



## NGT ESHS Solutions

**PROJECT TITLE:**

A DESKTOP PALAEOLOGICAL IMPACT ASSESSMENT FOR THE PROPOSED  
VREDEFORT WEST EXT PWP

**PROJECT REFERENCE NUMBER:**

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**SPECIALIST REPORT:**

Palaeontological Impact Assessment for the Proposed  
Vredefort West PWP, Free State Province, South Africa

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## DECLARATION OF INDEPENDENCE

Marion Bamford for NGT has compiled this report. 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.

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<b>ASSOCIATION/PROFESSIONAL BODY</b>	FRSSAf, mASSAf, PSSA, SASQUA
<b>YEARS OF EXPERIENCE IN THE INDUSTRY</b>	22
<b>SIGNATURE (HAND SIGNATURE ON APPROVAL BY CLIENT)</b>	

## **EXECUTIVE SUMMARY**

A Palaeontological Impact Assessment was requested for excavating two trenches on the Farm Mimosa Grove 491. The client is submitting a prospecting right application, along with the required environmental authorisation application. To comply with 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 of a gold prospecting area. Other minor minerals may be mined in the same site.

### **Conclusions:**

The Farm Mimosa Grove 491 falls on ancient non-fossiliferous rocks of the Witwatersrand Group (Government and Jeppestown Subgroups) in the central and east parts. A narrow section in the west occurs on sandstones and shales of the Vryheid Formation that could preserve fossil plants of the *Glossopteris* flora (early Permian).

### **Recommendations:**

A Fossil Chance Find Protocol should be followed once drilling and coring commences as there is a small chance that fossil plants could occur in the small footprint of the coring site. If fossils are found by the responsible person a palaeontologist should be called to assess them.

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## LIST OF ABBREVIATIONS

ACRONYMS	DESCRIPTION
<b>AUTHORITIES</b>	
ASAPA	Association of South African Professional Archaeologists
FSPHRA	Free State Provincial Heritage Resources Authority
NGT	Nurture, Grow, Treasure
SADC	Southern African Developing Community
SAHRA	South African Heritage Resources Agency
<b>DISCIPLINE</b>	
AIA	Archaeological Impact Assessment
BAR	Basic Assessment Report
CMP	Cultural Management Plan
ESA	Early Stone Age
EIAs	Environmental Impact Assessment
EMPr	Environmental Management Programme
EIA	Early Iron Age
HCMP	Heritage Cultural Management Plan Report
HIA	Heritage Impact Assessment
LIA	Late Iron Age
LSA	Late Stone Age
MIA	Middle Iron Age
MSA	Middle Stone Age
<b>LEGAL</b>	
NEMA	National Environmental Management Act
NHRA	National Heritage Resources Act



## **TERMS AND DEFINITIONS**

### ***Archaeological resources***

These include:

- Material remains resulting from human activities which are in a state of disuse and are in or on land and which are older than 100 years including artefacts, human and hominid remains and artificial features and structures;
- Rock art, being any form of painting, engraving or other graphic representation on a fixed rock surface or loose rock or stone, which was executed by human agency and which is older than 100 years, including any area within 10m of such representation;
- Wrecks, being any vessel or aircraft, or any part thereof which was wrecked in South Africa, whether on land, in the internal waters, the territorial waters or in the maritime culture zone of the republic as defined in the Maritimes Zones Act, and any cargo, debris or artefacts found or associated therewith, which is older than 60 years or which SAHRA considers to be worthy of conservation;
- Features, structures and artefacts associated with military history which are older than 75 years and the site on which they are found.

### ***Palaeontological***

This means any fossilised remains or fossil trace of animals or plants which lived in the geological past, other than fossil fuels or fossiliferous rock intended for industrial.

### ***Cultural significance***

This means aesthetic, architectural, historical, scientific, social, spiritual, linguistic or technological value or significance.

