Nurture | Grow | Treasure

NGT ESHS Solutions

PROJECT TITLE:

PURE SOURCE MINE – ENVIRONMENTAL IMPACT REPORT AND ENVIRONMENTAL IMPACT MANAGEMENT REPORT

PROJECT REFERENCE:

DATE OF ISSUE:

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SPECIALIST REPORT:

Palaeontological Impact Assessment for the mining rights application for farm Woodlands 407, situated in the Free State Province, South Africa

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DECLARATION OF INDEPENDENCE

Marion Bamford has compiled this report on behalf of NGT ESHS. 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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SIGNATURE (HAND SIGNATURE)	

EXECUTIVE SUMMARY

A Palaeontological Impact Assessment was requested for the Mining Rights application for the farm Woodlands 407, situated in the Free State Province (SAHRIS Interim Comment 12979). This PIA included the whole farm. 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 project.

Conclusions:

The proposed site lies on Quaternary sands and soils, volcanic rocks of the Lindeques Drift Complex, Klipriviersberg Group and the Hekpoort Formation (Pretoria group, Transvaal Supergroup). Only the Malmani Group dolomites and limestones are potentially fossiliferous as they could have stromatolites. Stromatolites are trace fossils of algal activity but very rarely contain the microbes preserved within them.

Recommendations:

Stromatolites, i.e. rocks, are not the target of the mining rights application which is for construction sand, refractory sand, recreational sand, aggregates and diamonds. The mining activities, therefore will not impact on the stromatolites, if present. Since the planned buildings may be positioned on harder surfaces, there is a small chance that this could include stromatolites. Since there is a low probability of finding fossils a Fossil Chance Find Protocol should be followed once mining and excavation commences in the Malmani Group rocks. If any stromatolites are discovered by the responsible person in charge, they should be rescued and put aside for a professional palaeontologist to assess. As far as the palaeontology is concerned the project may proceed and no site visit is necessary until such time.

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LIST OF ABBREVIATIONS

ACRONYMS	DESCRIPTION
AUTHORITIES	
ASAPA	Association of South African Professional Archaeologists
FDDM	Fezile Dabi District Municipality
FSPHRA	Free State Provincial Heritage Resources Authority
MLM	Moqhaka Local Municipality
NGT	Nurture, Grow, Treasure
SADC	Southern African Developing Community
SAHRA	South African Heritage Resources Agency
DISCIPLINE	
AIA	Archaeological Impact Assessment
CMP	Cultural Management Plan
ESA	Early Stone Age
EIA	Early Iron Age
EIR	Environmental Impact Report
EIMP	Environmental Impact Management Report
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
LEGAL	
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

Monte Cristo Commercial Park (Proprietary) Limited (wholly owned by the Van Wyk Land Corporation (Pty) Ltd "VLDC" Group) proposes mining as set out here under. A Palaeontological Impact Assessment (PIA) was requested for the proposed mining rights application for Farm Woodlands 407, including all three portions of the farm *(Figure 1).*

The receiving environment is located near Sasolburg in the Ngwathe Local Municipality within the Fezile Dabi District Municipality, in the Free State Province of South Africa. The mining area is located approximately 15 km northwest of the town of Sasolburg, in the Free State Province, South Africa. The project area consists of (i) the Remaining extent (Re), (ii) the Remainder (of portion 1) and (iii) Portion 3 of the farm Woodlands 407 and covers an area of approximately 858 ha *(Figure 1).* The project is referred to as the Pure Source Mine. A regional road S171 connecting to the R42 borders the property along the southern boundary. The mining right application area or project area lies on the above-mentioned portions of the farm Woodlands 407, previously covered by the Prospecting Right FS30/5/1/1/2/608 PR as indicated on the locality map *(Figure 2)*.

The project area is located approximately 30 km south-west of the middle of the Vredefort dome and 16km from the 8km south-west of the buffer zone *(Figure 3).* The Woodlands project area falls outside of the 5km protected areas, as indicated by the buffer, and as such the proposed project will not have an impact on the paleontological resources located in the Vredefort region *(Figure 4).*

The Applicant has submitted a Mining Right application, along with the requisite Environmental Authorisation application. In order 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 PIA was completed for the proposed miming *(Table 2).*

Table 1: Site Location and Property Information

Erf or farm number/s	Woodlands 407 (portion RE, RE of portion 1 and portion 3)
Town	Near Parys
Responsible local authority	Ngwathe Local Municipality
Ward	6
Magisterial district	Fezi Dabi District Municipality
Region	Free State Province
Country	South Africa
Site centre GPS coordinates	• 26° 44' 48.82" S • 27° 36' 42.51" E

