Palaeontological Impact Assessment for the Prospecting Right Application on Farm Ruighoek 169 JP, west of Pilanesberg, North West Province

Desktop Study (Phase 1)

For

SLR Consulting (South Africa) (Pty) Ltd

26 February 2022

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Expertise of Specialist

The Palaeontologist Consultant: Prof Marion Bamford
Qualifications: PhD (Wits Univ, 1990); FRSSAf, mASSAf
Experience: 33 years research and lecturing in Palaeontology
25 years PIA studies and over 300 projects completed

Declaration of Independence

This report has been compiled by Professor Marion Bamford, of the University of the Witwatersrand, sub-contracted by SLR Consulting (South Africa) (Pty) Ltd. 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 prospecting right application by Pilanesberg Platinum Mines (Pty) Ltd on the Farm Ruighoek 169JP, to the west of Pilanesberg, North West Province. They plan to dig trenches and put in boreholes.

To comply with the regulations of the South African Heritage Resources Agency (SAHRA) in terms of Section 38(8) of the National Heritage Resources Act, 1999 (Act No. 25 of 1999) (NHRA), a desktop Palaeontological Impact Assessment (PIA) was completed for the proposed development.

The proposed site lies on the Quaternary sands and alluvium that are unlikely to preserve any fossils although the lithology is indicated as moderately sensitive on the South African Heritage Resources Information System (SAHRIS) Palaeosensitivity map. Nonetheless, a Fossil Chance Find Protocol should be added to the Environmental Management Programme (EMPr). Based on this information it is recommended that no further palaeontological impact assessment is required unless fossils are found by the contractor/environmental officer/other designated responsible person once excavations/drilling/mining activities have commenced. The **Impact is insignificant** both before and after mitigation, therefore, as far as the palaeontology is concerned, the project should be authorised.

Table of Contents

1. Background

Pilanesberg Platinum Mines (Pty) Ltd is applying for a Prospecting Right on portion 5 of the farm Ruighoek 169JP, therefore a Basic Assessment (BA) in terms of the Environmental Impact Assessment (EIA) Regulations, 2014 (as amended) promulgated under the National Environmental Management Act, 107 of 1998 (NEMA) is being done by SLR Consulting (South Africa) (Pty) Ltd (SLR).

The Pilanesberg Platinum Mine (PPM) is an open pit platinum and chrome mining and mineral processing operation and comprises various onsite infrastructure such as an open pit mine (West Pit), temporary and permanent waste rocks dumps (WRDs), a processing plant complex, a tailings scavenger plant, a chrome recovery plant, a tailings storage facility (TSF) and support infrastructure. The current mining operation involves accessing the two commonly exploited 'Platinum Group Metals (PGM)-bearing' reef horizons, the Merensky (silicate) and UG2, in a single open-cast mining operation. In addition to the existing infrastructure, an Environmental Authorisation (EA) was issued by the Department of Mineral Resources and Energy (DMRE) on 21 July 2020 for a plant expansion on site, known as the KELL plant, for which construction is due to commence early 2022. (Figures 1, 2).

The mineral processing operations at PPM comprise a silicate (Merensky-Pseudo reef) section and a UG2 section to cater for the different reefs being mined. The mineral processing operations incorporate the following main components:

- Run of Mine (ROM) crushing and screening.
- Dense Medium Separation (DMS) for a proportion of the silicate ores.
- DMS waste storage.
- Milling and flotation circuits (one UG2 ore circuit and one Merensky ore circuit).
- Merensky (silicate) concentrator plant.
- UG2 concentrator plant.
- TSF.
- Chemical storage, mixing and dosing systems.
- Final concentrate storage and loading facilities.

DESCRIPTION OF THE PROPOSED PROJECT

<u>1a - Details of the Prospecting Right Area</u>

Pilanesberg Platinum Mines (Pty) Ltd proposes to secure a prospecting right (PR) for portion 5 of the farm Ruighoek 169JP. The area under consideration is located adjacent to an area where mining rights (MRs) have been granted. Therefore, the procurement of a PR is to ensure a development pipeline of the existing operations in the area.

The PR area is located approximately 60 km and 28 km north-west of Rustenburg and Sun City, respectively. Various smaller towns and villages are in close proximity to the prospecting area, namely Mabeleleng (± 4 km south); Tlhatlhaganyane (± 7 km east); Makgope (± 8 km north-west); and Mkoshong (± 4.5 km south-west). An important area of interest, the Pilanesberg National Park, is located approximately 4 km to the east (refer to Figure 1, 2).

Portion 5 of the farm Ruighoek 169JP measures approximately 130 ha in extent. The PR area, located on portion 5 of the farm Ruighoek 169 JP, is approximately 5 ha in extent. The co-ordinates of the boundary points of the proposed PR area are illustrated in Table 1.

