POFADDER WIND ENERGY FACILITY 1 (PTY) LTD

Pofadder WEFs 1, 2, 3
Palaeontology

DEA Reference: *(or applicable)*
Report Prepared by: Prof. Marion Bamford
Issue Date: 23 February 2022
Version No.: 1

POFADDER WIND ENERGY FACILITY 1 (PTY) LTD

POFADDER WEFs 1, 2, 3

PALAEONTOLOGY

EXECUTIVE SUMMARY

A desktop Palaeontological Impact Assessment (PIA) was completed for three proposed Pofadder WEF 1, 2 and 3 projects for the applicants Pofadder Wind Energy Facility 1 (Pty) Ltd, Pofadder Wind Energy Facility 2 (Pty) Ltd and Pofadder Wind Energy Facility 3 (Pty) Ltd for whole area on Farms Gannapoort 202, De Neus 149, Lovedale 201, Sand Gat 150, Puts Berg 203, Quagga-Maag 200 and Willems Opdam 220, about 20km east of Pofadder, Northern Cape Province. The project area lies on the margin of the Kalahari and Karoo Basins and is underlain by non-fossiliferous rocks of the Namaqua-Natal Suite.

Most of the project area is of zero to insignificant palaeosensitivity but there are parts that are moderately sensitive. These are on the Mbizane Formation (Dwyka Group, Karoo Supergroup) and the Tertiary calcretes. Fossils are rare and their distribution unpredictable so a Fossil Chance Find Protocol should be followed once excavations for foundations and infrastructure commence**. As far as the palaeontology is concerned there are no preferred areas and NO no-go areas because the Significance Rating of the Impact is Negative low**. The project should be authorised.

Summary of Palaeontological Impact:

Project Phase	Pre-mitigation Impact	Post-mitigation Impact
Alternatives - none		
Planning	n/a	n/a
Construction	Negative low	Negative low
Operation	n/a	n/a
Decommissioning	n/a	n/a

NATIONAL ENVIRONMENTAL MANAGEMENT ACT, 1998 (ACT NO. 107 OF 1998) AND ENVIRONMENTAL IMPACT REGULATIONS, 2014 (AS AMENDED) - REQUIREMENTS FOR SPECIALIST REPORTS (APPENDIX 6)

Regulation GNR 326 of 4 December 2014, as amended 7 April 2017, Appendix 6	**Palaeontology**
1. (1) A specialist report prepared in terms of these Regulations must contain- a) details of- i. the specialist who prepared the report; and ii. the expertise of that specialist to compile a specialist report including a curriculum vitae;	iv and Section 1.3
b) a declaration that the specialist is independent in a form as may be specified by the competent authority;	iv
c) an indication of the scope of, and the purpose for which, the report was prepared;	1.1
(cA) an indication of the quality and age of base data used for the specialist report;	1.2
(cB) a description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change;	6.1
d) the date and season of the site investigation and the relevance of the season to the outcome of the assessment;	n/a
e) a description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of equipment and modelling used;	1.4
f) details of an assessment of the specific identified sensitivity of the site related to the proposed activity or activities and its associated structures and infrastructure, inclusive of a site plan identifying site alternatives;	
g) an identification of any areas to be avoided, including buffers;	Not for this project
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;	Figures 3 and 4. No no-go areas or buffers required
i) a description of any assumptions made and any uncertainties or gaps in knowledge;	5

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) or activities;	6
k) any mitigation measures for inclusion in the EMPr;	Appendix A
l) any conditions for inclusion in the environmental authorisation;	Appendix A
m) any monitoring requirements for inclusion in the EMPr or environmental authorisation;	Appendix A
n) a reasoned opinion- i. (as to) whether the proposed activity, activities or portions thereof should be authorised; (iA) regarding the acceptability of the proposed activity or activities; and ii. if the opinion is that the proposed activity, activities 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;	8
o) a description of any consultation process that was undertaken during the course of preparing the specialist report;	Not for palaeontology
p) a summary and copies of any comments received during any consultation process and where applicable all responses thereto; and	Not for palaeontology
q) any other information requested by the competent authority.	None
2) Where a government notice *gazetted* by the Minister provides for any protocol or minimum information requirement to be applied to a specialist report, the requirements as indicated in such notice will apply.	N/a

DETAILS OF THE SPECIALIST, DECLARATION OF INTEREST AND UNDERTAKING UNDER OATH

	(For official use only)
File Reference Number:	
NEAS Reference Number:	DEA/EIA/
Date Received:	

Application for authorisation in terms of the National Environmental Management Act, Act No. 107 of 1998, as amended and the Environmental Impact Assessment (EIA) Regulations, 2014, as amended (the Regulations)

PROJECT TITLE

Pofadder WEFs 1, 2, 3

Kindly note the following:

1. This form must always be used for applications that must be subjected to Basic Assessment or Scoping & Environmental Impact Reporting where this Department is the Competent Authority.
2. This form is current as of 01 September 2018. It is the responsibility of the Applicant / Environmental Assessment Practitioner (EAP) to ascertain whether subsequent versions of the form have been published or produced by the Competent Authority. The latest available Departmental templates are available at https://www.environment.gov.za/documents/forms.
3. A copy of this form containing original signatures must be appended to all Draft and Final Reports submitted to the department for consideration.
4. All documentation delivered to the physical address contained in this form must be delivered during the official Departmental Officer Hours which is visible on the Departmental gate.
5. All EIA related documents (includes application forms, reports or any EIA related submissions) that are faxed; emailed; delivered to Security or placed in the Departmental Tender Box will not be accepted, only hardcopy submissions are accepted.