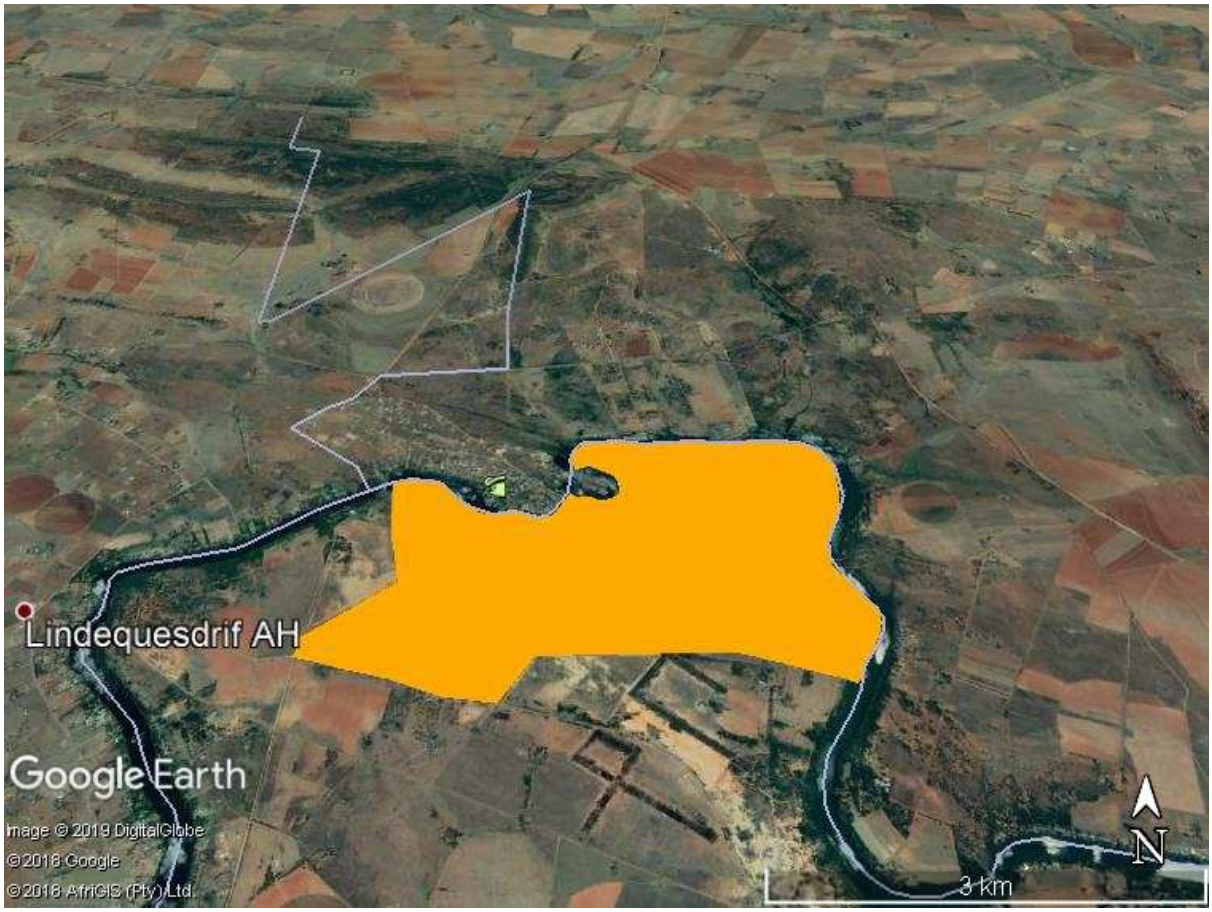


Figure 1: Google Earth map showing the outline of the farm Woodlands 407.

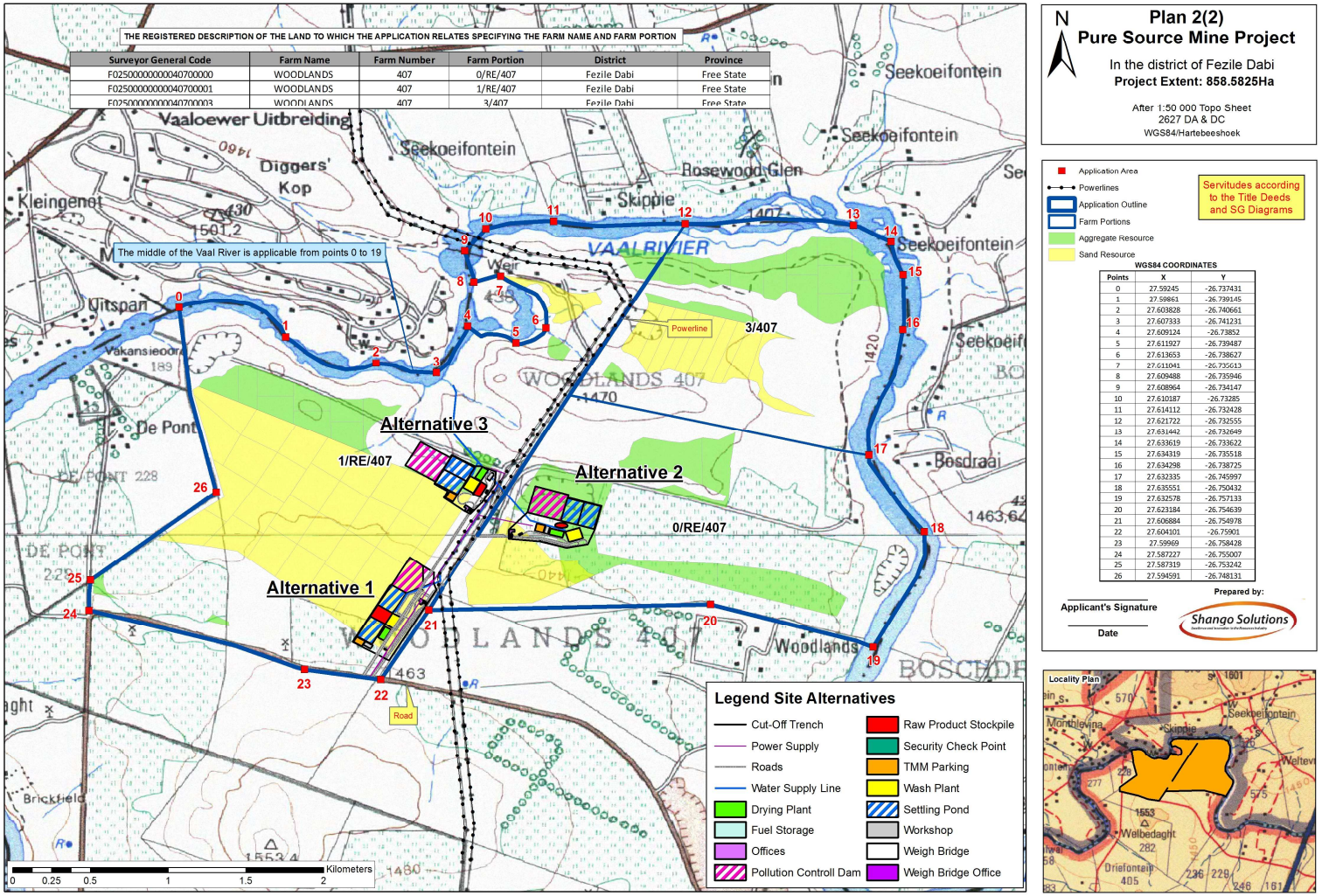


Figure 2: Map of the proposed development and mining infrastructure on farm Woodlands 407, Free State Province. Map supplied by Shango Solutions.

