Palaeontological Impact Assessment for the proposed plant expansion on Farms Tuschenkomst 135JP and Witkleifontein 136JP for Pilansberg Platinum Mines, Northwest Province

Desktop Study

For

SLR Consulting (Africa) (Pty) Ltd

20 May 2019

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Expertise of Specialist

The Palaeontologist Consultant is: Prof Marion Bamford
Qualifications: PhD (Wits Univ, 1990); FRSSAf, ASSAf
Experience: 30 years research; 22 years PIA studies

Declaration of Independence

This report has been compiled by Professor Marion Bamford, of the University of the Witwatersrand, sub-contracted by SLR Consulting (Africa) (Pty) Ltd, 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 expansion to the processing plant at Pilansberg Platinum Mine (PPM) on Farms Tuschenkomst 135 JP and Witvleifontein 136 JP, just north of the Pilansberg National Park. 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 plant expansion. SAHRA CaseID: 13618.

The proposed site predominantly lies on Quaternary sands and alluvium that overlie the non-fossiliferous Rustenburg Layered Suite and contains platinum group metals (PGM). There is a very small chance that the small outcrop of Magaliesburg Formation (Pretoria Group, Transvaal Supergroup) could contain trace fossils of "microbially induced sedimentary structures". Most of the Quaternary Kalahari sands and alluvium do not preserve fossils because they are aeolian and weathered but if pans (not visible on Google Earth) are present then there is a very small chance that fossil plants or bones might be preserved. Although there is a very small chance that fossils might occur in the project area a Chance Find Protocol should be added to the EMPr. Based on this information it is recommended that no palaeontological site visit is required until the responsible person on site during construction finds any fossils.

Table of Contents

1. Background

The mine which is located to the west and north-west of the Pilanesberg National Park (Figure 1) in the North West Province was constructed and operates under an approved mining right and associated authorisations. The approved PPM mining operation comprises:

- open pits;
- river diversions;
- temporary and permanent waste rock stockpiles;
- temporary topsoil dumps;
- haul roads;
- processing facility;
- tailings storage facility;
- sewage treatment facility;
- mining contractors' site complexes;
- temporary waste storage facilities;
- offices;
- workshops; and
- other support infrastructure.

PPM is now proposing to undertake an EIA/EMP amendment for the expansion of the existing PPM processing facility on the farms Witkleifontein 136 JP and Tuschenkomst 135 JP. This will incorporate a second UG2 milling and flotation circuit, a hydrometallurgical processing facility for the treatment of flotation concentrate as well as tailings and chrome recovery facilities.

PPM is proposing to amend its approved EIA/EMP to expand the existing metallurgical processing facility located on the farms Witkleifontein 136 JP and Tuschenkomst 135 JP (Figure 2). The expanded processing facility will extend the life of the processing operations to 50 years. Should the proposed plant expansion project be approved, the following facilities will be built and operated within the footprint of the existing processing and tailings facilities:

- UG2 milling and flotation sections with a production throughput of approximately 65 000 tonnes of ore per annum;
- hydrometallurgical plant for the sulphate leach extraction of base metals from the flotation concentrate utilising oxygen (O_2) and sulphuric acid (H_2SO_4) and the chloride leach extraction of platinum group metals (PGM) and gold utilising chlorine gas (Cl_2) and hydrochloric acid (HCl). The estimated production rate is 110 000 tonnes of flotation concentrate per annum.
- two tailings retreatment plants for the extraction of PGMs, which will involve the treatment of tailings from the flotation sections as well the retreatment of tailings material from the tailings storage facility ; and a chrome recovery facility.

A Palaeontological Impact Assessment was requested for the PPM plant expansion project. As requested, SAHRIS CaseID:13618, 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.