### ***Development***

This means any physical intervention, excavation, or action, other than those caused by natural forces, which may in the opinion of the heritage authority in any way result in the change to the nature, appearance or physical nature of a place or influence its stability and future well-being, including:

- Construction, alteration, demolition, removal or change in use of a place or a structure at a place;
- Carrying out any works on or over or under a place;

- Subdivision or consolidation of land comprising a place, including the structures or airspace of a place;
- Constructing or putting up for display signs or boards; any change to the natural or existing condition or topography of land;
- And any removal or destruction of trees, or removal of vegetation or topsoil.

***Heritage resources:*** This means any place or object of cultural significance.

## 1. INTRODUCTION

The application area is approximately 130km south southeast of Johannesburg, about 30km west of Parys. The surface geology of the area consists of rocks of the Karoo Supergroup overlying those of the Central Rand and West Rand groups of the Witwatersrand Supergroup (Figure 1). The Witwatersrand Supergroup represents a period of major sedimentation within an inland sea which commenced 2 970 million years ago. The lower West Rand Group sediments were deposited within a shallow sea, while the upper Central Rand Group sediments represent terrestrial river deposits. Certain conglomerate layers within the Witwatersrand rocks known as reefs host the world's most prolific accumulation of gold. The Witwatersrand rocks are thought to occur at relatively shallow depths (0-500m) in the current target area as it occurs on the southwestern portion of the Vredefort Dome.

Reimold and Gibson (1996) describe the Vredefort Dome as a major meteorite impact that struck the Witwatersrand Basin 2 023 million years ago. The impact severely shattered, fractured, and in places, overturned the Witwatersrand strata in the collar of the dome and, during elastic rebound, also exhumed a portion of the granite crust from beneath the basin in the centre of the structure (Wilson and Anhaeusser, 1998). The result is that the central, most deeply buried portion of the Witwatersrand Basin is extremely well exposed in an arcuate belt of steeply dipping to overturned strata that preserves, in addition, Dominion Group, Ventersdorp and Transvaal Supergroups.

A Palaeontological Impact Assessment was requested for excavating two trenches on the Farm Mimosa Grove 491 (Figure 1). The client is submitting a prospecting right application, along with the required environmental authorisation application. To comply with 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 of a gold prospecting area. Other minor minerals may be mined in the same site.

Table 1: Specialist report requirements in terms of Appendix 6 of the EIA Regulations (2014)

A specialist report prepared in terms of the Environmental Impact Regulations of 2014 must contain:	Relevant section in report
Details of the specialist who prepared the report	Appendix B
The expertise of that person to compile a specialist report including a curriculum vitae	Appendix B
A declaration that the person is independent in a form as may be specified by the competent authority	Page Error! Bookmark not defined.
An indication of the scope of, and the purpose for which, the report was prepared	Section Error! Reference source not found.
The date and season of the site investigation and the relevance of the season to the outcome of the assessment	N/A
A description of the methodology adopted in preparing the report or carrying out the specialised process	Section 2
The specific identified sensitivity of the site related to the activity and its associated structures and infrastructure	Section 3.2 Error! Reference source not found.
An identification of any areas to be avoided, including buffers	N/A
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
A description of any assumptions made and any uncertainties or gaps in knowledge;	Section 5
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 4
Any mitigation measures for inclusion in the EMPr	Appendix A
Any conditions for inclusion in the environmental authorisation	n/a
Any monitoring requirements for inclusion in the EMPr or environmental authorisation	Section 7
A reasoned opinion as to whether the proposed activity or portions thereof should be authorised	N/A

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	N/A
A description of any consultation process that was undertaken during the course of carrying out the study	N/A
A summary and copies if any comments that were received during any consultation process	N/A
Any other information requested by the competent authority.	N/A