Departmental Details

Postal address:
Department of Environmental Affairs
Attention: Chief Director: Integrated Environmental Authorisations
Private Bag X447
Pretoria
0001

Physical address:
Department of Environmental Affairs
Attention: Chief Director: Integrated Environmental Authorisations
Environment House
473 Steve Biko Road
Arcadia

Queries must be directed to the Directorate: Coordination, Strategic Planning and Support at:
Email: EIAAdmin@environment.gov.za

1. SPECIALIST INFORMATION

Specialist Company Name:	Marion Bamford Consulting			
B-BBEE	Contribution level (indicate 1 to 8 or non-compliant)	exempt	Percentage Procurement recognition	
Specialist name:	Marion Bamford			
Specialist Qualifications:	PhD (Palaeontology)			
Professional affiliation/registration:	fRSSAf, mASSAf, PSSA, SASQUA, IOP. IAWA, INQUA			
Physical address:	24A 8th Avenue, Parktown North, Johannesburg, 2193			
Postal address:	P O Box 652, Wits, 2050			
Postal code:	2193 / 2050	Cell:	082 555 6937	
Telephone:	011 717 6690	Fax:	x	
E-mail:	Marion.bamford@wits.ac.za ; marionbamford12@gmail.com			

2. DECLARATION BY THE SPECIALIST

I, __Marion Kathleen Bamford__, declare that –

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

Signature of the Specialist

Marion Bamford Consulting

Name of Company:

24 March 2022

Date:

3. UNDERTAKING UNDER OATH/ AFFIRMATION

I, ___Marion Kathleen Bamford_____, swear under oath / affirm that all the information submitted or to be submitted for the purposes of this application is true and correct.

M Bamford

Signature of the Specialist

Marion Bamford Consulting

Name of Company

24 March 2022

Date

Signature of the Commissioner of Oaths

24 MARCH 2022

Date

I certify that the DEPONENT has acknowledged that he/she knows and understands the contents of this affidavit, that he/she does not have any objection to taking the oath, and that he/she considers it to be binding on his/her conscience, and which was sworn to and signed before me at WITS on this day of 24 MARCH 20 22 and that the administering oath complied with the regulations contained in Government Gazette No. R 1258 of 21 July 1972, as amended.

Signature:

Name: GITA PATEL

Commissioner of Oaths, District of Johannesburg

Ex Officio Title: MANAGER

Faculty/Office: International Students Office.

University of the Witwatersrand, Johannesburg.

1 Jan Smuts Avenue, Braamfontein 2000; Johannesburg

POFADDER WIND ENERGY FACILITY 1 (PTY) LTD

POFADDER WEFs 1, 2, 3

PALAEONTOLOGY

Contents

List of Tables

List of Figures

List of Appendices

List of Abbreviations

fRSSAf – Fellow of the Royal Society of South Africa
IAWA – International Association of wood Anatomists
INQUA – International Quaternary Association
IOP – International Organisation of Palaeobotanists
mASSAf – Member of the Academy of Sciences of South Africa
NEMA – National Environmental Management Act
PIA - Paleontological Impact Assessment
SAHRA - South African Heritage Resources Agency

POFADDER WIND ENERGY FACILITY 1 (PTY) LTD

POFADDER WEFs 1, 2, 3

PALAEONTOLOGY

1. INTRODUCTION

The applicants Pofadder Wind Energy Facility 1 (Pty) Ltd, Pofadder Wind Energy Facility 2 (Pty) Ltd and Pofadder Wind Energy Facility 3 (Pty) Ltd are proposing the development of three commercial Wind Energy Facilities (WEFs) and associated infrastructure on a site located approximately 20km South East of Pofadder within the Kai !Garib Local Municipality and the Z F Mgcawu District Municipality in the Northern Cape Province. Due to the nature of palaeontological heritage (i.e. related to geological formations), all three WEFs are considered in a single specialist report, although they will have three separate impact assessment processes under the 2014 Environmental Impact Assessment Regulations (GN No. R982, as amended) for listed activities contained Listing Notices 1, 2 and 3 (GN R983, R984 and R985, as amended). The three projects are known as Pofadder Wind Energy Facility 1, Pofadder Wind Energy Facility 2 and Pofadder Wind Energy Facility 3.

A preferred project site with an extent of 24 000ha has been identified as a technically suitable area for the development of the three WEF projects. It is proposed that each WEF will comprise of up to 30 turbines with a combined contracted capacity of up to 200MW per WEF.

The project site comprises the following farm portions:

- Remaining Extent (Portion 0) of the Farm Ganna-Poort 202;
- Remaining Extent (Portion 0) of the Farm Lovedale 201; and
- Portion 3 of the Farm Sand Gat 150.

Each project site is proposed to accommodate the following infrastructure, which will enable the wind farm to supply a contracted capacity of up to 200MW:

- Up to 30 wind turbines with a maximum hub height of up to 200m;
- A transformer at the base of each turbine;
- Concrete turbine foundations and turbine hardstands;
- Temporary laydown areas which will accommodate the boom erection, storage and assembly area;
- Cabling between the turbines, to be laid underground where practical;
- An on-site substation of up to 1.25ha in extent to facilitate the connection between the wind farm and the electricity grid;
- An internal overhead 132kV power line, with a servitude of 32m, to connect the wind farm to the collector substation;

- Access roads to the site will be8-12 m in width
- Internal access roads between project components inclusive of stormwater infrastructure with a width of approximately 6 – 8 m;
- A temporary concrete batching plant; and
- Operation and Maintenance buildings including a gate house, security building, control centre, offices, warehouses, a workshop and visitors centre.

