NGT ESHS Solutions

PROJECT TITLE:

BASIC ASSESSMENT REPORT FOR THE AMENDMENT OF AN EXISTING PROSPECTING RIGHT AND ENVIRONMENTAL AUTHORIZATION, LOCATED IN BOTHAVILLE NE EXT, SITUATED IN THE FREE STATE PROVINCE

PROJECT REFERENCE:

BOTHAVILLE NE EXT A

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SPECIALIST REPORT:

Palaeontological Impact Assessment for the amendment of an existing Prospecting Right and Environmental Authorisation for Bothaville NE Ext A 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. 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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EXECUTIVE SUMMARY

A Palaeontological Impact Assessment (PIA) was requested for the amendment of an existing Prospecting Right and Environmental Authorisation for Bothaville NE Ext A situated in the Free State Province. This PIA mainly focused on the eight proposed drillhole positions located on the farms Concord 392 (Portion RE), Eureke 761 (Portion 1) and Tarantaaldraai 156 (Portion 1). The receiving environment is located in the Moqhaka Local Municipality of the Fezile Dabi District Municipality, in the Free State Province, South Africa. 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 drilling.

Conclusions:

The proposed sites lie on Quaternary sands which overlie shales of the Vryheid Formation of the Ecca Group. Beneath these are the Central Rand Group, Witwatersrand Supergroup of the Free State Goldfield. Only the Vryheid Formation of the Karoo Supergroup is potentially fossiliferous. It is composed predominantly of mudstones, sandstones and shales and could have fossil plants typical of the *Glossopteris* flora. The Jurassic dolerite dykes and overlying Quaternary sands do not preserve fossils.

Recommendations:

A Fossil Chance Find Protocol should be followed once drilling commences. If any fossils 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.

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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
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
LEGAL	
NEMA	National Environmental Management Act
NHRA	National Heritage Resources Act

TERMS AND DEFINITIONS

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

Welkom, the largest town in the Free State Goldfield, is situated nearly 270 kilometres (km) towards the southwest of Johannesburg, about 1 370 metres above mean sea level (mamsl). The area is typically flat, represented by treeless grassland, where farming is prominent. Annual rainfall is around 550 millimetres (mm) and drainage occurs into small Karoo pans. Infrastructure is well developed *(Figures 1-3).*

The Witwatersrand Supergroup which hosts gold, is generally overlain by 500 m of Karoo Supergroup strata *(Figure 4),* predominantly horizontally bedded sandstones and shales of the Vryheid Formation, Ecca Group contains coal at shallow depths which might be exploitable.

The Welkom Goldfield hosted eleven mines in the triangle between Allanridge, Welkom and Virginia, 270 km southwest of Johannesburg. Historically, these mines have collectively produced in excess of 9.6 Million kg Au (gold). The Central Rand Group of the Witwatersrand Supergroup is present at Bothaville with four potentially economic placer deposits. The mineralised reefs at Bothaville are the Basal Reef, Big Pebble Conglomerate, A Reef and the B Reef. In addition to gold, the primary exploration target, silver, uranium, sulphur, diamonds, rare earths and platinum group metals are currently and have been historically, extracted as by-products of gold mining. Pretorius (1986) published a map showing the distribution of Witwatersrand rocks below the Karoo cover rocks *(Figure 4).*

A Palaeontological Impact Assessment (PIA) was requested for the proposed prospecting project. This PIA mainly focused on the eight proposed drillhole positions located on three farms: Concord 392 (Portion RE), Eureke 761 (Portion 1) and Tarantaaldraai 156 (Portion 1). The receiving environment is located near Bothaville in the Moqhaka Local Municipality within the Fezile Dabi District Municipality, in the Free State Province of South Africa.

The Applicant has submitted a Prospecting 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 drilling *(Table 1).*

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! eference 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 0 **Error! Reference ource 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 0
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

