  
Consulting CC

On behalf of:  
Eskom Holdings (SOC) Limited

**Postal address:**  
P.O. Box 13755  
Hatfield  
0028  
South Africa

**Cell:** +27 (0) 79 626 9976  
**Fax:** +27 (0) 86 678 5358  
**E-mail:** [bmgeoserv@gmail.com](mailto:bmgeoserv@gmail.com)

**DESKTOP PALAEOLOGICAL HERITAGE IMPACT ASSESSEMENT REPORT ON  
THE SITE OF A PROPOSED SOLAR POWER PRODUCTION FACILITY (THE TUTUKA  
SOLAR ENERGY FACILITY) TO BE LOCATED ON PORTIONS 4, 10, 11 AND 12 OF  
FARM PRETORIUS VLEY 374 IS, MPUMALANGA PROVINCE**

Prepared for:

Heritage Contract and Archaeological Consulting CC

On Behalf of:

Eskom Holdings (SOC) Limited

Prepared By:

Prof B.D. Millstead

## EXECUTIVE SUMMARY

Eskom Holdings (SOC) Limited is proposing the establishment of a commercial solar energy facility (using photovoltaic technology) known as the Tutuka Solar Power Facility. Two localities are proposed for the location of the photovoltaic facility, these being the preferred location lying immediately to the south of the Tutuka Power Station and an alternative location located immediately adjacent to each other; the two being separated by the width of a road. The two proposed areas are located approximately 21 km north-east of Standerton and 38 km south-west of Bethal on Portions 4, 10, 11 and 12 of the Farm Pretorius Vley 374 IS, Magisterial District of Standerton, Lekwa Local Municipality, Mpumalanga Province. The aerial extent of the preferred location is approximately 98.8 ha; while that of the alternative site is approximately 36 ha. Should development occur upon the preferred project location the solar energy facility will have a planned capacity of 65.9 MW, but will have a smaller capacity of 24 MW if it occurs on the alternative location. Due to the proximity of the two alternative project areas as well as the similarity of their underlying geology the potential impacts posed by the project upon the palaeontological heritage of both areas will be collectively discussed in this report.

Eskom Holdings (SOC) Limited has appointed Savannah Environmental (Pty) Ltd to undertake Full Environmental Impact Assessment of the proposed project and the subsequent production of an Environmental management Program (EMPr) for the project. Savannah Environmental (Pty) Ltd has appointed Heritage Contract and Archaeological Consulting CC, as independent consultants, to undertake a desktop Heritage Impact Assessment of the project area. Heritage Contract and Archaeological Consulting CC has contracted BM Geological Services to provide a desktop Palaeontological Heritage Impact Assessment Report in respect of the proposed project that will form part of the final Heritage Impact Assessment Report.

The preferred project location and the identified alternative location are both underlain by potentially fossiliferous sedimentary rocks of the Early Permian Vryheid Formation. The potential for the proposed project to result in a negative impact upon the palaeontological heritage of the site has been assessed as moderate. The fossils known to be present within the formation elsewhere in South Africa are known to contain highly scientifically and culturally significant fossils, particularly the plant macrofossils of the *Glossopteris* flora. Any damage caused to the fossil materials that may be present within the strata underlying the project area would be both permanent and irreversible. The following damage mitigation protocols are recommended:

- Appropriate line staff of Eskom Holdings (SOC) Limited such as environmental officers should be trained to identify the types of fossils that may be expected to occur within the Vryheid Formation as well as be educated concerning the scientific and cultural importance of those fossils.

- A close examination should be made of all excavations while they are occurring by the trained line staff.
- Should any fossil materials be identified, the particular excavations should be halted and SAHRA informed of the discovery (as required in Section 3.3 above). A palaeontologist should then be mandated to inspect the fossil materials and ascertain their scientific and cultural importance.
- A significant potential benefit of the examination of the excavations associated with the construction of the project is that currently unobservable fossils may be uncovered. As long as the construction process is closely monitored it is possible that potentially significant fossil material may be made available for scientific study.
- Should scientifically or culturally significant fossil material exist within the project area any negative impact upon it could be mitigated by its excavation (under permit from SAHRA) by a palaeontologist and the resultant material being lodged with an appropriately permitted institution. In the event that an excavation is impossible or inappropriate the fossil or fossil locality could be protected and the site of any planned construction moved.
- The proposed excavations should also be inspected at a regular interval by a palaeontologist.

The project has been assessed as being socially beneficial, herein, as it would provide renewable electricity to an increasingly stressed national power grid. Should the damage mitigation and prevention protocols outlined, herein, be implemented this would minimise the possibility of any negative impact upon the fossil heritage of the area.

**This desktop study has not identified any palaeontological reason to prejudice the progression of the Tutuka Solar Energy Facility within either the preferred project location or the identified alternative location, subject to the recommended damage mitigation procedures being enacted. No additional studies (e.g., a Full Palaeontological Assessment) are required to be performed.**

## TABLE OF CONTENTS

1	INTRODUCTION.....	6
2	TERMS OF REFERENCE AND SCOPE OF THE STUDY.....	6
3	LEGISLATIVE REQUIREMENTS.....	8
3.1	The National Heritage Resources Act.....	8
3.2	Need for Impact Assessment Reports.....	8
3.3	Legislation Specifically Pertinent to Palaeontology*.....	9
3.4	The National Environmental Management Act [as amended].....	10
4	RELEVANT EXPERIENCE.....	11
5	INDEPENDENCE.....	11
6	GEOLOGY AND FOSSIL POTENTIAL.....	11
6.1	Vryheid Formation.....	11
6.1.1	Geology.....	11
6.1.2	Palaeontological potential.....	14
7	ENVIRONMENT OF THE PROPOSED PROJECT SITE.....	15
8	OVERVIEW OF SCOPE OF THE PROJECT.....	19
8.1	Effect of project on the geology.....	19
9	IMPACT ASSESSMENT.....	19
9.1	Nature of Impact.....	19
9.2	Extent of impact.....	20
9.3	Duration of impact.....	20
9.4	Probability of impact.....	20
9.5	Significance of the impact.....	21
9.6	Severity / Benefit scale.....	21
9.7	Status.....	22
10	DAMAGE MITIGATION, REVERSAL AND POTENTIAL IRREVERSABLE LOSS.....	22
10.1	Mitigation.....	22
10.2	Reversal of damage.....	23
10.3	Degree of irreversible loss.....	23
11	ASSUMPTIONS, UNCERTAINTIES AND GAPS IN KNOWLEDGE.....	23
12	ENVIRONMENTAL IMPACT STATEMENT.....	23

13	REFERENCES .....	25
----	------------------	----

### TABLE OF FIGURES

<b>Figure 1:</b>	Location map showing the position of the Newcastle Solar Energy Facility and its associated proposed power line.....	7
------------------	--	---

<b>Figure 2:</b>	Geological map of the area underlying the Newcastle Solar Energy Facility and its associated power line. ....	12
------------------	---	----