In order to evacuate the energy generated by the WEF's to supplement the national grid, Pofadder Grid (Pty) Ltd is proposing to develop a ~50km (132/400kV) high voltage overhead transmission powerline to connect the three proposed wind farms to the new planned Eskom Karana Substation. Application for a corridor in which to situate the gridline is the subject of a separate EA application (Pofadder Gridline for the Pofadder Wind Energy Facilities). The EA applications for the three wind farm projects and gridline are being undertaken in parallel as they are co-dependent, i.e. one will not be developed without the other.

1.1 Scope and Objectives

This report will assess the likelihood of fossils occurring in the sediments of all four farms listed above using the mapped geological formations and likely associated palaeontology, and make recommendations for preferred and no-go areas.
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.

1.2 Terms of Reference

ASHA Consulting was asked to conduct a field assessment and desktop study and compile three Heritage Impact Assessments (HIAs) for the proposed projects. The HIAs were to meet the requirements of the heritage authorities and include the following:

- Describe the affected environment;
- Describe the legal, policy and planning context;
- Identify and (where required) respond to issues;
- Identify opportunities and constraints;
- Predict and assess impacts; and
- Recommend management actions and monitoring programmes.

ASHA was also asked to subcontract a palaeontological specialist to provide a desktop assessment of the potential palaeontological impacts. This would form a separate report to be submitted along with the HIA. The present report deals with the palaeontology.

1.3 Specialist Credentials

Curriculum vitae (short) - Marion Bamford PhD
July 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 ; 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 12-20 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:

- 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
- Frankfort-Windfield Eskom Powerline 2020 for 1World
- Beaufort West PV Facility 2021 for ACO Associates
- Copper Sunset MR 2021 for Digby Wells
- Sannaspos PV Facility 2021 for CTS Heritage
- Smithfield-Rouxville-Zastron PL 2021 for TheroServe

xi) Research Output

Publications by M K Bamford up to December 2021 peer-reviewed journals or scholarly books: over 160 articles published; 5 submitted/in press; 10 book chapters.
Scopus h-index = 30; Google scholar h-index = 35; -i10-index = 92
Conferences: numerous presentations at local and international conferences.

1.4 Assessment Methodology

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' representivity or scientific importance to decide if the fossils can be destroyed or a representative sample collected (*not applicable to this assessment*).

2. ASSUMPTIONS AND LIMITATIONS

The whole of South Africa has been mapped by experienced geologists on a scale of 1:50 000 and these maps have been compiled and produced in commercially available maps by the Geological Survey (now called the Council for Geosciences). In addition, palaeontologists have assessed the formations, members and facies for fossils and these are recorded in publications and databases in the national repositories such as museums and universities. SAHRA has combined the two sources of data (provincial palaeotechnical reports) and produced the SAHRIS palaeosensitivity maps. We can confidently assume that there is good coverage for South Africa but the limitation is that not every potentially fossiliferous site has been visited by a palaeontologist. It should also be noted that any area designated as potentially fossiliferous will not necessarily contain any fossils because specific palaeoenvironmental conditions are required for the preservation of organic matter.

