

**Palaeontological Impact Assessment for the proposed  
Safell Cluster Project,  
Free State Province**

**Desktop Study (Phase 1)**

**For**

**Heritage Contracts and Archaeological Consulting**

**07 June 2021**

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## **Expertise of Specialist**

The Palaeontologist Consultant: Prof Marion Bamford  
Qualifications: PhD (Wits Univ, 1990); FRSSAf, ASSAf  
Experience: 32 years research; 24 years PIA studies

## **Declaration of Independence**

This report has been compiled by Professor Marion Bamford, of the University of the Witwatersrand, sub-contracted by Heritage Contracts and Archaeological Consulting, Modimolle, South Africa. The views expressed in this report are entirely those of the author and no other interest was displayed during the decision making process for the Project.

Specialist: Prof Marion Bamford

Signature:

A handwritten signature in blue ink, appearing to read 'MKBamford', with a horizontal line underneath it.

## Executive Summary

A Palaeontological Impact Assessment was requested for the Scaffell Cluster Project that includes four Photovoltaic Facilities (Scaffell, Damlaagte, Vlakfontein and Ilikwa) and associated grid connection infrastructure just south of the Vaal River and adjacent to the N1 highway.

To comply with the regulations of the South African Heritage Resources Agency (SAHRA) in terms of Section 38(8) of the National Heritage Resources Act, 1999 (Act No. 25 of 1999) (NHRA), a desktop Palaeontological Impact Assessment (PIA) was completed for the proposed development.

The proposed site lies on four different groups of rocks. The non-fossiliferous rocks are from the Archaean Ventersdorp and Witwatersrand Supergroup, and the Quaternary alluvium and sands. Ancient dolomites and limestones of the Malmani Subgroup (Chuniespoort Group, Transvaal Supergroup) may have stromatolites. These are trace fossils of ancient algal colonies and only extremely rarely are the algae preserved. Since they are common trace fossils there will be no significant impact on the palaeontological heritage of South Africa. Shales, mudstones and sandstones of the Dwyka Group and the Vryheid Formation (Ecca Group, Karoo Supergroup) may preserve fossil plants of the *Glossopteris* flora.

It is recommended that, as far as the palaeontology is concerned, the Scaffell Cluster Project be authorised with the following conditions:

- A Palaeontologist carries out a site visit once excavations commence for the Damlaagte and Vlakfontein PV sites ONLY.
- The responsible person on site checks the sands and alluvium for fossils for the Scaffell PV site ONLY.

No action is required for the entire Ilikwa project or for any of the grid connections. The type of PV collector, support structure or battery storage system has no effect whatsoever on the palaeontological impact; only the depth of foundations may impact the palaeontology, if fossils are present.

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# NEMA Requirements

Table 1: Specialist Report Requirements in terms of Appendix 6 of the EIA Regulations (Amended 2017)

	<b>A specialist report prepared in terms of the Environmental Impact Regulations of 2017 must contain:</b>	<b>Relevant section in report</b>
ai	Details of the specialist who prepared the report	Appendix B
aii	The expertise of that person to compile a specialist report including a curriculum vitae	Appendix B
b	A declaration that the person is independent in a form as may be specified by the competent authority	Page 1
c	An indication of the scope of, and the purpose for which, the report was prepared	Section 1
ci	An indication of the quality and age of the base data used for the specialist report: SAHRIS palaeosensitivity map accessed – date of this report	Yes
cii	A description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change	Section 6
d	The date and season of the site investigation and the relevance of the season to the outcome of the assessment	N/A for fossils
e	A description of the methodology adopted in preparing the report or carrying out the specialised process	Section 3
f	The specific identified sensitivity of the site related to the activity and its associated structures and infrastructure	Section 6
g	An identification of any areas to be avoided, including buffers	N/A
h	A map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;	N/A
i	A description of any assumptions made and any uncertainties or gaps in knowledge;	Section <b>Error! Reference source not found.</b>

j	A description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives, on the environment	Section 6
k	Any mitigation measures for inclusion in the EMPr	Section 6, 7, Appendix A
l	Any conditions for inclusion in the environmental authorisation	Section 6, 8, 9
m	Any monitoring requirements for inclusion in the EMPr or environmental authorisation	Section 9, Appendix A
ni	A reasoned opinion as to whether the proposed activity or portions thereof should be authorised	Section 7
nii	If the opinion is that the proposed activity or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan	Section 7
o	A description of any consultation process that was undertaken during the course of carrying out the study	N/A
p	A summary and copies if any comments that were received during any consultation process	N/A
q	Any other information requested by the competent authority.	N/A

# 1. Background

South Africa Mainstream Renewable Power Developments (Pty) Ltd has contracted SLR to manage EIA requirements for the proposed solar photovoltaic project.

The Scaffell Cluster Project consists of four separate solar PV facilities and associated grid connection infrastructure<sup>1</sup> with a total generating capacity of up to 525 MW<sub>ac</sub>. This Palaeontological Impact Assessment (PIA) is for the Scaffell Cluster project that includes the following four facilities (Figures 1-2):

Name of facility	Farm name and portion	Development footprint area
Damlaagte Solar PV Facility	Damlaagte 229 - Remaining Extent	166 ha
Scaffell Solar PV Facility	Willow Grange 246 - Portion 3	257 ha
Vlakfontein Solar PV Facility	Vlakfontein 161 - Portion 6	169 ha
Iilikwa Solar PV Facility	Proceedfontein 100 - Portion 5	132 ha

The Scaffell Cluster Project site is located 19 km west of the town Sasolburg. Access to the project site is provided via an unnamed road to the north of the project site, which also routes above the N1 for 4 km in a westerly direction. This unnamed road connects to the Boundary Road at the Vaal Eden intersection. The project site is within the Central Strategic Transmission Corridor – a node for the development and expansion of large-scale electricity / grid connection infrastructure, i.e., power lines and substations, etc. Existing grid connection infrastructure within the vicinity of the project site include the following:

- Scaffell Main Transmission Substation;
- Mercury – Zeus 765 kV Power Line;
- Olympus – Scaffell 1 275 kV Power Line,
- Scaffell – Snowdon 1 275 kV Power Line; and
- Makalu – Scaffell 1 275 kV Power Line.

All of the above-mentioned power lines connect to the Scaffell MTS located 2 km south – east of the project site. The grid connection infrastructure associated with the proposed project would either be a direct connection or loop in / loop out connection. Table XX and XX include technical information associated with each solar PV facility and grid connection. The anticipated operation life of each solar PV facility is 20-years. Beyond this duration, each solar PV facility and grid connection may continue to operate subject to further approvals, or be decommissioned. A Palaeontological Impact Assessment was requested for the Scaffell Cluster Project in order to comply with the regulations of the South African Heritage Resources Agency (SAHRA) in terms of Section 38(8) of the National Heritage Resources Act, 1999 (Act No. 25 of 1999) (NHRA). A desktop Palaeontological Impact Assessment (PIA) was completed for the proposed development and is reported herein.

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<sup>1</sup> Each grid connection will comprise a Switching Station and Transmission Line which will both have a capacity of up to 132 kV.









Figure 2: Google Earth map of the proposed Scaffell Cluster project for solar PV facilities and associated grid connection infrastructure. West (white area) is the Damlaagte Solar PV facility, the central (orange area) is the Scaffel Solar PV facility, the east (lilac area) is the Vlakfontein Solar PV Facility, and the southern section (green area) is the Ilikwa Solar PV Facility. Map supplied by HCAC/SLR.

Table 2: Technical Information of the Scafell Cluster Solar PV Facilities

Component	Damlaagte Solar PV Facility	Scafell Solar PV Facility	Vlakfontein Solar PV Facility	Ilikwa Solar PV Facility
<b>Farm name &amp; portion number:</b>	Damlaagte 229 Remaining Extent	Willow Grange 246 Portion 3	Vlakfontein 161 Portion 6	Procedeerfontein 100 Portion 5
<b>Property size:</b>	282.22 ha	521.05 ha	299.95 ha	276.86 ha
<b>Project Site size:</b>	173 ha	361 ha	255 ha	195 ha
<b>Development footprint size:</b>	166 ha	257 ha	169 ha	132 ha
<b>Centre coordinates of site:</b>	26°47'29.47"S 27°37'43.58"E	26°47'46.97"S 27°38'20.00"E	26°48'10.41"S 27°39'0.92"E	26°48'55.45"S 27°37'35.52"E
<b>Capacity</b>	Up to 150 MW <sub>ac</sub>	Up to 150 MW <sub>ac</sub>	Up to 150 MW <sub>ac</sub>	Up to 100 MW <sub>ac</sub>
<b>Installed PV panel height</b>	Up to 3 m			
<b>Number of PV panels</b>	Up to 304 452	Up to 304 252	Up to 304 252	Up to 154 440
<b>IPP Substation capacity</b>	Up to 33 kV / 132 kV			

Component	Damlaagte Solar PV Facility	Scafell Solar PV Facility	Vlakfontein Solar PV Facility	Ilikwa Solar PV Facility
<b>Substation footprint</b>	Up to 2.5 ha			
<b>Grid Connection</b>	<ul style="list-style-type: none"> <li>• 132 kV power line from the 33 kV / 132 kV from the on-site substation to the Scafell MTS</li> <li>• 132 kV power line from the 33 kV / 132 kV on-site substation via Loop-in / Loop-out connection into the existing Bernina – Leeudoring Shaft / Scafell 132 kV power lines.</li> </ul>	<ul style="list-style-type: none"> <li>• 132 kV power line from the 33 kV / 132 kV from the on-site substation to the Scafell MTS</li> <li>• 132 kV power line from the 33 kV / 132 kV on-site substation via Loop-in / Loop-out connection into the existing Scafell – West Wits 2 132 kV power lines.</li> </ul>	<ul style="list-style-type: none"> <li>• 132 kV power line from the 33 kV / 132 kV from the on-site substation to the Scafell MTS</li> <li>• 132 kV power line from the 33 kV / 132 kV on-site substation via Loop-in / Loop-out connection into the existing Scafell / Tahiti 132 kV power lines or the Lochvaal Rural / Scafell 132 kV</li> </ul>	<ul style="list-style-type: none"> <li>• 132 kV power line from the 33 kV / 132 kV from the on-site substation to the Scafell MTS</li> <li>• 132 kV power line from the 33 kV / 132 kV on-site substation via Loop-in / Loop-out connection into the existing Scafell / Tahiti 132 kV power lines or the Lochvaal Rural / Scafell 132 kV</li> </ul>
<b>Grid Connection Corridor Length &amp; Width</b>	Up to 2 km long and 150 m (and up to 500 m wide at the footprint of each Switching Station)			
<b>BESS footprint</b>	Up to 2 ha			
<b>BESS technology</b>	Lithium-ion or Redox Flow Batteries			
<b>Size of laydown area</b>	Up to 3 ha			

