Palaeontological Impact Assessment for the proposed Gamolilo Prospecting/Mining Rights Application, northwest of Kuruman, North West Province

Desktop Study (Phase 1)

For

Archaeological and Heritage Services Africa (Pty) Ltd

27 January 2020

Prof Marion Bamford
Palaeobotanist
P Bag 652, WITS 2050
Johannesburg, South Africa
Marion.bamford@wits.ac.za

Expertise of Specialist

The Palaeontologist Consultant: Prof Marion Bamford
Qualifications: PhD (Wits Univ, 1990); FRSSAf, ASSAf
Experience: 31 years research; 23 years PIA studies

Declaration of Independence

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

Specialist: Prof Marion Bamford

Signature: 

Executive Summary

A palaeontological Impact Assessment was requested for the proposed Prospecting and Mining Rights Application on the Farm Gamolilo 72, northwest of Kuruman, Northern Cape Province. 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 Palaeontological Impact Assessment (PIA) was completed for the proposed project.

The proposed site lies predominantly on the banded ironstone of the Danielskuil and Kuruman Formations (Asbestos Hills Subgroup, Ghaap Group, Transvaal Supergroup) with a small section on the Quaternary Aeolian sands and on Tertiary surface limestones. The iron formations are too old for body fossils and do not preserve any micro-organisms. The two younger sediments very rarely preserve fossils and only in specific settings such as pan silcretes or limestone tufas. None has been recorded on the farms and none is evident from the satellite imagery (Google Earth), so it is highly unlikely that there are any fossils deposits present. Nonetheless, a Fossil Chance Find Protocol should be added to the EMPr. Based on this information it is recommended that no palaeontological site visit is required unless fossils are found by the geologist/ responsible person once drilling or mining activities have commenced.

Table of Contents

1. Background

A Palaeontological Impact Assessment was requested for the proposed prospecting and mining rights application for the Farm Gamolilo 72 by Botshelo T and G Mining Resources (Figure 1). The farm is approximately 56km northwest of Kuruman, Northern Cape Province.

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 application and is presented herein

Table 1: Specialist report requirements in terms of Appendix 6 of the EIA Regulations (amended 2017)

	A specialist report prepared in terms of the Environmental Impact Regulations of 2017 must contain:	**Relevant section in report**
ai	Details of the specialist who prepared the report	Appendix B
aii	The expertise of that person to compile a specialist report including a curriculum vitae	Appendix B
b	A declaration that the person is independent in a form as may be specified by the competent authority	Page 1
c	An indication of the scope of, and the purpose for which, the report was prepared	Section 1
ci	An indication of the quality and age of the base data used for the specialist report: SAHRIS palaeosensitivity map accessed – date of this report	Yes
cii	A description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change	Section 5
d	The date and season of the site investigation and the relevance of the season to the outcome of the assessment	N/A
e	A description of the methodology adopted in preparing the report or carrying out the specialised process	Section 2
f	The specific identified sensitivity of the site related to the activity and its associated structures and infrastructure	Section 4
g	An identification of any areas to be avoided, including buffers	N/A
h	A map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;	N/A
i	A description of any assumptions made and any uncertainties or gaps in knowledge;	Section 5
j	A description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives, on the environment	Section 4