<b>Figure 3:</b>	Schematic north-south oriented stratigraphic section of the Ecca Group in the north-east corner of the Karoo Basin. The Volksrust and Pietermaritzburg Formations can only be recognised when the Vryheid Formation forms part of the vertical sequence. In the north and north-western portions of the basin the Pietermaritzburg Formation was not deposited and the coal-bearing strata of the Vryheid Formation rest directly upon the basement. ....	13
------------------	---	----

<b>Figure 4:</b>	Google earth image of the site of the proposed Newcatle Solar Energy Facility (red polygon) and its associated power line (purple line). ....	16
------------------	---	----

<b>Figure 5:</b>	Map of the two project area and its immediate environs. The project area lies on the southern margin of a low rounded hill. No significant fluvial systems traverse the proposed power production infrastructure, but two located to the immediate west and south of the site flow in to the Ingagane River. The western drainage line cross-cuts the proposed power line. The topographic contour interval is 20 m.....	17
------------------	--	----

<b>Figure 6:</b>	Map of the distribution of the vegetation veld types located beneath the project area and within its immediate environs (after Mucina and Rutherford, 2006)....	18
------------------	---	----

## **1 INTRODUCTION**

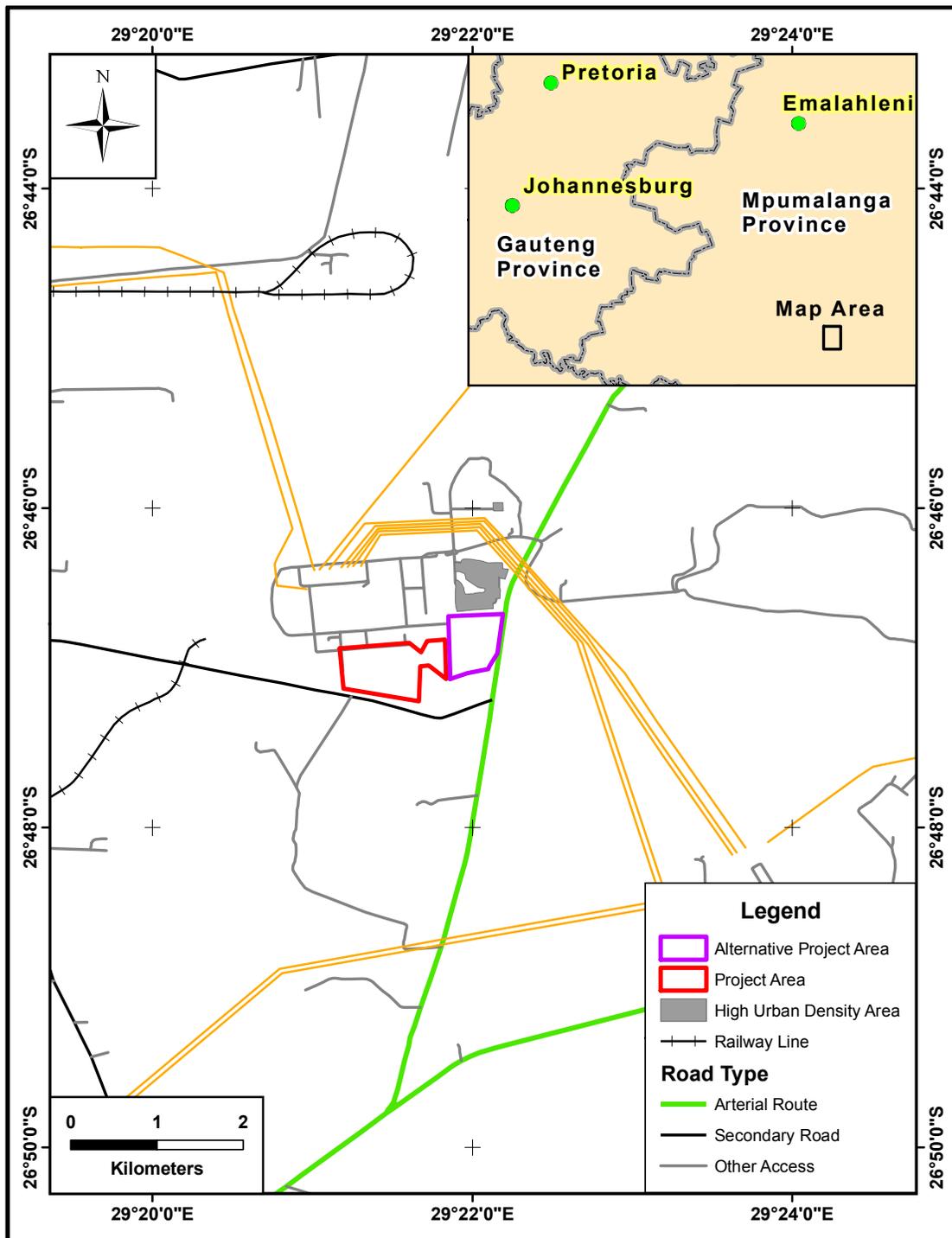
Eskom Holdings (SOC) Limited is proposing the establishment of a commercial solar energy facility (using photovoltaic technology) known as the Tutuka Solar Power Facility. Two localities are proposed for the location of the photovoltaic facility, these being the preferred location lying immediately to the south of the Tutuka Power Station and an alternative location located immediately adjacent to each other; the two being separated by the width of a road (Figure 1). The two proposed areas are located approximately 21 km north-east of Standerton and 38 km south-west of Bethal on Portions 4, 10, 11 and 12 of the Farm Pretorius Vley 374 IS, Magisterial District of Standerton, Lekwa Local Municipality, Mpumalanga Province. The aerial extent of the preferred location is approximately 98.8 ha; while that of the alternative site is approximately 36 ha. Should development occur upon the preferred project location the solar energy facility will have a planned capacity of 65.9 MW, but will have a smaller capacity of 24 MW if it occurs on the alternative location. Due to the proximity of the two alternative project areas as well as the similarity of their underlying geology the potential impacts posed by the project upon the palaeontological heritage of both areas will be collectively discussed in this report.

Eskom Holdings (SOC) Limited has appointed Savannah Environmental (Pty) Ltd to undertake Full Environmental Impact Assessment of the proposed project and the subsequent production of an Environmental management Program (EMPr) for the project. Savannah Environmental (Pty) Ltd has appointed Heritage Contract and Archaeological Consulting CC, as independent consultants, to undertake a desktop Heritage Impact Assessment of the project area. Heritage Contract and Archaeological Consulting CC has contracted BM Geological Services to provide a desktop Palaeontological Heritage Impact Assessment Report in respect of the proposed project that will form part of the final Heritage Impact Assessment Report.