Component	Damlaagte Solar PV Facility	Safell Solar PV Facility	Vlakfontein Solar PV Facility	Ilikwa Solar PV Facility
<b>Operation and maintenance buildings</b>	<ul style="list-style-type: none"> <li>• Offices</li> <li>• Operations and Control Centre</li> <li>• Operation and Maintenance Area / Warehouse / Workshop</li> <li>• Ablution Facilities</li> <li>• Security and Guard House</li> </ul>			
<b>Main access road</b>	Gravel, 2.5 km long and 8 m wide			
<b>Internal access road</b>	Gravel, 12 km long and 5 m wide			

Table 3: Technical Information of the Scaffell Cluster Solar Grid Connections

Component	Damlaagte Solar PV Facility Grid Connection	Scaffell Solar PV Facility Grid Connection	Vlakfontein Solar PV Facility Grid Connection	Ilikwa Solar PV Facility Grid Connection
<b>Property details:</b>	Damlaagte 229 Remaining Extent Willow Grange 246 Portion 3 Proceederfontein 100 Portion 5 Scaffell 448 Remaining Extent	Willow Grange 246 Portion 3 Damlaagte 229 Remaining Extent Proceederfontein 100 Portion 5 Scaffell 448 Remaining Extent	Vlakfontein 161 Portion 6 Willow Grange 246 Portion 3 Proceederfontein 100 Portion 5 Scaffell 448 Remaining Extent	Proceederfontein 100 Portion 5 Willow Grange 246 Portion 3 Scaffell 448 Remaining Extent
<b>Grid connection corridor length and width:</b>	<b>Alternative 1:</b> 150 m wide and up to 5 km long	<b>Alternative 1:</b> 150 m wide and up to 5 km long	<b>Alternative 1:</b> 150 m wide and up to 5 km long	<b>Alternative 1:</b>

<b>Component</b>	<b>Damlaagte Solar PV Facility Grid Connection</b>	<b>Scaffell Solar PV Facility Grid Connection</b>	<b>Vlakfontein Solar PV Facility Grid Connection</b>	<b>Iilikwa Solar PV Facility Grid Connection</b>
	<b>Alternative 2:</b> 150 m wide and up to 5 km long	<b>Alternative 2:</b> 150 m wide and up to 5 km long	<b>Alternative 2:</b> 150 m wide and up to 5 km long	150 m wide and up to 5 km long  <b>Alternative 2:</b> 150 m wide and up to 5 km long
<b>Servitude width:</b>	Up to 31 m			
<b>Switching Station capacity:</b>	33 / 132 kV			
<b>Transmission Line capacity:</b>	Up to 132 kV			
<b>Transmission Line length:</b>	Up to 2 km			
<b>Transmission Line pylons:</b>	Monopole or Lattice pylons, or a combination of both where required.			
<b>Transmission line pylon height:</b>	Up to 40 m			
<b>Access to transmission servitude:</b>	A 12 m wide and 2 km long jeep track will be required and constructed during the construction phase of the proposed project. Existing roads and jeep tracks within existing servitudes in the study area will be used as far as possible to gain access to the grid connection corridor during the construction and operation phase of the proposed project.			

## 2. Project Alternatives

Various alternatives are being considered for the proposed Project. These include location and technology alternatives. Location alternatives being considered are for the grid connection infrastructure. Two 150 m wide (and up to 500 m wide at the footprint for each switching station) and up to 5 km long grid connection corridors are being assessed and considered for each solar PV facility. Other alternatives identified include battery energy storage systems, monofacial and bifacial PV panel modules and PV panel mounting technologies. The alternatives considered for the Scafell Cluster Project grid connection corridors are described in the following sections:

### 2.1 Damlaagte Solar PV Facility Grid Connection Corridor Alternatives

Two grid connection corridors have been identified and assessed in this Report for the placement of grid connection infrastructure for the Damlaagte Solar PV Facility (refer to Figure 3:). These corridors are described as follows:

- **Grid Connection Corridor Alternative 1**

This corridor is 150 m wide and is approximately 2.0 km in length. The proposed grid connection is from the on-site substation (Switching Station) of the proposed Damlaagte Solar Facility located on Damlaagte RE/229 and extends for about 1 km in an easterly direction across Willow Grange 3/246 before turning about 90° south for 0.6 km across Scafell RE/448, then turning slightly southeast for 0.3 km before terminating at the Scafell Eskom MTS. This is the shortest most direct route to connect to the Scafell Eskom MTS.

- **Grid Connection Corridor Alternative 2**

This corridor is 150 m wide and is also approximately 2.5 km in length. This proposed grid connection starts at the on-site substation (Switching Station) of the proposed Damlaagte Solar Facility located on Damlaagte RE/229 and extends for about 0.6 km in an easterly direction across Willow Grange 3/246, then turns about 90° southwest for 0.7 km and then southeast for 0.9 km onto Procedeerfontein 5/100, and then turns northeast for 0.2 km before terminating at the Scafell Eskom MTS located on Scafell RE/448.

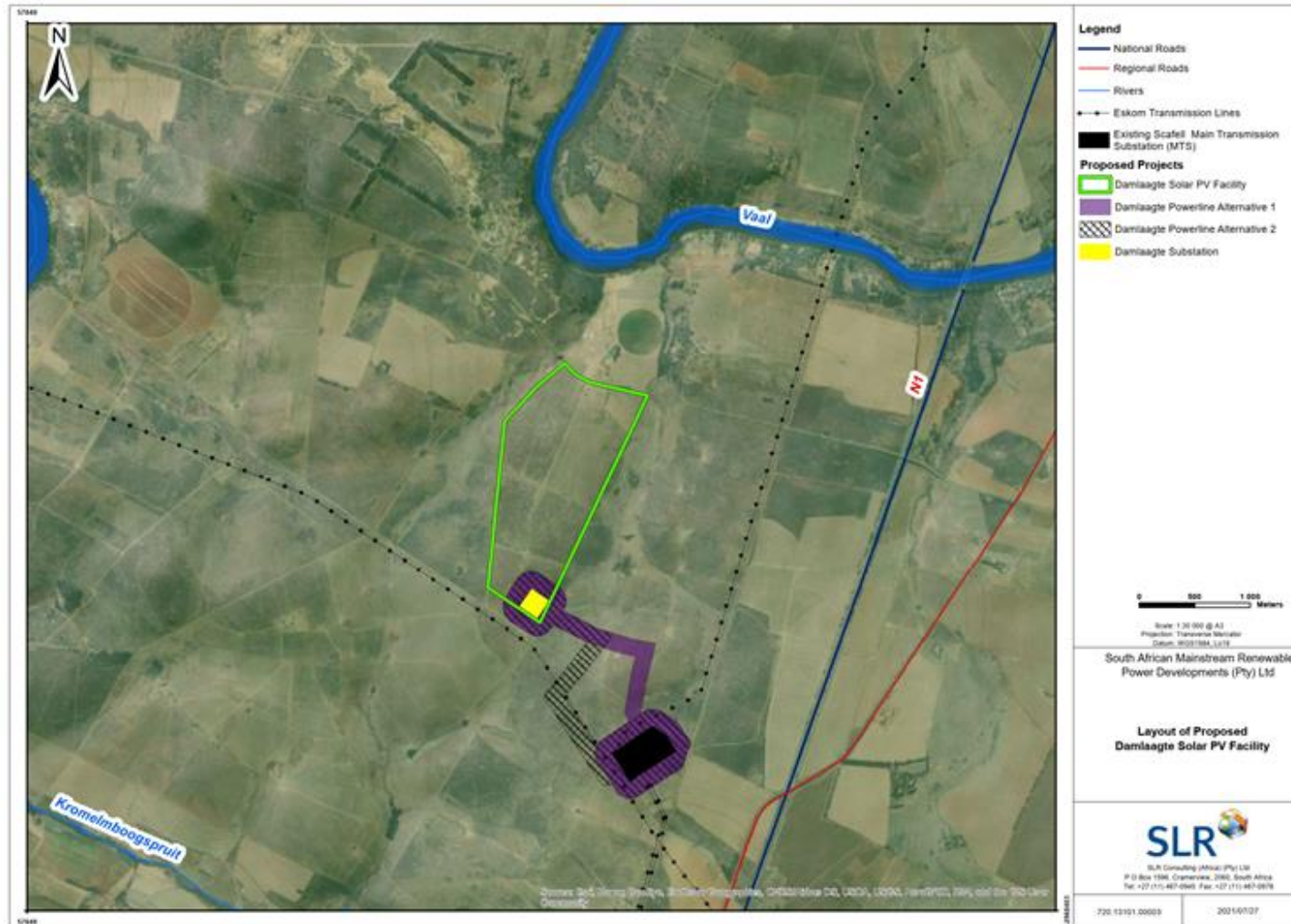


Figure 3: Locality Map Illustrating the location of the grid connection corridor alternatives for the Damlaagte Solar PV Facility Grid Connection



## 2.2 Scafell Solar PV Facility Grid Connection Corridor Alternatives

Two grid connection corridors have been identified and assessed in this Report for the placement of grid connection infrastructure for the Scafell Solar PV Facility (refer to Figure 3:). These corridors are described as follows:

- **Grid Connection Corridor Alternative 1**

This corridor is 150 m wide and is approximately 0.9 km in length. The proposed grid connection is from the on-site substation (Switching Station) of the proposed Scafell Solar Facility located on Willow Grange 3/246 and extends for about 0.6 km south across Scafell RE/448, then turning slightly southeast for 0.3 km, terminating at the Scafell Eskom MTS. This is the shortest most direct route to connect to the Scafell Eskom MTS.