3. TECHNICAL DESCRIPTION

3.1 Project Location

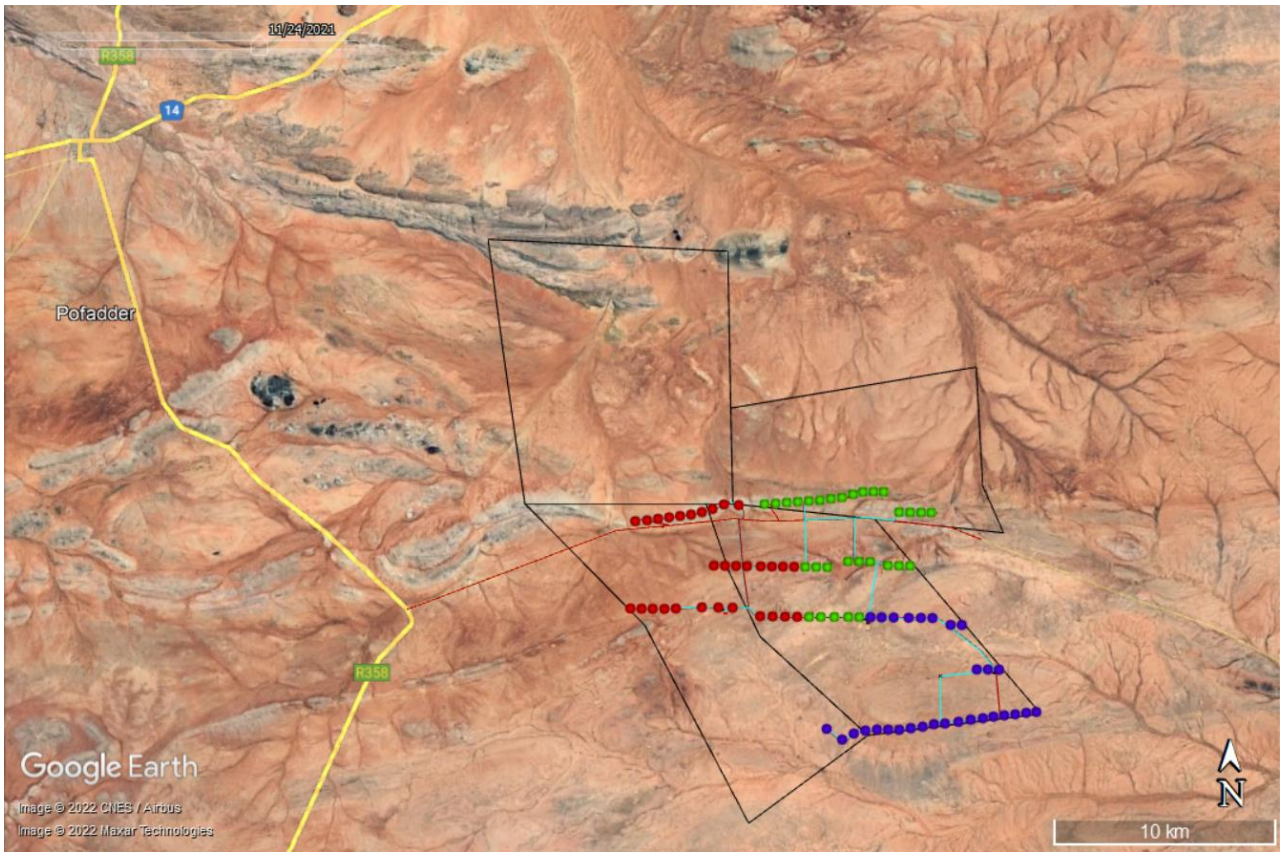

Figure 1: Google Earth map to show the farm boundaries and possible turbine locations (red, green and purple dots represent WEF1, WEF2 and WEF3 respectively).

3.2 Project Description

The applicants are proposing the development of three commercial Wind Energy Facilities and associated infrastructure on a site located approximately 20 km southeast of Pofadder within the Kai !Garib Local Municipality and the ZF Mgcawu District Municipality in the Northern Cape Province.

A preferred project site with an extent of 24 000 ha has been identified as a technically suitable area for the development of the three WEF projects (Figure 1). It is proposed that each WEF will comprise of up to 30 turbines with a combined contracted capacity of up to 200 MW per WEF.

The three project sites are each proposed to accommodate the following infrastructure, which will enable the wind farm to supply a contracted capacity of up to 200 MW:

- Up to 30 wind turbines with a maximum hub height of up to 200 m;

- A transformer at the base of each turbine;
- Concrete turbine foundations and turbine hardstands;
- Temporary laydown areas which will accommodate the boom erection, storage and assembly area;
- Cabling between the turbines, to be laid underground where practical;
- An on-site substation of up to 1.25 ha in extent to facilitate the connection between the wind farm and the electricity grid;
- An internal overhead 132 kV power line, with a servitude of 32 m, to connect the wind farm to the collector substation;
- Access roads to the site and between project components inclusive of stormwater infrastructure. A 12 m road corridor may be temporary impacted during construction and rehabilitated to 6m wide after construction.
- Pofadder WEF 1 will have a total road network of about 50 km.
- A temporary concrete batching plant; and
- Operation and Maintenance buildings including a gate house, security building, control centre, offices, warehouses, a workshop and visitors' centre.

In order to evacuate the energy generated by the WEFs to supplement the national grid, Pofadder Grid (Pty) Ltd is proposing two grid connection alternatives which will be assessed separately.

3.2.1 Layout Alternatives

The site has been screened for environmental sensitivities and the layout designed to avoid sensitive locations. As such, no alternative layouts are assessed here aside from the No-Go option. The site is suited to wind energy generation and thus other forms of power generation technology have not been considered.

4. LEGAL REQUIREMENT AND GUIDELINES

Any proposed development must comply with the National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA) and Environmental Impact Assessment (EIA) Regulations, 2014 (as amended) - Requirements for Specialist Reports (Appendix 6)

In particular for this Palaeontology report, the development must 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). Further, if fossils of scientific significance occur in the project footprint and need to be removed, then a collecting permit must be obtained by the paleontologist from SAHRA before the fossils are removed, and all protocols adhered to.

5. DESCRIPTION OF THE RECEIVING ENVIRONMENT

The area is semi-arid with short, sparse grass and low bushes. The topography is generally flat with low ridges and shallow water courses for ephemeral streams and pans.

5.1 Geological setting

The eight farms lie in the northeastern margin of the Karoo Basin where the basal Karoo sediments overlie the ancient igneous and metamorphic rocks of the Namaqua-Natal Belt (Figure 2; Table 2). These rocks in turn are overlain by much younger Tertiary calcretes and Quaternary sands and alluvium.

The Namaqua-Natal Province is a tectono-stratigraphic province and forms the southern and western boundary of the ancient Kaapvaal Craton, and extends below the Karoo Basin sediments to the south (Cornell et al., 2006). It comprises rocks that were formed during the Namaqua Orogeny (mountain-building) some 1200 – 1000 million years ago. It has been divided by geologists into a number of terranes (similar lithology and bounded by shear zones). There are three main lithologic units used to separate the terranes as well as the shear zones but still there is some debate about the terranes (ibid). Very simply, the lithologic units are older reworked rocks, juvenile rocks formed during tectonic activities and metamorphosed, and intrusive granitoids.

According to Cornell et al. (2006) the five terranes are:
A - Richtersveld Subprovince (undifferentiated terranes)
B – **Bushmanland Terrane** (granites)
C – Kakamas Terrane (supracrustal metapelite ca 2000 Ma
D – Areachap Terrane (supracrustal rocks and granitoids)
E – Kaaien Terrane (Keisian aged metaquartzites and deformed volcanic rocks).

The project lies in the **Bushmanland Terrane** with its northern boundary against the Richtersveld Subprovince and the eastern boundary against the Kakamas Terrance (ibid). According to Moore et al. (1990, in Cornell et al., 2006), the Bushmanland Terrane rocks can be divided into three distinct age groups:

A, A basement complex (Achab Gneiss, Gladkop Suite) that is mainly composed of granitic rocks of Kheisian age (2050 - 1700 Ma).