## **2 TERMS OF REFERENCE AND SCOPE OF THE STUDY**

The terms of reference for this study were as follows:-

- Conduct a desktop assessment of the potential impact of the proposed project on the palaeontological heritage of the project area.
- Describe the possible impact of the proposed development on the palaeontological heritage of the site, according to a standard set of conventions.
- Quantify the possible impact of the proposed development on the palaeontological heritage of the site, according to a standard set of conventions.
- Provide an overview of the applicable legislative framework.
- Make recommendations concerning future work programs as, and if, necessary.



**Figure 1:** Location map showing the position of both the preferred and the alternative project areas for the Tutuka Solar Energy Facility.

### **3 LEGISLATIVE REQUIREMENTS**

South Africa’s cultural resources are primarily dealt with in two Acts. These are the National Heritage Resources Act (Act 25 of 1999) and the National Environmental Management Act (Act 107 of 1998).

#### **3.1 The National Heritage Resources Act**

The following are protected as cultural heritage resources by the National Heritage Resources Act:

- Archaeological artefacts, structures and sites older than 100 years,
- Ethnographic art objects (e.g. prehistoric rock art) and ethnography,
- Objects of decorative and visual arts,
- Military objects, structures and sites older than 75 years,
- Historical objects, structures and sites older than 60 years,
- Proclaimed heritage sites,
- Grave yards and graves older than 60 years,
- Meteorites and fossils,
- Objects, structures and sites of scientific or technological value.

The Act also states that those heritage resources of South Africa which are of cultural significance or other special value for the present community and for future generations must be considered part of the national estate and fall within the sphere of operations of heritage resources authorities. The national estate includes the following:

- Places, buildings, structures and equipment of cultural significance,
- Places to which oral traditions are attached or which are associated with living heritage,
- Historical settlements and townscapes,
- Landscapes and features of cultural significance,
- Geological sites of scientific or cultural importance,
- Sites of Archaeological and palaeontological importance,
- Graves and burial grounds,
- Sites of significance relating to the history of slavery,
- Movable objects (e.g. archaeological, palaeontological, meteorites, geological specimens, military, ethnographic, books etc.).

#### **3.2 Need for Impact Assessment Reports**

Section 38 of the Act stipulates that any person who intends to undertake an activity that falls within the following:

- The construction of a linear development (road, wall, power line, canal etc.) exceeding 300 m in length,

- The construction of a bridge or similar structure exceeding 50 m in length,
- Any development or other activity that will change the character of a site and exceed 5 000 m<sup>2</sup> or involve three or more existing erven or subdivisions thereof,
- Re-zoning of a site exceeding 10 000 m<sup>2</sup>,
- Any other category provided for in the regulations of SAHRA or a provincial heritage 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. If there is reason to believe that heritage resources will be affected by such development, the developer may be notified to submit an impact assessment report. A Palaeontological Impact Assessment (PIA) only looks at the potential impact of the development palaeontological resources of the proposed area to be affected.

### **3.3 Legislation Specifically Pertinent to Palaeontology\***

\*Note: Section 2 of the Act defines “palaeontological” material as “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”.

Section 35(4) of this Act specifically deals with archaeology, palaeontology and meteorites. The Act states that no person may, without a permit issued by the responsible heritage resources authority (national or provincial):

- Destroy, damage, excavate, alter, deface or otherwise disturb any archaeological or palaeontological site or any meteorite,
- Destroy, damage, excavate, remove from its original position, collect or own any archaeological or palaeontological material or object or any meteorite,
- Trade in, sell for private gain, export or attempt to export from the Republic any category of archaeological or palaeontological material or object, or any meteorite; or
- Bring onto or use at an archaeological or palaeontological site any excavation equipment or any equipment that assists in the detection or recovery of metals or archaeological and palaeontological material or objects, or use such equipment for the recovery of meteorites,
- Alter or demolish any structure or part of a structure which is older than 60 years as protected.

The above mentioned palaeontological objects may only be disturbed or moved by a palaeontologist, after receiving a permit from the South African Heritage Resources Agency (SAHRA). In order to demolish such a site or structure, a destruction permit from SAHRA will also be needed.

Further to the above point, Section 35(3) of this Act indicates that “any person who discovers archaeological or palaeontological objects or material or a meteorite in the course of development or agricultural activity must immediately report the find to the responsible heritage resources authority, or to the nearest local authority offices or museum, which must immediately notify such heritage resources authority”. Thus, regardless of the granting of any official clearance to proceed with any development based on an earlier assessment of its impact on the Palaeontological Heritage of an area, the development should be halted and the relevant authorities informed should fossil objects be uncovered during the progress of the development.

### **3.4 The National Environmental Management Act [as amended]**

This Act does not provide the detailed protections and administrative procedures for the protection and management of the nation’s Palaeontological Heritage as are detailed in the National Heritage Resources Act, but is more general in its application. In particular Section 2(2) of the Act states that environmental management must place people and their needs at the forefront of its concerns and, amongst other issues, serve their cultural interests equitably. Further to this point section 2(4)(a)(iii) states that disturbances of sites that constitute the nation’s cultural heritage should be avoided, and where it cannot be avoided should be minimised and remedied.

Section 23(1) indicates that a general objective of integrated environmental management is to identify, predict and evaluate the actual and potential impact of activities upon the cultural heritage. This section also highlights the need to identify options for mitigating of negative effects of activities with a view to minimising negative impacts.

In order to give effect to the general objectives of integrated environmental management outlined in the Act the potential impact on cultural heritage of activities that require authorisation or permission by law must be investigated and assessed prior to their implementation and reported to the relevant organ of state. Thus, a survey and evaluation of cultural resources must be done in areas where development projects that will potentially negatively affect the cultural heritage will be performed. During this process the impact on the cultural heritage will be determined and proposals for the mitigation of the negative effects made.

#### **4 RELEVANT EXPERIENCE**

Prof Millsteed holds a PhD in palaeontology and has previously been employed as a professional palaeontologist with the Council for Geoscience in South Africa. He is currently the principle of BM Geological Services and has sufficient knowledge of palaeontology and the relevant legislation required to produce this Palaeontological Impact Assessment Report. Dr Millsteed is registered with the South African Council for Natural Scientific Professions (SACNASP), and is a member of the Palaeontological Society of South African and the Geological Society of South Africa.

#### **5 INDEPENDENCE**

Prof Millsteed was contracted as an independent consultant to conduct this Palaeontological Heritage Impact Assessment study and shall receive fair remuneration for these professional services. Neither Prof Millsteed nor BM Geological Services has any financial interest either in Eskom Holdings (SOC) Limited or the proposed Tutuka Solar Energy Facility.