- **Grid Connection Corridor Alternative 2**

This corridor is 150 m wide and is also approximately 2.2 km in length. This proposed grid connection starts at the on-site substation (Switching Station) of the proposed Scafell Solar Facility located on Willow Grange 3/246 and extends for about 0.4 km in a westerly direction across Willow Grange 3/246, then turns southwest for 0.7 km and then southeast for 0.9 km onto Procedeerfontein 5/100, and then turns northeast for 0.2 km before terminating at the Scafell Eskom MTS located on Scafell RE/448.

## 2.3 Vlakfontein Solar PV Facility Grid Connection Corridor Alternatives

Two grid connection corridors have been identified and assessed in this Report for the placement of grid connection infrastructure for the Vlakfontein Solar PV Facility (refer to Figure 5). These corridors are described as follows:

- **Grid Connection Corridor Alternative 1**

This corridor is 150 m wide and is approximately 2.0 km in length. The proposed grid connection is from the on-site substation (Switching Station) of the proposed Vlakfontein Solar Facility located on Vlakfontein 6/161 and extends for about 0.8 km in a westerly direction across Willow Grange 3/246 before turning about 90° south for 0.6 km across Scafell RE/448, then turning slightly southeast for 0.3 km, terminating at the Scafell Eskom MTS. This is the shortest most direct route to connect to the Scafell Eskom MTS.

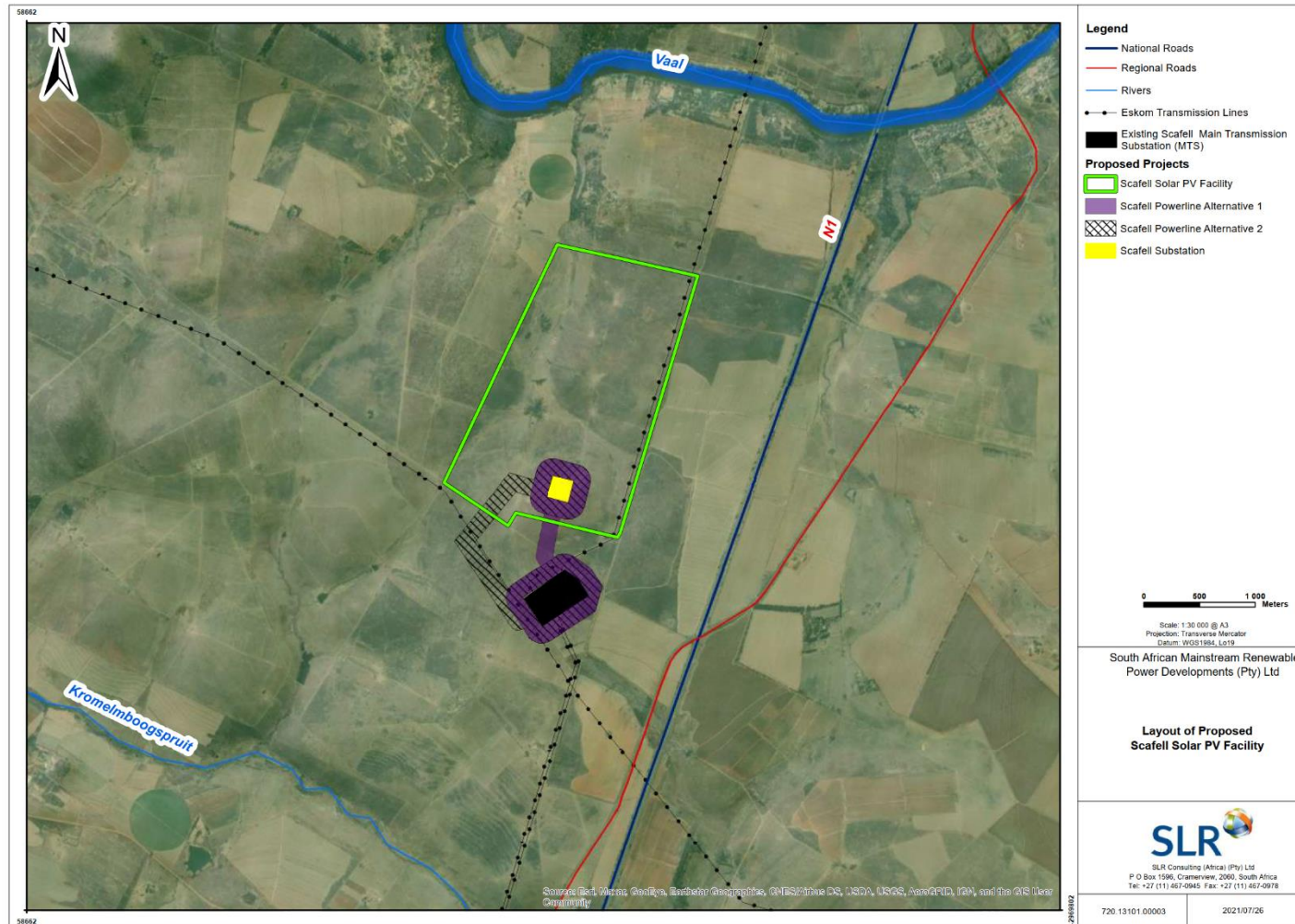


Figure 4: Locality Map Illustrating the location of the grid connection corridor alternatives for the Scaffell Solar PV Facility Grid Connection

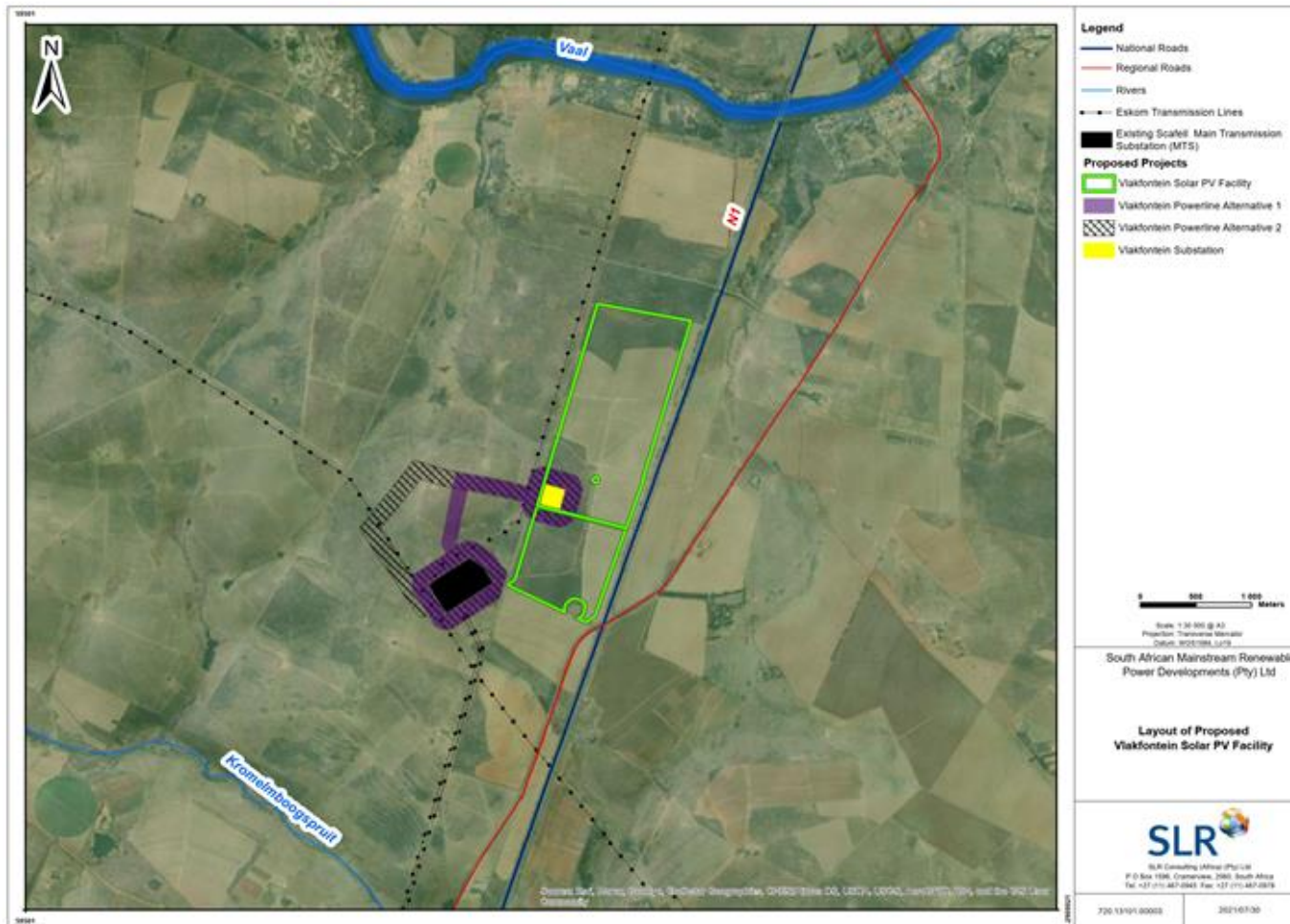


Figure 5: Locality Map Illustrating the location of the grid connection corridor alternatives for the Vlakfontein Solar PV Facility Grid Connection

- **Grid Connection Corridor Alternative 2**

This corridor is 150 m wide and is approximately 3.0 km in length. The proposed grid connection is from the on-site substation (Switching Station) of the proposed Vlakfontein Solar Facility located on Vlakfontein 6/161 and extends for about 1.2 km in a westerly direction across Willow Grange 3/246, then 0.7 km in a south-westerly direction across Procedeerfontein 5/100, a further 0.9 km in a south-easterly direction and then turns northeast for 0.2 km before terminating at the Scafell Eskom MTS located on Scafell RE/448.

## 2.4 Ilikwa Solar PV Facility Grid Connection Corridor Alternatives

Two grid connection corridors have been identified and assessed in this Report for the placement of grid connection infrastructure for the Vlakfontein Solar PV Facility (refer to Figure 6). These corridors are described as follows:

- **Grid Connection Corridor Alternative 1**

This corridor is 150 m wide and is approximately 2.3 km in length. The proposed grid connection is from the on-site substation (Switching Station) of the proposed Ilikwa Solar Facility located on Procedeerfontein 5/100 and extends for about 0.3 km in a south-easterly direction before moving north-easterly for 0.7 km across Willow Grange 3/246, then turning east for 0.4 km then directly south for 0.6 km crossing Scafell RE/448, then a further 0.3 km in a south easterly direction, before terminating at the Scafell Eskom MTS.