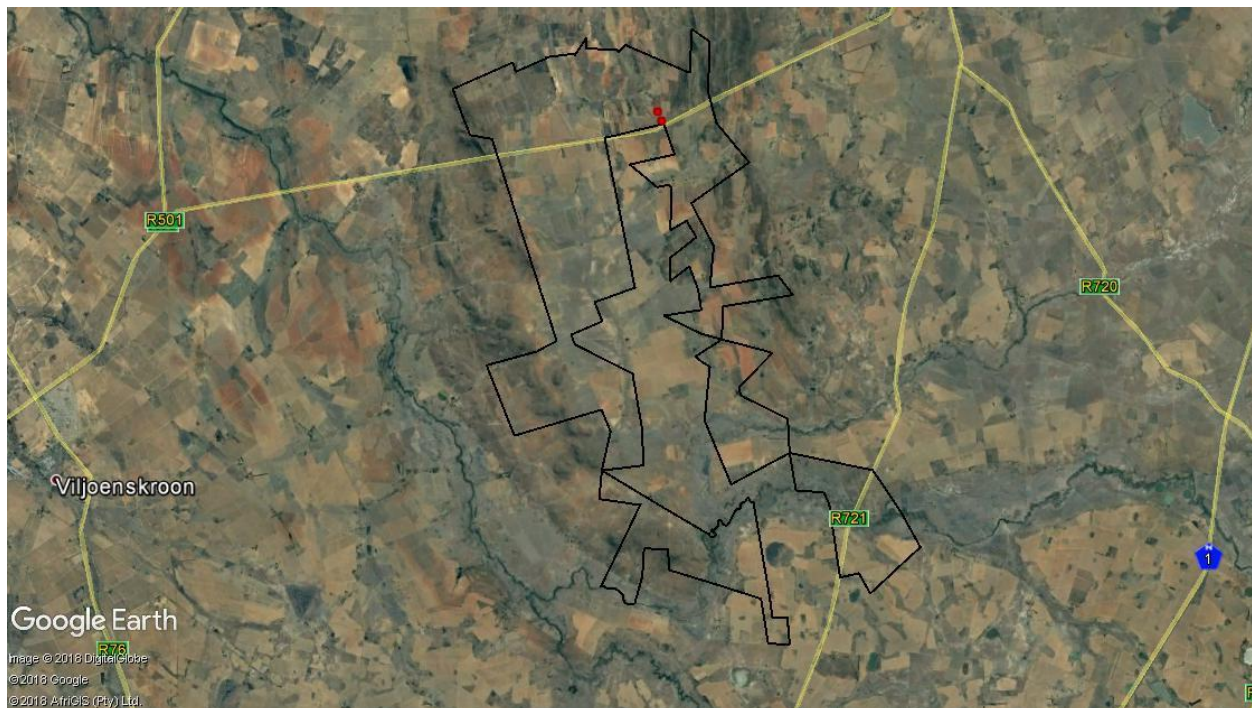


Figure 1: Google Earth map of the proposed site for the exploration for the Vredefort West Est project, and the site for two trenches shown as indicated by the red dots. Map supplied by NGT.

## 2. 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' representivity or scientific importance to decide if the fossils can be destroyed or a representative sample collected.



### 3. GEOLOGY AND PALAEOBIOLOGY

#### 3.1. Project location and geological context

The area for the proposed exploration project is west of Vredefort and lies on rocks of the Ecca Group, mostly Vryheid and Volksrust Formations with outcrops of the older Chuniesport Group, Witwatersrand Supergroup with Jurassic dolerite dykes and some Quaternary sand cover. Beneath these rocks are ancient rocks of the Witwatersrand Basin, namely the Central Rand and East Rand Groups, that are the target of this project. The Witwatersrand Supergroup deposition began about 3076 million years ago and ended about 2714 Ma (McCarthy, 2006) and the bolide impact that formed the Vredefort Dome occurred approximately 2017 Ma (Reimold, 2006) has preserved the gold and other minerals emplaced. Finally, the more recent uplift of southern Africa and subsequent erosion, has meant that these deposits are nearer the earth's surface (Robb and Meyer, 1995; McCarthy, 2006).