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 1
An indication of the scope of, and the purpose for which, the report was prepared	Section 1
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 ii
An identification of any areas to be avoided, including buffers	N/A
A map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;	N/A
A description of any assumptions made and any uncertainties or gaps in knowledge;	Section 5
A description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives, on the environment	Section 4
Any mitigation measures for inclusion in the EMPr	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 Figures 5, 6
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	Section 8
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

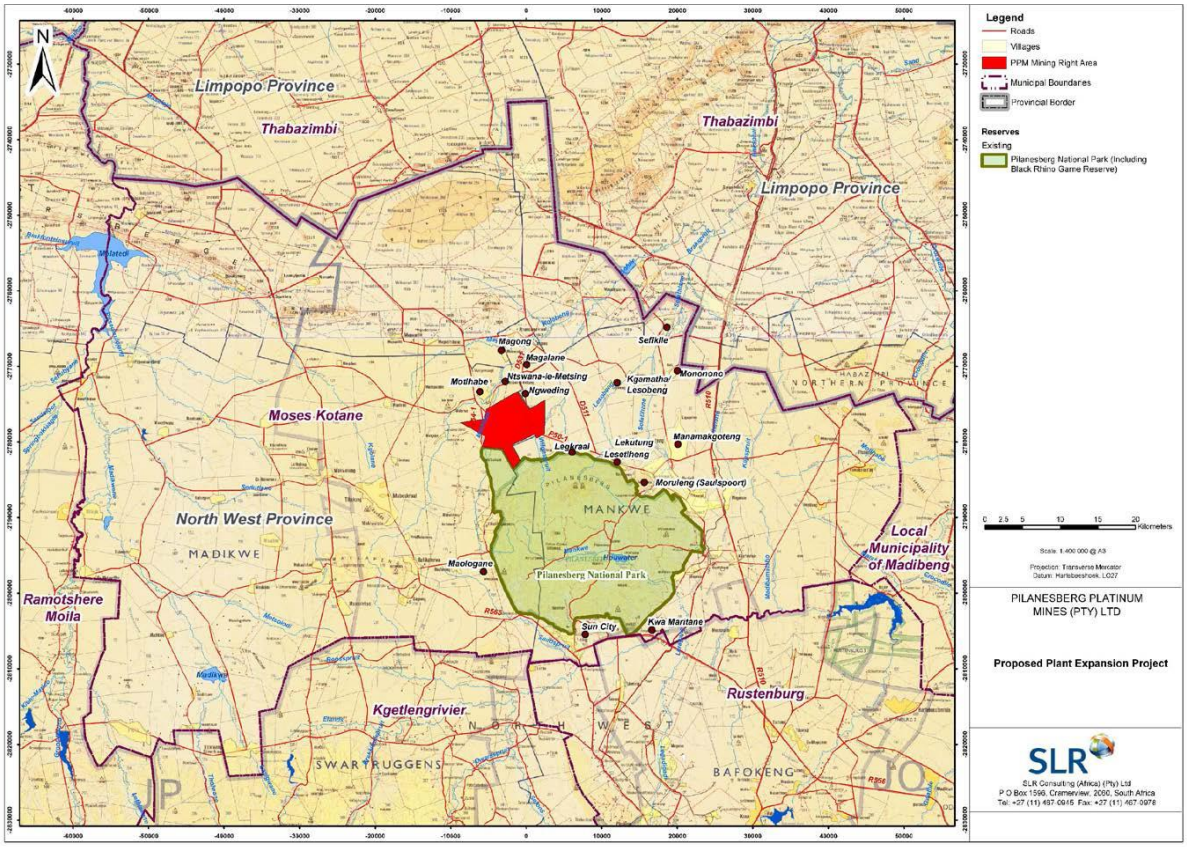

Figure 1: Map showing the location of the Pilansberg Platinum Mine (red) situated to the north of Pilansberg National Park (green). Map supplied by SLR.