Table 1: Co-ordinates of the Prospecting Right Area

Point	**Latitude**	**Longitude**
A	25º 12' 48.58'' S	26º 55' 51.74'' E
B	25º 12' 52.12'' S	26º 56' 52.12'' E
C	25º 12' 59.21'' S	26º 56' 00.11'' E
D	25º 12' 57.24'' S	26º 55' 53.74'' E

1b - Details of Prospecting Activities

The target minerals for the project are PGMs including gold, nickel, copper, cobalt and other metals and minerals associated therewith (excluding chrome). The planned timeframe to complete the proposed prospecting work is provided below.
The Proposed Work Programme is as follows:

- Phase I – Trenching and Analysis; and Initial Diamond Drilling, Logging and Reef Sample Analysis – planned 12 months (year 1)
- Phase II – Environmental Study of Prospecting Right Area; 3D Modelling; and Metallurgical Test Work and Geotechnical Investigation - planned 24 months (year 2 – 3)

The prospecting activities would be conducted in a phased approach, with each phase dependent on results of the preceding phase. The two phases are explained in the following sections.

1c - Phase I – Soil Sampling and Initial Analysis

Phase 1 will consist of a programme where nine boreholes will be drilled, logged and sampled. The information is required to establish the depth of the PGM-bearing reefs, comprising the UG2 Chromitite and Merensky Reef, and to check the grade and quantity of the reefs. Samples will be submitted for assay for PGMs, copper and nickel. The boreholes are planned to be between 20 – 150 m deep. In addition to the boreholes, five trenches of around 100 m long will be dug to establish the sub-outcrop position of the PGM reefs. The trenches will be around 1.5 m deep and 1 m wide.

1d - Phase II – Final Drilling and Investigation.

A geological/structural model will be compiled so that the dimensions and locality of the mineral resource can be established. This will be followed by the compilation of a resource model. The geological and resource models will incorporate all the information from the adjacent properties, where a significant amount of drilling has been done.

A Palaeontological Impact Assessment (PIA) was requested for the proposed project. To comply with the regulations of the South African Heritage Resources Agency (SAHRA) in terms of Section 38(8) of the National Heritage Resources Act, 25 of 1999 (NHRA), a desktop PIA was completed for the proposed development and is reported herein.

Table 2: NEMA and EIA Regulations, 2014 (as amended) - Requirements for Specialist Reports (Appendix 6).

	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 Environmental Management Programme (EMPr)	Section 8, 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	Section 8, Appendix A
ni	A reasoned opinion as to whether the proposed activity or portions thereof should be authorised	Section 6

	A specialist report prepared in terms of the Environmental Impact Regulations of 2017 must contain:	Relevant section in report
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	Sections 6, 8
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 of any comments that were received during any consultation process	N/A
q	Any other information requested by the competent authority.	N/A
2	Where a government notice gazetted by the Minister provides for any protocol or minimum information requirement to be applied to a specialist report, the requirements as indicated in such notice will apply.	N/A