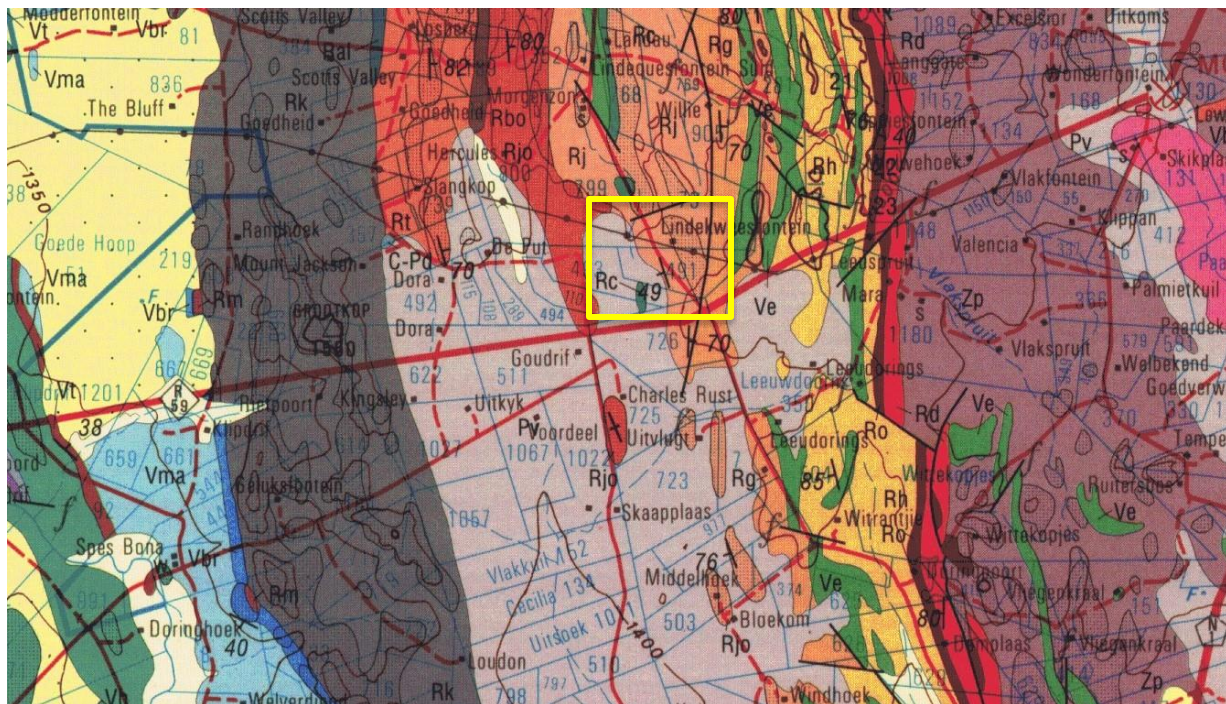


Figure 2: Geological map of the area south and west of Vredefort. The location of the proposed project is indicated within the yellow rectangle. Abbreviations of the rock types are explained in Table 2. Map enlarged from the Geological Survey 1: 250 000 map 1986.