#### **6 GEOLOGY AND FOSSIL POTENTIAL**

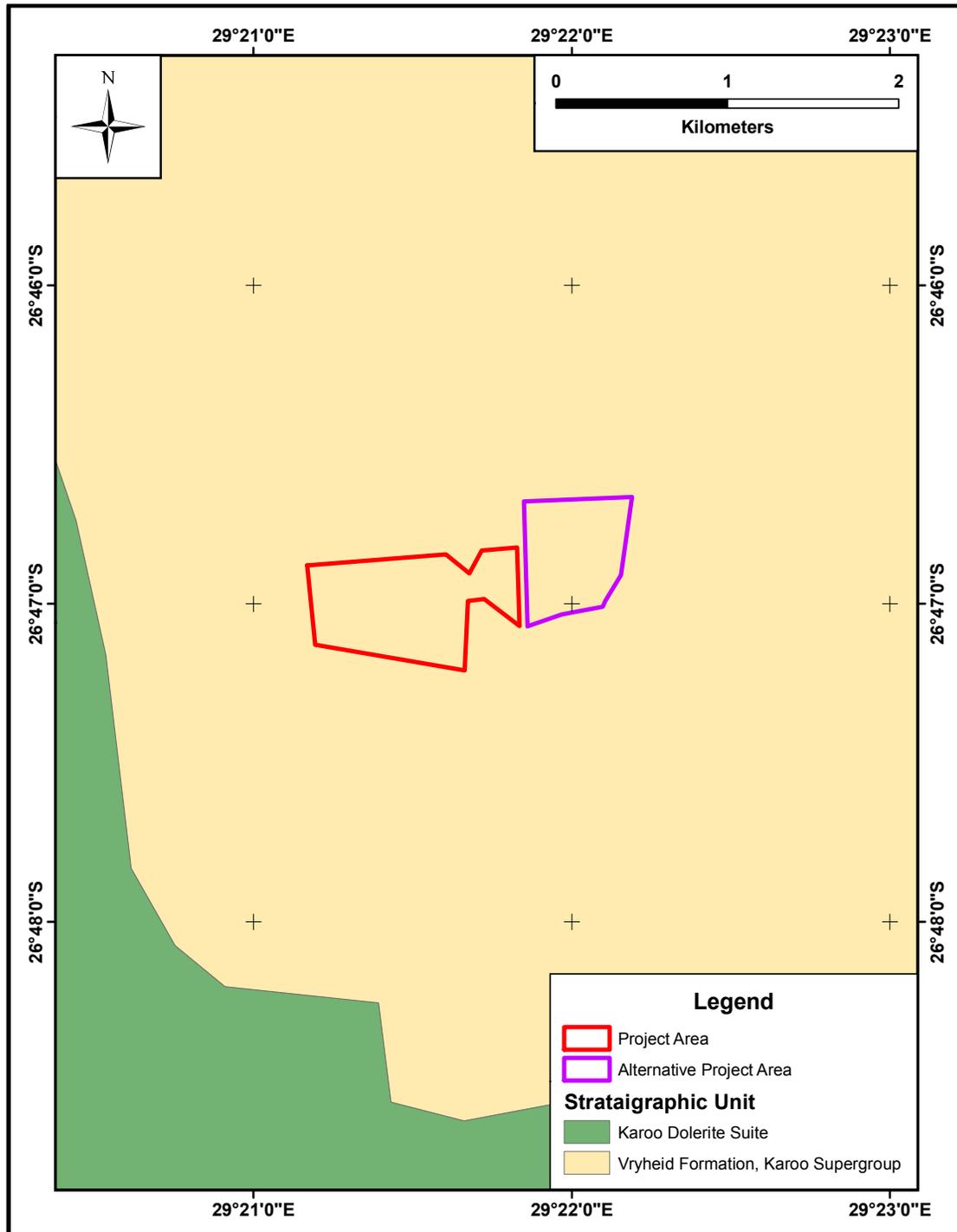
Figure 2 shows that both the preferred project area and the identified alternative area are completely underlain by rocks of the Early Permian Vryheid Formation. A summary of the characteristics of the Vryheid Formation and its fossiliferous potential follows.

##### **6.1 Vryheid Formation**

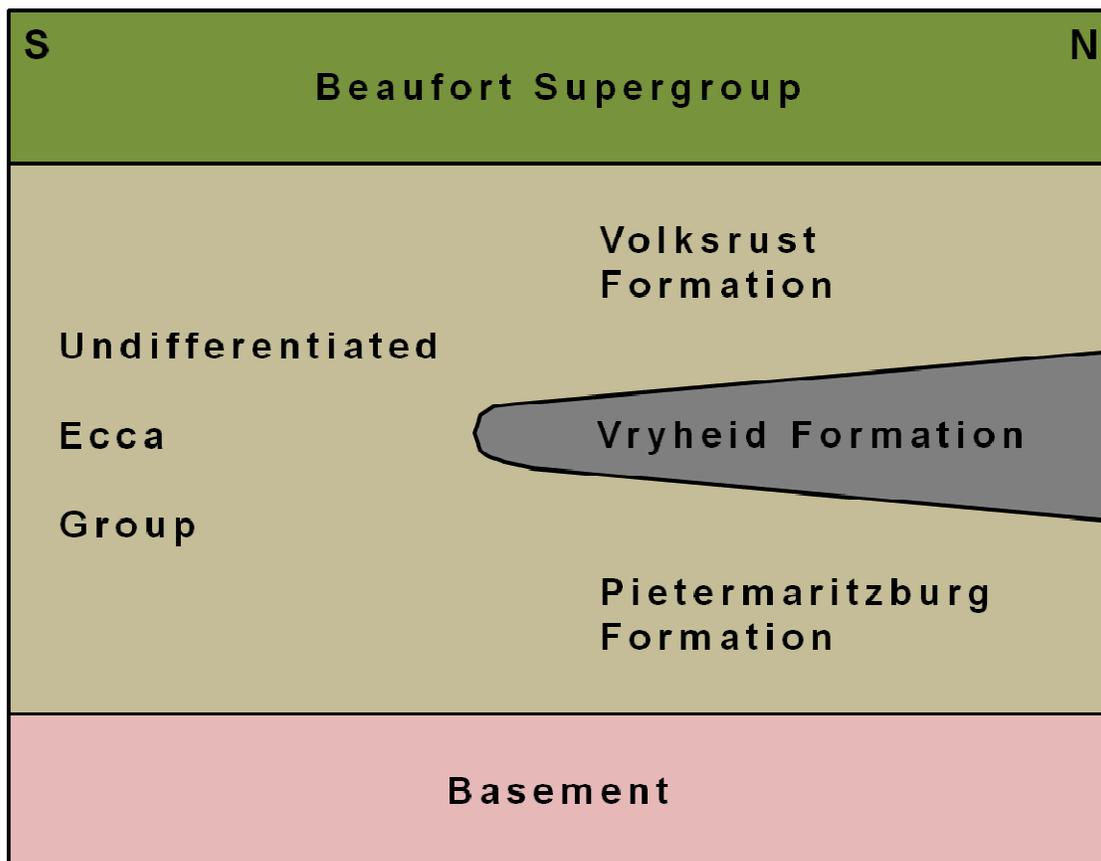
###### **6.1.1 Geology**

The Main Karoo Basin consists of a retro-arc foreland basin filled with a lithological succession ranging in age from the Late Carboniferous to the Middle Jurassic (Johnson *et al.*, 2006). The basin-fill sequence wedges out northwards over the adjacent Kaapvaal Craton.