- **Grid Connection Corridor Alternative 2**

This corridor is 150 m wide and is approximately 1.4 km in length. The proposed grid connection is from the on-site substation (Switching Station) of the proposed Ilikwa Solar Facility located on Procedeerfontein 5/100 and extends for about 1.2 km in a south-easterly direction before at 90° northeast for 0.2 km into the Scafell Eskom MTS located on Scafell RE/448.

## 2.5 Technology Alternatives

### 2.5.1 Photovoltaic Panels / Modules

Three types of photovoltaic panels / modules are being considered and would be utilised for the proposed Project. These include the following:

- **Monocrystalline Modules** are made from pure silicon crystal ingots melted down and drawn out into a solid silicon crystal. The cells are then cut from the silicon crystal. The cells are rigid and mounted on a rigid frame. The modules are covered in glass to protect the cells from being damaged. The advantages and disadvantages of monocrystalline modules are made from pure silicon. The advantage of monocrystalline modules is that the modules are highly efficient. The disadvantage is that they are expensive to produce.



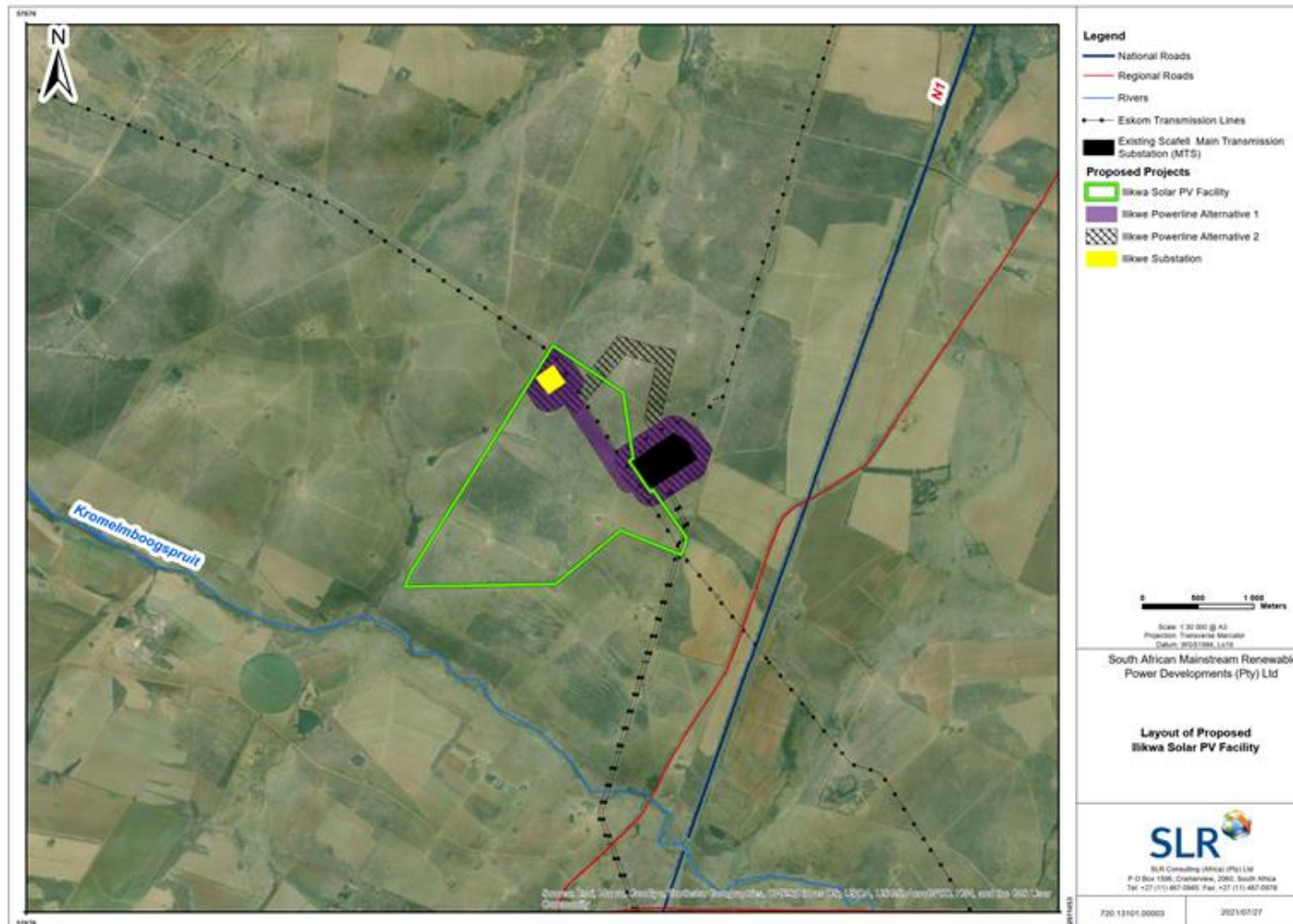


Figure 6: Locality Map illustrating the location of the grid connection corridor alternatives for the Ilikwa Solar PV Facility Grid Connection

- **Polycrystalline Modules** are made with silicon along with added impurities. It is melted down and cut up into wafers which make up the blocks in a module. The cells are then cut from the silicon crystal with added impurities. The cells are rigid and mounted on a rigid frame. The modules are covered in glass to protect the cells from being damaged. The advantages of polycrystalline modules are that they are silicon-based, however, they contain impurities. The advantage of this is that the modules are cheaper to produce. The disadvantage is that they are not as efficient as monocrystalline modules.
- **Thin Film Modules** are cells manufactured from a chemical ink compound that has similar properties to that of silicon cells. The ink compound is printed onto a sheet metal to form the base of the module. This sheet is heated to turn it into a semiconductor (like silicon). A layer of glass is also added to cover the cell surface. This allows thin-film modules to match the lifespan of silicon modules, allowing them to be competitive with silicon-based module technologies. The main advantage of thin-film modules is that, due to the manufacturing process of the modules, they are cheaper to produce and therefore cheaper to purchase compared to silicon-based modules. The disadvantage of thin-film modules is that they are slightly less efficient than silicon-based modules.

### 2.5.2 Photovoltaic Panel-Type

Mainstream is considering the use of Monofacial and Bifacial PV panel modules for the proposed solar PV facilities. Monofacial PV panel modules generate electricity from one side of the module, whereas bifacial PV panel modules generate electricity from the front and rear side of the module thus providing more output. Bifacial PV panel modules are regarded as having a higher energy yield in comparison to monofacial PV panel modules. Thus, the utilisation of bifacial PV panel modules will require the placement of reflective material beneath the PV panel module such as concrete to enhance the albedo effect from the rear surface of the module.

### 2.5.3 Mounting Structures

Mainstream is considering the use of either fixed tilt or dual tracking (single or dual axis) mounting structures for the proposed solar PV facilities. The mounting structures alternatives are described below:

- **Single-axis tracking** – this system has a single degree of flexibility that serves as an axis of rotation and is usually aligned along a North-South path. The advantages of this system are that it is cheaper, more reliable, and has a longer lifespan than dual-axis systems. The disadvantages are that the system has a lower energy output and fewer technological advancements.
- **Dual-axis tracking** – this system allows for two degrees of flexibility, offering a wider range of motion. The primary and secondary axes work together to allow these trackers to point the solar panels at specific points in the sky. The advantages of the dual axis include a higher degree of flexibility, allowing for a higher energy output and a higher degree of accuracy in directional pointing. The disadvantages of this system

are that the system is mechanically complex making it more likely for something to go wrong, has a lower lifespan and reliability, and is unreliable during cloudy or overcast weather. Directions moves on a dual axis, meaning it can move in two different directions.

- **Fixed axis** – a fixed-tilt system positions the modules at a “fixed” tilt and orientation.

#### 2.5.4 Battery Energy Storage Systems

Mainstream is considering the use of either Solid State or Redox Flow Batteries for the Battery Energy Storage Systems (BESS) for each of the solar PV facilities. Each of the BESS-type technologies are described in detail below:

- **Solid State Batteries**

Solid State Batteries are energy storage units that are associated with a range of containerised systems ranging from 500 kWh to 4 MWh. For a 150 MWac renewable energy facility, a total footprint area of up to 2 ha will be required for the placement of containerised solid-state batteries within each footprint of the proposed solar PV facilities. In general, solid-state batteries consist of numerous battery cells that collectively form modules. Each cell contains an anode, cathode, and an electrolyte. The modules will be assembled and packed inside shipping-size containers (i.e., 17 m long, 3.5 m wide and 4 m high) and delivered to the study area for placement within each of the solar PV facilities proposed for the Scafell Cluster Project. Each container will be placed on a raised concrete plinth of up to 30 cm and may be stacked on top of each other to a maximum height of approximately 15 m. Additional infrastructure associated with the modules include inverters and temperature control equipment which will be positioned inside the containers.

- **Redox Flow Batteries**

Redox Flow Batteries (RFB) are also being considered as an alternative for the proposed solar PV facilities. For this technology, energy is stored as an electrolyte in the flow cells. Specific options include Sodium polysulfide / bromine (PSB) flow batteries, Vanadium Redox (VRB) flow batteries, and Zinc-Bromine (ZNBR) flow batteries which would be contained in small banded areas. RFBs generally consist of two half-cells containing liquid electrolyte systems. Once supplied with electrical energy a reduction - oxidation (redox) reaction between ions of the two electrolytes, separated by a membrane, charge the electrodes (i.e., cathode and anode) with energy. Energy discharge from an RFB is achieved by a reversed redox reaction between ions resulting in the potential for electrical energy to be drawn from the electrodes. The footprint of a RFB system is approximately 150 x 100 m, with a height of 15 m. The system consists of two electrolyte storage tanks that are contained within a 2.5 m high berm wall which prevents leakage of the electrolyte chemical into the surrounding environment.

An assessment of the potential impacts anticipated from the alternatives considered for the Scafell Cluster Project is included in Chapter 6 of this Report. **Note that the type of film, the PV panel type, the mounting structure and the type of battery storage system make no difference to the palaeontological impact. Only the footprint of foundations is relevant**

because the fossils would be in the rocks and above-ground structures make no difference to them. Only deep foundations are likely to impact on any fossils, if present.

### 3 Methods and Terms of Reference

The Terms of Reference (ToR) for this study were to undertake a PIA and provide feasible management measures to comply with the requirements of SAHRA.