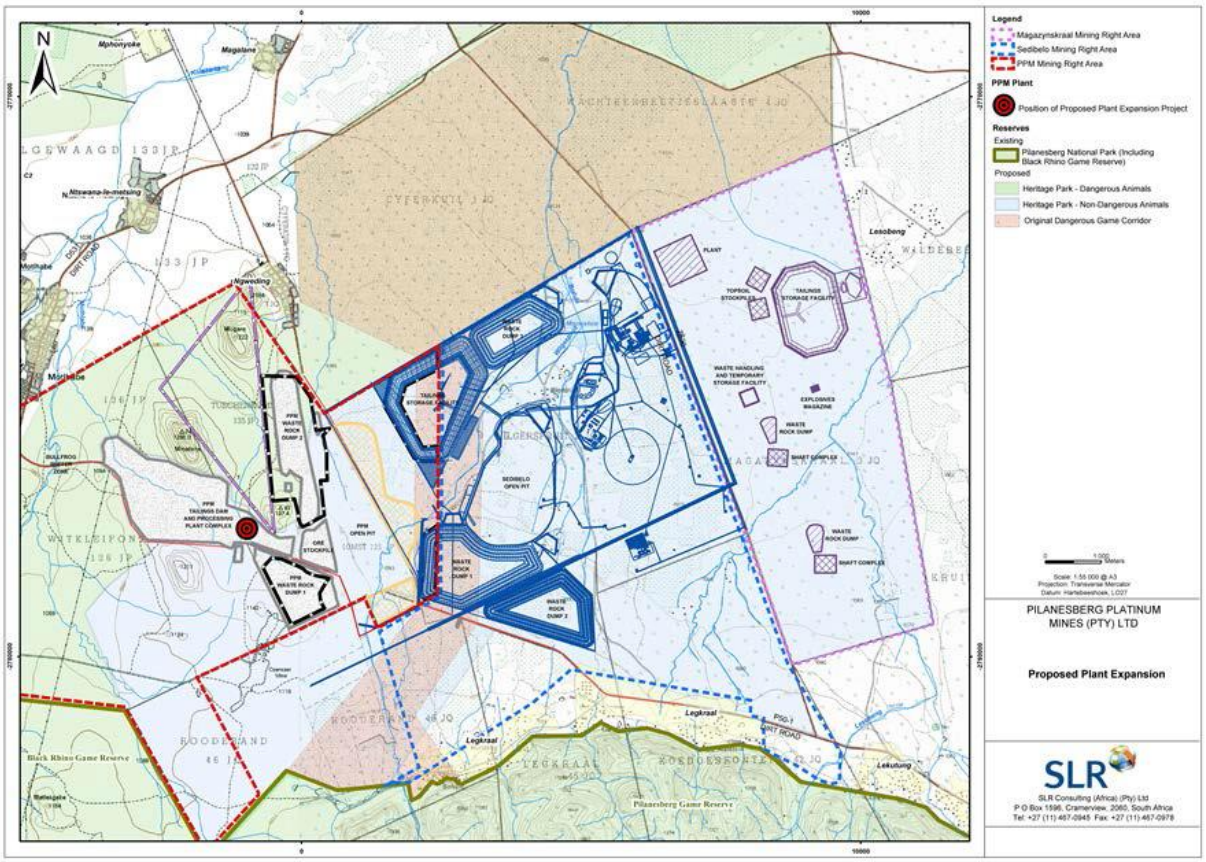

Figure 2: Site map for the Pilansberg Platinum Mine plant expansion.