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

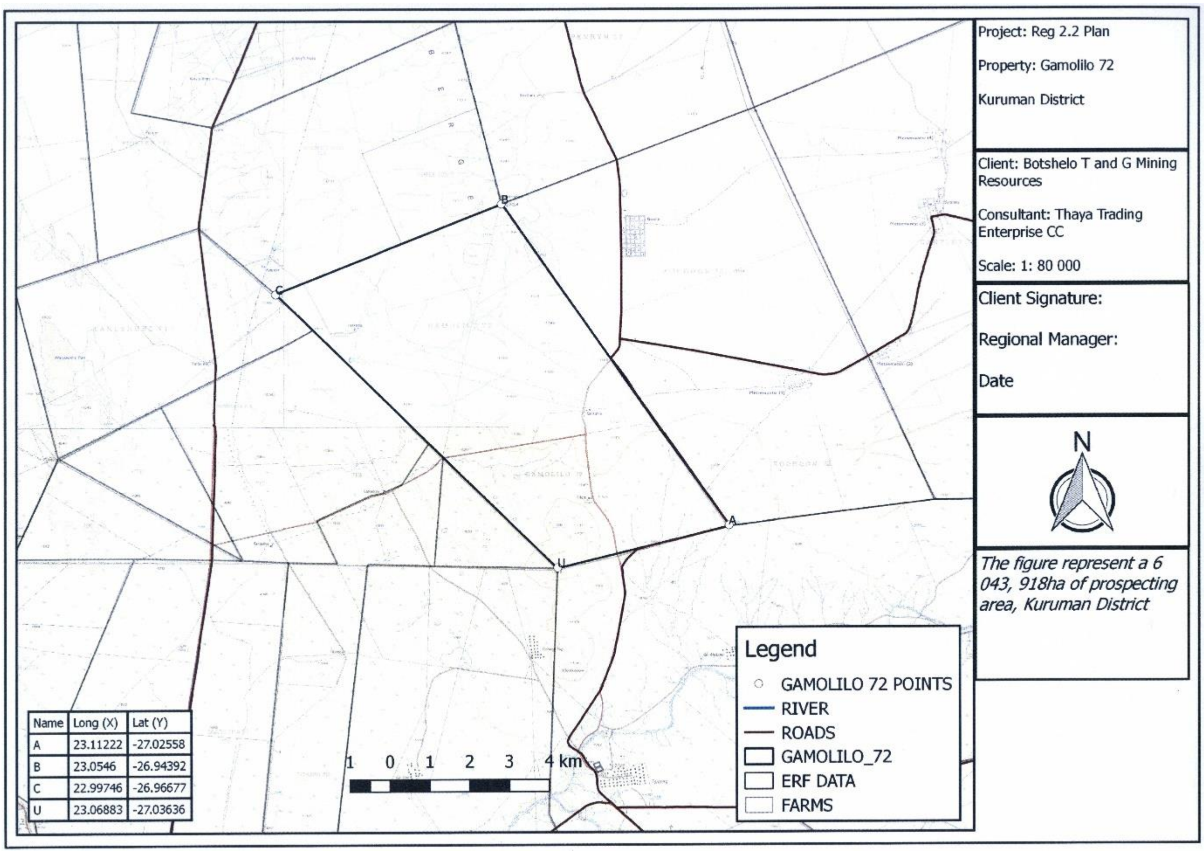

Figure 1: Topographical map of the proposed Prospecting and Mining Rights application on Farm Gamolilo 72, about 56 km northwest of Kuruman. Coordinates are given on the map. Map supplied by AHSA.

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 (*not applicable to this assessment*).