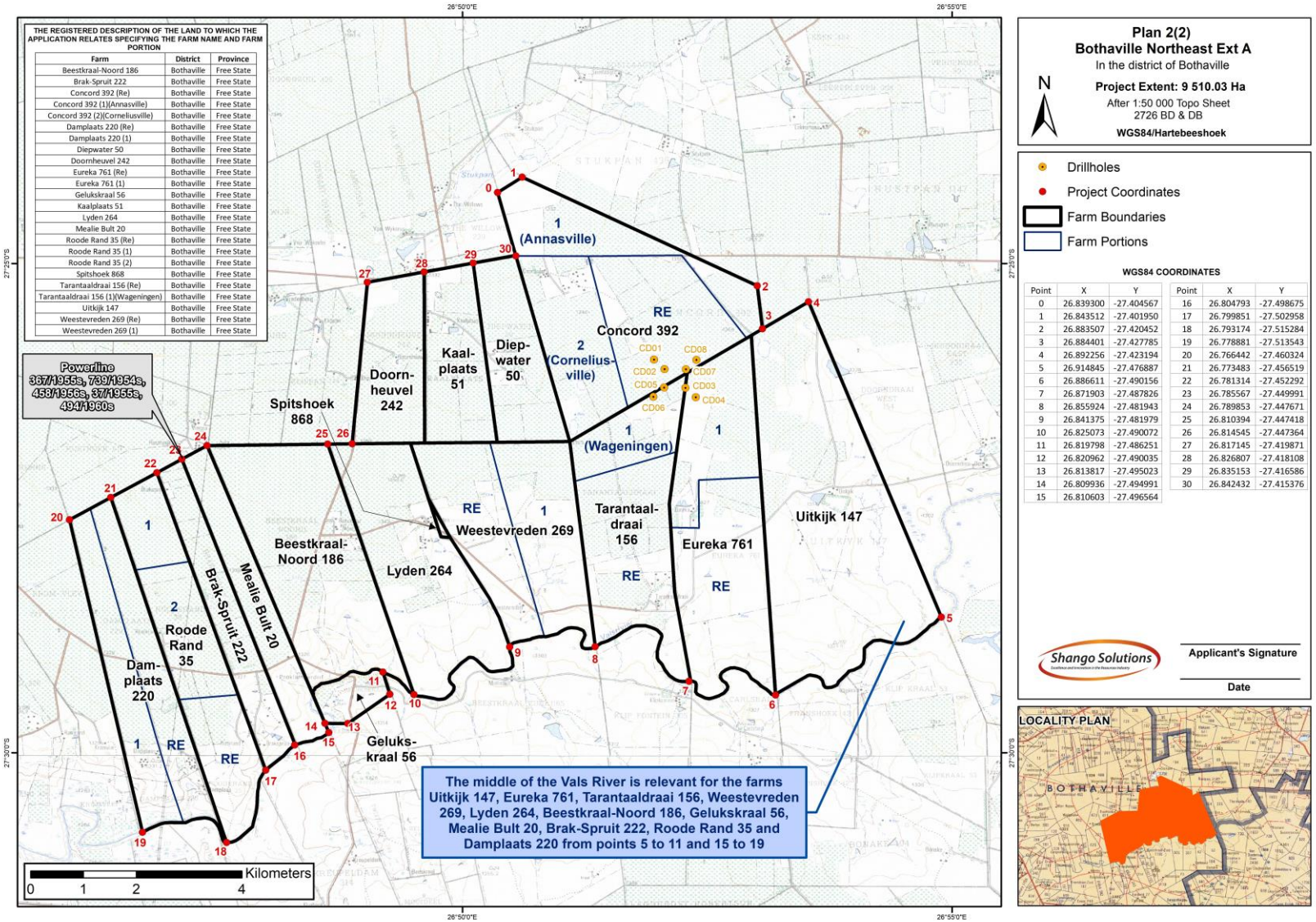

Figure 1: Map of the proposed outline of properties in the Bothaville project (black outline) with farm names. Map supplied by Shango Solutions.