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

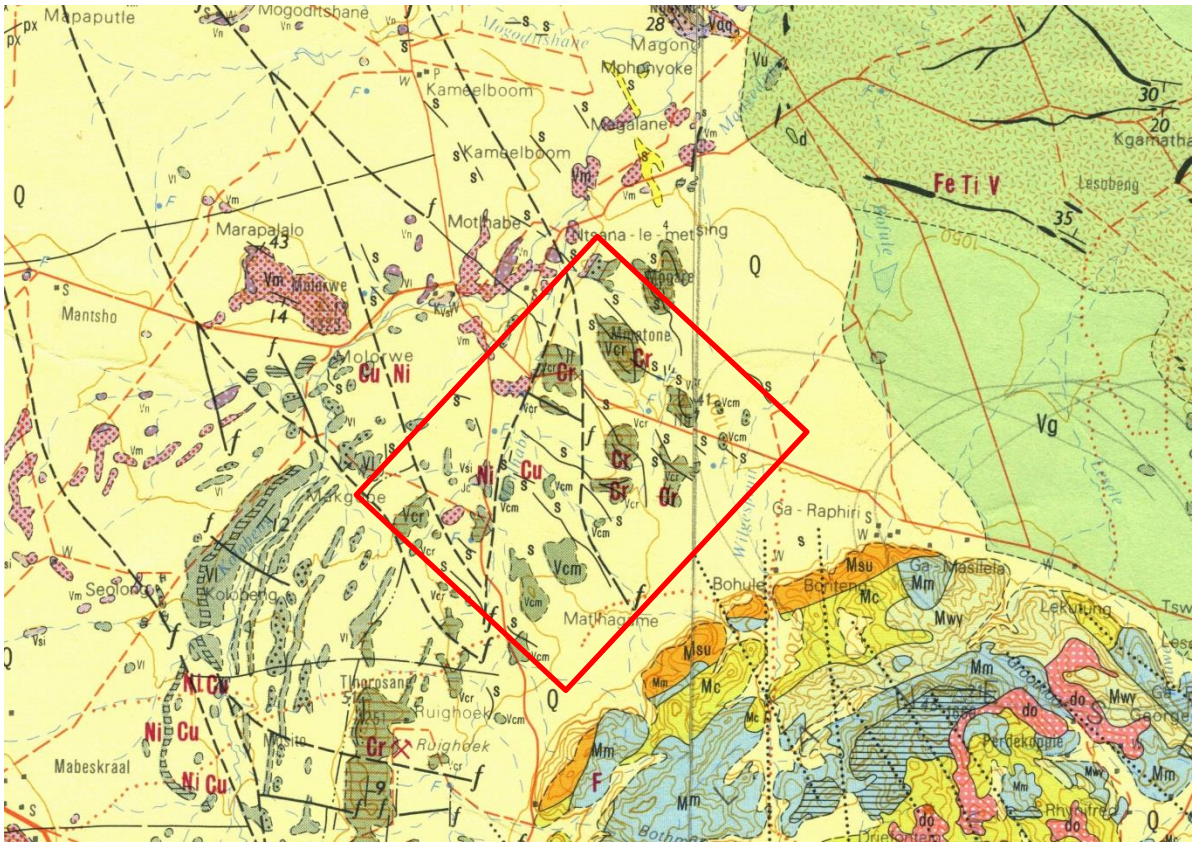

Figure 3: Geological map of the area around the Pilansberg Platinum Mine with part of the National Park in the lower right hand corner. The location of the proposed project is indicated within the red rectangle. Abbreviations of the rock types are explained in Table 2. Map enlarged from the Geological Survey 1: 250 000 map Rustenburg 2526, 1981.

Table 2: Explanation of symbols for the geological map and approximate ages (Cawthorne et al., 2006; Eriksson et al., 2006; Partridge et al., 2006). SG = Supergroup; Fm = Formation; Ma = million years.

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
Vcm	Mathlagame Norite, Rustenburg Layered Suite, Bushveld Complex	Norite	Ca 2050 Ma
Vcr	Ruighoek Pyroxenite, Rustenburg Layered Suite, Bushveld Complex	Pyroxenite	Ca 2050 Ma
Vl	Tweelaagte Bronzitite,	Bronzite, Harburgite,	Ca 2050 Ma

Symbol	Group/Formation	Lithology	Approximate Age
	Groenfontein Harzburgite, Makgope Bronzitite, Rustenburg Layered Suite, bushveld Complex	other volcanic rocks	
Vm	Magaliesberg Formation, Pretoria Group, Transvaal Supergroup	Sandstones, mudrock lenses, quartzite, minor hornfels	Ca 2750 – 2650 Ma

The mine (Figures 1, 2) is situated in the Bushveld Complex (Figure 3) which is rich in platinum group metals, especially within the Rustenburg Layered Suite. Much research has been done on these deposits, and a number of models have been proposed for its formation (Cawthorne et al., 2006; Latypov et al., 2018). Much of the deposits are below ground.