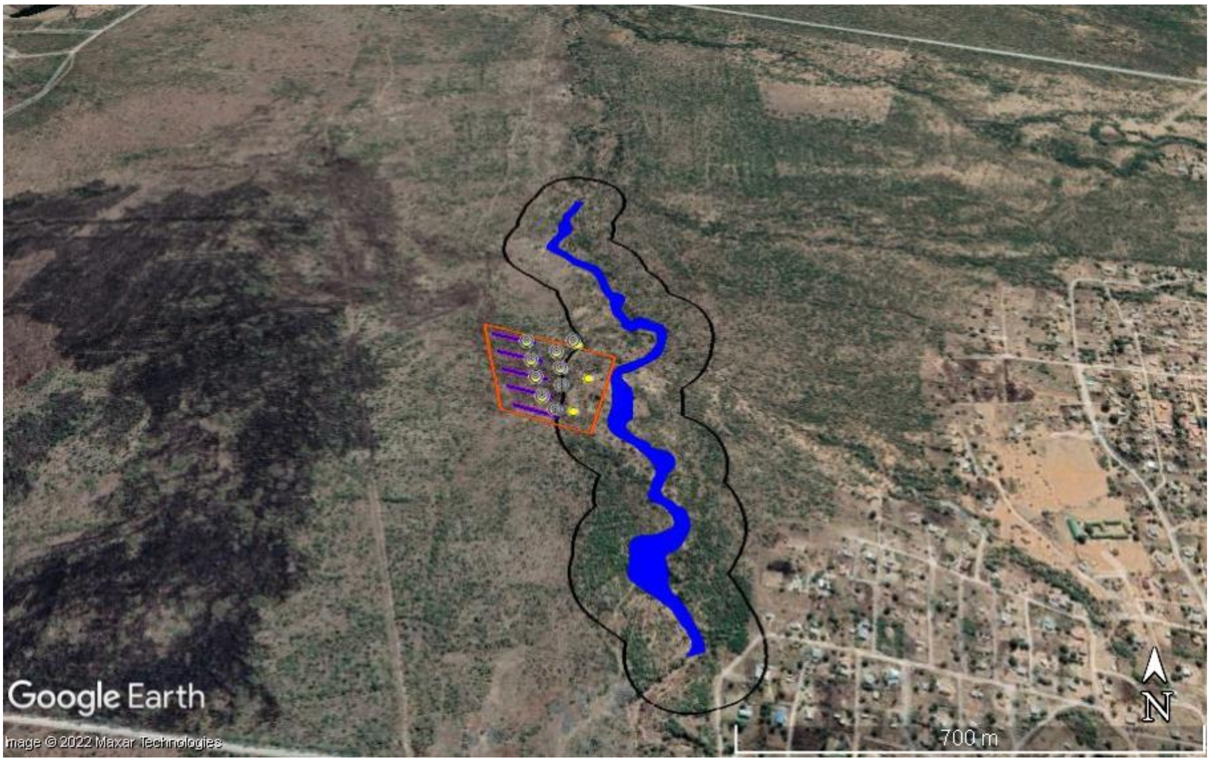

Figure 1: Google Earth map of the general area to show the relative landmarks. Portion 5 of the farm Ruighoek 169JP is shown by the orange line. Blue is the wetland buffer zone.

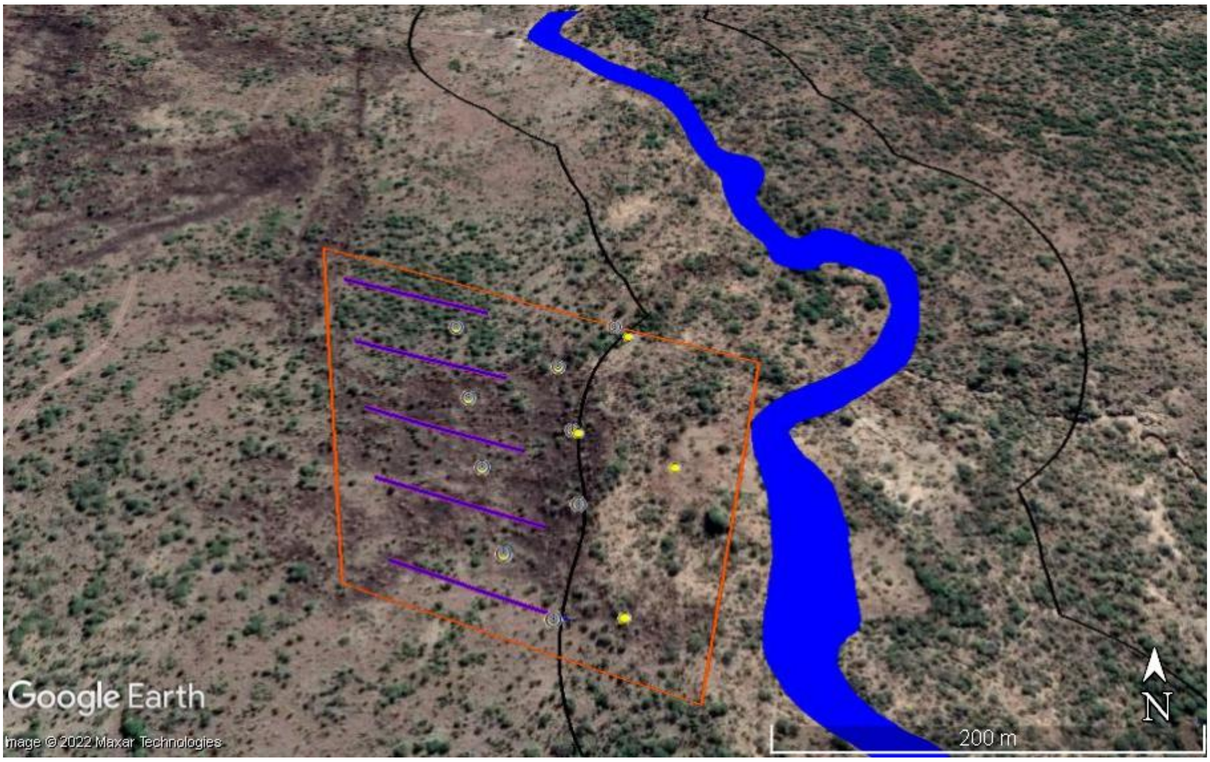

Figure 2: Google Earth Map of the proposed prospecting on portion 5 of Farm Ruighoek 169JP. Purple lies are tranches and yellow dots are the boreholes. Blue band is the wetland buffer zone. Orange line is the full extent of portion 5 of the farm Ruighoek 169JP area.