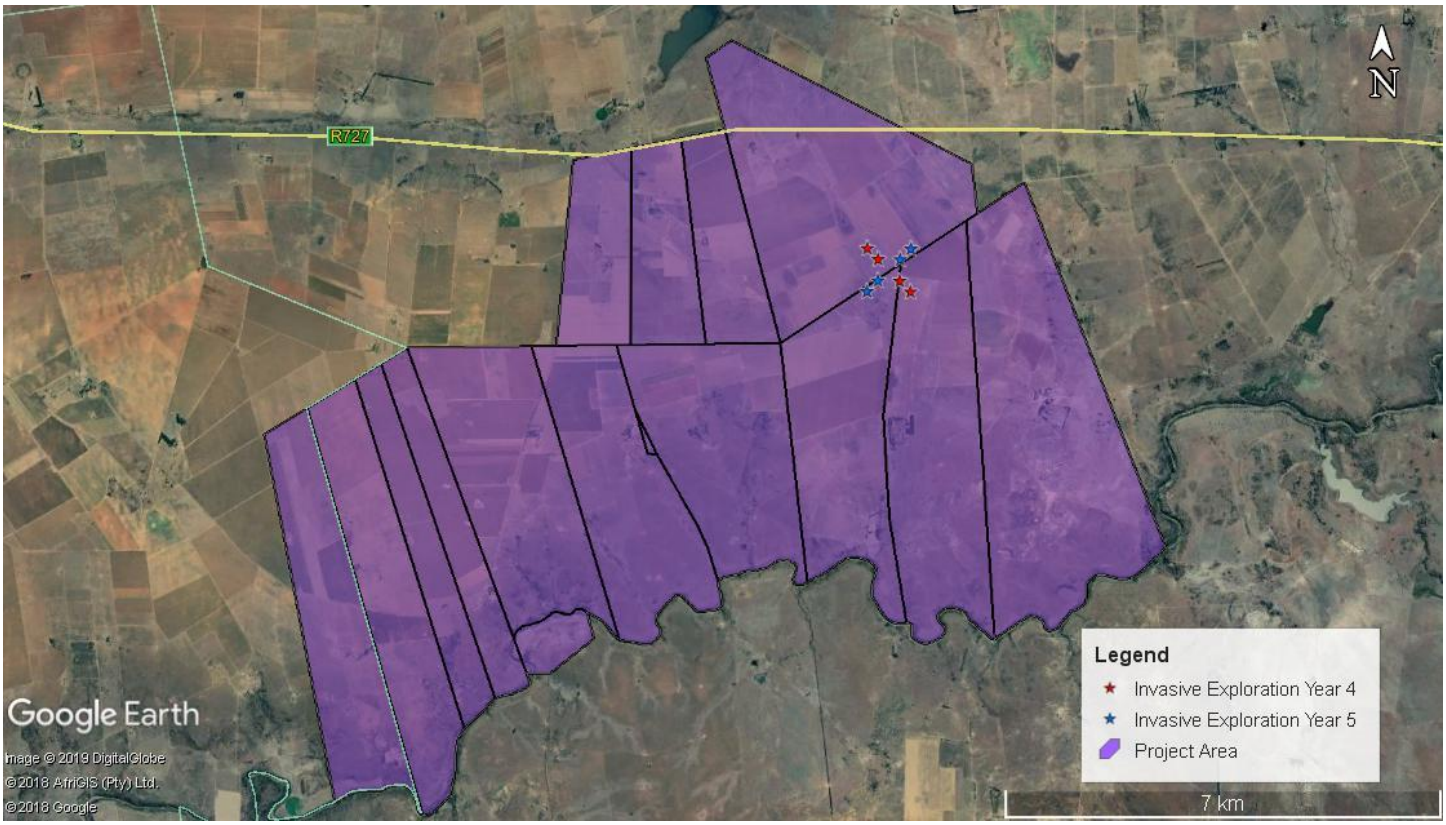

Figure 2: Google Earth map showing the outlines of the farms within the project and the eight proposed drill sites.

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 in will be completed and is guided by the requirements of the NEMA EIA Regulations (2014) (*Tables 2 -5*).

Table 2: 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 3: 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 4: Risk assessment.

	Destruction of Paleontological resources– Proposal					
	Impact Name	**Destruction of Paleontological 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	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 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 5: 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 general geological map, the drill sites lie in the Quaternary sands but very close to an outcrop of the Vryheid Formation, Ecca Group of the Karoo Supergroup *(Figure 3 and Table 6)* and this formation most likely underlies the Quaternary Kalahari sands *(Figure 4).* The Karoo rocks may be up to 500 m thick in this part of the Karoo Basin. Below this cover are the Central Rand Group volcanic rocks, shales, conglomerates and quartzites that contain gold and potentially other minerals such as Base metals (cobalt, copper, manganese, molybdenum, nickel, lead, tungsten and zinc) (Pretorius *et al.,* 1986).

The Ecca Group rocks are predominantly siltstones and shales with mudrocks, sandstones, and coals in the Vryheid Formation. They were deposited in the shallow fluvial to deltaic settings for the Vryheid formation, and deeper waters for the Volksrust Formation.