3. Geology and Palaeontology

i. Project location and geological context

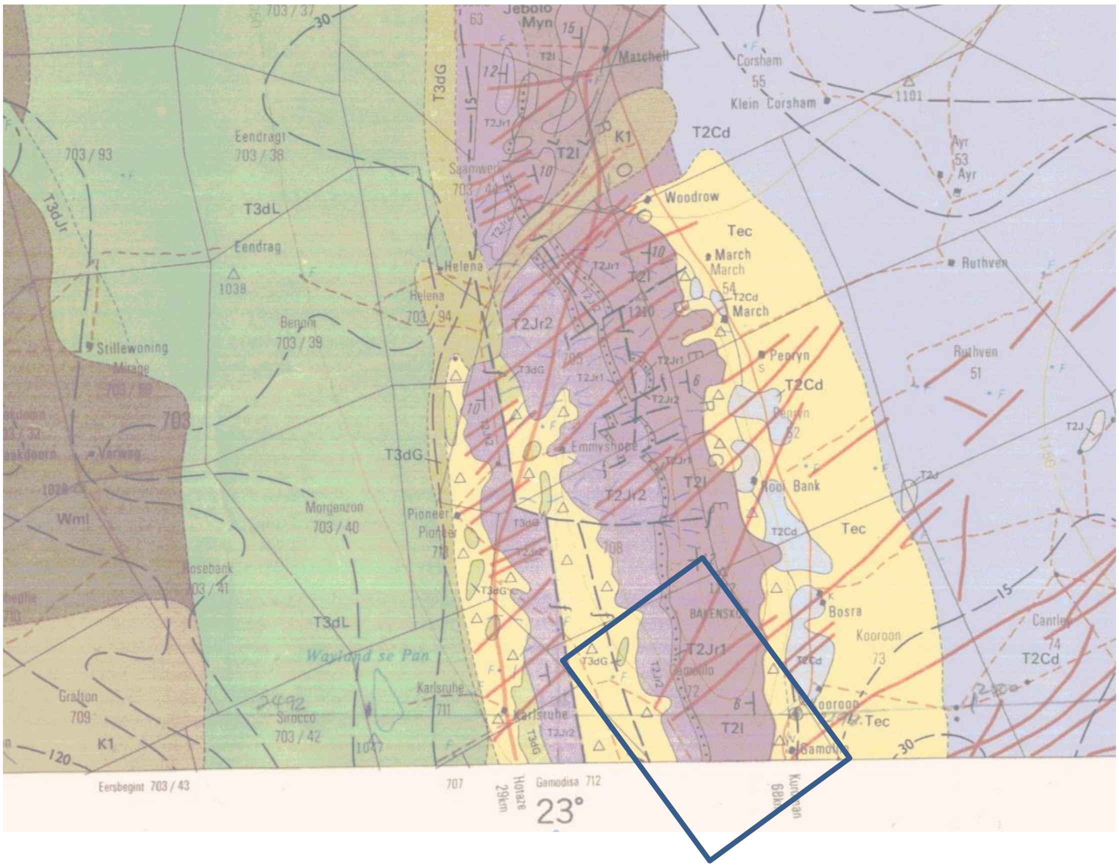

Figure 2a: Geological map of the area north of Tsineng and the northern part of the proposed mining area on Farm Gamolilo 72 indicated within the blue outline. Abbreviations of the rock types are explained in Table 2. Map enlarged from the Geological Survey 1: 250 000 map 2622 Morokweng.