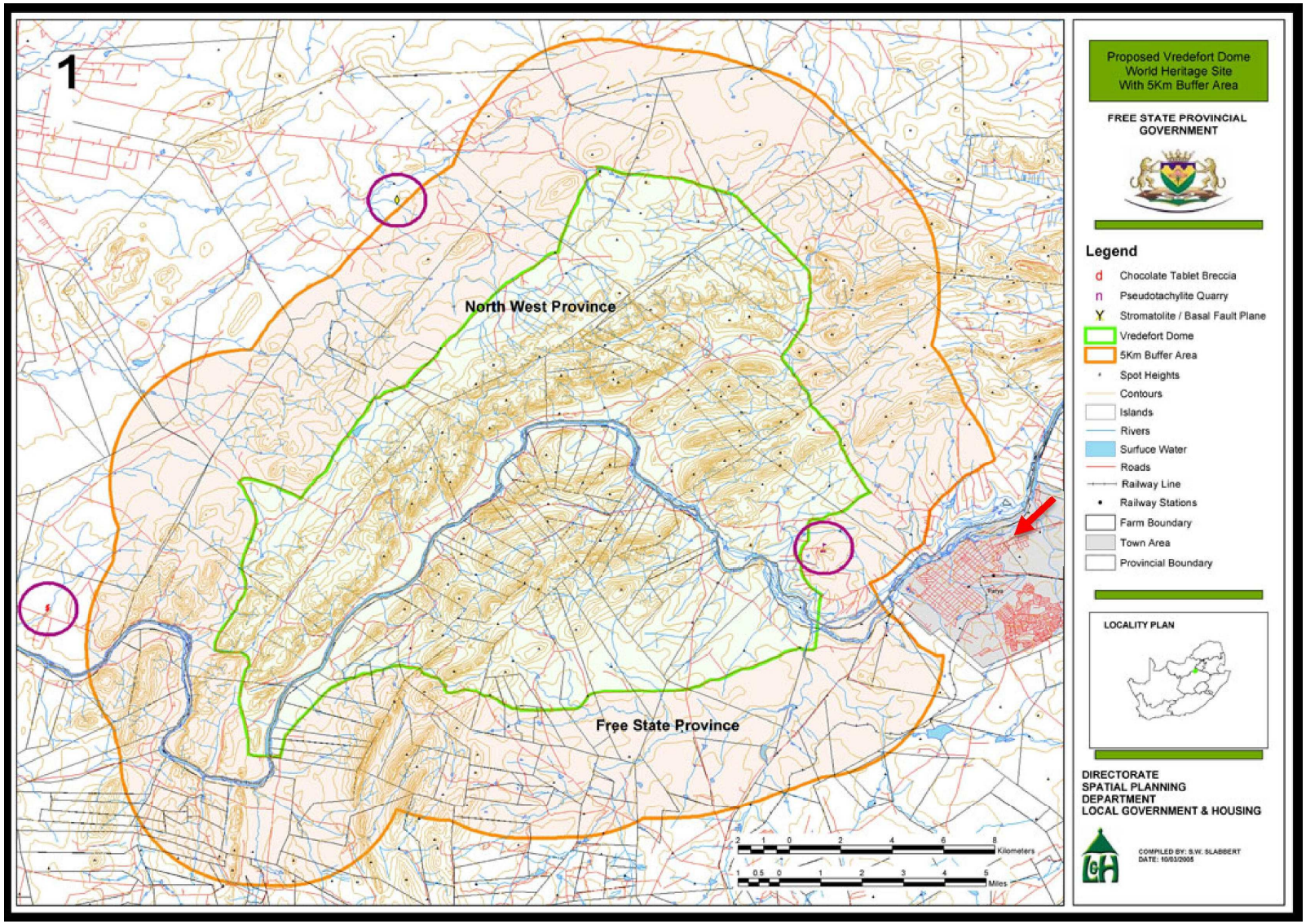


Figure 3: Map of the Vredefort dome (red arrow indicates Parys) and its buffer zone (Source: UNESCO).

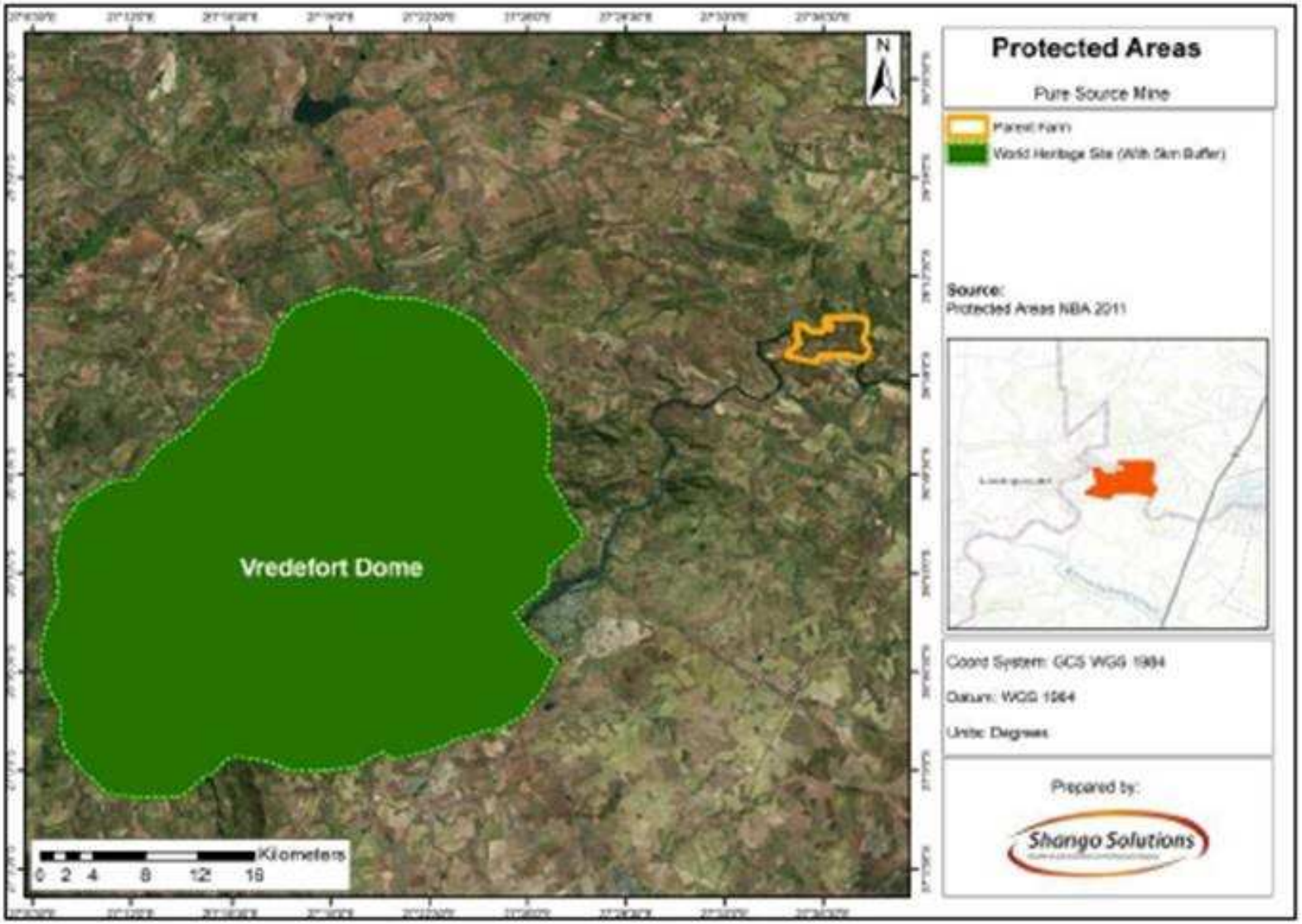


Figure 4: Map indicating the relation of the project area to the Vredefort dome (Source: Shango)

Table 2: 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 0
The specific identified sensitivity of the site related to the activity and its associated structures and infrastructure	Section 0 **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 0
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	n/a
Any conditions for inclusion in the environmental authorisation	n/a
Any monitoring requirements for inclusion in the EMPr or environmental authorisation	Section 8
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

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*).
4. Determination of fossils' representivity or scientific importance to decide if the fossils can be destroyed or a representative sample collected.