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

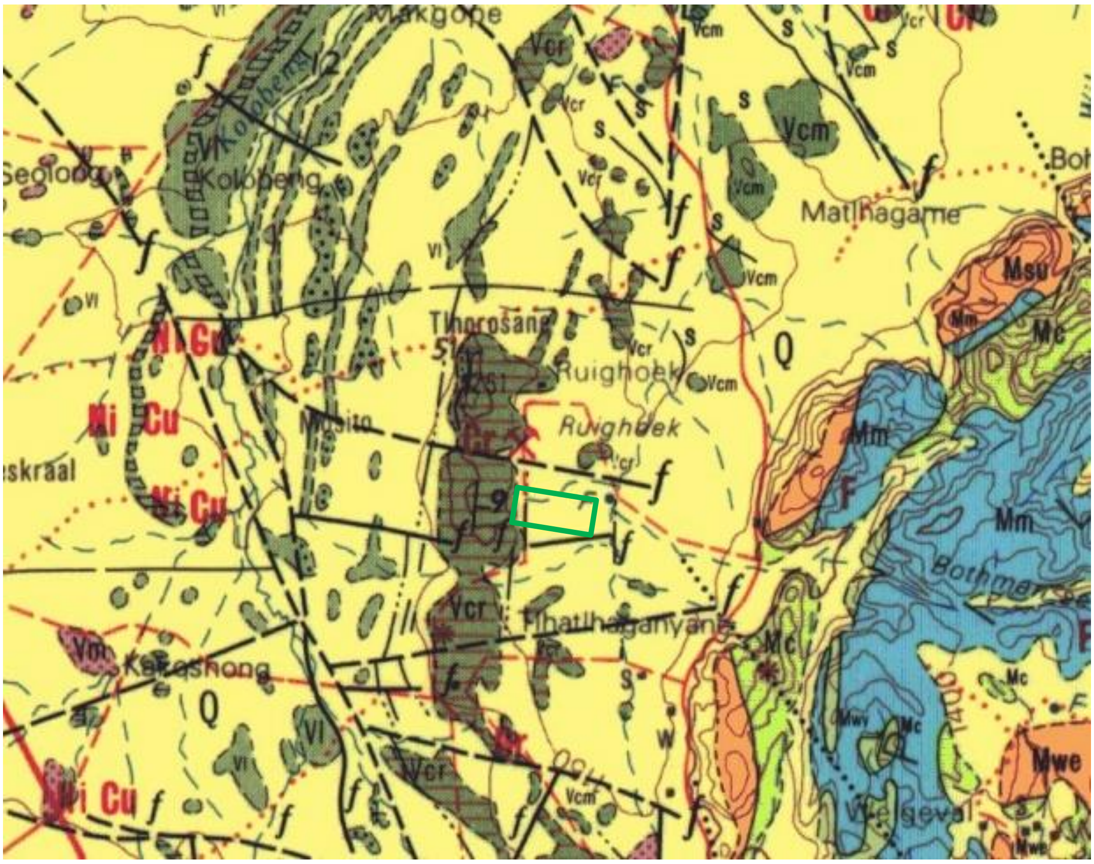

Figure 3: Geological map of the area around portion 5 of the farm Ruighoek 169JP (green rectangle). Abbreviations of the rock types are explained in Table 3. Map enlarged from the Geological Survey 1: 250 000 map 2526 Rustenburg.

Table 3: Explanation of symbols for the geological map and approximate ages (Cawthorn et al., Partridge et al., 2006; Verwoerd, 2006). SG = Supergroup; Fm = Formation; Ma = million years; grey shading = formations impacted by the project.

Symbol	Group/Formation	Lithology	Approximate Age
Q	Quaternary	Alluvium, sand, calcrete	Neogene, ca 2.5 Ma to present
Jd	Jurassic dykes	Dolerite dykes, intrusive	Jurassic, approx. 180 Ma
Mc	Chakise Foyaite, Pilanesberg Complex	Foyaite	Mesoproterozoic Ca 1306 – 1180 Ma
Msu	Sun City Syenite, Pilanesberg Complex	Syenite	Mesoproterozoic Ca 1306 – 1180 Ma
M	Mamkwe Fm	Lava, tuff, breccia	
Vg	Pyramid Gabbro-norite, Rustenburg Layered Suite, Bushveld Complex	Gabbro, norite	Palaeoproterozoic Ca 2055 Ma

Symbol	Group/Formation	Lithology	Approximate Age
Vcm	Matlagame Norite, Rustenburg Layered Suite, Bushveld Complex	Norite	Palaeoproterozoic Ca 2055 Ma
Vcr	Ruighoek Pyroxenite, Rustenburg Layered Suite, Bushveld Complex	Pyroxenite	Palaeoproterozoic Ca 2055 Ma

The project area lies in the Palaeoproterozoic Transvaal Basin that is filled with several cycles of sedimentation from about 2 600 to 2055 million years ago. Then a series of volcanic rocks intruded through the sequence and these are called the Rustenburg Layered Suite of the Bushveld Igneous Complex. These volcanic rocks do not preserve any fossils but as they are rich in platinum group elements they have been well researched (Cawthorn et al., 2006 and many recent publications).