In the Main Karoo Basin of South Africa the Vryheid Formation is a sandstone and coal-rich stratigraphic unit that interfingers with (i.e., is transitional with and partially time equivalent to) the overlying Volkrust and underlying Pietermaritzburg Formations; both of which are both are predominantly argillaceous (Figure 3). Genetically the formation can be divided into lower fluvial-dominated deltaic interval, a middle fluvial interval (the coal-bearing zone) and an upper fluvial-dominated deltaic interval (Johnson *et al.*, 2006). The thickness and frequency of the sandstone units increases from the base of the formation, reaching their maximum in the middle fluvial interval and then decrease again towards the overlying Volksrust Formation. To the south and south-east the



**Figure 2:** Geological map of the area underlying the two possible project areas for the Tutuka Solar Energy Facility.



**Figure 3:** Schematic north-south oriented stratigraphic section of the Ecca Group in the north-east corner of the Karoo Basin. The Volksrust and Pietermaritzburg Formations can only be recognised when the Vryheid Formation forms part of the vertical sequence. In the north and north-western portions of the basin the Pietermaritzburg Formation was not deposited and the coal-bearing strata of the Vryheid Formation rest directly upon the basement.

Vryheid Formation grades laterally into undifferentiated, deep-water argillites of the Ecca Group (Figure 3).

The Vryheid Formation is one of sixteen (16) recognised stratigraphic units that constitute the Permian Ecca Group. During the deposition of the Ecca Group the basin was dominated by a large sea (the salinity levels of this water body remain unresolved). The exception to this model was the deposition of the coal-bearing strata of the Vryheid Formation along the northern margin during an episode of deltaic progradation into the basin.

Deposition of the Vryheid Formation was terminated by a basin-wide transgression that drowned the Vryheid deltas and their coal swamps resulting in the deposition of the deep water sediments of the Volksrust Formation.

#### 6.1.2 Palaeontological potential

The most conspicuous and common components of the palaeontological record of the Ecca Group in general are the plant macrofossils of the *Glossopteris* flora. Two large and conspicuous leaf form taxa dominate the *Glossopteris* flora; these being *Glossopteris* and *Gangamopteris*. Within the upper Ecca (containing the Vryheid Formation) *Gangamopteris* has ceased to occur with only *Glossopteris* present (Anderson and McLauchlan, 1976). The palaeobotanical record of the Ecca Group is diverse and the literature describing it is voluminous (numerous papers having been published by E. Plumstead, H. Anderson, J. Anderson, E. Kovaks-Endrődy and M. Bamford amongst others). A comprehensive review of the flora in the Karoo Basin literature is, accordingly, beyond the scope of this study, but a thorough review of the palaeobotanical content of the Ecca Group in general and the Vryheid Formation in particular is presented in Bamford (2004). In that summary it is indicated that the Vryheid Formation can be expected to contain the plant macrofossils *Buthlezeria*, *Sphenophyllum*, *Rangia*, *Phyllotheca*, *Schizoneura*, *Sphenopteris*, *Noeggerathiopsis*, *Taeniopteris*, *Pagiophyllum* and *Benlightfootia* and the wood taxa *Australoxylon* and *Prototaxoxylon*. In addition to the above records can be added the observations of Tavener-Smith *et al.*, (1988) where it was noted that both *Glossopteris* and *Vertebraria* occur within the palaeontological record of the formation.

In portions of the formation that are typified by low thermal alteration abundant assemblages of palynomorph plant microfossils (including acritarchs) can be expected (Anderson, 1977).

Jubb and Gardiner (1975) report the presence of fragmentary fish fossils within the Ecca sequence of southern Africa; these being *Coelacanthus dendrites* from the Somkele coal-field of northern Natal and *Namaichthys digitata* from correlative strata in the Senge Coal-fields of Zimbabwe. While fish faunas are obviously rare and none have been reported from the Vryheid Formation the possibility remains that they may be present.

Animal body fossils are rare within the Ecca Group in general (excepting the time equivalent faunas of the Whitehill Formation). However, no reptile fossils have been identified within the Vryheid Formation.

Hobday and Tavener-Smith (1975) reviewed trace fossil assemblages identified within the Vryheid Formation. Within that fossil assemblage they identified two forms

(*Helminthopsis* and *Taphrelminthopsis* within horizontally laminated siltstones and mudstones that represent part of the deep water *Nerites* community.

## **7 ENVIRONMENT OF THE PROPOSED PROJECT SITE**

The two areas reported upon herein for the photovoltaic facility are large; being approximately 98.8 ha for the preferred location approximately 36 ha for the identified alternative location. Examination of Google earth imagery (Figure 4) indicates that the preferred location of the photovoltaic generation facility is located immediately south of the Tutuka Power Station while the alternative site is located immediately to the south-east of the power station. The R38 road lies immediately adjacent to the eastern border of the alternative site and another road (possibly a dirt road) lies close to the southern borders of both alternative project sites. It is apparent from the Google earth imagery that the entire surface extent of both sites appears to have been substantially altered by human activity and is no longer in their original natural states (Figure 5). The land surface is otherwise flat and topographically featureless. No significant fluvial drainage lines traverse either alternative site, but a number of surface water bodies are located proximal to, and along the southern margins of, the two alternative sites (Figure 4 and 6).