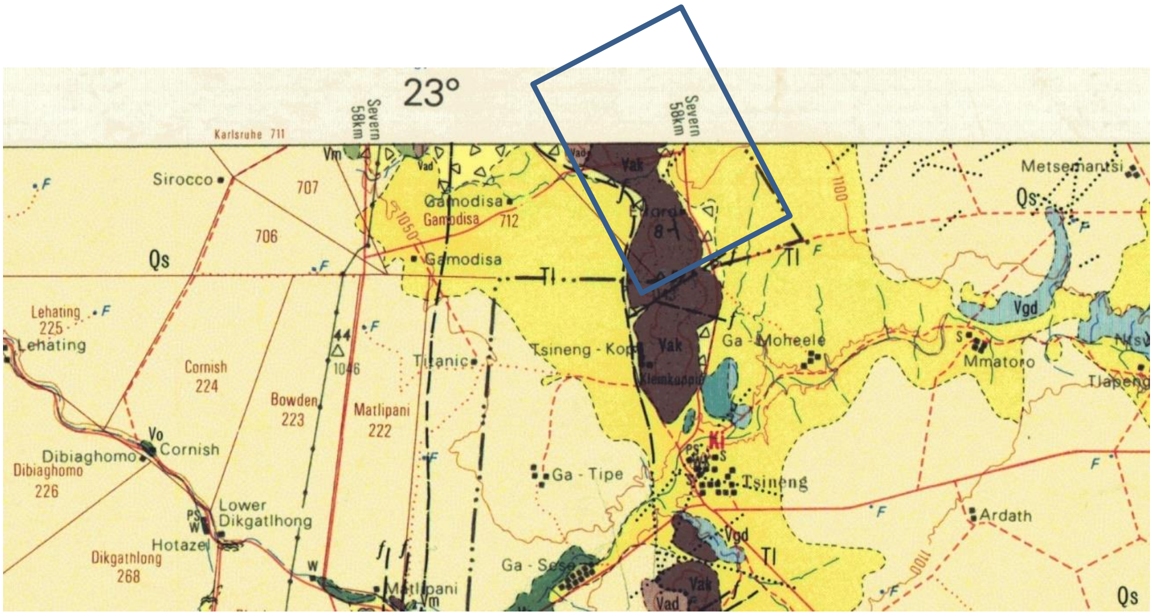

Figure 2b: Southern part of the Farm Gamolilo enlarged from Geological map 2722 Kuruman. This map adjoins the one in Figure 2a but as they were produced at different times by different geologists the colours and symbols differ.

Table 2: Explanation of symbols for the geological map and approximate ages (Eriksson et al., 2006). Where two symbols are shown in the left hand column the first one is for the older map Figure 2a, and the second one is for Map 2b. SG = Supergroup; Fm = Formation; Ma = million years; grey shading = formations impacted by the project.

Symbol	Group/Formation	Lithology	Approximate Age
Qs	Quaternary	Aeolian sands	Neogene, ca 25 Ma to present
Tec / Tl	Tertiary limestone	Surface limestone	Tertiary ca 65 Ma to present
Vo	Ongeluk Fm, Postmasburg Group, Transvaal SG.	Volcanic rocks, andesitic lava	Ca 2222 Ma
Vm	Makganyene Fm, Postmasburg Group, Transvaal SG.	Diamictite, banded jasper, mudstone, sandstone, grit	>2222 Ma
T2Jr2 / Vad	Danielskuil Fm, Asbestos Hills Subgroup, Ghaap Group, Transvaal SG.	Jaspilite and crocidilite	Ca 2432 Ma
T21 / Vak	Kuruman Fm, Asbestos Hills Subgroup, Ghaap Group, Transvaal SG	Iron formation	Ca 2465 Ma
Vgd	Ghaap Group, Transvaal SG		2462 – 2432 Ma

The mining area falls in the Ghaap Plateau Sub-basin of the Griqualand West Basin and the rocks outcropping here are included in the upper part of the Transvaal Supergroup (Figure 2a, b). They are more than 2222 million years old and were deposited during a sequence of regressions and transgressions of a large sea, thus forming one of the world's earliest carbonate platforms (Eriksson et al., 2006, p. 241). Much of the Transvaal Supergroup rocks are buried under Kalahari sands and limestones in this basin.

Geologically the Ghaap Plateau sub-basin has been divided into two groups, the lower or older Ghaap Group and upper or younger Postmasburg Group. Three Subgroups are defined for the Ghaap Group: lower Schmidsdrif Subgroup with the Boomplaas and Clearwater Formations, and the middle Campbell Rand Subgroup with eight formations, Monteville, Reivilo, Fairfield, Klipfonteinheuvel, Papkuil, Gamohaan and Tsineng formations. Asbestos Hills Subgroup is the upper part and has three formations, the Kliphuis, Kuruman and Danielskuil Formations. The upper group, the Postmasburg Group unconformably overlies the Ghaap Group, and has two formations, the Makganyane and Ongeluk Formations.

Considerably younger sand and limestone cover these rocks and indicate a much drier environment than the underlying lacustrine or marine deposits of the Transvaal Supergroup.

ii. Palaeontological context

The palaeontological sensitivity of the area under consideration is presented in Figure 3. The site for development is predominantly in the Danielskuil and Kuruman Formations (both of the Asbestos Hills Subgroup, Ghaap Group, Transvaal Supergroup) with a small section on the Tertiary limestones (Figure 2a, b).

The Kuruman Formation is composed of banded ironstone and shows a number of cycles of deposition in a subsiding basin (Eriksson et al., 2006, p. 48) and is not fossiliferous. The Danielskuil Formation overlies the Kuruman Formation and is composed of reworked Kuruman-type banded iron formation so is granular rather than finely laminated (ibid). It has been interpreted as a shallowing upward sequence of lower order cycles (Beukes and Klein, 1990). Although banded ironstone is the product of oxidation of iron minerals, and the oxygen was released by cyanobacteria, there is no direct link between banded ironstone and any micro-organism. These iron-rich rocks were formed long before any body fossils had evolved, so banded iron formation is not fossiliferous.