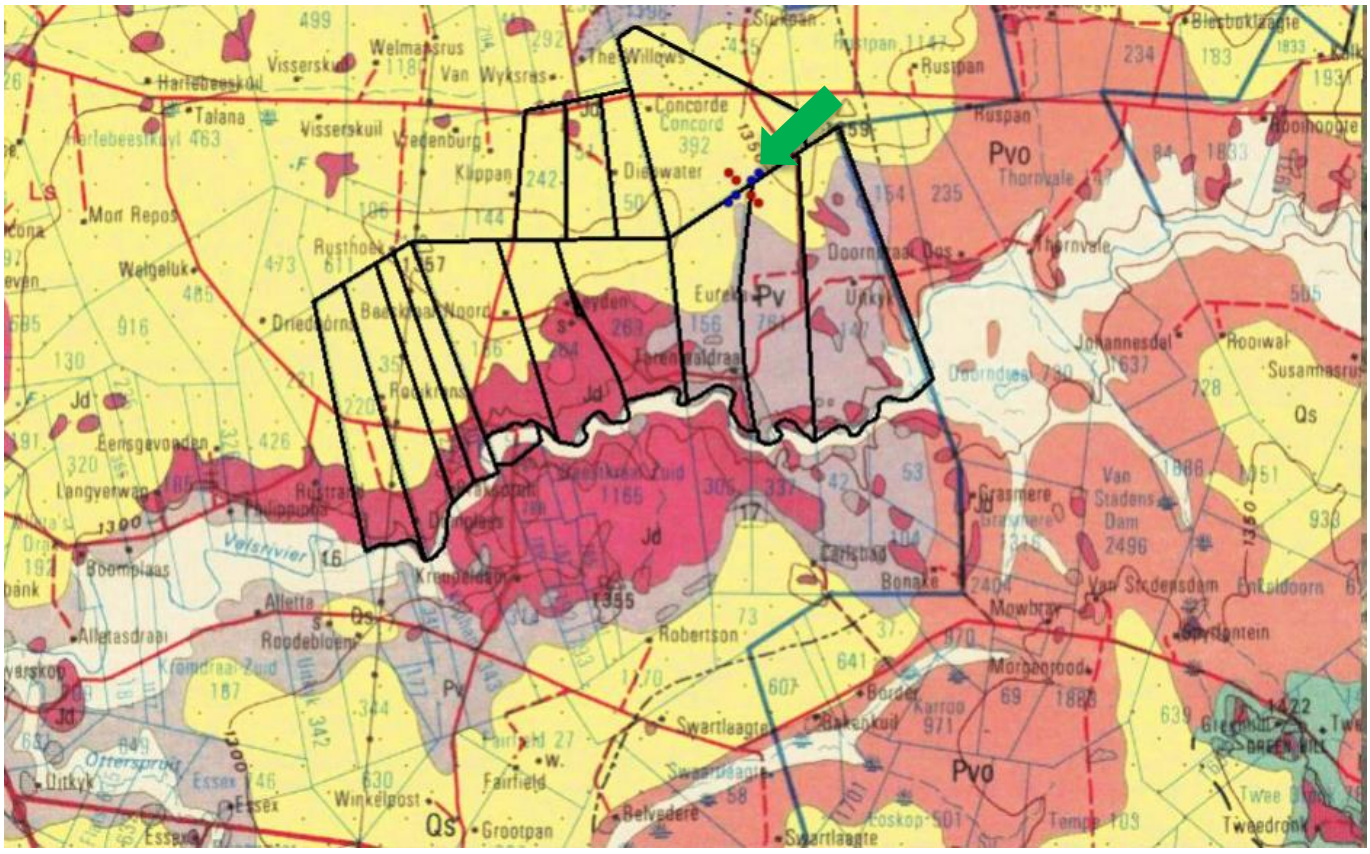

Figure 3: Geological map of the area around Bothaville. The location of the proposed drilling sites is indicated with the green arrow. Abbreviations of the rock types are explained in Table 6. Map enlarged from the Geological Survey 1: 250 000 map 1986.

Table 6: Explanation of symbols for the geological map and approximate ages (Barbolini et al., 2016; Johnson 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, Ecca Group, Karoo SG	Mudstones, siltstones, shales,	(late Permian) Guadalupian, Capitanian to Lopingian, Wuchiapingian; Ca 266 – 256 Ma
Pv	Vryheid Fm, Ecca Group. Karoo SG	Sandstone, siltstones, shale, coal	(Mid late Permian), Guadalupian, Wordian; Ca 269-266 Ma