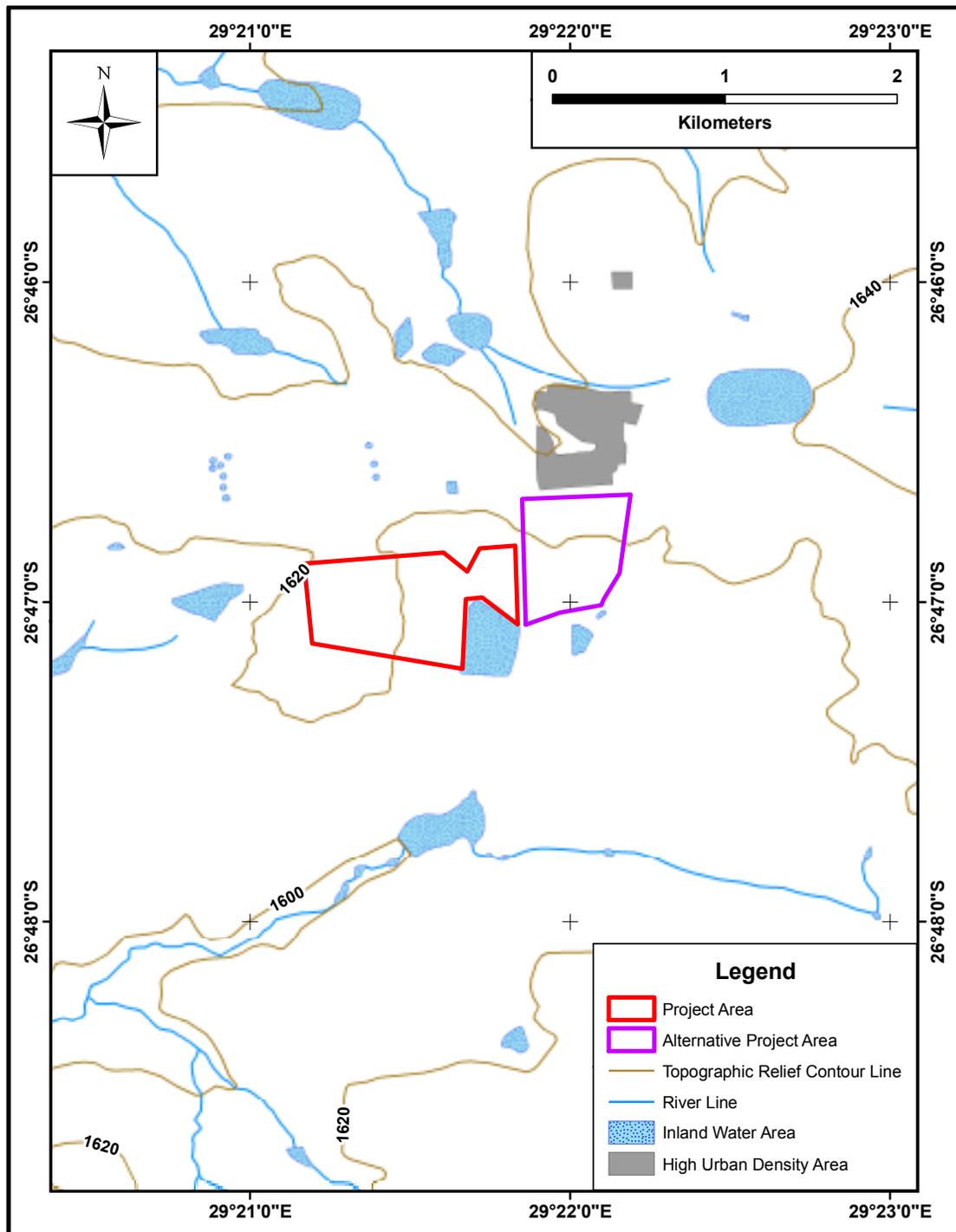
The natural vegetation cover of the two alternative project areas consists of the Soweto Highveld Grassland veld type (Figure 7). The conservation status of the Soweto Highveld Grassland is described by Mucina and Rutherford (2006) as endangered. However, it was apparent from Google earth imagery that the entire surface extent of both alternative project areas has previously been extensively modified and how much of the original native vegetation remains on site is uncertain.



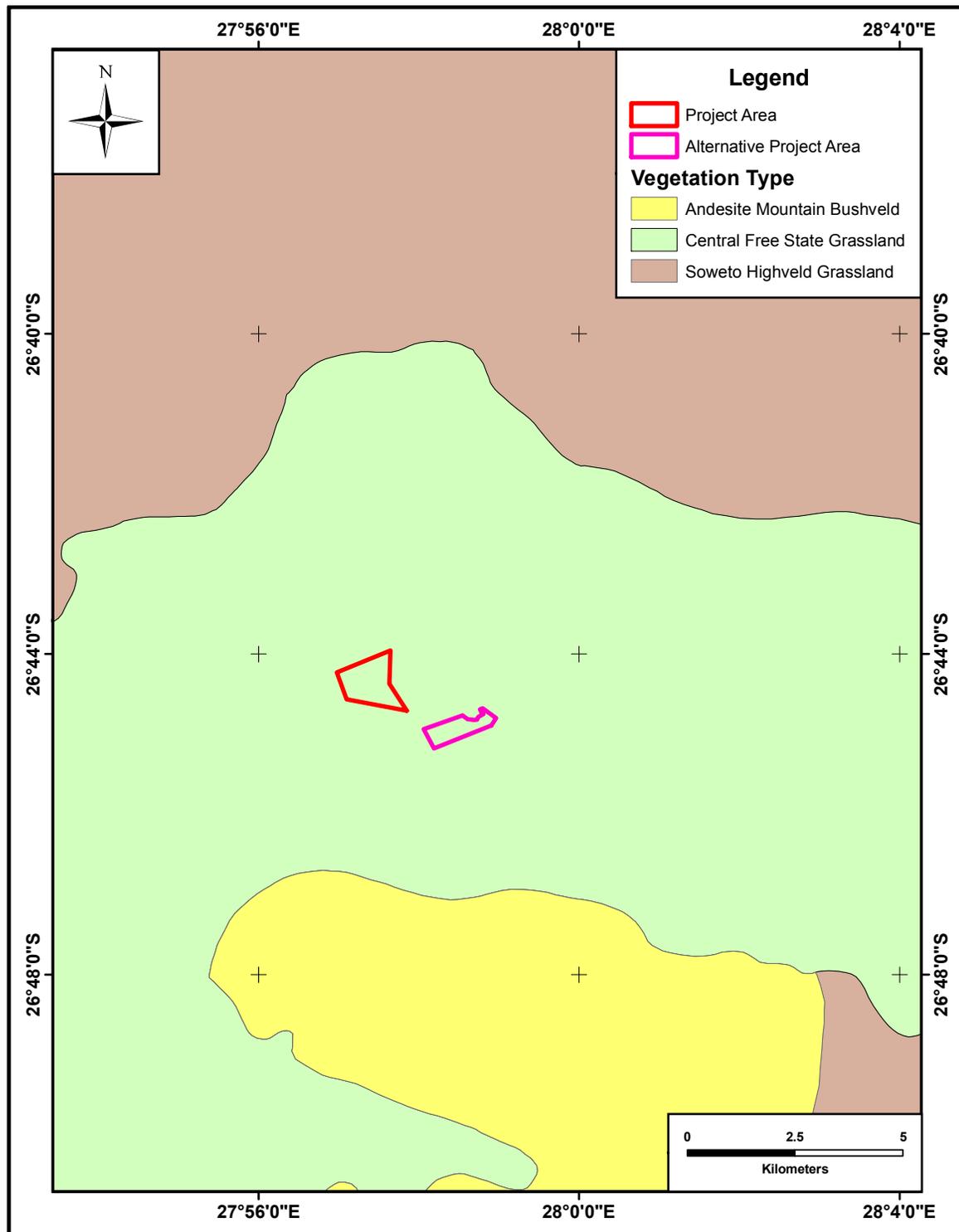
**Figure 4:** Google earth image of the site of the preferred (red polygon) and the alternative (purple polygon) project areas for the proposed Tutuka Solar Energy Facility and its associated power line (purple line).



**Figure 5:** Google earth image of the two possible project areas (the preferred location is the red polygon and the alternative location is the purple polygon). The extensive disturbance of the land surface of the entire extent of both areas is evident.



**Figure 6:** Map of the two project area and its immediate environs. The project area lies on the southern margin of a low rounded hill. No significant fluvial systems traverse either project area but several ponded surface water bodies are located proximally to both areas. The topographic contour interval is 20 m.