According to the Palaeotechnical Report of the North West Province (Groenewald et al., 2014) the whole of the Ghaap Group sediments are very highly sensitive as they have stromatolites and microfossils in the cherts, however no references or examples are provided. Neither type of fossil is mentioned in the main texts on the Danielskuil and Kuruman Formations (Beukes, 1984, Beukes and Klein, 1990).

Fossils are rare in Quaternary deposits and are not randomly distributed, especially in aeolian sands because such sands have been transported by winds and winds are only able to transport small particles – like sand grains. Fossils are sometimes found in pan or spring deposits but these would be visible from satellite imagery (Google Earth) as depressions or low mounds respectively. For example, the Kathu Complex comprising several deposits, Townlands, Kathu 1, 2, KP1, around the town of Kathu, near Kuruman has archaeological artefacts made from the local banded ironstone, jaspilite and quartz (Walker et al., 2014). There are also some plant (pollen) and faunal remains in the pan silcrete.

Surface limestone, such as minor ridges and deposits or well weathered former tufas such as the Taung deposits, may have fossil plants and bones entrapped in the limestone but these are large features and have been mapped and surveyed.

Tertiary cave sites such as Wonderwerk Cave in the Kuruman Hills have been occupied by humans since 2 million years ago, have also been well studied and mapped. No similar features have been recorded for the Farm Gamolilo.

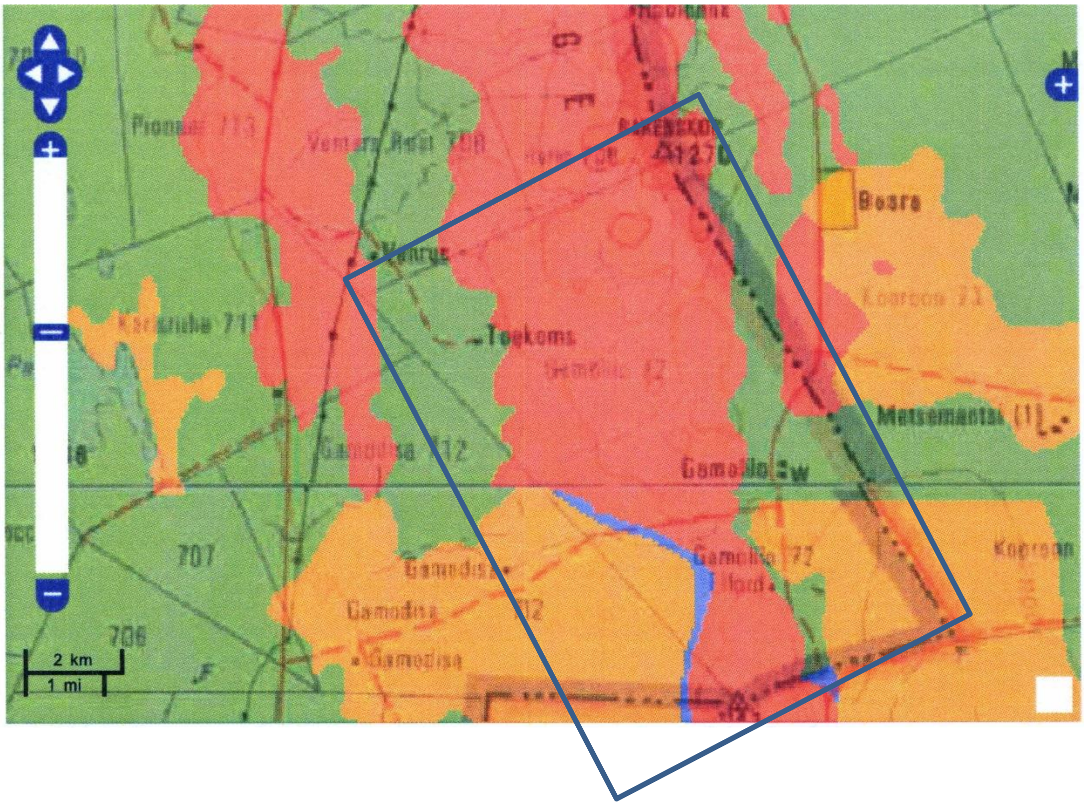

Figure 3: SAHRIS palaeosensitivity map for the farm Gamolilo 72 shown within the blue outline. Background colours indicate the following degrees of sensitivity: red = very highly sensitive; orange/yellow = high; green = moderate; blue = low; grey = insignificant/zero.