Impact Significance Rating was completed and was guided by the requirements of the NEMA EIA Regulations (2014) (*Tables 3-6*).

Table 3: Table indicating the impact significance rating.

Alternative No	**List Alternative Names**	
Proposal	Development	
Alternative 1	Development Area 01	
Alternative 2	Development Area 02	
Nature	-1	Negative
	1	Positive
Extent	1	Activity (i.e. limited to the area applicable to the specific activity)
	2	Site (i.e. within the development property boundary),
	3	Local (i.e. the area within 5 km of the site),
	4	Regional (i.e. extends between 5 and 50 km from the site
	5	Provincial / National (i.e. extends beyond 50 km from the site)
Duration	1	Immediate (<1 year)
	2	Short term (1-5 years),

	3	Medium term (6-15 years),
	4	Long term (the impact will cease after the operational life span of the project),
	5	Permanent (no mitigation measure of natural process will reduce the impact after construction).
Magnitude/ Intensity	1	Minor (where the impact affects the environment in such a way that natural, cultural and social functions and processes are not affected),
	2	Low (where the impact affects the environment in such a way that natural, cultural and social functions and processes are slightly affected),
	3	Moderate (where the affected environment is altered but natural, cultural and social functions and processes continue albeit in a modified way),
	4	High (where natural, cultural or social functions or processes are altered to the extent that it will temporarily cease), or
	5	Very high / don't know (where natural, cultural or social functions or processes are altered to the extent that it will permanently cease).
Reversibility	1	Impact is reversible without any time and cost.
	2	Impact is reversible without incurring significant time and cost.
	3	Impact is reversible only by incurring significant time and cost.
	4	Impact is reversible only by incurring prohibitively high time and cost.
	5	Irreversible Impact
Probability	1	Improbable (the possibility of the impact materialising is very low as a result of design, historic experience, or implementation of adequate corrective actions; <25%),
	2	Low probability (there is a possibility that the impact will occur; >25% and <50%),
	3	Medium probability (the impact may occur; >50% and <75%),
	4	High probability (it is most likely that the impact will occur- > 75% probability), or
	5	Definite (the impact will occur),

Public feedback	1	Low: Issue not raised in public responses
	2	Medium: Issue has received a meaningful and justifiable public response
	3	High: Issue has received an intense meaningful and justifiable public response
Cumulative Impact	1	Low: Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is unlikely that the impact will result in spatial and temporal cumulative change.
	2	Medium: Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is probable that the impact will result in spatial and temporal cumulative change.
	3	High: Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is highly probable/definite that the impact will result in spatial and temporal cumulative change.
Irreplaceable loss of resources	1	Low: Where the impact is unlikely to result in irreplaceable loss of resources.
	2	Medium: Where the impact may result in the irreplaceable loss (cannot be replaced or substituted) of resources but the value (services and/or functions) of these resources is limited.
	3	High: Where the impact may result in the irreplaceable loss of resources of high value (services and/or functions).
Degree of Confidence	Low	<30% certain of impact prediction
	Medium	>30 and < 60% certain of impact prediction
	High	>60% certain of impact prediction
Priority	Ranking	Prioritisation Factor
3	Low	1,00
4	Medium	1,17
5	Medium	1,33
6	Medium	1,50
7	Medium	1,67
8	Medium	1,83

9	High	2,00
Phase		
Planning		
Construction		
Operation		
Decommissioning		
Rehab and closure		

Table 4: Impact rating table with impact mitigation.

IMPACT DESCRIPTION		PRE – MITIGATION							POST – MITIGATION								IMPACT PRIORITISATION		
Impact	Phase	Nature	Extent	Duration	Magnitude	Reversibility	Probability	Pre-mitigation ER	Nature	Extent	Duration	Magnitude	Reversibility	Probability	Post-mitigation ER	Confidence	Public response	Cumulative Impact	Irreplaceable loss
1. Heritage Impact Ratings	Planning	-1	3	2	2	2	5	-11,25	-1	3	1	2	2	4	-8	High	1	2	1
								0	-1						0				
								0							0				

Table 5: Risk assessment.

	A. 1. Transformation of palaeontological resource – Proposal					
	Impact Name	**Palaeontological Impact Assessment**				
	Alternative	**Proposal**				
	Phase	**Planning**				
	Environmental Risk					
	Attribute	**Pre-mitigation**	**Post-mitigation**	**Attribute**	**Pre-mitigation**	**Post-mitigation**
	Nature of Impact	-1	-1	Magnitude of Impact	2	2
	Extent of Impact	3	3	Reversibility of Impact	2	2
	Duration of Impact	2	1	Probability	5	4
	Environmental Risk (Pre-mitigation)					-11,25
	Mitigation Measures					
	Heritage Risks					
	Heritage Risk (Post-mitigation)					-8,00
	Degree of confidence in impact prediction:					High
	Impact Prioritisation					
	Public Response					1
	Low: Issue not raised in public responses					
	Cumulative Impacts					2
	Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is probable that the impact will result in spatial and temporal cumulative change.					
	Degree of potential irreplaceable loss of resources					1
	The impact is unlikely to result in irreplaceable loss of resources.					
	Prioritisation Factor					1,17
	Final Significance					-9,33

Table 6: Final Significance Ratings

SIGNIFICANCE RATINGS	
Value	**Description**
< -10	Low Negative (i.e. where this impact would not have a direct influence on the decision to develop in the area)
≥ -10 and < -20	Medium Negative (i.e. where the impact could influence the decision to develop in the area)
≥ -20	High Negative (i.e. where the impact must have an influence on the decision process to develop in the area)
< 10	Low Positive (i.e. where this impact would not have a direct influence on the decision to develop in the area)
≥ 10 and < 20	Medium Positive (i.e. where the impact could influence the decision to develop in the area)
≥ 20	High Positive (i.e. where the impact must have an influence on the decision process to develop in the area)

3. GEOLOGY AND PALAEONTOLOGY

3.1. Project location and geological context

According to the geological map *(Figure 5),* the farm Woodlands lies in the ancient volcanic rocks, some dolomite and Quaternary sands.