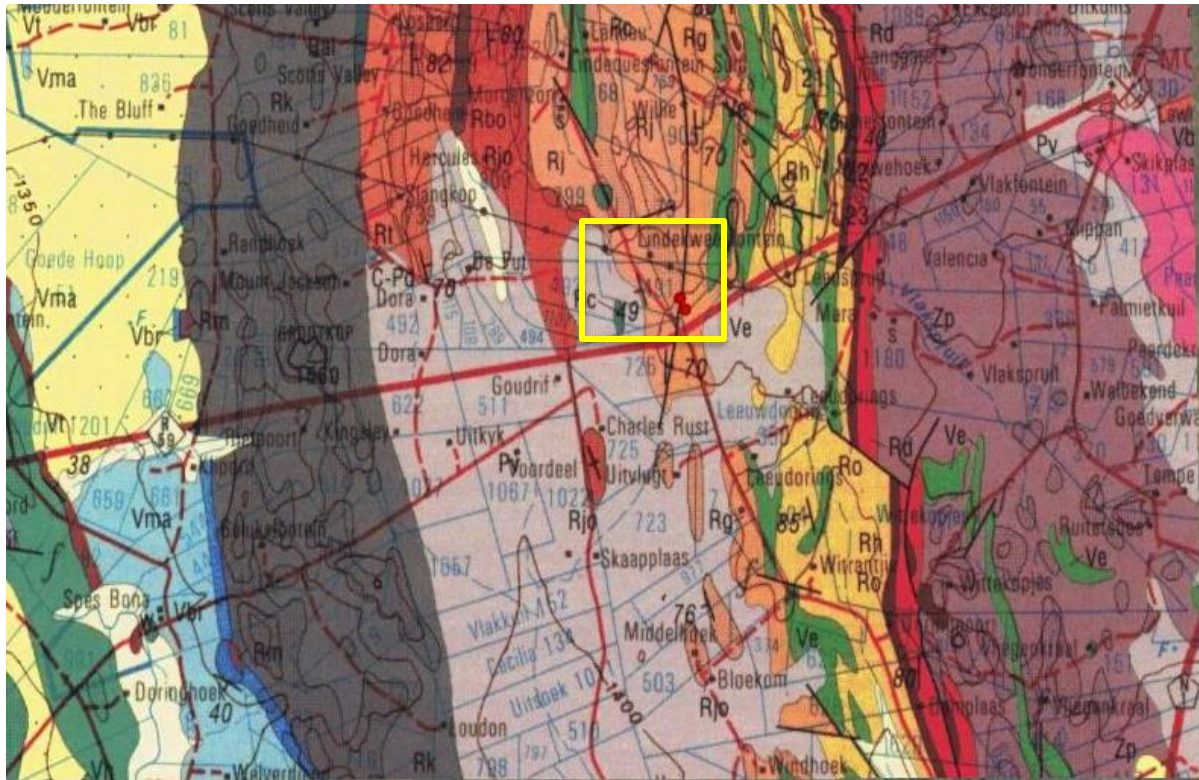


Figure 3: Geological map of the area south and west of Vredefort. The location of the proposed project is indicated within the yellow rectangle and the trenches are indicated by red dots. Abbreviations of the rock types are explained in Table 2. Map enlarged from the Geological Survey 1: 250 000 map 1986



Table 2: Explanation of symbols for the geological map and approximate ages (Barbolini et al., 2016; Johnson et al., 2006; McCarthy et al., 2006; Robb et al., 2006). SG = Supergroup; Fm = Formation.

Symbol	Group/Formation	Lithology	Approximate Age
Q	Quaternary	Alluvium, sand, calcrete	Neogene, ca 25 Ma to present
Jd	Jurassic dykes	Dolerite dykes, intrusive	Jurassic, approx. 180 Ma
Pvo	Volksrust Fm, Eccca Group	Shales,	(Late Permian) Guadalupian, Capitanian to Lopingian, Wuchiapingian; Ca 266 – 256 Ma
Pv	Vryheid Fm, Eccca Group	Sandstone, shale, coal	(Mid Late Permian), Guadalupian, Wordian; Ca 269-266 Ma
Vdi	diabase	diabase	
Vm	Malmani subgroup, Chuniespoort Group Transvaal SG	Dolomite, chert	>2400 Ma
Rj	Jeppetown subgroup West Rand Group Witwatersrand SG	Shale, quartzite, lava	>2600 Ma
Rg	Government subgroup West Rand Group Witwatersrand SG	Quartzite, shale	>2600 Ma
Rd	Dominion Group	Volcanics	Ca 3074 Ma
ZA	Basement	Granite, gneiss	>3090 Ma

### 3.2. Palaeontological context

The palaeontological sensitivity of the area under consideration is presented in Figure 3. The sites for the two trenches is on Farm Mimosa Grove 491. The underlying rocks that are the target of this prospecting operation are too old and of igneous or metamorphic origin so do not contain fossils, so they will not be considered further. These are the Government (eastern half of the Farm Mimosa) and Jeppetown (central part of the Farm) Subgroups of the Witwatersrand Group.

The western part of the Farm Mimosa Grove is on the sandstones and shales of the early Permian Vryheid Formation. In contrast the older Vryheid Formation in this part of the Karoo Basin has a patchy but significant fossil record with a variety of plant impressions from the *Glossopteris* flora (Plumstead, 1969; Anderson and Anderson, 1985).