B, A variety of supracrustal sequences of mixed sedimentary and volcanic origin and probably fitting into three broad age groups (ca 1900, 1600 and 1200 Ma).

C, Suites of syn- and late-tectonic Namaquan intrusive rocks, generally of granitic to charnockitic composition. This group includes the Little Namaqualand Suite (ca 1200 Ma), the Spektakel Suite (ca 1060 Ma) and the basic rocks of the Koperberg and Wortel Suites and Nouzees Complex (1060 – 1030 Ma), as well as the ca 950 Ma pegmatites.

The Namaqua-Natal Province rocks are volcanic in origin and frequently metamorphosed so they do not preserve any fossils and will not be considered further. Several outcrops occur on the farms and probably underlie the Quaternary sands and Tertiary Calcretes.

The Mbizane Formation is the oldest layer of the Karoo Supergroup and was deposited in the Karoo basin as the various icesheets melted and dropped sediments into the basin. It comprises diamictites, tillites, and some sandstones and mudstones (Johnson at al., 2006).

Haddon and McCarthy (2005) proposed that the Kalahari basin formed as a response to down-warp of the interior of the southern Africa, probably in the Late Cretaceous. This, along with possible uplift along epeirogenic axes, back-tilted rivers into the newly formed Kalahari basin and deposition of the Kalahari Group sediments began. Sediments included basal gravels in river channels, sand and finer sediments. A period of relative tectonic stability during the mid-Miocene saw the silcretisation and calcretisation of older Kalahari Group lithologies, and this was followed in the Late Miocene by relatively minor uplift of the eastern side of southern Africa and along certain epeirogenic axes in the interior. More uplift during the Pliocene caused

erosion of the sand that was then reworked and redeposited by aeolian processes during drier periods, resulting in the extensive dune fields that are preserved today.

Tertiary calcretes cover large parts of the Northern Cape but they are difficult to date and there are several ages suggested (see Partridge et al., 2006). Nonetheless, it is accepted that calcretes form under alternating cycles humid and arid climatic conditions in strata that have calcium carbonate (Netterberg, 1969). More recent research using geophysical techniques to measure uplift of the continent during the Cretaceous and tertiary, combined with the fossil record (Braun et al., 2014) suggest that there were two predominant humid periods during the Tertiary. The whole of the Eocene (56-33 Ma) and a short period during the early Miocene (ca 20-19 Ma) were humid according to their estimation. It is possible that the Northern Cape calcretes formed during one of these periods.

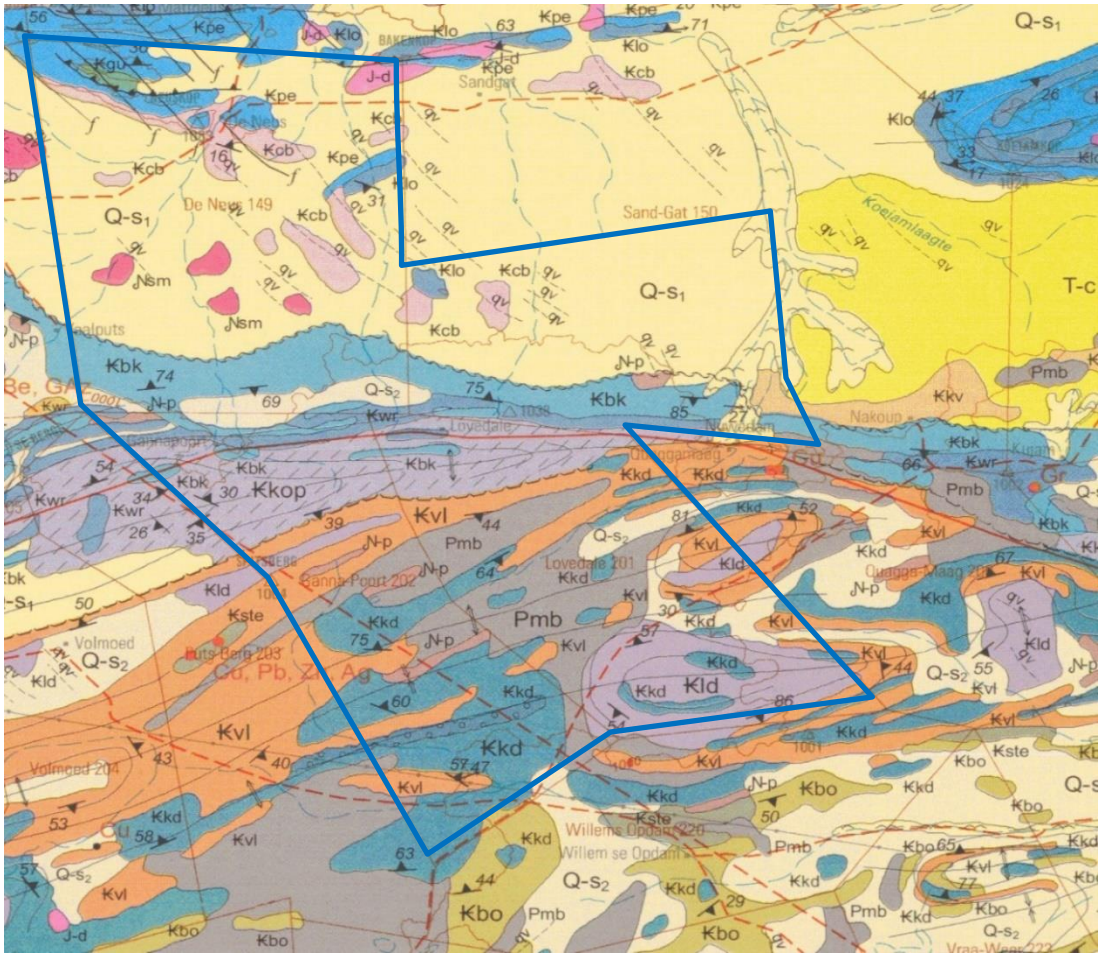

Figure 2: Geological map of the area around the proposed Pofadder WEF 1, 2, 3 project site, as indicated by the blue polygon. Abbreviations of the rock types are explained in Table 2. Map enlarged from the Geological Survey 1: 250 000 map 2918 Pofadder.