**Figure 7:** Map of the distribution of the vegetation veld types located beneath the two possible project areas and their immediate environs (after Mucina and Rutherford, 2006).

## **8 OVERVIEW OF SCOPE OF THE PROJECT**

The Tutuka Solar Energy Photovoltaic Facility is proposed to consist of the following infrastructure elements:

- Arrays of photovoltaic (PV) panels.
- Mounting structures to support the PV panels.
- Cabling between the project components.
- Inverters/transformer enclosures.
- An on-site substation or switching station.
- A power line to facilitate the connection of the solar energy facility to the existing substation/power line at the power station.
- Internal access roads.
- Buildings (which could include workshop area for maintenance and storage, and an on-site office).

### **8.1 Effect of project on the geology**

It may be interpreted from Section 8 above that the development anticipated within the project area could be expected to be restricted to the upper 1-2 m of the land surface, with the deepest anticipated impacts upon the underlying geology resulting from the excavations required to lay the underground cables and for the foundations required for the various buildings, photovoltaic panels or the power line pylons.

## **9 IMPACT ASSESSMENT**

The potential impact of the proposed solar energy photovoltaic facility is categorised below according to the criteria outlined below.

### **9.1 Nature of Impact**

The potential negative impacts of the proposed project on the palaeontological heritage of the area are:

- Damage or destruction of fossil materials during the construction of project infrastructural elements to a maximum depth of those excavations. Many fossil taxa (particularly vertebrate taxa) are known from only a single fossil and, thus, any fossil material is potentially highly significant. Accordingly, the loss or damage to any single fossil can be potentially significant to the understanding of the fossil heritage of South Africa and to the understanding of the evolution of life on Earth in general. Where fossil material is present and will be directly affected by the building or

construction of the project’s infrastructural elements the result will potentially be the irreversible damage or destruction of the fossil(s).

- Movement of fossil materials during the construction phase, such that they are no longer *in situ* when discovered. The fact that the fossils are not *in situ* would either significantly reduce or completely destroy their scientific significance.
- The loss of access for scientific study to any fossil materials present beneath infrastructural elements for the life span of the existence of those constructions and facilities.

## 9.2 Extent of impact

The possible extent of the permanent impact of the proposed project on the palaeontological heritage of South Africa is restricted to the damage, destruction or accidental relocation of fossil material caused by the excavations and construction of the necessary infrastructure elements forming part of the project. The possible source of a less permanent negative impact on the palaeontological heritage is the loss of access for scientific research to any fossil materials that become covered by the various infrastructural elements that comprise the project. The **extent of the area of potential impact is, accordingly, categorised as local** (i.e., restricted to the project site).

## 9.3 Duration of impact

The anticipated duration of the identified potential impact is assessed as potentially **permanent to long term**. This assessment is based on the fact that, in the absence of mitigation procedures (should fossil material be present within the area to be affected) the damage or destruction of any palaeontological materials will be permanent. Similarly, any fossil materials that exist below the structures and infrastructural elements that will constitute the solar power facility and the associated power line pylons will be unavailable for scientific study for the life of the existence of those features. The life of the facility is expected to be permanent herein.

## 9.4 Probability of impact

The sediments of the Vryheid Formation are noted for containing an important palaeontological heritage particularly in respect of plant macrofossils of the *Glossopteris* flora. However, the occurrence of fossils within the geological record is erratic in general and the chance of impacting upon most macrofossil types at any particular point within the Vryheid Formation is low. It must be noted however, that where plant macrofossils or trace fossils are present within a sequence (as they are in the Vryheid Formation) they are often in dense accumulations and the probability of a negative impact is accordingly assessed as being **moderate**.

## 9.5 Significance of the impact

Should the project progress without due care to the possibility of fossils being present within the Vryheid Formation the resultant damage, destruction or inadvertent relocation any affected fossils will be permanent and irreversible. This potential for negative impact is accentuated by the fact that often the plant macrofossils and trace fossils that are known to be present in this formation often occur in dense accumulations, and as such, if any negative impact occurs it may well affect many fossils simultaneously. The delta top/fluvial/coal swamp environments that existed during the deposition of the Vryheid Formation provide an important window into the evolution of plant life of the famous *Glossopteris* flora during the Early Permian within the Main Karoo Basin. Their significance is due to the uniqueness of their terrestrial environments within the basin fill of the Main Karoo Basin at that time. Thus, any fossil materials occurring within the project area are potentially extremely scientifically and culturally significant and any negative impact on them would be of **high significance**.

The scientific and cultural significance of fossil materials is underscored by the fact that many fossil taxa (particularly vertebrate taxa) are known from only a single fossil and, thus, any fossil material is potentially highly significant. Accordingly, the loss or damage to any single fossil can be potentially significant to the understanding of the fossil heritage of South Africa and to the understanding of the evolution of life on Earth in general. Where fossil material is present and will be directly affected by the construction of project infrastructural elements the result will potentially be the irreversible damage or destruction of the fossil(s).

The certainty of the exact *in situ* location of fossils and their precise location within the stratigraphic sequence is essential to the scientific value of fossils. The movement of any fossil material during the construction of the facility that results in the exact original location of the fossil becoming unknown will either greatly diminish or destroy the scientific value of the fossil.

## 9.6 Severity / Benefit scale

The proposed project is categorised, herein, as being potentially **beneficial**. This classification is based on the intention that the project will provide renewable energy to an increasingly strained national power grid.

The probability of a negative impact on the palaeontological heritage of the project areas has been categorised as moderate. However, the implementation of suitable damage mitigation and avoidance protocols, as outlined below, will minimise the probability of any negative impact occurring.

## 9.7 Status

The proposed project would provide electricity to the national power grid, which is currently regularly failing to meet the demands placed upon it. As such, the project is determined as having a **positive status** herein.

## 10 DAMAGE MITIGATION, REVERSAL AND POTENTIAL IRREVERSABLE LOSS

The degree to which the possible negative effects of the proposed project can be mitigated, reversed or will result in irreversible loss of the palaeontological heritage can be determined as discussed below.

### 10.1 Mitigation

It was identified above (see Section 7) that it appears that the entire surface extents of both the preferred and the alternative project areas have been extensively modified by human activity. Accordingly, there appears to be little chance of undamaged or *in situ* fossil materials existing at surface. As such there is little point to conducting a site investigation (i.e., Full Palaeontological Impact assessment Study) on either site prior to commencement of the construction phase of the project. The following damage mitigation protocols are, however, recommended:

- Appropriate line staff of Eskom Holdings (SOC) Limited such as environmental officers should be trained to identify the types of fossils that may be expected to occur within the Vryheid Formation as well as be educated concerning the scientific and cultural importance of those fossils.
- A close examination should be made of all excavations while they are occurring by the trained line staff.
- Should any fossil materials be identified, the particular excavations should be halted and SAHRA informed of the discovery (as required in Section 3.3 above). A palaeontologist should then be mandated to inspect the fossil materials and ascertain their scientific and cultural importance.
- A significant potential benefit of the examination of the excavations associated with the construction of the project is that currently unobservable fossils may be uncovered. As long as the construction process is closely monitored it is possible that potentially significant fossil material may be made available for scientific study.
- Should scientifically or culturally significant fossil material exist within the project area any negative impact upon it could be mitigated by its excavation (under permit from SAHRA) by a palaeontologist and the resultant material being lodged with an appropriately permitted institution. In the event that an excavation is

impossible or inappropriate the fossil or fossil locality could be protected and the site of any planned construction moved.