The methods employed to address the ToR included:

1. Consultation of geological maps, literature, palaeontological databases, published and unpublished records to determine the likelihood of fossils occurring in the affected areas. Sources included records housed at the Evolutionary Studies Institute at the University of the Witwatersrand and SAHRA databases;
2. Where necessary, site visits by a qualified palaeontologist to locate any fossils and assess their importance (*not applicable to this assessment*);
3. Where appropriate, collection of unique or rare fossils with the necessary permits for storage and curation at an appropriate facility (*not applicable to this assessment*); and
4. Determination of fossils' representativity or scientific importance to decide if the fossils can be destroyed or a representative sample collected (*not applicable to this assessment*).

### 4 Geology and Palaeontology

#### 4.1 Project location and geological context

The site is on the north-eastern outer margin of the Vredefort Dome where the older Witwatersrand Basin rocks have been forced up through the overlying Transvaal Supergroup rocks by the bolide impact. Unconformably overlying the Witwatersrand Basin rocks are the Vryheid Formation (Ecca Group, Karoo Supergroup) shales and sandstones, with the much younger Quaternary sands and soils accumulated in the river and stream channels. Four unrelated series of rocks are exposed in a small area.

The Ventersdorp and Witwatersrand Supergroups form the rim of the impact crater. They are volcanic or igneous in origin, but some are sedimentary and were deposited in a shallow aquatic or marginal aquatic environment. The Ventersdorp and Witwatersrand Supergroup have been well-studied because of their economic value, gold, and associated metals.

In the Transvaal Basin the Transvaal Supergroup is divided into two Groups, the lower Chuniespoort Group, and the upper Pretoria Group (with ten formations; Eriksson *et al.*, 2006). The Malmani Subgroup comprises dolomites and limestones and is divided into five formations based on chert content, stromatolitic morphology, intercalated shales, and erosion surfaces; it is the lower part of the Chuniespoort Group.



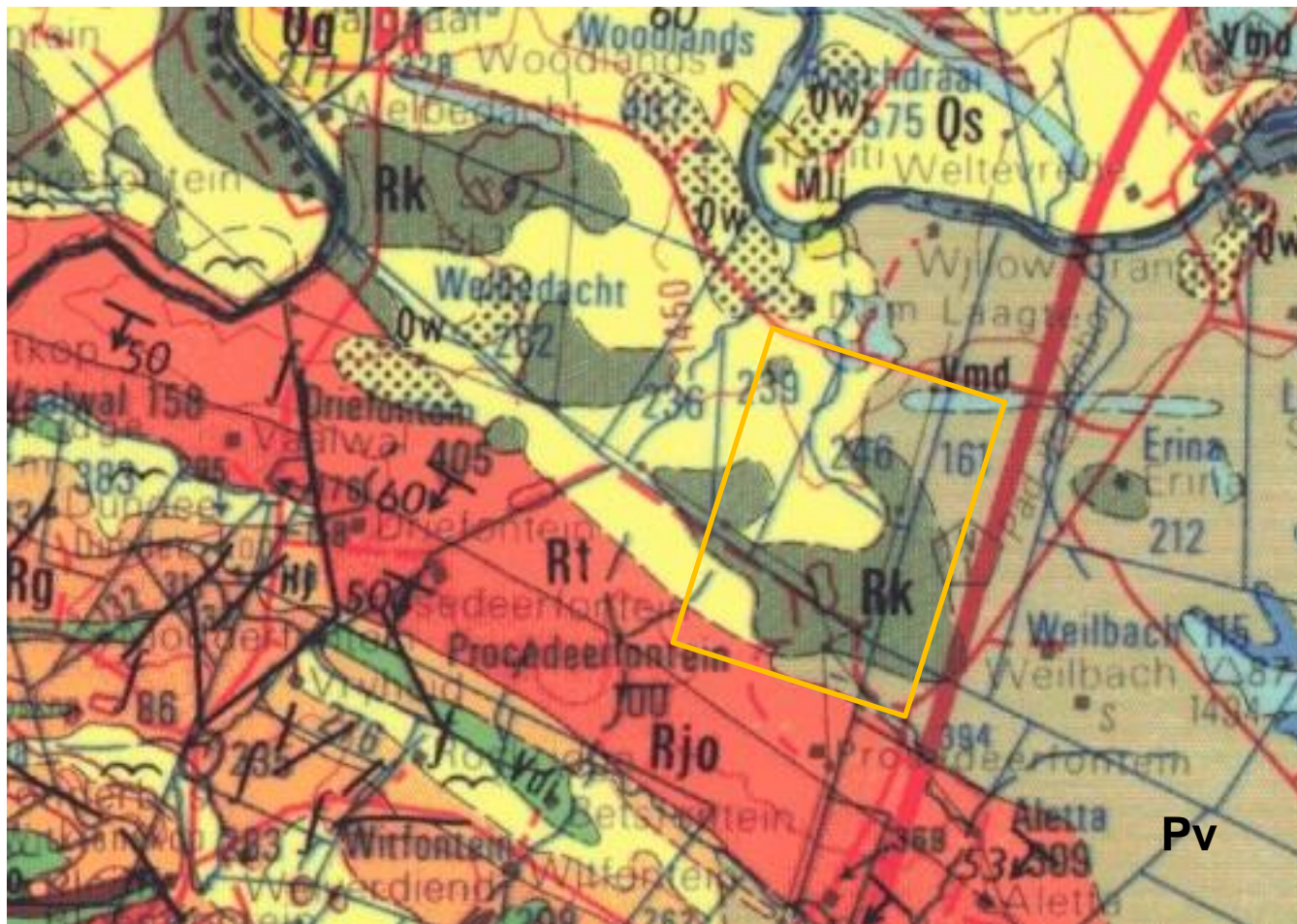


Figure 7: Geological map of the area around the Scaffel Cluster project with the four farms as indicated (229 – Damlagte; 246 – Willow Grange; 161 – Vlakfontein; 100 – Procedeerfontein). The whole project is indicated within the yellow rectangle. Abbreviations of the rock types are explained in Table 4. Map enlarged from the Geological Survey 1: 250 000 map 2626 West Rand.

Table 4: Explanation of symbols for the geological map and approximate ages (Eriksson et al., 2006. Johnson et al., 2006; McCarthy et al., 2006; van der Westhuizen et al., 2006). SG = Supergroup; Fm = Formation; Ma = million years; grey shading = formations impacted by the project.

Symbol	Group/Formation	Lithology	Approximate Age
Q	Quaternary	Alluvium, sand, calcrete	Neogene, ca 2.5 Ma to present
Jd	Jurassic dykes	Dolerite dykes, intrusive	Jurassic, approx. 180 Ma
Pv	Vryheid Fm, Eccca Group, Karoo SG	Shales, sandstone, coal	Early Permian, Middle Eccca
Vm	Malmani Subgroup, Chuniespoort Group, Transvaal SG	Dolomite, chert	Ca 2750 – 2650 Ma
Rk	Klipriviersberg Group, Ventersdorp SG	Andesite, tuff	Ca 2714 Ma
Rt	Turfontein Subgroup, Central Rand Group, Witwatersrand SG	Conglomerate, quartzite	Ca 2750 Ma
Rjo	Johannesburg Subgroup, Central Rand Group, Witwatersrand SG	Quartzite, conglomerate, shale	
Rg	Government Subgroup, West Rand Group, Witwatersrand SG	Quartzite, shale	

In this region there are marginal outcrops of the lower Karoo Supergroup sediments, in particular the lower Eccca Group shales and mudstones that make up the Vryheid Formation. These sediments were deposited around the Karoo Basin as it gradually filled up. As the continent moved away from the pole and the climate warmed up the margins of the deltas, flood plains and lagoons were well vegetated.

The youngest strata in the region are the Quaternary sands and soils that were formed from the weathering of the older rocks and transporting by wind and water into river valleys or along streams.

#### 4.2 Palaeontological context

The palaeontological sensitivity of the area under consideration is presented in Figure 8. Since the Klipriviersberg Group rocks are all volcanic in origin with varying proportions of mafic lava, amygdaloidal and porphyritic tuffs and are older than 2417 million years (van der Westhuizen *et al.*, 2006) they are of the wrong type and too old to contain any fossils. The Johannesburg Subgroup is composed of quartzite, conglomerate and shale, and is too old to preserve any fossils.

In the Malmani Subgroup stromatolites are common. Stromatolites are the trace fossils of algal colonies that grew in the warm shallow seas of the continent more than 2500 million years ago. As the algae photosynthesised in the low oxygen atmosphere they deposited layer upon layer of calcium carbonate, calcium sulphate, magnesium sulphate and other compounds. The stromatolite structures have been classified by researchers but very seldom



have the algal cells been preserved in the structures. Furthermore, they are microscopic in size and one requires thin sections and microscopes to be able to see the unicellular organisms. This lithology is indicated as moderately sensitive (green), figure 4.

Although the Vryheid formation shales and sandstones are in the project footprint they are unlikely to contain fossils because this is at the extreme margin of the Karoo sediments and no fossils have been reported. More significantly the proposed site is on farmlands that have been ploughed and planted over many years. Fossils do not occur in soils as these are the weathered product of shales and sandstones together with organic material. Below the soils there might be intact shales and fossils of the *Glossopteris* flora (*Glossopteris*, lycopods, sphenophytes, ferns, early gymnosperms; Plumstead, 1969; Anderson and Anderson, 1985). The overlying Quaternary sands along the river have been transported and do not preserve fossils.