There are small surface outcrops of the older Magaliesburg Formation (Pretoria Group, Transvaal Supergroup) in the north western part of Witkleifontein Farm, and small, sporadic outcrops of the Rustenburg Layered Suite rocks over most of the farm areas attesting to the target rocks below the surface. The latter are ancient, volcanic and metamorphosed (Cawthorne et al., 2006). Most of the land surface is overlain by undifferentiated Quaternary sands, alluvium and calcetes.

ii. Palaeontological context

The palaeontological sensitivity of the area under consideration is presented in Figure 4. The oldest rocks, the Magaliesberg Formation sandstones and quartzites, are more than 2100 million years old and represent the regressive shoreline of the Transvaal Basin (Eriksson et al., 2006, 2012). In some exposures of the Magaliesburg Formation trace fossils, trails, ripples, etc., generally known as microbially induced sedimentary structures (MISS) have been recorded, for example just east of Pretoria (Parizot et al., 2005). These trace fossils are evidence of the past presence of algae and bacteria in the shallow waters, but the organisms are not preserved. They are described as polygons or trails called *Manchuriphycus* (Figure 5).

The site for development is predominantly overlain by the Quaternary sands, alluvium and calcretes. Sands and soils do not preserve fossils because of their aeolian or weathered nature. Very rarely fossils may be covered by aeolian dunes or cemented in pans and their immediate surrounds. An example of this is Kathu Pan near Kuruman, Northern Cape Province (Figure 6), where lithic artifacts are abundant and bone and plant fragments are extremely rare (Porat et al., 2010; Walker et al., 2014). No pans have been recorded for this site.

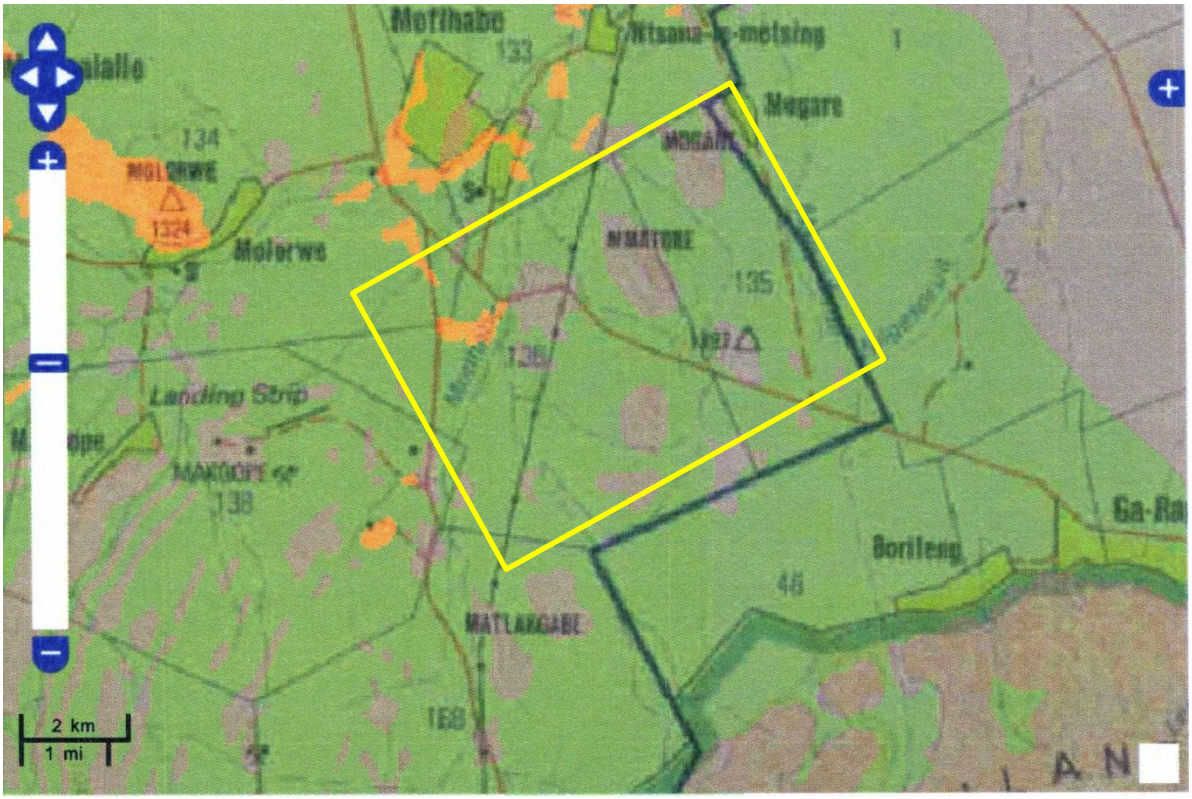

Figure 4: SAHRIS palaeosensitivity maps for the site for the proposed PPM plant expansion shown within the yellow rectangle. Colours indicate the following degrees of sensitivity: red = very highly sensitive; orange/yellow = high; green = moderate; blue = low; grey = insignificant/zero.