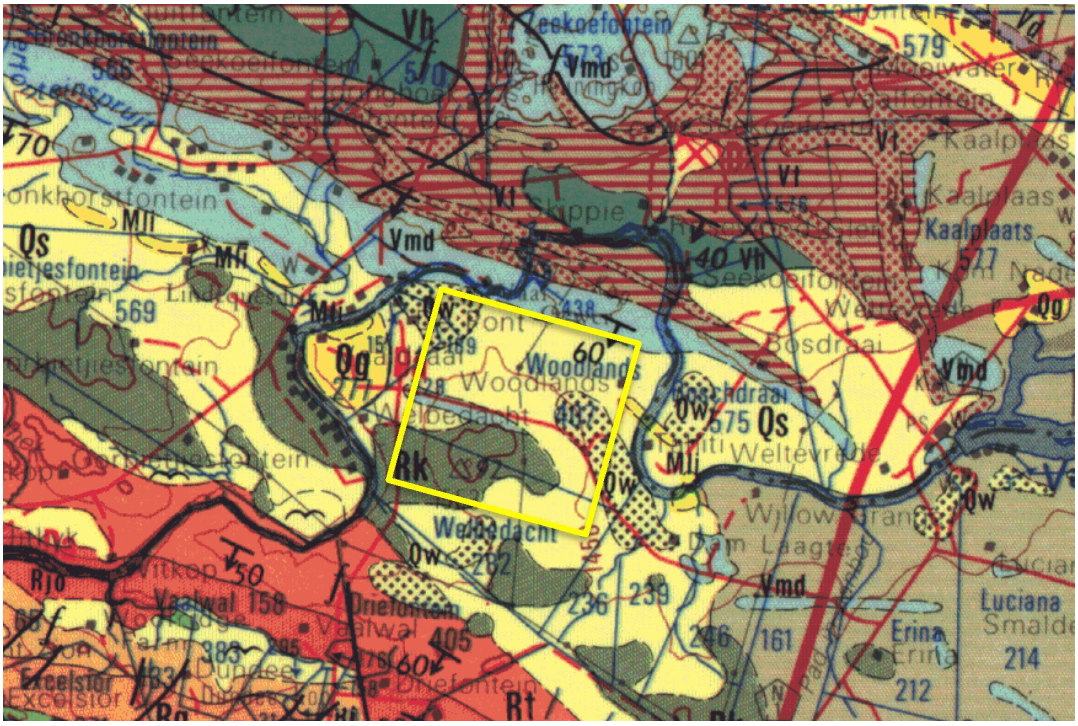


Figure 5: Geological map of the area around Woodlands farm 407. The location of the proposed mining rights indicated with the yellow rectangle. (Abbreviations of the rock types are explained in Table 7). Map enlarged from the Geological Survey 1: 250 000 map 1986

Table 7: Explanation of symbols for the geological map and approximate ages (Anhaeusser, 2006; Eriksson et al., 2006; Johnson et al., 2006). SG = Supergroup; Fm = Formation; Ma = million years.

Symbol	Group/Formation	Lithology	Approximate Age
Qs	Quaternary – soil cover	Alluvial soils	Last 2.5 Ma
Qw	Quaternary – sand	Aeolian sands	Last 2.5 Ma
Mli	Lindesque Drift Complex	Syenodiorite, albite syenite, lamprophyre	Palaeoarchaean to Mesoarchaean 3500-2800 Ma
Vh	Hekpoort Fm, Pretoria Group, Transvaal SG	Andesite, conglomerate, tuff	Ca 2222 Ma
Vt	Timeball Hill Fm, Pretoria Group, Transvaal SG	Ferruginous shale, hornfels, ferruginous quartzites	<2420 – 2222 Ma
Vmd	Malmani Subgroup, Chuniespoort Group, Transvaal SG.	Dolomite, chert, chert breccia	Ca 2642 – 2500 Ma
Rk	Klipriviersberg	Basalts, lava	

The Kaapvaal Craton has a very long history of igneous intrusion and types of rocks. One such period and type of rocks are the 3500-2800 Ma ultramafic and mafic intrusions (Anhaeusser, 2006), including the Lindeques Drift Complex. This intrusion straddles the Vaal River about 20km northeast of Parys (*Figure 1-2*, Farm Woodlands) forming an elongated body into the dolomites of the Transvaal Supergroup. It comprises lamprophyre, syenodiorite, albite-syenite dykes and pegmatitic schlieren in the lamprophyre (ibid).

Also predominantly comprised of volcanic rocks, various lavas (komatiitic lava, felsic lava and porphyritic lavas), the Klipriviersberg Group is the lower group of the Ventersdorp Supergroup and outcrops on the farm Woodlands, diagonally across the centre from northwest to southeast. The younger Malmani Group rocks also follow this trend, as do the Timeball Hill and Hekpoort Formations. The Malmani Group comprises dolomites, limestones, cherts and chert breccias and is divided into five formations. They represent deposition in tidal, intertidal and subtidal zones from a shallow marine setting (Eriksson *et al.*, 2006; 2012).

Slightly younger, the Timeball Hill Formation ferruginous shales, hornfels and ferrugineous quartzites were deposited in a shallow to deep marine environment. In contrast the Hekpoort Formation is volcanic and comprises basaltic andesite and pyroclastic rocks (Eriksson *et al.,* 2006).

Covering much of these ancient rocks are the Quaternary or Kalahari sands, represented here as soil cover or as aeolian sands. Their origin is from surrounding strata but their deposition is much more recent.