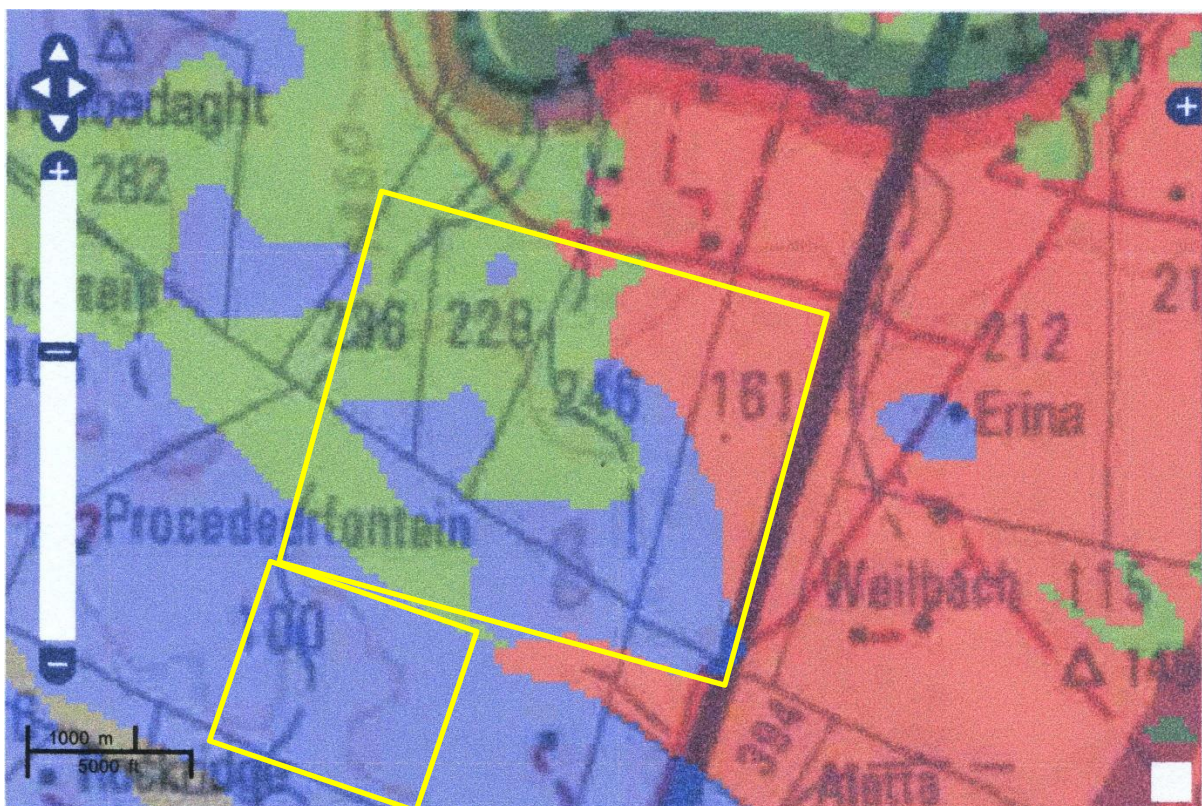


Figure 8: SAHRIS palaeosensitivity map for the site for the proposed Scaffel PV Cluster shown within the yellow rectangle. Background colours indicate the following degrees of sensitivity: red = very highly sensitive; orange/yellow = high; green = moderate; blue = low; grey = insignificant/zero.

From the SAHRIS map above (Figure 8) the area is indicated as very highly sensitive (red) for the Malmani Subgroup and the Vryheid Formation. It is moderately sensitive (green) for the Quaternary alluvium and sands, and has low sensitivity (blue) for the Ventersdorp and Witwatersrand Supergroups. Therefore, only the development areas of the Scaffel and Vlakfontein solar PV facilities are associated with a moderate and very high palaeosensitivity.

## 5. Assumptions and uncertainties

Based on the geology of the area and the palaeontological record as we know it, it can be assumed that the formation and layout of the dolomites, sandstones, shales and sands are typical for the country and some do contain fossil plant, insect, invertebrate and vertebrate material. The sands and soils of the Quaternary period would not preserve fossils. No fossils are likely in the ploughed and cultivated soils. It is not known if fossils are preserved below ground in the shales of the Vryheid Formation.

## 6 Impact assessment

An assessment of the potential impacts to possible palaeontological resources considers the criteria according to the SLR impact Rating Method in Appendix C.

Table 5: Summary of the palaeontology of each part of the project and the action required. (Colours are those from the SAHRIS palaeosensitivity map: red = very highly sensitive; green = moderately sensitive; blue/black = insignificant to zero sensitivity).

Name of Facility & location	PV site and grid connections	Palaeontology and Action required
Damlaagte Solar PV Facility Damlaagte 228 - REM	PV site	Quaternary alluvium = possible fossils – Fossil Chance find protocol for developer/contractor
	Grid Alt 1	Klipriviersberg = no fossils – no action
	Grid Alt 2	Klipriviersberg = no fossils – no action
Scafell Solar PV Facility Willow Grange 246 - Portion 3	PV site	Vryheid Fm = possible fossils – site visit when excavations commence
	Grid Alt 1	Klipriviersberg = no fossils – no action
	Grid Alt 2	Klipriviersberg = no fossils – no action
Vlakfontein Solar PV Facility Vlakfontein 161 - Portion 6	PV Site	Vryheid Fm = possible fossils – site visit when excavations commence
	Grid Alt 1	Klipriviersberg = no fossils – no action
	Grid Alt 2	Klipriviersberg = no fossils – no action
Ilikwa Solar PV Facility Proceedfontein 100 - Portion 5	PV site	Klipriviersberg = no fossils – no action
	Grid Alt 1	Klipriviersberg = no fossils – no action
	Grid Alt 2	Klipriviersberg = no fossils – no action

Table 5: Outcomes of the Impact Consequence and Significance Ratings from SLR Impact table (Appendix C)

Category	Pre – mitigation	Post mitigation = site visit and removal of any fossils (if present)
Intensity	Low	Zero – very low
Duration	Permanent	Short

Extent	Local	Local
Probability	Possible	Improbable
Degree		High
Confidence	High	High
Mitigation		Very low
Loss of Resources	Medium	Low
Reversibility	Permanent	Permanent
Consequence	Low	Very low
Significance	Very low	Insignificant

### Rationale

Although the SAHRIS palaeosensitivity map indicates that the Vryheid Formation and the Malmani Subgroup rocks are very highly sensitive, in reality fossils are rare and sporadically distributed within these strata. The ground surface is covered with soils that do not preserve fossils. It is not known if any fossils occur below the surface or at what depth and this cannot be determined until excavations commence.

The moderately sensitive Quaternary alluvium has been transported by the river and does not preserve fossils within the sediments, however, small fossils or fragments of fossils might be entrapped in the transported sediments. As such, they would have been sorted (i.e. only robust fossils would survive and any fragile fossils would have been destroyed and so only a very small portion of the original fossil assemblage from an unknown source might survive), and fragmented so their scientific value is greatly reduced.

The significance to the local population is very low because the presence or absence fossils does not affect their livelihood, income, or health. The significance to science and society is higher because the loss of fossils might mean a loss to knowledge.

### Mitigation

When excavations commence for the foundations for the PV facilities for the Scaffel and Vlakfontein projects a palaeontologist should do a site visit.

For the Damlaagte PV facility, the developer, contractor or Environmental Officer should follow the Fossil Chance Find Protocol (Section 9).

No action is required for the grid connections for any of the projects because the sites and routes are on non-fossiliferous rocks.

No action is required for the Ilikwa PV facility because it on volcanic rocks.

## 7 Recommendation

Based on experience and the lack of any previously recorded fossils from the area, it is extremely unlikely that any fossils would be preserved in the covering soils and sands of the Quaternary that have been ploughed and cultivated. There is a very small chance that fossils may occur below ground in the shales of the early Permian Vryheid Formation, or in the dolomites of the Malmani Subgroup, so a Fossil Chance Find Protocol should be added to the

EMPr. Only when excavations have commenced for foundations for the photocells and support structure, and only for Damlaagte and Vlakfontein PVs, then a palaeontologist must do a site visit and inspect the diggings. If fossils are present then a representative sample must be collected (with a SAHRIS permit, and curated in a recognised institution).

In summary, it is recommended that, as far as the palaeontology is concerned, the Scaffel Cluster Project be authorised with the following conditions:

1. A Palaeontologist carried out a site visit once excavations commence for the Damlaagte and Vlakfontein PV sites ONLY.
2. The responsible person checks the sands and alluvium for fossils for the Scaffel PV site ONLY.

No action is required for the entire Ilikwa project or for any of the grid connections. The type of PV collector, support structure or battery storage system has no effect whatsoever on the palaeontological impact; only the depth of foundations may impact the palaeontology, if fossils are present.

## 8 References

Anderson, J.M., Anderson, H.M., 1985. Palaeoflora of Southern Africa: Prodrum of South African megafloras, Devonian to Lower Cretaceous. A.A. Balkema, Rotterdam. 423 pp.

Johnson, M.R., van Vuuren, C.J., Visser, J.N.J., Cole, D.I., Wickens, H.deV., Christie, A.D.M., Roberts, D.L., 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. Geological Society of South Africa, Johannesburg / Council for Geoscience, Pretoria. Pp 461 – 499.

McCarthy, T.S., 2006. The Witwatersrand Supergroup. In: Johnson, M.R., Anhaeusser, C.R. and Thomas, R.J., (Eds). The Geology of South Africa. Geological Society of South Africa, Johannesburg / Council for Geoscience, Pretoria. Pp 155-186.

Plumstead, E.P., 1969. Three thousand million years of plant life in Africa. Geological Society of southern Africa, Annexure to Volume LXXII. 72pp + 25 plates.

Van der Westhuizen, W.A., de Bruijn, H., Meintjes, P.G., 2006. The Ventersdorp Supergroup. In: Johnson, M.R., Anhaeusser, C.R. and Thomas, R.J., (Eds). The Geology of South Africa. Geological Society of South Africa, Johannesburg / Council for Geoscience, Pretoria. pp 187-208.

## 9 Chance Find Protocol

**Monitoring Programme for Palaeontology – to commence once the excavations / drilling activities begin.**

1. The following procedure is only required if fossils are seen on the surface and when drilling/excavations commence.
2. When excavations begin the rocks and must be given a cursory inspection by the Environmental Control Officer (ECO) or designated person. Any fossiliferous material (plants, insects, bone, coal) should be put aside in a suitably protected place. This way the project activities will not be interrupted.
3. Photographs of similar fossils must be provided to the developer and contractor to assist in recognizing the fossil plants, vertebrates, invertebrates or trace fossils in the shales and mudstones (for example see Figures 5, 6). This information will be built into the EMP's training and awareness plan and procedures.
4. Photographs of the putative fossils can be sent to the palaeontologist for a preliminary assessment.
5. If there is any possible fossil material found by the developer/environmental control officer then a qualified palaeontologist to be sub-contracted for this project, should visit the site to inspect the selected material and check the dumps where feasible.
6. Fossil plants or vertebrates that are considered to be of good quality or scientific interest by the palaeontologist must be removed, catalogued and housed in a suitable institution where they can be made available for further study. Before the fossils are removed from the site a SAHRA permit must be obtained. Annual reports must be submitted to SAHRA as required by the relevant permits.
7. If no good fossil material is recovered then no site inspections by the palaeontologist will be necessary. A final report by the palaeontologist must be sent to SAHRA once the project has been completed and only if there are fossils.
8. If no fossils are found and the excavations have finished then no further monitoring is required.