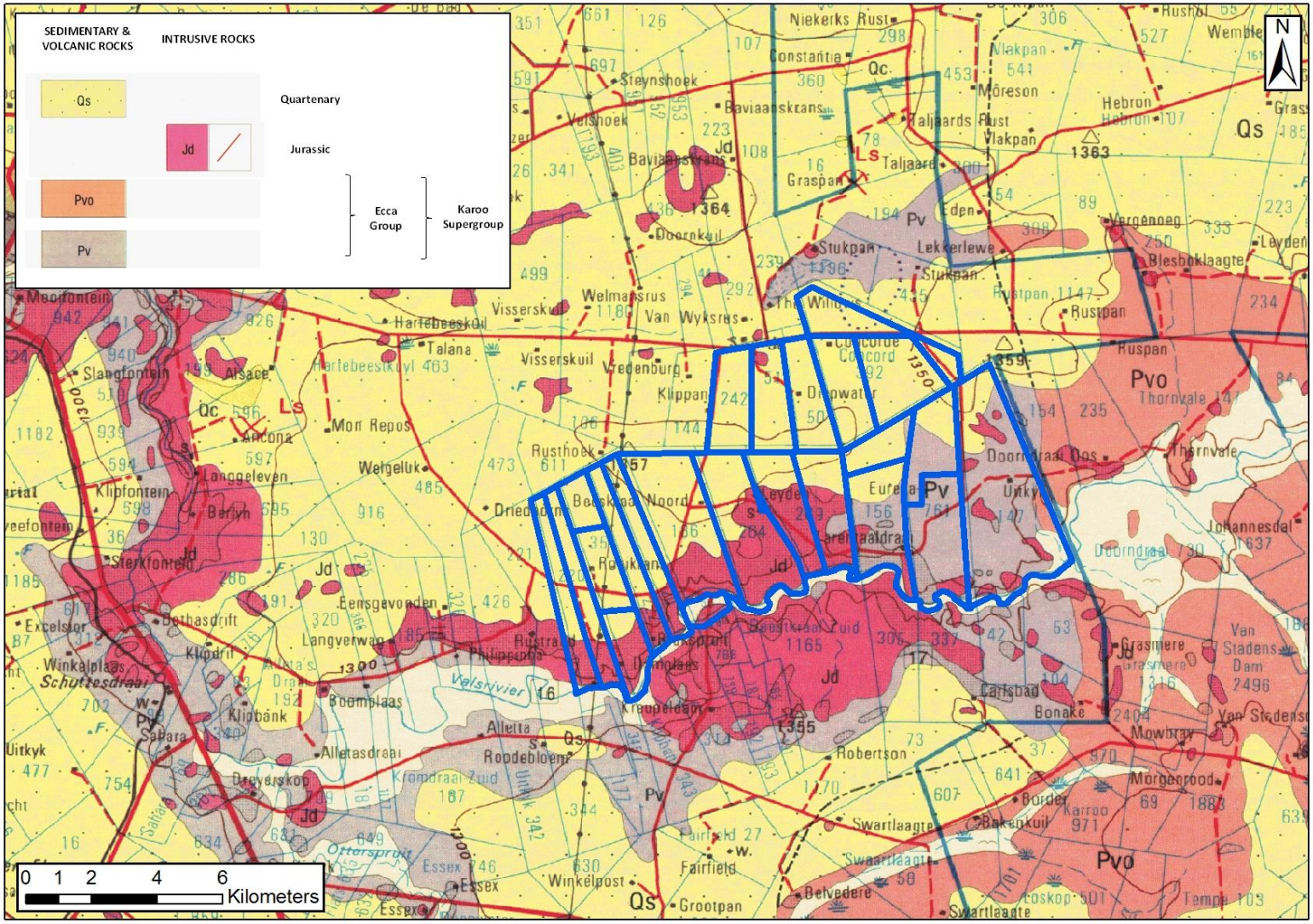

Figure 4: Geological map showing the farm borders for the Bothaville NE Ext A project and the dominance of Quaternary sands. Map provided by Shango Solutions.

3.2. Palaeontological context

Quaternary sands do not preserve fossils as they are too friable, often mobile and oxidized by continued drying out of the global climate and so form calcretes. In exceptional circumstances fossils and archaeological material can be preserved in and around pans. However, no pans were identified in the proposed drillhole sites.

In this north-western part of the Karoo Basin, the Ecca Group *(Figure 4, Table 6)* comprises two formations, the lower one being the Vryheid Formation and the upper the Volksrust Formation. Fossil plants are common in the former but rare from latterr formation. Fossil vertebrates are extremely rare from this time period as very few had evolved. Coals and impression fossils of the Glossopteris flora are abundant in some parts of the Vryheid Formation and include Glossopteris leaves, roots, fructifications, sphenophytes, lycopds and ferns and silicified wood (Plumstead, 1969; Anderson and Anderson, 1985, Bamford, 2004).

The Volksrust Formation is predominantly argillaceous (clay) and represents a transgressive open shelf sequence composed mostly of muds deposited from suspension. There is evidence that the upper and lower layers of the Volksrust Formation were deposited in lacustrine, to lagoonal and shallow coastal embayment settings (Johnson et al*.,* 2006). In contrast the older Vryheid Formation has a patchy but significant fossil record with a variety of plant impressions from the *Glossopteris* flora.

Jurassic dolerite dykes are common in the region as a whole but do not contain fossils as these would have been badly affected or destroyed by the intruding volcanic material.

From the SAHRIS palaeo-sensitivity map above (Figure. 5), all of the area is indicated as moderately sensitive (green) so a desktop study is presented here. The area is covered by Quaternary sands which are not fossiliferous, nor are the underlying ancient Witwatersrand Basin mineral rich deposits. Volksrust Formation shales in most cases are not fossiliferous. The Vryheid Formation can potentially preserve fossils but for most of the area to be drilled they are underlying the Kalahari sands and would not be visible until drilling or trenching begins. Currently the area is farmland and outcrops are not evident from the Google Earth map. Since there does not appear to be pans in the Kalahari sands, no fossils are likely to occur.