Table 2: Explanation of symbols for the geological map and approximate ages (Cornell et al., 2006. Johnson et al., 2006; Partridge et al., 2006). SG = Supergroup; Fm = Formation; Ma = million years; grey shading = formations impacted by the project.

Symbol	Group/Formation	Lithology	Approximate Age
Qs-1	Quaternary sands	Re windblown sands and dunes	Quaternary, ca 2.5 Ma to present

Symbol	Group/Formation	Lithology	Approximate Age
Qs-2	Quaternary sands	Sand, scree, rubble, sandy soil	
T-c	Tertiary Calcrete	calcrete	Tertiary, ca 65 Ma to 2.5 Ma
Jd	Jurassic dyke	Dolerite	Ca 183 Ma
Pmb	Mbizane Fm, Dwyka Group, Karoo SG	Diamictite, tillites, subordinate sandstone and mudstone	Late Carboniferous to Early Permian. Ca 300 – 290 Ma
Kbk	Brulkolk Fm, Bushmanland Group, Namaqua-Natal Suite	Gneiss	>1200 Ma
Kvl	Voelmoed Fm, Kamiesberg Group, Namaqua-Natal Suite	Quartzite, schist, ironstone	Ca 1600 Ma
Kkd	Kraandraai Fm, Kamiesberg Group, Namaqua-Natal Suite	Gneiss	Ca 1600 Ma
Kld	Lekkerdrink Fm, Gladkop Group, Namaqua-Natal Suite	Gneiss	2050 – 1700 Ma
Kkp	Koeipoort Fm, Gladkop Metamorphic Suite, Namaqua-Natal Suite	Gneiss	2050 – 1700 Ma

5.2 Palaeontology

The palaeontological sensitivity of the area under consideration is presented in Figure 3. Parts of the area are in the Mbizane Formation of the Dwyka Group diamictites tillites, sandstone, mudstone and shales, and these potentially could preserve fossils. Around 300-290 Ma the climate in southern Africa was still relatively cool, but there were well developed Carboniferous floras in the northern hemisphere. In South Africa, however, much of the land surface was covered by ice sheets. As they melted they dropped the moraine trapped in the ice, together with limited plant matter from the vegetation that gradually recovered and colonised the land surface. Terrestrial vertebrates had not evolved at this time. The late Carboniferous flora comprised Glossopteris leaves and seeds, wood, and other plants such as lycopods, sphenophytes and ferns.

The Dwyka Group is made up of seven facies that were deposited in a marine basin under differing environmental settings of glacial formation and retreat. Of the seven facies that have been recognised in the Dwyka Group fossil plant fragments have only been recognised from the mudrock facies. They have been recorded from around Douglas only (Johnson et al., 2006; Anderson and McLachlan 1976) although the Dwyka Group exposures are very extensive. Jurassic Dolerites do not contain fossils as they are igneous intrusives.

The Tertiary calcretes can trap fossils and artefacts when associated with palaeo-pans or palaeo-springs (Partridge et al., 2006). Where deflation has occurred, for example along the west coast of South Africa, any

trapped materials in the different levels can be concentrated in the depo-centre of the pan or dune and thus it can be challenging to interpret the deposit (Felix-Henningsen et al., 2003).

The Aeolian sands, dunes, scree and alluvium of the Quaternary do not preserve fossils because they have been transported and reworked, but in some regions these may have covered pan or spring deposits and these can trap fossils, and more frequently archaeological artefacts. Usually these geomorphological features can be detected using satellite imagery. No such features are visible.