**Appendix A – Examples of fossils from the Malmani Subgroup and Vryheid Formation**



Figure 8: Stromatolites as seen in surface view, from the Malmani Subgroup.



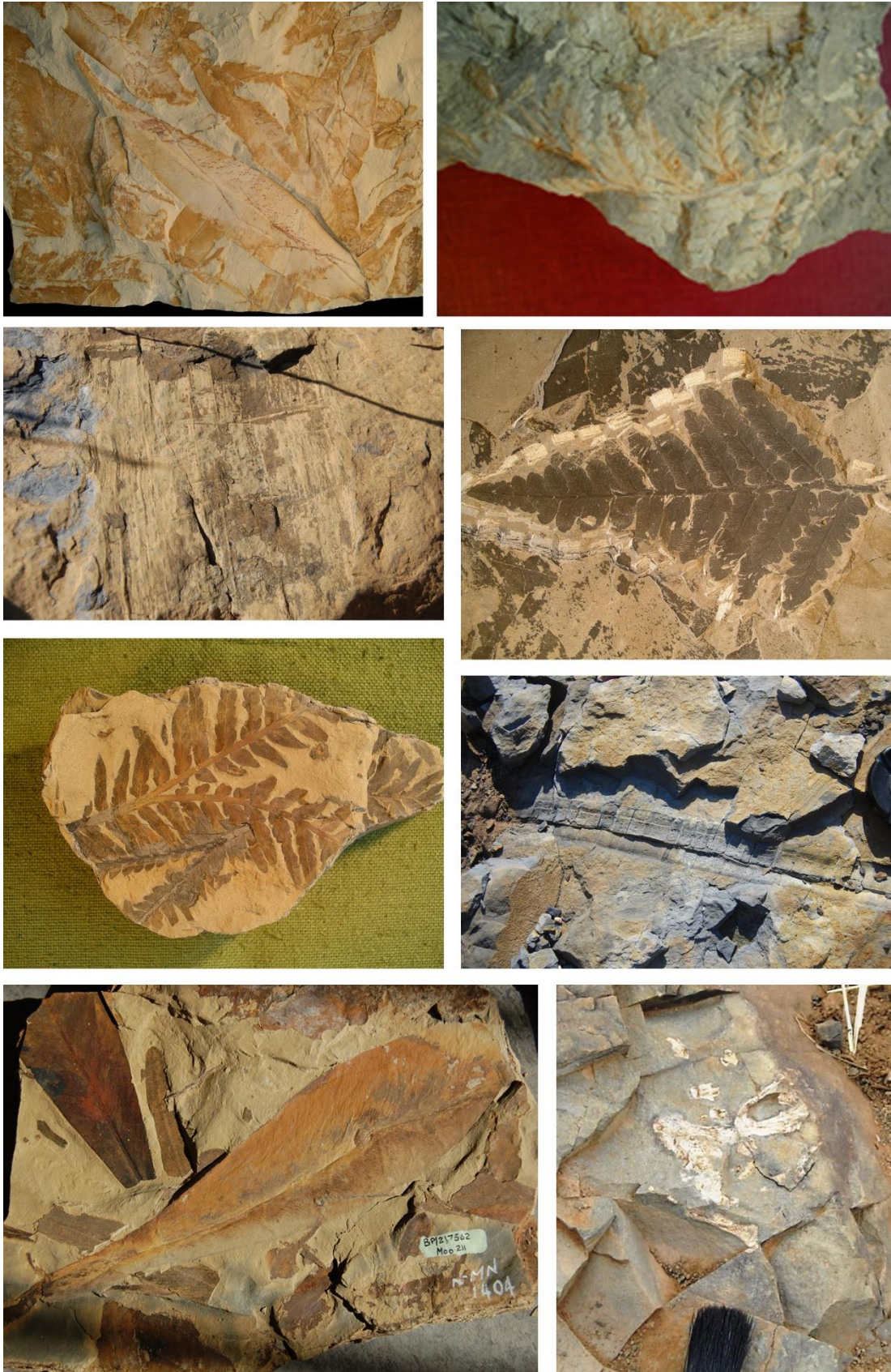


Figure 10: Photographs of a selection of fossil plants from the Glossopteris flora, Vryheid Formation (Ecca Group, Karoo Supergroup).

## Appendix B – Details of specialist

### Curriculum vitae (short) - Marion Bamford PhD January 2021

#### i) Personal details

Surname : **Bamford**  
First names : **Marion Kathleen**  
Present employment : Professor; Director of the Evolutionary Studies Institute.  
Member Management Committee of the NRF/DST Centre of Excellence Palaeosciences, University of the Witwatersrand, Johannesburg, South Africa-  
Telephone : +27 11 717 6690  
Fax : +27 11 717 6694  
Cell : 082 555 6937  
E-mail : [marion.bamford@wits.ac.za](mailto:marion.bamford@wits.ac.za) ; [marionbamford12@gmail.com](mailto:marionbamford12@gmail.com)

#### ii) Academic qualifications

Tertiary Education: All at the University of the Witwatersrand:

1980-1982: BSc, majors in Botany and Microbiology. Graduated April 1983.

1983: BSc Honours, Botany and Palaeobotany. Graduated April 1984.

1984-1986: MSc in Palaeobotany. Graduated with Distinction, November 1986.

1986-1989: PhD in Palaeobotany. Graduated in June 1990.

#### iii) Professional qualifications

*Wood Anatomy Training (overseas as nothing was available in South Africa):*

1994 - Service d'Anatomie des Bois, Musée Royal de l'Afrique Centrale, Tervuren, Belgium, by Roger Dechamps

1997 - Université Pierre et Marie Curie, Paris, France, by Dr Jean-Claude Koeniguer

1997 - Université Claude Bernard, Lyon, France by Prof Georges Barale, Dr Jean-Pierre Gros, and Dr Marc Philippe

#### iv) Membership of professional bodies/associations

Palaeontological Society of Southern Africa

Royal Society of Southern Africa - Fellow: 2006 onwards

Academy of Sciences of South Africa - Member: Oct 2014 onwards

International Association of Wood Anatomists - First enrolled: January 1991

International Organization of Palaeobotany – 1993+

Botanical Society of South Africa

South African Committee on Stratigraphy – Biostratigraphy - 1997 - 2016

SASQUA (South African Society for Quaternary Research) – 1997+  
 PAGES - 2008 –onwards: South African representative  
 ROCEEH / WAVE – 2008+  
 INQUA – PALCOMM – 2011+onwards

### **vii) Supervision of Higher Degrees**

All at Wits University

Degree	Graduated/completed	Current
Honours	11	0
Masters	10	4
PhD	11	4
Postdoctoral fellows	10	5

### **viii) Undergraduate teaching**

Geology II – Palaeobotany GEOL2008 – average 65 students per year  
 Biology III – Palaeobotany APES3029 – average 25 students per year  
 Honours – Evolution of Terrestrial Ecosystems; African Plio-Pleistocene Palaeoecology;  
 Micropalaeontology – average 2-8 students per year.

### **ix) Editing and reviewing**

Editor: *Palaeontologia africana*: 2003 to 2013; 2014 – Assistant editor  
 Guest Editor: *Quaternary International*: 2005 volume  
 Member of Board of Review: *Review of Palaeobotany and Palynology*: 2010 –

Review of manuscripts for ISI-listed journals: 25 local and international journals

## **x) Palaeontological Impact Assessments**

Selected – list not complete:

- Thukela Biosphere Conservancy 1996; 2002 for DWAF
- Vioolsdrift 2007 for Xibula Exploration
- Rietfontein 2009 for Zitholele Consulting
- Bloeddrift-Baken 2010 for TransHex
- New Kleinfontein Gold Mine 2012 for Prime Resources (Pty) Ltd.
- Thabazimbi Iron Cave 2012 for Professional Grave Solutions (Pty) Ltd
- Delmas 2013 for Jones and Wagener
- Klipfontein 2013 for Jones and Wagener
- Platinum mine 2013 for Lonmin
- Syferfontein 2014 for Digby Wells
- Canyon Springs 2014 for Prime Resources
- Kimberley Eskom 2014 for Landscape Dynamics
- Yzermyne 2014 for Digby Wells
- Matimba 2015 for Royal HaskoningDV
- Commissiekraal 2015 for SLR
- Harmony PV 2015 for Savannah Environmental

- Glencore-Tweefontein 2015 for Digby Wells
- Umkomazi 2015 for JLB Consulting
- Ixia coal 2016 for Digby Wells
- Lambda Eskom for Digby Wells
- Alexander Scoping for SLR
- Perseus-Kronos-Aries Eskom 2016 for NGT
- Mala Mala 2017 for Henwood
- Modimolle 2017 for Green Vision
- Klipoortjie and Finaalspan 2017 for Delta BEC
- Ledjadja borrow pits 2018 for Digby Wells
- Lungile poultry farm 2018 for CTS
- Olienhout Dam 2018 for JP Celliers
- Isondlo and Kwasobabili 2018 for GCS
- Kanakies Gypsum 2018 for Cabanga
- Nababeep Copper mine 2018
- Glencore-Mbali pipeline 2018 for Digby Wells
- Remhoogte PR 2019 for A&HAS
- Bospoort Agriculture 2019 for Kudzala
- Overlooked Quarry 2019 for Cabanga
- Richards Bay Powerline 2019 for NGT
- Eilandia dam 2019 for ACO
- Eastlands Residential 2019 for HCAC
- Fairview MR 2019 for Cabanga
- Graspan project 2019 for HCAC
- Lieliefontein N&D 2019 for EnviroPro
- Skeerpoort Farm Mast 2020 for HCAC
- Vulindlela Eco village 2020 for 1World
- KwaZamakhule Township 2020 for Kudzala
- Sunset Copper 2020 for Digby Wells
- McCarthy-Salene 2020 for Prescali
- VLNR Lodge 2020 for HCAC
- Madadeni mixed use 2020 for EnviroPro

#### **xi) Research Output**

Publications by M K Bamford up to December 2019 peer-reviewed journals or scholarly books: over 150 articles published; 5 submitted/in press; 10 book chapters.