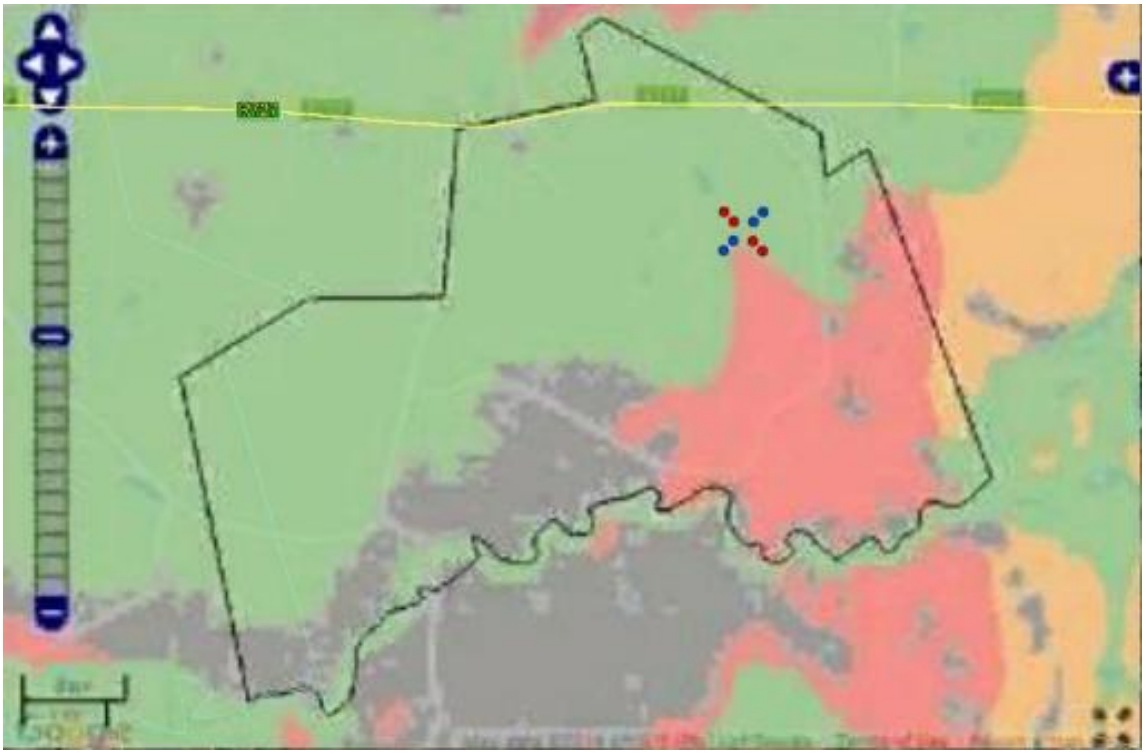

Figure 5: SAHRIS palaeosensitivity maps for the proposed drilling of cores for the Bothaville NE Ext A project. Project boundary indicated in black. Colours indicate the following degrees of sensitivity: red = very highly sensitive; orange/yellow = high; green = moderate sensitivity; grey= zero/insignificant sensitivity.

IMPACT ASSESSMENT AND RATINGS

Since any fossils, if discovered during the drilling stage, would have been rescued and removed from the site (with a SAHRA permit), then the palaeontological heritage impact is only relevant for this first stage *(Table 7).*

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 8-12 and Figure 6-10.

Table 7: Identification of the Potential impacts at different phases of the project

PHASE	REASONING	IMPACT	IMPACTS ASSOCIATED WITH THE CURRENT PROJECT
Prospecting / drilling	If fossils are found, they can be rescued and removed from the site	High but mitigation (removal) will remove impact	Yes
Planning and Design	No fossils or fossils have been removed	Nil	Yes
Construction	No fossils or fossils have been removed	Nil	Yes
Operation	No fossils or fossils have been removed	Nil	Yes
Decommissioning	No fossils or fossils have been removed	Nil	Yes
Rehabilitation and Closure	No fossils or fossils have been removed	Nil	Yes

Table 8: 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					
Paleontological 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	2	2
	Extent of Impact	2	1	Reversibility of Impact	2	2
	Duration of Impact	2	2	Probability	2	2
	Environmental Risk (Pre-mitigation)					-4,00
	Mitigation Measures					
	See Recommendations in Section 6					
	Environmental Risk (Post-mitigation)					-3,50
	Degree of confidence in impact prediction:					Medium
	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					2
	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.					
	Prioritisation Factor					1,33
	Final Significance					-4,67

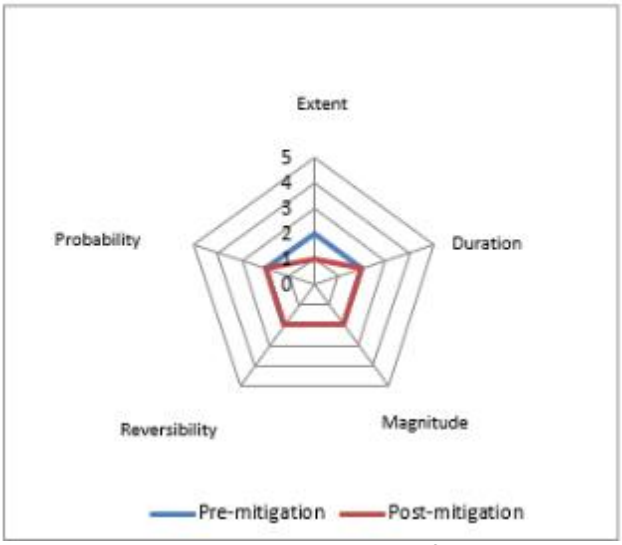

Figure 6: Radar chart indicating the pre-and post-mitigation for the Planning phase for Paleontological Resources