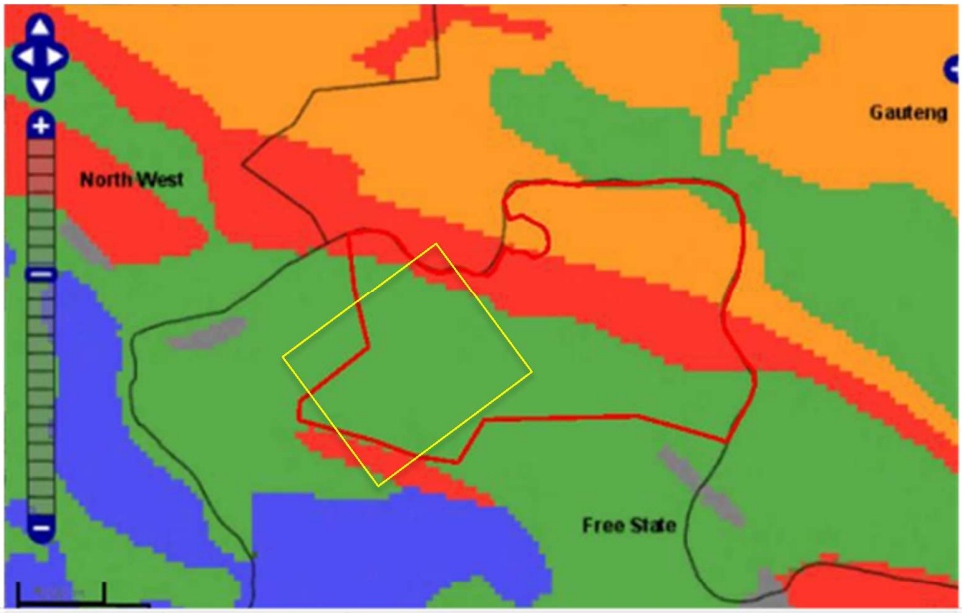
3.2. Palaeontological context

Volcanic rocks do not preserve fossils so the Lindeques Complex, Klipriviersberg Group and Hekpoort Formations would not contain any fossils.

Timeball Hill rocks were deposited in a deep marine environment and are too old to preserve body fossils, so no fossils would be found here. The Malmani Group dolomites might contain stromatolites. Stromatolites are trace fossils of algal colony activity and are the fine layers of minerals laid down by algal colonies inhabiting warm, shallow seas. Minerals usually include calcium carbonate, calcium sulphate, magnesium carbonate and magnesium sulphate. Any fossil algae are very rarely preserved in the dolomites and can only be seen in thin section under a microscope.

The Quaternary deposits are young enough for a wide variety of plants and animals but because of their reworked nature, soils or aeolian sands, fossils are not preserved in this medium. In very rare settings, such as calcretes associated with pan or spring sites, fossil bones, plant impressions and archaeological material can be trapped. However, there is no indication of pans in this area.

According to the SAHRIS Paleo-sensitivity map, the very highly sensitive areas (red) *(Figure 6)* relate to the Malmani Group dolomites and stromatolites may occur here. The highly sensitive areas (orange) relate to the Timeball Hill Formation but, based on the past environment of an ancient deep marine setting pre-dating the evolution of life larger than microbes, it is very unlikely that the palaeosensitivity is accurate. A moderate sensitivity (green) relates to the Quaternary sands and soils, but this is unlikely. The three alternative sites for the proposed buildings fall in the moderately sensitive area.



Colour	Sensitivity	Required Action
RED	VERY HIGH	field assessment and protocol for finds is required
ORANGE/YELLOW	HIGH	desktop study is required and based on the outcome of the desktop study, a field assessment is likely
GREEN	MODERATE	desktop study is required
BLUE	LOW	no palaeontological studies are required however a protocol for finds is required
GREY	INSIGNIFICANT/ZERO	no palaeontological studies are required
WHITE/CLEAR	UNKNOWN	these areas will require a minimum of a desktop study. As more information comes to light, SAHRA will continue to populate the map.

Figure 6: SAHRIS palaeosensitivity map for the site for the proposed mining rights application, Woodlands 407. Building and construction sites are within the yellow rectangle. Colours indicate the following degrees of sensitivity: red = very highly sensitive; orange/yellow = high; green = moderately sensitive; blue/grey = very low to zero sensitivity.

4. IMPACT ASSESSMENT AND RATINGS

Since any fossils, if discovered during the mining, excavation and construction stage, would have been rescued and removed from the site (with a SAHRA permit), the palaeontological heritage impact is only relevant for this first stage *(Table 8).*

An assessment of the potential impacts to possible palaeontological resources considers the criteria encapsulated in the document “Method of assessing impacts” using the relevant scores and calculations summarized in *Table 9-13* and *Figure 7-11.*

Table 8: Identification of the Potential impacts at different phases of the project

PHASE	REASONING	IMPACT
Mining	If fossils are found, they can be rescued and removed from the site	High but mitigation (removal) will remove impact
Planning and Design	No fossils or fossils have been removed	Nil
Construction	No fossils or fossils have been removed	Nil
Operation	No fossils or fossils have been removed	Nil
Decommissioning	No fossils or fossils have been removed	Nil
Rehabilitation and Closure	No fossils or fossils have been removed	Nil

Table 9: Impact and risk assessment rating for the pre-and post-mitigation for the Planning phase for Paleontological Resources

	A. Destruction/damage of palaeontological resources - Proposal					
Palaeontological impact Assessment	**Impact Name**	**Destruction/damage of palaeontological resources**				
	Alternative	**Proposal**				
	Phase	**Planning**				
	Environmental Risk					
	Attribute	**Pre-mitigation**	**Post-mitigation**	**Attribute**	**Pre-mitigation**	**Post-mitigation**
	Nature of Impact	-1	-1	Magnitude of Impact	1	1
	Extent of Impact	1	1	Reversibility of Impact	5	5
	Duration of Impact	1	1	Probability	1	1
	Environmental Risk (Pre-mitigation)					-2,00
	Mitigation Measures					
	See Recommendations in Section 6					
	Environmental Risk (Post-mitigation)					-2,00
	Degree of confidence in impact prediction:					High
	Impact Prioritisation					
	Public Response					1
	Low: Issue not raised in public responses					
	Cumulative Impacts					1
	Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is unlikely that the impact will result in spatial and temporal cumulative change.					
	Degree of potential irreplaceable loss of resources					1
	The impact is unlikely to result in irreplaceable loss of resources.					
	Prioritisation Factor					1,00
	Final Significance					-2,00

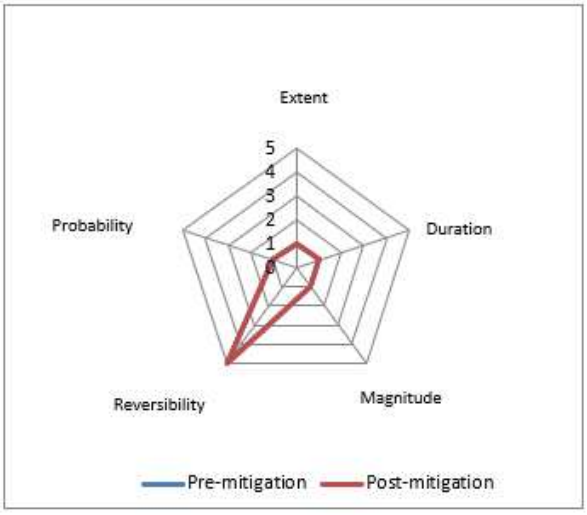


Figure 7: Radar chart indicating the pre-and post-mitigation for the Planning phase for Paleontological Resources