Around 1450 million years ago there was a series of volcanic and plutonic activities that produced the Pilanesberg Alkaline Province, amongst others (Verwoerd, 2006). Today this large geological structure is about 530 m^2 and rises 300-600 m above the surrounding area (ibid). The rocks are volcanic in origin and so not preserve fossils.

In more recent times the overlying sediments have been eroded from this region and replaced by Tertiary and Quaternary sands. This fluvial and aeolian sourced cover is extensive and covers large parts of the northwest and west of South Africa. According to Partridge et al. (2006) these sands form one of the largest palaeo-ergs in the world. The younger strata have been re-dated by Matmon et al., (2015) who indicated that in the southern Kalahari, the majority of deposition occurred rapidly at 1.0–1.2 Ma.

ii. Palaeontological context

The palaeontological sensitivity of the area under consideration is presented in Figure 4. The site for prospecting is indicated as moderately sensitive and this applies to the surface deposits of sand and alluvium. Such young sands are unlikely to preserve fossils because the medium is transported, loose and well aerated so does not provide the necessary conditions (burial in an anoxic, low energy environment; Briggs and MacMahon, 2016). Sands, however, may bury features that could preserve fossils, such as palaeo-pans or palaeo-springs. Pans are much more common farther to the north-west (Goudie and Wells, 1995). Furthermore, such features are usually visible in the satellite imagery but nothing of this nature is visible on the Google Earth map (Figure 2).

If palaeo-pans or palaeo-springs are present then they would preserve vertebrate bones that are usually fragmented, calcified wood pieces or archaeological artefacts.

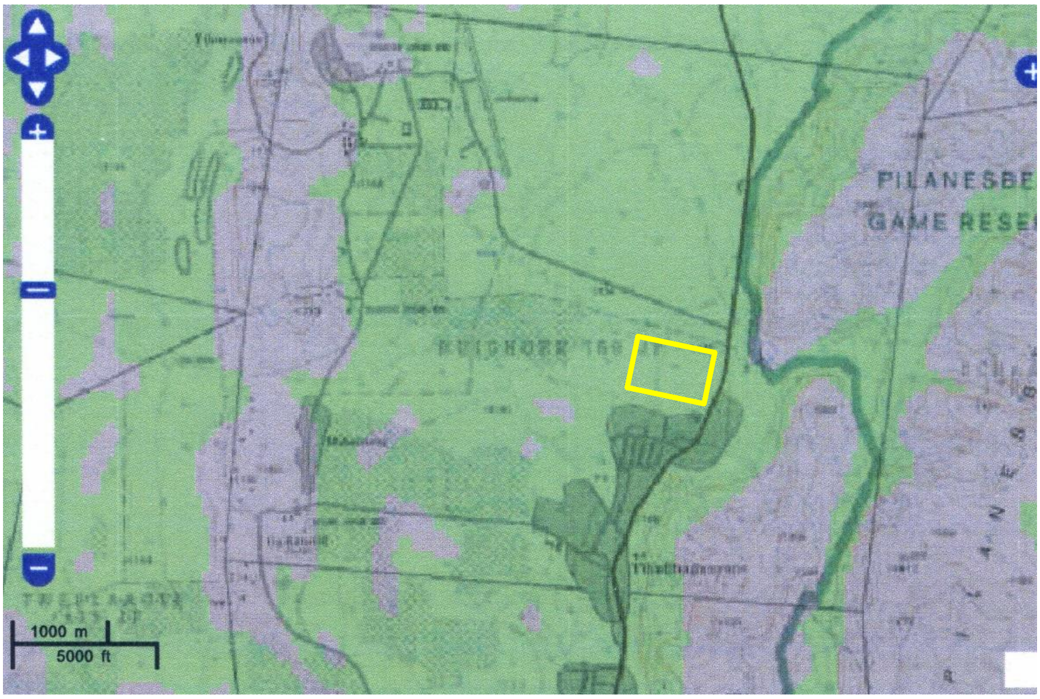

Figure 4: South African Heritage Resources Information System (SAHRIS) palaeosensitivity map for the site for the proposed PR application on portion 5 of the farm Ruighoek 169JP (yellow rectangle). Background colours indicate the following degrees of sensitivity: red = very highly sensitive; orange/yellow = high; green = moderate; blue = low; grey = insignificant/zero.