- The proposed excavations should also be inspected at a regular interval by a palaeontologist.

## **10.2 Reversal of damage**

Any damage to, or the destruction of, palaeontological materials or reduction of scientific value due to a loss of the original location is **irreversible**.

## **10.3 Degree of irreversible loss**

Once a fossil is damaged, destroyed or moved from its original position without its geographical position and stratigraphic location being recorded the **damage is irreversible**.

Fossils are usually scarce and sporadic in their occurrence and the chances of negatively impacting on a fossil in any particular area are low. However, any fossil material is potentially of the greatest scientific and cultural importance. Thus, the potential always exists during construction and excavation within potentially fossiliferous rocks for the permanent and irreversible loss of extremely significant or irreplaceable fossil material. This said, many fossils are incomplete in their state of preservation or are examples of relatively common taxa. As such, just because a fossil is present it is not necessarily of great scientific value. Accordingly, not all fossils are necessary significant culturally or scientifically significant and the potential degree of irreversible loss will vary from case to case. The judgement on the significance of the fossil must be made by an experienced palaeontologist.

## **11 ASSUMPTIONS, UNCERTAINTIES AND GAPS IN KNOWLEDGE**

The information provided within this report was derived from a desktop study of available maps and scientific literature; no direct observation was made of the area as result of a site visit.

## **12 ENVIRONMENTAL IMPACT STATEMENT**

A desktop Palaeontological Impact Assessment Study has been conducted on both the preferred location for this project as well as an alternative, immediately adjacent, project location of the proposed Tutuka Solar Energy Photovoltaic Facility. The proposed alternative project areas are both moderately large; being approximately 55 ha for the preferred location and approximately 34 ha 4.4 ha for the identified alternative location. However, any negative impacts to the palaeontological heritage of the region will be

limited to the footprint area of the required infrastructure and the extent of any impacts is accordingly characterised as local.

The effects of the required construction operations to the geological strata underlying the project area will be restricted to the Early Permian Vryheid Formation; this geological unit is known to be fossiliferous. The probability of the project resulting in a negative impact on the palaeontological heritage of the Vryheid Formation has been assessed as moderate. Any negative impact on the fossil materials will potentially be highly significant due to the scientific and cultural importance of many of the fossils that may be expected to be present. However, the social benefits of the project have been classified as beneficial, herein, as the project aims to provide renewable electricity to the increasingly stressed national power grid. The following damage mitigation protocols are accordingly recommended:

- Appropriate line staff of Eskom Holdings (SOC) Limited such as environmental officers should be trained to identify the types of fossils that may be expected to occur within the Vryheid Formation as well as be educated concerning the scientific and cultural importance of those fossils.
- A close examination should be made of all excavations while they are occurring by the trained line staff.
- Should any fossil materials be identified, the particular excavations should be halted and SAHRA informed of the discovery (as required in Section 3.3 above). A palaeontologist should then be mandated to inspect the fossil materials and ascertain their scientific and cultural importance.
- A significant potential benefit of the examination of the excavations associated with the construction of the project is that currently unobservable fossils may be uncovered. As long as the construction process is closely monitored it is possible that potentially significant fossil material may be made available for scientific study.
- Should scientifically or culturally significant fossil material exist within the project area any negative impact upon it could be mitigated by its excavation (under permit from SAHRA) by a palaeontologist and the resultant material being lodged with an appropriately permitted institution. In the event that an excavation is impossible or inappropriate the fossil or fossil locality could be protected and the site of any planned construction moved.
- The proposed excavations should also be inspected at a regular interval by a palaeontologist.

The implementation of these protocols will minimise the potential negative impact of the project and ensure that the severity/benefit scale for the project is beneficial.

**This desktop study has not identified any palaeontological reason to prejudice the progression of the Tutuka Solar Energy Facility within wither the preferred project location or the identified alternative location, subject to the recommended damage mitigation procedures being enacted. No additional studies (e.g., a Full Palaeontological Assessment) are required to be performed.**

### 13 REFERENCES

Anderson, J.M. (1977). The biostratigraphy of the Permian and Triassic. Part 3. A review of Gondwana Permian palynology with particular reference to the northern Karroo Basin of South Africa. *Memoirs of the Botanical Survey of South Africa*, 41: 1–133.

Anderson, A.M. and McLauchlan, I.R. (1976). The plant record in the Dwyka and Ecca Series (Permian) of the south-western half of the Great Karroo Basin, South Africa. *Palaeontologia Africana*, 19: 31-42.

Bamford, M.K. (2004). Diversity of woody vegetation of Gondwanan southern Africa. *Gondwana Research*, 7: 153-164.

Johnson, M.R., van Vuuren, C.J., Visser, J.N.J., Cole, D.I., de V. Wickens, H., Christie, A.D.M., Roberts, D.I., and Brandl, G. (2006). *Sedimentary Rocks of the Karoo Supergroup*, in Johnson, M.R., Anhaeusser, C.R. and Thomas, R.J. (eds) The Geology of South Africa, Johannesburg: Council for Geoscience, Pretoria: Geological Society of South Africa: 461–499.

Jubb, R.A. and Gardiner, B.G., (1975). A preliminary catalogue of identifiable fossil fish material from southern Africa. *Annals of the South African Museum*, 67 (11): 381–440.

Hobday, D.K. and Taverner-Smith, R. (1975). Trace fossils in the Ecca of northern Natal and their palaeoenvironmental significance. *Palaeontologia Africana*, 18: 47-52.

Mucina, L. and Rutherford, M.C. (Eds) (2006). The vegetation of South Africa, Lesotho and Swaziland. *Strelizia* 19. South African National Biodiversity Institute, Pretoria.

Republic of South Africa (1998). *National Environmental Management Act* (No 107 of 1998). Pretoria: The Government Printer.

Republic of South Africa (1999). *National Heritage Resources Act* (No 25 of 1999). Pretoria: The Government Printer.

Taverner-Smith, R., Cooper, J.A.G. and Rayner, R.J. (1988). Depositional environments in the Volksrust Formation (Permian) in the Mhlatuze River, Zululand. *South African Journal of Geology*, 91: 198-206.

Palaeontological Impact Assessment Report – Eskom Holdings (SOC) Limited’s proposed Tutuka Solar Energy Facility near Standerton, Mpumalanga Province

Prof B.D. Millstead

27<sup>th</sup> November 2014