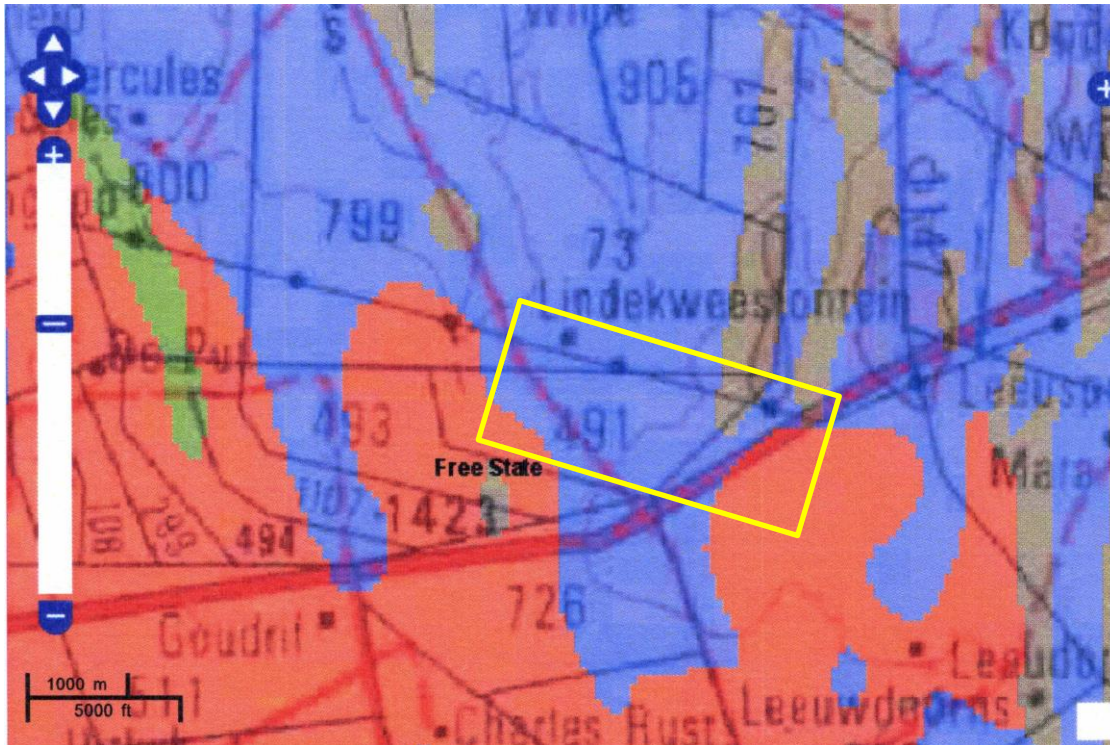


Figure 4: SAHRIS palaeosensitivity maps for the site for the proposed trenches on Farm Mimosa Grove 491 shown within the yellow rectangle. Colours indicate the following degrees of sensitivity: red = very highly sensitive; orange/yellow = high; green = moderate

From the SAHRIS palaeosensitivity map above much of the area is indicated as low sensitivity (blue) with highly sensitive indicated in the west so a desktop study is presented here. It is possible that the fossils may be impacted if the trenching is planned for the western half of the farm (Figure 3). Vertebrate fossils seldom occur with fossil plants but the plants that could occur here are leaves and fructifications of the glossopterids, ferns, sphenophytes, lycopods and some early gymnosperms – all in the form of impressions.

#### 4. IMPACT ASSESSMENT

An assessment of the potential impacts to possible palaeontological resources considers the criteria encapsulated in **Error! Reference source not found.** and 4:

Table 3: Criteria for assessing impacts

PART A: DEFINITION AND CRITERIA		
<b>Criteria for ranking of the SEVERITY/NATURE of environmental impacts</b>	<b>H</b>	Substantial deterioration (death, illness or injury). Recommended level will often be violated. Vigorous community action.
	<b>M</b>	Moderate/ measurable deterioration (discomfort). Recommended level will occasionally be violated. Widespread complaints.
	<b>L</b>	Minor deterioration (nuisance or minor deterioration). Change not measurable/ will remain in the current range. Recommended level will never be violated. Sporadic complaints.
	<b>L+</b>	Minor improvement. Change not measurable/ will remain in the current range. Recommended level will never be violated. Sporadic complaints.
	<b>M+</b>	Moderate improvement. Will be within or better than the recommended level. No observed reaction.
	<b>H+</b>	Substantial improvement. Will be within or better than the recommended level. Favourable publicity.
<b>Criteria for ranking the DURATION of impacts</b>	<b>L</b>	Quickly reversible. Less than the project life. Short term
	<b>M</b>	Reversible over time. Life of the project. Medium term
	<b>H</b>	Permanent. Beyond closure. Long term.
<b>Criteria for ranking the SPATIAL SCALE of impacts</b>	<b>L</b>	Localised - Within the site boundary.
	<b>M</b>	Fairly widespread – Beyond the site boundary. Local
	<b>H</b>	Widespread – Far beyond site boundary. Regional/ national
<b>PROBABILITY (of exposure to impacts)</b>	<b>H</b>	Definite/ Continuous
	<b>M</b>	Possible/ frequent
	<b>L</b>	Unlikely/ seldom