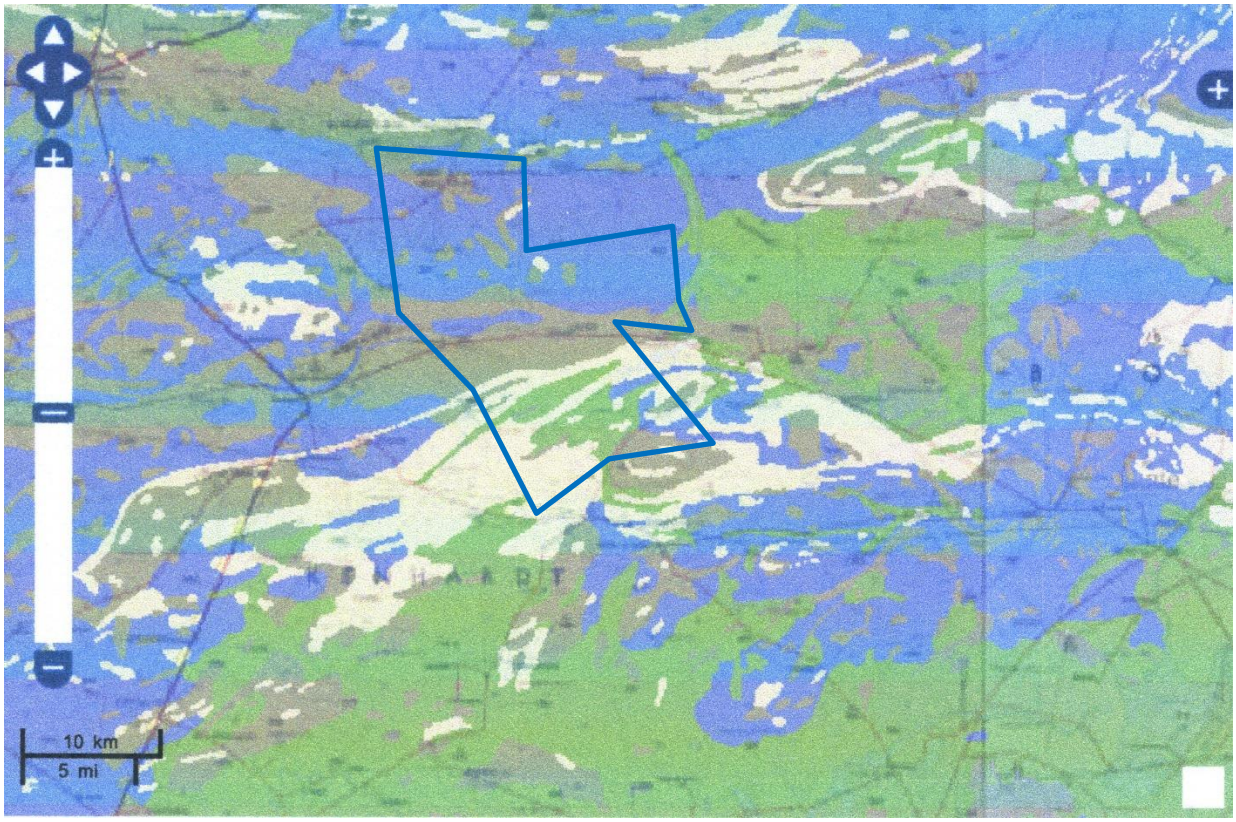

Figure 3: SAHRIS palaeosensitivity map for the entire study area showing all the farms within the polygon. Background colours indicate the following degrees of sensitivity: red = very highly sensitive; orange/yellow = high; green = moderate; blue = low; grey = insignificant/zero.

The green colour (moderately sensitive) applies to two lithologies that potentially could preserve fossils. Types of fossils and general areas where they could occur are indicated in Table 3.

Table 3: Possible occurrence of fossils and general location

Formation	Types of fossils	Location in project area
Mbizane Fm	Fragmentary plants of the early Glossopteris flora	Gannapoort 202 – south Lovedale 201 – centre and south Sand Gat 150 – none Puts Berg 203 – central Quagga-Maag 200 – NW corner

		Willems Opdam 220 - south
Tertiary calcrete	Fragmentary fossils of bones or silicified wood, leaf impressions	Gannapoort 202 – none Lovedale 201 – none Sand Gat 150 – southeast Puts Berg 203 – none Quagga-Maag 200 – none Willems Opdam - none

6. SPECIALIST FINDINGS / IDENTIFICATION AND ASSESSMENT OF IMPACTS

The vegetation, or lack thereof, has no impact on the palaeontology. The height of the turbines or other infrastructure has no impact on the palaeontology, only the ground area is relevant.

Most of the area is on non-fossiliferous rocks of the Namaqua-Natal Suite and the Quaternary sands but there are some areas of moderately palaeosensitivity (Table 3 above). It should be noted that palaeosensitivity is only moderate, so according to the SAHRA regulations no site visit is required. A Fossil Find Protocol is required for the moderately sensitive areas only (see Appendix A). Only if fossils are found by the environmental officer or other responsible person once excavations for foundations have commenced, and if assessed to be scientifically important by the paleontologist based on photographs, would a collecting permit from SAHRA be required.

As far as the paleontology is concerned there are no no-go areas, and no farm has no restrictions whatsoever.

The identification and assessment of impacts is described in this section. Direct and indirect impacts for the various project phases are assessed and rated according to the methodology developed by SiVEST. Project stages, as follows:

- Planning or pre-construction – not relevant to palaeontology
- Construction – during excavations for foundations, roads and infrastructure, the environmental officer/contractor/other responsible person must follow the Fossil Chance Find protocol;
- Operation; Not relevant for the palaeontology,and
- Decommissioning – not relevant for the palaeontology.

6.1 Cumulative Impacts

The palaeontological impact is only relevant to the footprint of this project and will not be affected by any other Renewable Energy Facilities (REFs) and large scale industrial developments be constructed within 35km of the proposed development.

Cumulative impacts for palaeontology are acceptable.

The specialist reports for other REFs and their recommendations, mitigation measures and conclusion have been considered. Each depends on the palaeontology of the respective project footprints and so the SAHRA recommendations have to be followed in each case.