From the SAHRIS map above the area is indicated as moderately sensitive (green) for the Quaternary alluvium and sands so a Desktop study is required.

4. Impact assessment

An assessment of the potential impacts to possible palaeontological resources considers the criteria encapsulated in the SLR Impact Assessment Methodology included in Appendix C.

Table 4: For the Palaeontological Impact using the criteria:

Phase	Prospecting (excavation of trenches, boreholes)	
Feature	Pre-mitigation	Post-mitigation
Mitigation – remove any fossils found (see Section 8)	No action	Follow Fossil Chance Find Protocol – remove any fossils found
Intensity	Low	Low positive
Duration	Low	Low
Extent	Very low	Very low
Consequence	Low	Low
Probability (from above)	Unlikely – Very Low	Unlikely – Very Low

Significance (Consequence x probability)	Insignificant	Insignificant

Phase: Only the prospecting phase is relevant to the PIA. Rehabilitation would occur later, i.e. after mitigation.

Mitigation: Implement the Fossil Chance Find Protocol (Section 8 and Appendix A). If fossils occur on site they need to be photographed, removed and stored in a safe place for a palaeontologist to assess.

Intensity: Fossils have not been recorded from the area and are unlikely to be present. They would be fragmented and out of context so of limited scientific value. If fossils are found after excavations this would be a positive addition to our knowledge.

Duration: Once rescued, fossils would be removed from the site and have no impact on future activities.

Extent: Only fossils on the surface of or underground the trenches and boreholes would be affected.

Summary: Based on the nature of the project, surface activities may impact upon the fossil heritage only if preserved in the trench and borehole areas. The geological structures suggest that the rocks below ground (RLS) are too old to contain fossils and the wrong kind as igneous/volcanic rocks do not preserve fossils. The soils and alluvium on the surface do not preserve fossils. Taking account of the defined criteria, the potential impact to fossil heritage resources is insignificant, both before and after mitigation.

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 gabbro, norite, pyroxenites and surface sand and alluvium are typical for the country and do not contain fossil plant, insect, invertebrate and vertebrate material. The 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 Quaternary sand and alluvium, nor in any of the volcanic rocks that are expected to occur below ground (the target of the prospecting activity). There is a very small chance that fossils may occur in features such as palaeo-pans or palaeo-springs, but no such feature is visible in the satellite imagery. Nonetheless, a Fossil Chance Find Protocol should be added to the EMPr. If fossils are found by the environmental officer, or other responsible person once trenching and drilling have commenced then they should be photographed, rescued and a palaeontologist called to assess and collect a representative sample. The impact on the palaeontological heritage would be **insignificant**. As far as the palaeontology is concerned, the project should be authorised.

7. References

Briggs, D.E.G., McMahon, S., 2016. The role of experiments in the taphonomy of exceptional preservation. Palaeontology 59, 1-11.

Cawthorn, R.G., Eales, H.V., Walraven, F., Uken, R., Watkeys, M.K., 2006. The Bushveld Complex. 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 261-281.

Goudie, A.S., Wells, G.L., 1995. The nature, distribution and formation of pans in arid zones. Earth Science Reviews 38, 1–69.

Matmon, A., Hidy, A.J., Vainer, S., Crouvi, O., Fink, D., 2015. New chronology for the southern Kalahari Group sediments with implications for sediment-cycle dynamics and early hominin occupation. Quaternary Research. 84 (1), 118–132. http://dx.doi.org/10.1016/j.yqres.2015.04.009.

Partridge, T.C., Botha, G.A., Haddon, I.G., 2006. Cenozoic deposits of the interior. In: Johnson, M.R., Anhaeusser, C.R. and Thomas, R.J., (Eds). The Geology of South Africa. Geological Society of South Africa, Johannesburg / Council for Geoscience, Pretoria. Pp 585-604.

Verwoerd, W.J., 2006. The Pilanesberg alkaline province. In: Johnson, M.R., Anhaeusser, C.R. and Thomas, R.J., (Eds). The Geology of South Africa. Geological Society of South Africa, Johannesburg / Council for Geoscience, Pretoria. pp 281-383.

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 fossils must be provided to the developer to assist in recognizing the fossil plants, vertebrates, invertebrates or trace fossils in the shales and mudstones. (for example see Appendix A - Figure 5). This information will be built into the EMP's training and awareness plan and procedures.