Table 10: Impact and risk assessment rating for the pre-and post-mitigation for the Construction phase for Palaeontological Resources

	B. Destruction/damage of palaeontological resources - Proposal					
Palaeontological Impact Assessment	**Impact Name**	**Destruction/damage of palaeontological resources**				
	Alternative	**Proposal**				
	Phase	**Construction**				
	Environmental Risk					
	Attribute	**Pre-mitigation**	**Post-mitigation**	**Attribute**	**Pre-mitigation**	**Post-mitigation**
	Nature of Impact	-1	-1	Magnitude of Impact	1	1
	Extent of Impact	1	1	Reversibility of Impact	5	2
	Duration of Impact	1	1	Probability	1	1
	Environmental Risk (Pre-mitigation)					-2,00
	Mitigation Measures					
	See Recommendations in Section 6					
	Environmental Risk (Post-mitigation)					-1,25
	Degree of confidence in impact prediction:					High
	Impact Prioritisation					
	Public Response					1
	Low: Issue not raised in public responses					
	Cumulative Impacts					1
	Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is unlikely that the impact will result in spatial and temporal cumulative change.					
	Degree of potential irreplaceable loss of resources					1
	The impact is unlikely to result in irreplaceable loss of resources.					
	Prioritisation Factor					1,00
	Final Significance					-1,25

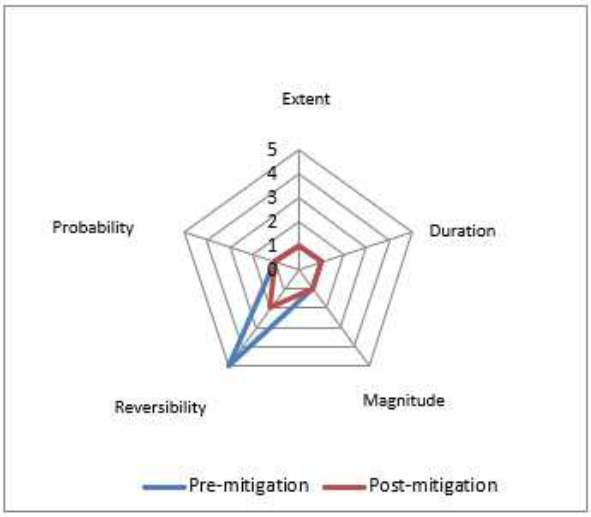


Figure 8: Radar chart indicating the pre-and post-mitigation for the Construction phase for Paleontological Resources

Table 11: Impact and risk assessment rating for the pre-and post-mitigation for the Operation phase for Paleontological Resources

	C. Destruction/damage of palaeontological resources - Proposal					
Palaeontological Impact Assessment	**Impact Name**	**Destruction/damage of palaeontological resources**				
	Alternative	**Proposal**				
	Phase	**Operation**				
	Environmental Risk					
	Attribute	**Pre-mitigation**	**Post-mitigation**	**Attribute**	**Pre-mitigation**	**Post-mitigation**
	Nature of Impact	-1	-1	Magnitude of Impact	1	1
	Extent of Impact	1	1	Reversibility of Impact	5	2
	Duration of Impact	1	1	Probability	1	1
	Environmental Risk (Pre-mitigation)					-2,00
	Mitigation Measures					
	See Recommendations in Section 6					
	Environmental Risk (Post-mitigation)					-1,25
	Degree of confidence in impact prediction:					High
	Impact Prioritisation					
	Public Response					1
	Low: Issue not raised in public responses					
	Cumulative Impacts					1
	Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is unlikely that the impact will result in spatial and temporal cumulative change.					
	Degree of potential irreplaceable loss of resources					1
	The impact is unlikely to result in irreplaceable loss of resources.					
	Prioritisation Factor					1,00
	Final Significance					-1,25

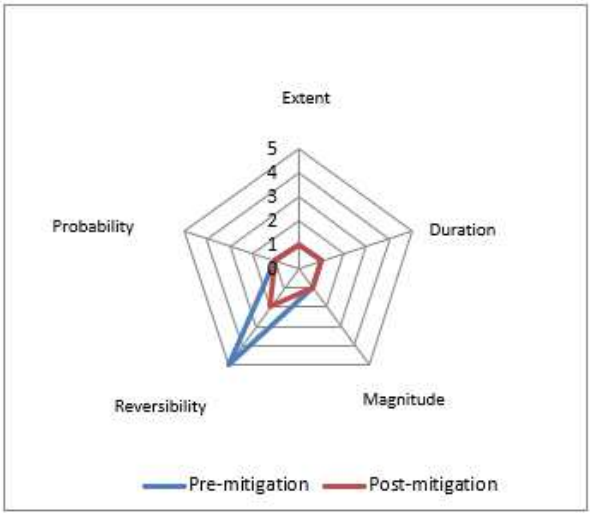


Figure 9: Radar chart indicating the pre-and post-mitigation for the Operation phase for Paleontological Resources

Table 12: Impact and risk assessment rating for the pre-and post-mitigation for the Decommissioning phase for Paleontological Resources

	D. Destruction/damage of palaeontological resources - Proposal					
Palaeontological Impact Assessment	**Impact Name**	**Destruction/damage of palaeontological resources**				
	Alternative	**Proposal**				
	Phase	**Decommissioning**				
	Environmental Risk					
	Attribute	**Pre-mitigation**	**Post-mitigation**	**Attribute**	**Pre-mitigation**	**Post-mitigation**
	Nature of Impact	-1	-1	Magnitude of Impact	1	1
	Extent of Impact	1	1	Reversibility of Impact	5	2
	Duration of Impact	1	1	Probability	1	1
	Environmental Risk (Pre-mitigation)					-2,00
	Mitigation Measures					
	See Recommendations in Section 6					
	Environmental Risk (Post-mitigation)					-1,25
	Degree of confidence in impact prediction:					High
	Impact Prioritisation					
	Public Response					1
	Low: Issue not raised in public responses					
	Cumulative Impacts					1
	Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is unlikely that the impact will result in spatial and temporal cumulative change.					
	Degree of potential irreplaceable loss of resources					1
	The impact is unlikely to result in irreplaceable loss of resources.					
	Prioritisation Factor					1,00
	Final Significance					-1,25