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

	A. 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	3	1
	Extent of Impact	2	1	Reversibility of Impact	5	5
	Duration of Impact	3	1	Probability	2	1
	Environmental Risk (Pre-mitigation)					-6,50
	Mitigation Measures					
	See Recommendations in Section 6					
	Environmental Risk (Post-mitigation)					-2,00
	Degree of confidence in impact prediction:					Medium
	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					2
	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.					
	Prioritisation Factor					1,33
	Final Significance					-2,67

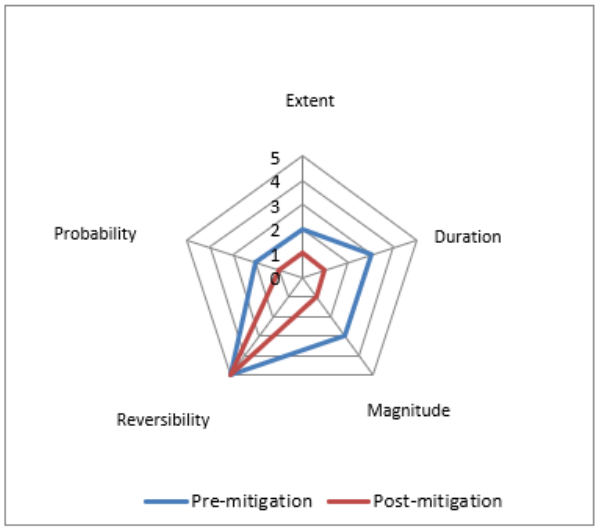

Figure 7: Radar chart indicating the pre-and post-mitigation for the Construction phase for Paleontological Resources

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

	A. Destruction/damage of palaeontological resources. - Proposal					
Paleontological 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	3	3
	Extent of Impact	3	1	Reversibility of Impact	4	2
	Duration of Impact	3	3	Probability	3	2
	Environmental Risk (Pre-mitigation)					-9,75
	Mitigation Measures					
	See Recommendations in Section 6					
	Environmental Risk (Post-mitigation)					-4,50
	Degree of confidence in impact prediction:					Medium
	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					3
	The impact may result in the irreplaceable loss of resources of high value (services and/or functions).					
	Prioritisation Factor					1,50
	Final Significance					-6,75

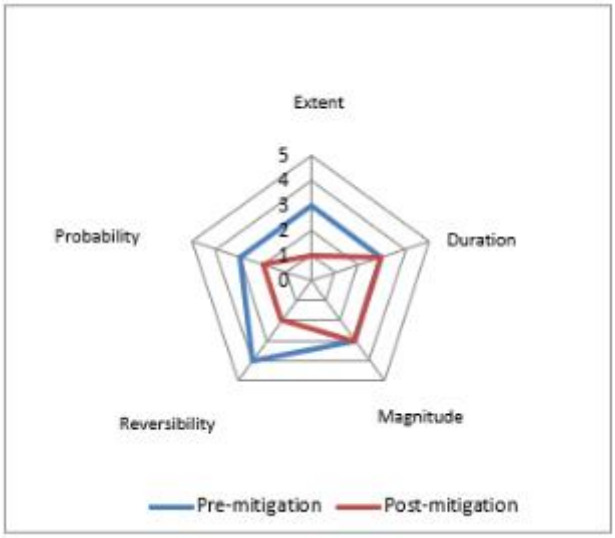

Figure 8: Radar chart indicating the pre-and post-mitigation for the Operation phase for Paleontological Resources

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

	A. 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	3	3
	Extent of Impact	2	1	Reversibility of Impact	3	2
	Duration of Impact	3	2	Probability	3	2
	Environmental Risk (Pre-mitigation)					-8,25
	Mitigation Measures					
	See Recommendations in Section 6					
	Environmental Risk (Post-mitigation)					-4,00
	Degree of confidence in impact prediction:					Medium
	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					2
	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.					
	Prioritisation Factor					1,33
	Final Significance					-5,33