4. Photographs of the putative fossils can be sent to the palaeontologist for a preliminary assessment.
5. If there is any possible fossil material found by the contractor/environmental officer then the qualified palaeontologist sub-contracted for this project, should visit the site to inspect the selected material and check the dumps where feasible.
6. Fossil plants or vertebrates that are considered to be of good quality or scientific interest by the palaeontologist must be removed, catalogued and housed in a suitable institution where they can be made available for further study. Before the fossils are removed from the site a SAHRA permit must be obtained. Annual reports must be submitted to SAHRA as required by the relevant permits.
7. If no good fossil material is recovered, then no site inspections by the palaeontologist will be necessary. A final report by the palaeontologist must be sent to SAHRA once the project has been completed and only if there are fossils.
8. If no fossils are found and the excavations have finished, then no further monitoring is required.

9. Appendix A – Examples of fossils from the Quaternary

Figure 5: Photographs of fossils that could be found in Quaternary alluvium and sands. Note the fragmentary nature.

10. Appendix B – Details of specialist

Curriculum vitae (short) - Marion Bamford PhD January 2022

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.
NRF Rating: C-2 (1999-2004); B-3 (2005-2015); B-2 (2016-2020); B-1 (2021-2026)

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	13	0
Masters	11	3
PhD	11	6
Postdoctoral fellows	15	1

viii) Undergraduate teaching
Geology II – Palaeobotany GEOL2008 – average 65 students per year
Biology III – Palaeobotany APES3029 – average 45 students per year
Honours – Evolution of Terrestrial Ecosystems; African Plio-Pleistocene Palaeoecology; Micropalaeontology – average 12-20 students per year.

ix) Editing and reviewing
Editor: Palaeontologia africana: 2003 to 2013; 2014 – Assistant editor
Guest Editor: Quaternary International: 2005 volume
Member of Board of Review: Review of Palaeobotany and Palynology: 2010 –
Associate Editor Open Science UK: 2021 -
Review of manuscripts for ISI-listed journals: 30 local and international journals
Reviewing of funding applications for NRF, PAST, NWO, SIDA, National Geographic, Leakey Foundation

x) Palaeontological Impact Assessments

Selected from the past five years only – list not complete:

- Mala Mala 2017 for Henwood
- Modimolle 2017 for Green Vision
- Klipoortjie and Finaalspan 2017 for Delta BEC
- Ledjadja borrow pits 2018 for Digby Wells
- Lungile poultry farm 2018 for CTS
- Olienhout Dam 2018 for JP Celliers
- Isondlo and Kwasobabili 2018 for GCS
- Kanakies Gypsum 2018 for Cabanga
- Nababeep Copper mine 2018
- Glencore-Mbali pipeline 2018 for Digby Wells
- Remhoogte PR 2019 for A&HAS
- Bospoort Agriculture 2019 for Kudzala
- Overlooked Quarry 2019 for Cabanga
- Richards Bay Powerline 2019 for NGT
- Eilandia dam 2019 for ACO
- Eastlands Residential 2019 for HCAC
- Fairview MR 2019 for Cabanga
- Graspan project 2019 for HCAC
- Lieliefontein N&D 2019 for EnviroPro
- Skeerpoort Farm Mast 2020 for HCAC

- Vulindlela Eco village 2020 for 1World
- KwaZamakhule Township 2020 for Kudzala
- Sunset Copper 2020 for Digby Wells
- McCarthy-Salene 2020 for Prescali
- VLNR Lodge 2020 for HCAC
- Madadeni mixed use 2020 for EnviroPro
- Frankfort-Windfield Eskom Powerline 2020 for 1World
- Beaufort West PV Facility 2021 for ACO Associates
- Copper Sunset MR 2021 for Digby Wells
- Sannaspos PV facility 2021 for CTS Heritage
- Smithfield-Rouxville-Zastron PL 2021 for TheroServe

xi) Research Output

Publications by M K Bamford up to January 2022 peer-reviewed journals or scholarly books: over 160 articles published; 5 submitted/in press; 10 book chapters.
Scopus h-index = 30; Google scholar h-index = 35; -i10-index = 92
Conferences: numerous presentations at local and international conferences.