From the SAHRIS map above (Figure 3) the area is indicated as mostly very highly sensitive (red) and this applies to the Danielskuil and Kuruman Formations, both of which are banded iron formations so sit is very unlikely that they contain fossils. The highly sensitive areas (orange) apply to the Tertiary limestones and the moderately sensitive areas (green apply to the Quaternary Aeolian sands. Fossils have not been recorded from the farm, and although rare occurrences of fossils have been recorded from these younger formations in other localities, they are relatively easy to observe from satellite imagery as discrete sites. No records have been found of fossils in the banded iron formations and it is assumed that the highly designation is based on the Ghaap Group as a whole, rather than the distinct and very different formations within this group, only of which do have stromatolites.

4. Impact assessment

An assessment of the potential impacts to possible palaeontological resources considers the criteria encapsulated in Table 3:

TABLE 3A: CRITERIA FOR ASSESSING IMPACTS

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

TABLE 3B: IMPACT ASSESSMENT

PART B: ASSESSMENT		
SEVERITY/NATURE	**H**	-
	M	-
	L	Banded iron doe shave fossils. Aeolian or wind-blown sands do not preserve plant fossils; only discrete pan or tufas would but none is recorded so it is very unlikely that fossils occur on the site. The impact would be very unlikely.
	L+	-
	M+	-
	H+	-
DURATION	**L**	-
	M	-
	H	Where manifest, the impact will be permanent.
SPATIAL SCALE	**L**	Since only the possible fossils within the area would be fossil plant or bone fragments trapped in pan silcretes or tufas from the Tertiary or Quaternary, the spatial scale will be localised within the site boundary.
	M	-
	H	-
PROBABILITY	**H**	**-**
	M	**-**
	L	Fossils will not be found in the iron deposits. It is extremely unlikely that any fossils would be found in the loose sand that is dominant or in any pan or tufa deposits, if they exist on the farms. Nonetheless, a Fossil 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 mostly much too old to contain fossils or of the wrong type, namely loose sands or surface limestone. Furthermore, the material to be mined is ancient and below the surface and does not preserve fossils. Since there is an extremely small chance that fossils from the Tertiary or Quaternary 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 banded iron formation, dolomites, sandstones, limestones and aeolian sands are typical for the country and do not contain fossil plant, insect, invertebrate and vertebrate material, except in exceptional cases where pan silcretes or tufas occur. The Aeolian sands of the Quaternary period 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 banded iron formation of the Danielskuil and Kuruman Formations, Tertiary limestones or Aeolian sands of the Quaternary. There is a very small chance that fossil may occur in pans or tufas but none is evident from the satellite imagery or been recorded. Nonetheless, a Fossil Chance Find Protocol should be added to the EMPr: if fossils are found once drilling or mining have commenced then they should be rescued and a palaeontologist called to assess and collect a representative sample.

7. References

Beukes, N.J., 1984. Sedimentology of the Kuruman and Griquatown iron-formations, Transvaal Supergroup, Griqualand West, South Africa. Precambrian Research 24, 47–84.

Beukes, N,J., Klein, C. 1990. Geochemistry and sedimentology of facies transition from the microbanded to the granular iron-formation in the early Proterozoic Transvaal Supergroup, South Africa. Precambrian Research 47, 99-139.

Eriksson, P.G., Altermann, W., Hartzer, F.J., 2006. The Transvaal Supergroup and its pre-cursors. 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 237-260.

Groenewald, G., Groenewald, D., Groenewald, S., 2014. SAHRA Palaeotechnical Report. Palaeontological Heritage for North West Province.