6.2 Overall Impact Rating

Table 4: Rating of impacts

ENVIRONMENTAL PARAMETER	ISSUE / IMPACT / ENVIRONMENTAL EFFECT/ NATURE	ENVIRONMENTAL SIGNIFICANCE BEFORE MITIGATION									RECOMMENDED MITIGATION MEASURES	ENVIRONMENTAL SIGNIFICANCE AFTER MITIGATION								
		E	P	R	L	D	I / M	TOTAL	STATUS (+ OR -)	S		E	P	R	L	D	I / M	TOTAL	STATUS (+ OR -)	S
Construction Phase																				
Palaeontology	If fossils of scientific value (rare, complete, index fossils) are present they might be destroyed when excavations for foundations commence	1	2	1	2	1	1	7	-	Low	**Follow the Fossil Chance Find Protocol and remove important fossils during excavations. These measures will be detailed in the EMPr.**	1	2	1	1	1	1	6	-	Low

ENVIRONMENTAL PARAMETER	ISSUE / IMPACT / ENVIRONMENTAL EFFECT/ NATURE	ENVIRONMENTAL SIGNIFICANCE BEFORE MITIGATION									RECOMMENDED MITIGATION MEASURES	ENVIRONMENTAL SIGNIFICANCE AFTER MITIGATION								
		E	P	R	L	D	I / M	TOTAL	STATUS (+ OR -)	S		E	P	R	L	D	I / M	TOTAL	STATUS (+ OR -)	S
Cumulative impacts																				
Palaeontology	If fossils of scientific value (rare, complete, index fossils) are present they might be destroyed when excavations for foundations commence	1	2	1	2	1	1	7	-	Low	Follow the Fossil Chance Find Protocol and remove important fossils during excavations. These measures will be detailed in the EMPr.	1	2	1	1	1	1	6	-	Low

Direct impacts to palaeontological resources would occur during the construction phase when excavations for foundations and other infrastructure are made. Given the relatively low local scientific significance of the identified palaeontology, the impact extent would be limited to the site. Because fossil resources are fairly abundant where they do occur, and if any fossils found are rescued, this will be a positive impact on science. Overall, the impact of this project will be low. There are no fatal flaws in terms of construction phase impacts to palaeontology.

7. COMPARATIVE ASSESSMENT OF ALTERNATIVES

Due to careful planning by the developer, only preferred WEF layouts were provided for assessment. As such, only the preferred and No-Go alternatives are assessed for these projects. The expected impacts for the preferred alternative are of low significance, while for the No-Go option no impacts are expected.

8. CONCLUSION

A desktop Palaeontological Impact Assessment (PIA) was completed for the proposed Pofadder WEF 1, 2 and 3 projects for the whole study area on Farms Gannapoort 202, De Neus 149, Lovedale 201 and Sand Gat 150, about 20km southeast of Pofadder, Northern Cape Province. The project area lies on the margin of the Kalahari and Karoo Basins and is underlain by non-fossiliferous rocks of the Namaqua-Natal Suite.

Most of the project area has zero to insignificant palaeosensitivity but there are parts that are moderately sensitive. These are on the Mbizane Formation (Dwyka Group, Karoo Supergroup) and the Tertiary calcretes. Fossils are rare and their distribution unpredictable so a Fossil Chance Find Protocol should be followed once excavations for foundations and infrastructure commence. As far as the palaeontology is concerned there are no preferred areas or alternatives and NO no-go areas because the Significance Rating of the Impact is Negative low. The project should be authorised.

ONLY the construction phase is relevant to the Palaeontological sensitivity of the site because fossils, if present, will only be visible once excavations have commenced. Following the Fossil Chance Find Protocol, any scientifically important fossils will be removed (mitigation) and there would be no further impacts from the operation and decommissioning phases of the project.

8.1 Impact Statement

The area covered by the four farms has mostly no sensitivity and some parts are moderately sensitive, therefore, as far as the palaeontological impact is concerned, the Pofadder WEF 1, 2 and 3 projects should be authorized.

9. REFERENCES

Anderson, A.M., McLachlan, I.R., 1976. The plant record in the Dwyka and Ecca Series (Permian) of the south-western half of the great Karoo Basin, South Africa. Palaeontologia africana 19, 31-42.

Cornell, D.H., Thomas, R.J., Moen, H.F.G., Reid, D.L., Moore, J.M., Gibson, R.L., 2006. The Namaqua-Natal Province. 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 325-379.

Haddon. I.G., McCarthy, T.S., 2005. The Mesozoic–Cenozoic interior sag basins of Central Africa: The Late-Cretaceous–Cenozoic Kalahari and Okavango basins. Journal of African Earth Sciences 43, 316–333.

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.

Felix-Henningsen, P., Kandel, A.W., Conard, N.J., 2003. The significance of calcretes and paleosols on ancient dunes of the Western Cape, South Africa, as stratigraphic markers and paleoenvironments. In: G. Füleky (Ed.) Papers of the 1st International Conference on Archaeology and Soils. BAR International S1163, pp. 45-52.

Netterberg, F., 1969. The interpretation of some basic calcrete types. South African Archaeological Bulletin 24, 117-122.

Partridge, T.C., Botha, G.A., Haddon, I.G., 2006. Cenozoic deposits of the interior. 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 585-604.

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.

10. APPENDIX A

Monitoring Programme for Palaeontology – to commence once the excavations for foundations and infrastructure begin.

1. The following procedure is only required if fossils are seen on the surface and when excavations commence.
2. When excavations begin the soil, sand or rock must be given a cursory inspection by the environmental officer or designated person. Any fossiliferous material (plants, insects, bone, wood) 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 to assist in recognizing the fragments of fossil plants, vertebrates, invertebrates or trace fossils in the shales and mudstones (for example see Figures 4, 5 in Appendix B). 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 officer then the qualified palaeontologist 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

11. APPENDIX B: PHOTOGRAPHS OF FOSSILS THAT COULD BE FOUND

Figure 4: Photographs of fossils that have been recovered from other Dwyka Group deposits and that might occur in the Mbizane Formation.

Figure 5: Photographs of fossils that have been recovered from other Quaternary sites in South Africa. Note the fractured nature of the fossils.