11. Appendix C – SLR Impact Assessment Methodology

PART A: DEFINITIONS AND CRITERIA*		
Definition of SIGNIFICANCE		**Significance = consequence x probability**
Definition of CONSEQUENCE		**Consequence is a function of intensity, spatial extent and duration**
Criteria for ranking of the INTENSITY of environmental impacts	**VH**	Severe change, disturbance or degradation. Associated with severe consequences. May result in severe illness, injury or death. Targets, limits and thresholds of concern continually exceeded. Substantial intervention will be required. Vigorous/widespread community mobilization against project can be expected. May result in legal action if impact occurs.
	H	Prominent change, disturbance or degradation. Associated with real and substantial consequences. May result in illness or injury. Targets, limits and thresholds of concern regularly exceeded. Will definitely require intervention. Threats of community action. Regular complaints can be expected when the impact takes place.
	M	Moderate change, disturbance or discomfort. Associated with real but not substantial consequences. Targets, limits and thresholds of concern may occasionally be exceeded. Likely to require some intervention. Occasional complaints can be expected.
	L	Minor (Slight) change, disturbance or nuisance. Associated with minor consequences or deterioration. Targets, limits and thresholds of concern rarely exceeded. Require only minor interventions or clean-up actions. Sporadic complaints could be expected.
	VL	Negligible change, disturbance or nuisance. Associated with very minor consequences or deterioration. Targets, limits and thresholds of concern never exceeded. No interventions or clean-up actions required. No complaints anticipated.
	VL+	Negligible change or improvement. Almost no benefits. Change not measurable/will remain in the current range.
	L+	Minor change or improvement. Minor benefits. Change not measurable/will remain in the current range. Few people will experience benefits.
	M+	Moderate change or improvement. Real but not substantial benefits. Will be within or marginally better than the current conditions. Small number of people will experience benefits.
	H+	Prominent change or improvement. Real and substantial benefits. Will be better than current conditions. Many people will experience benefits. General community support.
	VH+	Substantial, large-scale change or improvement. Considerable and widespread benefit. Will be much better than the current conditions. Favourable publicity and/or widespread support expected.
Criteria for ranking the DURATION of impacts	**VL**	Very short, always less than a year. Quickly reversible
	L	Short-term, occurs for more than 1 but less than 5 years. Reversible over time.
	M	Medium-term, 5 to 10 years.
	H	Long term, between 10 and 20 years. (Likely to cease at the end of the operational life of the activity)
	VH	Very long, permanent, +20 years (Irreversible. Beyond closure)
Criteria for ranking the EXTENT of impacts	**VL**	A part of the site/property.
	L	Whole site.
	M	Beyond the site boundary, affecting immediate neighbours
	H	Local area, extending far beyond site boundary.
	VH	Regional/National

PART B: DETERMINING CONSEQUENCE							
INTENSITY = VL							
DURATION	Very long	VH	Low	Low	Medium	Medium	High
	Long term	H	Low	Low	Low	Medium	Medium
	Medium term	M	Very Low	Low	Low	Low	Medium
	Short term	L	Very low	Very Low	Low	Low	Low
	Very short	VL	Very low	Very Low	Very Low	Low	Low
INTENSITY = L							
DURATION	Very long	VH	Medium	Medium	Medium	High	High
	Long term	H	Low	Medium	Medium	Medium	High
	Medium term	M	Low	Low	Medium	Medium	Medium
	Short term	L	Low	Low	Low	Medium	Medium
	Very short	VL	Very low	Low	Low	Low	Medium
INTENSITY = M							
DURATION	Very long	VH	Medium	High	High	High	Very High
	Long term	H	Medium	Medium	Medium	High	High
	Medium term	M	Medium	Medium	Medium	High	High
	Short term	L	Low	Medium	Medium	Medium	High
	Very short	VL	Low	Low	Low	Medium	Medium
INTENSITY = H							
DURATION	Very long	VH	High	High	High	Very High	Very High
	Long term	H	Medium	High	High	High	Very High
	Medium term	M	Medium	Medium	High	High	High
	Short term	L	Medium	Medium	Medium	High	High
	Very short	VL	Low	Medium	Medium	Medium	High
INTENSITY = VH							
DURATION	Very long	VH	High	High	Very High	Very High	Very High
	Long term	H	High	High	High	Very High	Very High
	Medium term	M	Medium	High	High	High	Very High
	Short term	L	Medium	Medium	High	High	High
	Very short	VL	Low	Medium	Medium	High	High
			VL	**L**	**M**	**H**	**VH**
			A part of the site/ property	Whole site	Beyond the site, affecting neighbours	Extending far beyond site but localised	Regional/ National
			EXTENT				

PART C: DETERMINING SIGNIFICANCE							
PROBABILITY (of exposure to impacts)	Definite/ Continuous	VH	Very Low	Low	Medium	High	Very High
	Probable	H	Very Low	Low	Medium	High	Very High
	Possible/ frequent	M	Very Low	Very Low	Low	Medium	High
	Conceivable	L	Insignificant	Very Low	Low	Medium	High
	Unlikely/ improbable	VL	Insignificant	Insignificant	Very Low	Low	Medium
			VL	L	M	H	VVH
			CONSEQUENCE				

PART D: INTERPRETATION OF SIGNIFICANCE	
Significance	**Decision guideline**
Very High	Potential fatal flaw unless mitigated to lower significance.
High	It must have an influence on the decision. Substantial mitigation will be required.
Medium	It should have an influence on the decision. Mitigation will be required.
Low	Unlikely that it will have a real influence on the decision. Limited mitigation is likely required.
Very Low	It will not have an influence on the decision. Does not require any mitigation
Insignificant	Inconsequential, not requiring any consideration.