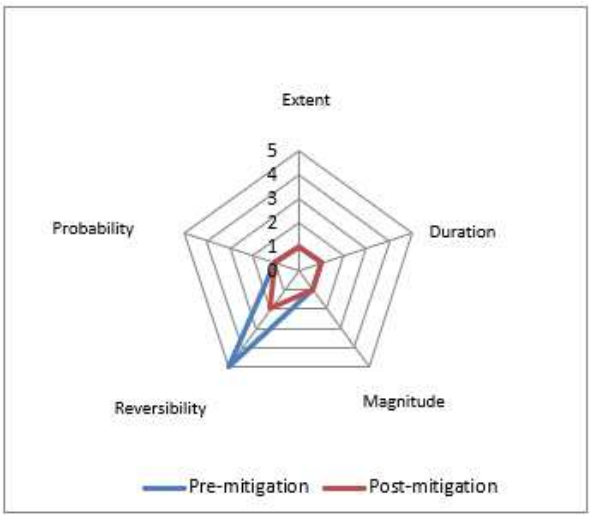


Figure 10: Radar chart indicating the pre-and post-mitigation for the Decommissioning phase for Paleontological Resources

Table 13: Impact and risk assessment rating for the pre-and post-mitigation for the Rehab and Closure phase for Paleontological Resources

	E. Destruction/damage of palaeontological resources - Proposal					
Palaeontological Impact Assessment	**Impact Name**	**Destruction/damage of palaeontological resources**				
	Alternative	**Proposal**				
	Phase	**Rehab and Closure**				
	Environmental Risk					
	Attribute	**Pre-mitigation**	**Post-mitigation**	**Attribute**	**Pre-mitigation**	**Post-mitigation**
	Nature of Impact	-1	-1	Magnitude of Impact	1	1
	Extent of Impact	1	1	Reversibility of Impact	5	2
	Duration of Impact	1	1	Probability	1	1
	Environmental Risk (Pre-mitigation)					-2,00
	Mitigation Measures					
	See Recommendations in Section 6					
	Environmental Risk (Post-mitigation)					-1,25
	Degree of confidence in impact prediction:					High
	Impact Prioritisation					
	Public Response					1
	Low: Issue not raised in public responses					
	Cumulative Impacts					1
	Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is unlikely that the impact will result in spatial and temporal cumulative change.					
	Degree of potential irreplaceable loss of resources					1
	The impact is unlikely to result in irreplaceable loss of resources.					
	Prioritisation Factor					1,00
	Final Significance					-1,25

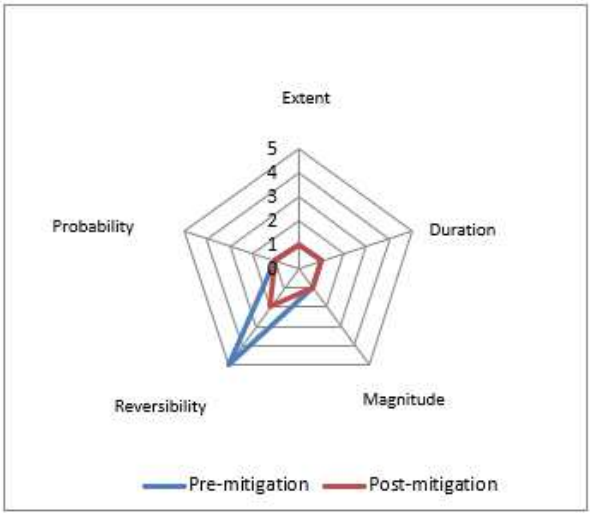


Figure 11: Radar chart indicating the pre-and post-mitigation for the Rehab and Closure phase for Paleontological Resources

Based on the nature of the project, surface activities would not impact upon the fossil heritage because this is limited to the dolomitic rocks of the Malmani Group that might contain stromatolites. Soils and sands do not contain fossils. Furthermore, the area has already been disturbed by agricultural activities. The geological structures suggest that the basal rocks are much too old and of the wrong type to contain fossils. Only the dolomites and limestones the Malmani Group could contain stromatolites which are trace fossils. Since there is an extremely small chance that fossils may be disturbed a Fossil Chance Find Protocol has been added to this report. Taking account of the defined criteria, the potential impact to fossil heritage resources is extremely 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 basal gneisses, granites, sandstones, shales and sands are typical for the country and do not contain any fossil plants, but the dolomites and limestones might contain stromatolites, trace fossils. The sands of the Quaternary period and ancient volcanic rocks would not preserve fossils. Stromatolites have been recorded from the Malmani Group in other parts of the country so there is a possibility that they occur in this area too.

6. RECOMMENDATION

Based on experience and the lack of any previously recorded fossils from the area, it is unlikely that any fossils would be preserved in the underlying volcanic rocks or in the loose soils and sands of the Quaternary. The sands and aggregates are the target of the proposed mining operation. There is an extremely small chance that fossils may occur in the dolomites and limestones of the Malmani Group so a Chance Find Protocol (Appendix A) should be added to the EIR and the EIMP, if fossils are found once mining and excavations have commenced then they should be rescued, and a palaeontologist or geologist be called to assess and collect a representative sample. Thereafter the palaeontology heritage will not be impacted on any further.

7. REFERENCES

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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.

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8. APPENDIX A - CHANCE FIND PROTOCOL

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

1. The following procedure is only required if fossils are seen on the surface and when mining or excavations commence.
2. When mining or excavations begin the rocks and must be given a cursory inspection by the environmental officer or designated person. Any fossiliferous material (stromatolites) should be put aside in a suitably protected place. This way the mining activities will not be interrupted.
3. Photographs of similar trace fossils/stromatolites must be provided to the developer to assist in recognizing the fossils in the shales and mudstones. This information will be built into the EMPr's training and awareness plan and procedures.
4. Photographs of the putative fossils can be sent to the palaeontologist or geologist 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. A final report by the palaeontologist must be sent to SAHRA if there are any fossils.
8. If no fossils are found and the excavations have finished, then no further monitoring is required.

9. APPENDIX B – DETAILS OF SPECIALIST

Curriculum vitae (short) - Marion Bamford PhD

January 2019

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	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

xi) Research Output

Publications by M K Bamford up to June 2018 peer-reviewed journals or scholarly books: over 125 articles published; 5 submitted/in press; 8 book chapters.

Scopus h index = 26; Google scholar h index = 30;

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)