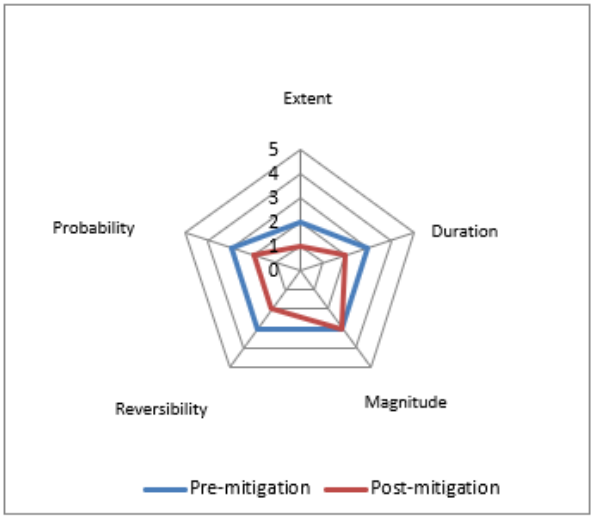

Figure 9: Radar chart indicating the pre-and post-mitigation for the Decommissioning phase for Paleontological Resources

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

	A. 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	3	2
	Extent of Impact	2	1	Reversibility of Impact	4	2
	Duration of Impact	3	2	Probability	3	2
	Environmental Risk (Pre-mitigation)					-9,00
	Mitigation Measures					
	See Recommendations in Section 6					
	Environmental Risk (Post-mitigation)					-3,50
	Degree of confidence in impact prediction:					Medium
	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					2
	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.					
	Prioritisation Factor					1,33
	Final Significance					-4,67

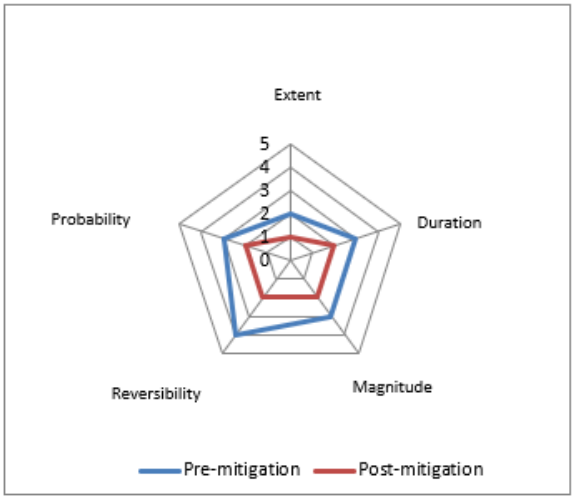

Figure 10: Radar chart indicating the pre-and post-mitigation for the Rehab and Closure phase for Paleontological Resources

Based on the nature of the project, surface activities would not impact upon the fossil heritage even if preserved, because 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 mudstones and siltstones of the Vryheid Formation could contain impression of fossil plants of the Glossopteris flora. Since there is an extremely small chance that fossils may be disturbed a 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.

4. 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 plant. The sands of the Quaternary period and dolerites of the Jurassic period would not preserve fossils. Fossil plants of the Glossopteris flora have been recorded from the Vryheid Formation, Ecca Group, in other parts of the Karoo Basin so there is a possibility that they occur in this area too.

5. 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 overlying dolerites of the Jurassic or in the loose sands of the Quaternary. There is an extremely small chance that fossils may occur in the mudstones or siltstones of the Vryheid Formation so a Chance Find Protocol (Appendix A) should be added to the EMPr, if fossils are found once drilling has commenced then they should be rescued, and a palaeontologist called to assess and collect a representative sample. Thereafter the palaeontology heritage will not be impacted on any further.

6. REFERENCES

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Bamford, M.K. 2004. Diversity of the woody vegetation of Gondwanan southern Africa. Gondwana Research 7, 153-164.

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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.

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.

Pretorius, D.A., Brink, W.C.J., Fouche, J., 1986. The Witwatersrand Basin: surface and subsurface geology and structure. In: Anhaeusser, C.R. and Maske, S., (Eds). Mineral Deposits of Southern Africa, Vol. 1. Geological Society of Southern Africa, Appendix (map).

Rubidge, B.S. (Ed), 1995. Biostratigraphy of the Beaufort Group (Karoo Supergroup). Biostratigraphy Series 1, South African Commission for Stratigraphy. Council for Geoscience, 46 pp.

7. APPENDIX A - CHANCE FIND PROTOCOL

Monitoring Programme for Palaeontology – to commence once the drilling for cores begins.

1. The following procedure is only required if fossils are seen on the surface and when drilling or excavations commence.
2. When drilling begins the rocks and must be given a cursory inspection by the environmental officer or designated person. Any fossiliferous material (shells, plants, insects, bone, coal) should be put aside in a suitably protected place. This way the mining activities will not be interrupted.
3. Photographs of similar fossil vertebrates bones 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 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.

8. APPENDIX B – DETAILS OF SPECIALIST

Curriculum vitae (short) - Marion Bamford PhD

June 2018

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 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)