Table 4: Impact Assessment

PART B: Assessment		
<b>SEVERITY/NATURE</b>	<b>H</b>	-
	<b>M</b>	-
	<b>L</b>	Although there are no records of fossils in this area it is possible that <i>Glossopteris</i> flora plants could occur in the Vryheid Formation. Since the footprint of the cores is very small the impact would be very unlikely.
	<b>L+</b>	-
	<b>M+</b>	-
	<b>H+</b>	-
	<b>H</b>	-
<b>DURATION</b>	<b>L</b>	-
	<b>M</b>	-
	<b>H</b>	Where manifest, the impact will be permanent.
<b>SPATIAL SCALE</b>	<b>L</b>	Since only the possible fossils within the area would be fossil plants from the <i>Glossopteris</i> flora in the shales, the spatial scale will be localised within the site boundary.
	<b>M</b>	-
	<b>H</b>	-
<b>PROBABILITY</b>	<b>H</b>	-
	<b>M</b>	-
	<b>L</b>	It is extremely unlikely that any fossils would be found in the ancient rocks but there is a small chance of finding fossil plants in the Vryheid Fm (west). Nonetheless a chance find protocol should be added to the eventual EMPr.

Based on the nature of the project, surface activities may impact upon the fossil heritage if preserved in the development footprint. The geological structures suggest that the rocks are either much too old to contain fossils. Furthermore, the material to be mined is ancient and below surface. Since there is a small chance that fossils from the Vryheid Formation on the western part of the farm a Chance find protocol has been added to this report. Taking account of the defined criteria, the potential impact to fossil heritage resources is low.

## **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 do contain fossil plant, insect, invertebrate and vertebrate material. The sands of the Quaternary period or rocks of the Witwatersrand Group would not preserve fossils.

## **6. 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 loose sands of the Quaternary. There is a small chance that fossils may occur in the shales of the early Permian Vryheid Formation, so a Chance Find Protocol should be added to the EMPr: if fossils are found by the responsible person overseeing the operations once trenching has commenced then the fossils should be rescued, and a palaeontologist called to assess and collect a representative sample.

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## APPENDIX A - CHANCE FIND PROTOCOL

### **Monitoring Programme for Palaeontology – to commence once the trenching begins.**

1. The following procedure is only required if fossils are seen on the surface and when excavations/prospecting commence.
2. When excavations begin the rocks and must be given a cursory inspection by the environmental officer or designated person. Any fossiliferous material (plants, insects, bone, coal) should be put aside in a suitably protected place. This way the prospecting activities will not be interrupted.
3. Photographs of similar fossil plants must be provided to the developer to assist in recognizing the fossil plants in the shales and mudstones (for example see Figure 1.5). 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/miners 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 the site inspections by the palaeontologist will not be necessary. Annual reports by the palaeontologist must be sent to SAHRA.
8. If no fossils are found and the excavations have finished then no further monitoring is required.



## APPENDIX B – DETAILS OF SPECIALIST

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

June 2018

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#### **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	6	1
Masters	8	1
PhD	10	2
Postdoctoral fellows	9	3

**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 –  
*Cretaceous Research*: 2014 -

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

Publications by M K Bamford up to June 2018 peer-reviewed journals or scholarly books: over 120 articles published; 5 submitted/in press; 8 book chapters.

Scopus h index = 26; Google scholar h index = 28;

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)