Scopus h-index = 29; Google scholar h-index = 35; i10-index = 92

Conferences: numerous presentations at local and international conferences.

#### **xii) NRF Rating**

NRF Rating: B-2 (2016-2020)

NRF Rating: B-3 (2010-2015)

NRF Rating: B-3 (2005-2009)

NRF Rating: C-2 (1999-2004)



# SLR Method for Impact Identification and Evaluation

The identification and assessment of environmental impacts is a multi-faceted process, using a combination of quantitative and qualitative descriptions and evaluations. It involves applying scientific measurements and professional judgement to determine the significance of environmental impacts associated with the proposed project. The process involves consideration of, *inter alia*: the purpose and need for the project; views and concerns of interested and affected parties (I&APs); social and political norms, and general public interest.

## 10 Identification and Description of Impacts

Identified impacts are described in terms of the nature of the impact, compliance with legislation and accepted standards, receptor sensitivity and the significance of the predicted environmental change (before and after mitigation). Mitigation measures may be existing measures or additional measures that were identified through the impact assessment and associated specialist input. The impact rating system considers the confidence level that can be placed on the successful implementation of mitigation.

## 11 Evaluation of Impacts and Mitigation Measures

### a. INTRODUCTION

Impacts are assessed using SLR's standard convention for assessing the significance of impacts, a summary of which is provided below.

In assigning significance ratings to potential impacts before and after mitigation the approach presented below is to be followed.

1. **Determine the impact consequence rating:** This is a function of the "intensity", "duration" and "extent" of the impact (see Section b). The consequence ratings for combinations of these three criteria are given in Section c.
2. **Determine impact significance rating:** The significance of an impact is a function of the consequence of the impact occurring and the probability of occurrence (see Section b). Significance is determined using the table in Section d.
3. **Modify significance rating (if necessary):** Significance ratings are based on largely professional judgement and transparent defined criteria. In some instances, therefore, whilst the significance rating of potential impacts might be "low", the importance of these impacts to local communities or individuals might be extremely high. The importance/value which interested and affected parties attach to impacts will be highlighted, and recommendations should be made as to ways of avoiding or minimising these perceived negative impacts through project design, selection of appropriate alternatives and / or management.
4. **Determine degree of confidence of the significance assessment:** Once the significance of the impact has been determined, the degree of confidence in the assessment will be qualified (see Section b). Confidence in the prediction is associated with any uncertainties, for example, where information is insufficient to assess the impact.

## b. CRITERIA FOR IMPACT ASSESSMENT

The criteria for impact assessment are provided below.

Criteria	Rating	Description
<b>Criteria for ranking of the INTENSITY (SEVERITY) of environmental impacts</b>	<b>ZERO TO VERY LOW</b>	Negligible change, disturbance or nuisance. The impact affects the environment in such a way that natural functions and processes are not affected. People / communities are able to adapt with relative ease and maintain pre-impact livelihoods.
	<b>LOW</b>	Minor (Slight) change, disturbance or nuisance. The impact on the environment is not detectable or there is no perceptible change to people's livelihood.
	<b>MEDIUM</b>	Moderate change, disturbance or discomfort. Where the affected environment is altered, but natural functions and processes continue, albeit in a modified way. People/communities are able to adapt with some difficulty and maintain pre-impact livelihoods but only with a degree of support.
	<b>HIGH</b>	Prominent change, disturbance or degradation. Where natural functions or processes are altered to the extent that they will temporarily or permanently cease. Affected people/communities will not be able to adapt to changes or continue to maintain-pre impact livelihoods.
<b>Criteria for ranking the DURATION of impacts</b>	<b>SHORT TERM</b>	< 5 years.
	<b>MEDIUM TERM</b>	5 to < 15 years.
	<b>LONG TERM</b>	> 15 years, but where the impact will eventually cease either because of natural processes or by human intervention.
	<b>PERMANENT</b>	Where mitigation either by natural processes or by human intervention will not occur in such a way or in such time span that the impact can be considered transient.
<b>Criteria for ranking the EXTENT / SPATIAL SCALE of impacts</b>	<b>LOCAL</b>	Impact is confined to project or study area or part thereof, e.g. limited to the area of interest and its immediate surroundings.
	<b>REGIONAL</b>	Impact is confined to the region, e.g. catchment, municipal region, etc.
	<b>NATIONAL</b>	Impact is confined to the country as a whole, e.g. South Africa, etc.
	<b>INTERNATIONAL</b>	Impact extends beyond the national scale.
<b>Criteria for determining the PROBABILITY of impacts</b>	<b>IMPROBABLE</b>	Where the possibility of the impact to materialise is very low either because of design or historic experience, i.e. ≤ 30% chance of occurring.
	<b>POSSIBLE</b>	Where there is a distinct possibility that the impact would occur, i.e. > 30 to ≤ 60% chance of occurring.
	<b>PROBABLE</b>	Where it is most likely that the impact would occur, i.e. > 60 to ≤ 80% chance of occurring.
	<b>DEFINITE</b>	Where the impact would occur regardless of any prevention measures, i.e. > 80% chance of occurring.
	<b>LOW</b>	≤ 35% sure of impact prediction.

Criteria	Rating	Description
Criteria for determining the DEGREE OF CONFIDENCE of the assessment	MEDIUM	> 35% and ≤ 70% sure of impact prediction.
	HIGH	> 70% sure of impact prediction.
Criteria for the DEGREE TO WHICH IMPACT CAN BE MITIGATED - the degree to which an impact can be reduced / enhanced	NONE	No change in impact after mitigation.
	VERY LOW	Where the significance rating stays the same, but where mitigation will reduce the intensity of the impact.
	LOW	Where the significance rating drops by one level, after mitigation.
	MEDIUM	Where the significance rating drops by two to three levels, after mitigation.
	HIGH	Where the significance rating drops by more than three levels, after mitigation.
Criteria for LOSS OF RESOURCES - the degree to which a resource is permanently affected by the activity, i.e. the degree to which a resource is irreplaceable	LOW	Where the activity results in a loss of a particular resource but where the natural, cultural and social functions and processes are not affected.
	MEDIUM	Where the loss of a resource occurs, but natural, cultural and social functions and processes continue, albeit in a modified way.
	HIGH	Where the activity results in an irreplaceable loss of a resource.
Criteria for REVERSIBILITY - the degree to which an impact can be reversed	IRREVERSIBLE	Where the impact is permanent.
	PARTIALLY REVERSIBLE	Where the impact can be partially reversed.
	FULLY REVERSIBLE	Where the impact can be completely reversed.

### c. DETERMINING CONSEQUENCE

Consequence attempts to evaluate the importance of a particular impact, and in doing so incorporates extent, duration and intensity. The ratings and description for determining consequence are provided below.

Rating	Description *
VERY HIGH	Impacts could be EITHER: of <b>high intensity</b> at a <b>regional level</b> and endure in the <b>long term</b> ; OR of <b>high intensity</b> at a <b>national level</b> in the <b>medium term</b> ; OR of <b>medium intensity</b> at a <b>national level</b> in the <b>long term</b> .
HIGH	Impacts could be EITHER: of <b>high intensity</b> at a <b>regional level</b> and endure in the <b>medium term</b> ; OR of <b>high intensity</b> at a <b>national level</b> in the <b>short term</b> ; OR of <b>medium intensity</b> at a <b>national level</b> in the <b>medium term</b> ; OR of <b>low intensity</b> at a <b>national level</b> in the <b>long term</b> ; OR of <b>high intensity</b> at a <b>local level</b> in the <b>long term</b> ; OR of <b>medium intensity</b> at a <b>regional level</b> in the <b>long term</b> .
MEDIUM	Impacts could be EITHER: of <b>high intensity</b> at a <b>local level</b> and endure in the <b>medium term</b> ; OR of <b>medium intensity</b> at a <b>regional level</b> in the <b>medium term</b> ;

Rating	Description *
	OR of <b>high intensity</b> at a <b>regional level</b> in the <b>short term</b> ; OR of <b>medium intensity</b> at a <b>national level</b> in the <b>short term</b> ; OR of <b>medium intensity</b> at a <b>local level</b> in the <b>long term</b> ; OR of <b>low intensity</b> at a <b>national level</b> in the <b>medium term</b> ; OR of <b>low intensity</b> at a <b>regional level</b> in the <b>long term</b> .
<b>LOW</b>	Impacts could be EITHER of <b>low intensity</b> at a <b>regional level</b> and endure in the <b>medium term</b> ; OR of <b>low intensity</b> at a <b>national level</b> in the <b>short term</b> ; OR of <b>high intensity</b> at a <b>local level</b> and endure in the <b>short term</b> ; OR of <b>medium intensity</b> at a <b>regional level</b> in the <b>short term</b> ; OR of <b>low intensity</b> at a <b>local level</b> in the <b>long term</b> ; OR of <b>medium intensity</b> at a <b>local level</b> and endure in the <b>medium term</b> .
<b>VERY LOW</b>	Impacts could be EITHER of <b>low intensity</b> at a <b>local level</b> and endure in the <b>medium term</b> ; OR of <b>low intensity</b> at a <b>regional level</b> and endure in the <b>short term</b> ; OR of <b>low to medium intensity</b> at a <b>local level</b> and endure in the <b>short term</b> . OR <b>Zero to very low intensity</b> with any combination of extent and duration.

\* Note: For any impact that is considered to be “Permanent” or “International” apply the “Long-Term” and “National” ratings, respectively.

d. DETERMINING SIGNIFICANCE

The consequence rating is considered together with the probability of occurrence in order to determine the overall significance using the table below.

		PROBABILITY			
		IMPROBABLE	POSSIBLE	PROBABLE	DEFINITE
CONSEQUENCE	VERY LOW	INSIGNIFICANT	INSIGNIFICANT	VERY LOW	VERY LOW
	LOW	VERY LOW	VERY LOW	LOW	LOW
	MEDIUM	LOW	LOW	MEDIUM	MEDIUM
	HIGH	MEDIUM	MEDIUM	HIGH	HIGH
	VERY HIGH	HIGH	HIGH	VERY HIGH	VERY HIGH

In certain cases it may not be possible to determine the significance of an impact. In these instances the significance is **UNKNOWN**.