Walker, S.J.H., Lukich, V., Chazan, M., 2014. Kathu Townlands: A High Density Earlier Stone Age Locality in the Interior of South Africa. PLoS ONE 9(7): e103436. doi:10.1371/journal.pone.0103436.

8. Chance Find Protocol

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

1. The following procedure is only required if fossils are seen on the surface and when drilling/excavations/mining 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 project 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 Figures 4-6). This information will be built into the EMP's training and awareness plan and procedures.
4. Photographs of the putative fossils can be sent to the palaeontologist for a preliminary assessment.
5. If there is any possible fossil material found by the developer/environmental 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 no site inspections by the palaeontologist will not be necessary. A final report by the palaeontologist must be sent to SAHRA once the project has been completed and only if there are fossils.
8. If no fossils are found and the excavations have finished then no further monitoring is required.

Appendix A – Examples of fossils

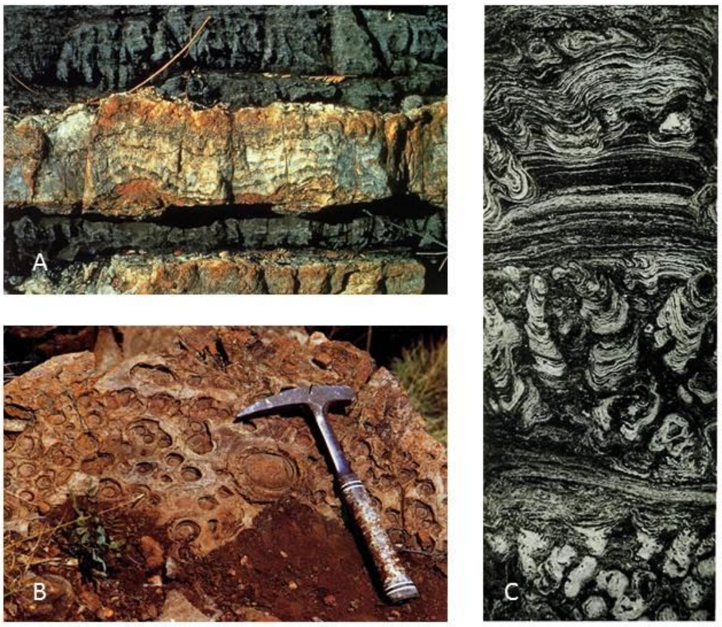

Figure 4: Stromatolites seen in side view and surface view.

Figure 5: Example of fossil bone in Quaternary pan sediments.

Figure 6: Examples of pieces of fossilised wood that have been transported.

Appendix B – Details of specialist

Curriculum vitae (short) - Marion Bamford PhD
January 2020

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	7	0
Masters	10	4
PhD	12	5
Postdoctoral fellows	10	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 –
Journal of African Earth Sciences: 2020 -

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 2017 for Henwood
- Modimolle 2017 for Green Vision
- Klipoortjie and Finaalspan 2017 for Delta BEC
- Ledjadja borrow pits 2018 for Digby Wells
- Lungile poultry farm 2018 for CTS
- Olienhout Dam 2018 for JP Celliers
- Isondlo and Kwasobabili 2018 for GCS
- Kanakies Gypsum 2018 for Cabanga

- Nababeep Copper mine 2018
- Glencore-Mbali pipeline 2018 for Digby Wells
- Remhoogte PR 2019 for A&HAS
- Bospoort Agriculture 2019 for Kudzala
- Overlooked Quarry 2019 for Cabanga
- Richards Bay Powerline 2019 for NGT
- Eilandia dam 2019 for ACO
- Eastlands Residential 2019 for HCAC
- Fairview MR 2019 for Cabanga
- Graspan project 2019 for HCAC
- Lieliefontein N&D 2019 for Enviropro

xi) Research Output

Publications by M K Bamford up to December 2019 peer-reviewed journals or scholarly books: over 140 articles published; 5 submitted/in press; 8 book chapters.
Scopus h-index = 27; Google scholar h-index = 32; -i10-index = 80
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)