From the SAHRIS map above most of the area is indicated as green so a desktop palaeontological impact study is presented here. The orange patch relates to the Magaliesberg Formation's potential microbially induced sedimentary structures. The green area relates to the Quaternary sands, and the grey to the non-fossiliferous Rustenburg Layered Suite.

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	MISS are extremely rare and difficult to recognise but there is a very small chance that they only occur in the northwestern patch on farm Witvleifontein. Quaternary fossils would only occur around pans and dunes but none is shown on the Google Earth map. 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 MISS in the Magaliesberg Fm outcrop or fossils around pans or dunes, the spatial scale will be localised within the site boundary.
	M	-
	H	-
PROBABILITY	**H**	**-**
	M	**-**
	L	It is extremely unlikely that any fossils would be found in the sandstones (Magaliesberg Fm) or loose or soils of the Quaternary. 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 most of the rocks are of volcanic origin and much too old to contain fossils. If pans are present in the footprint they might preserve fossils in the immediate surroundings. By far the majority of the area is loose sand and this does not preserve fossils. Since there is an extremely small chance that fossils from Quaternary pans or ancient trace fossils in the Magaliesberg Formation may be disturbed a Fossil Chance Find Protocol has been added to this report

(Section 8). 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 dolomites, sandstones, shales and sands 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; only pans or sand dunes might contain fossils but none are evident from the Google Earth imagery or the published maps.

6. Recommendation

Based on experience and the lack of any previously recorded fossils from the area, it is extremely unlikely that any fossils would be preserved in the loose sands of the Quaternary. There is very small chance that fossil may occur in the Magaliesbuerg Formation sandstones so a Fossil Chance Find Protocol should be added to the EMPr: if fossils are found once excavations have commenced then they should be rescued and a palaeontologist called to assess the fossils and collect a representative sample.

7. References

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.

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.

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.

Eriksson, P.G., Bartman, R., Catuneanu, O., Mazumder, R., Lenhardt, N., 2012. A case study of microbial mats-related features in coastal epeiric sandstones from the Palaeoproterozoic Pretoria Group, Transvaal Supergroup, Kaapvaal craton, South Africa; the effect of

preservation (reflecting sequence stratigraphic models) on the relationship between mat features and inferred palaeoenvironment. Sedimentary Geology 263, 67-75.

Latypov, R., Costin, G., Chistyakova, S., Hunt, E.J., Mukherjee, R., Naldrett, T. 2018. Platinum-bearing chromite layers are caused by pressure reduction during magma ascent. Nature Communications 9, 264. DOI: 10.1038/s41467-017-02773-w

Porat, N., Chazan, M., Grün, R., Aubert, m., Eisenmann, V., Kolska Horwitz, L., 2010. New radiometric ages for the Fauresmith industry from Kathu Pan, southern Africa: Implications for the Earlier to Middle Stone Age transition. Journal of Archaeological Science 37, 269-283.

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 for buildings, roads, infrastructure, etc., begin.

1. The following procedure is only required if fossils are seen on the surface and when excavations commence.
2. When excavations begin the rocks and sands must be given a cursory inspection by the environmental officer or designated person. Any fossiliferous material (MISS, plants, insects, bone, coal) should be put aside in a suitably protected place. This way the construction 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 5,6). 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 who has been sub-contracted for this phase of the 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, for example the Ditsong Museum in Pretoria or the University of the Witwatersrand. 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.
8. If no fossils are found and the excavations have finished then no further monitoring is required.

Appendix A – Examples of fossils that could occur in the project area.

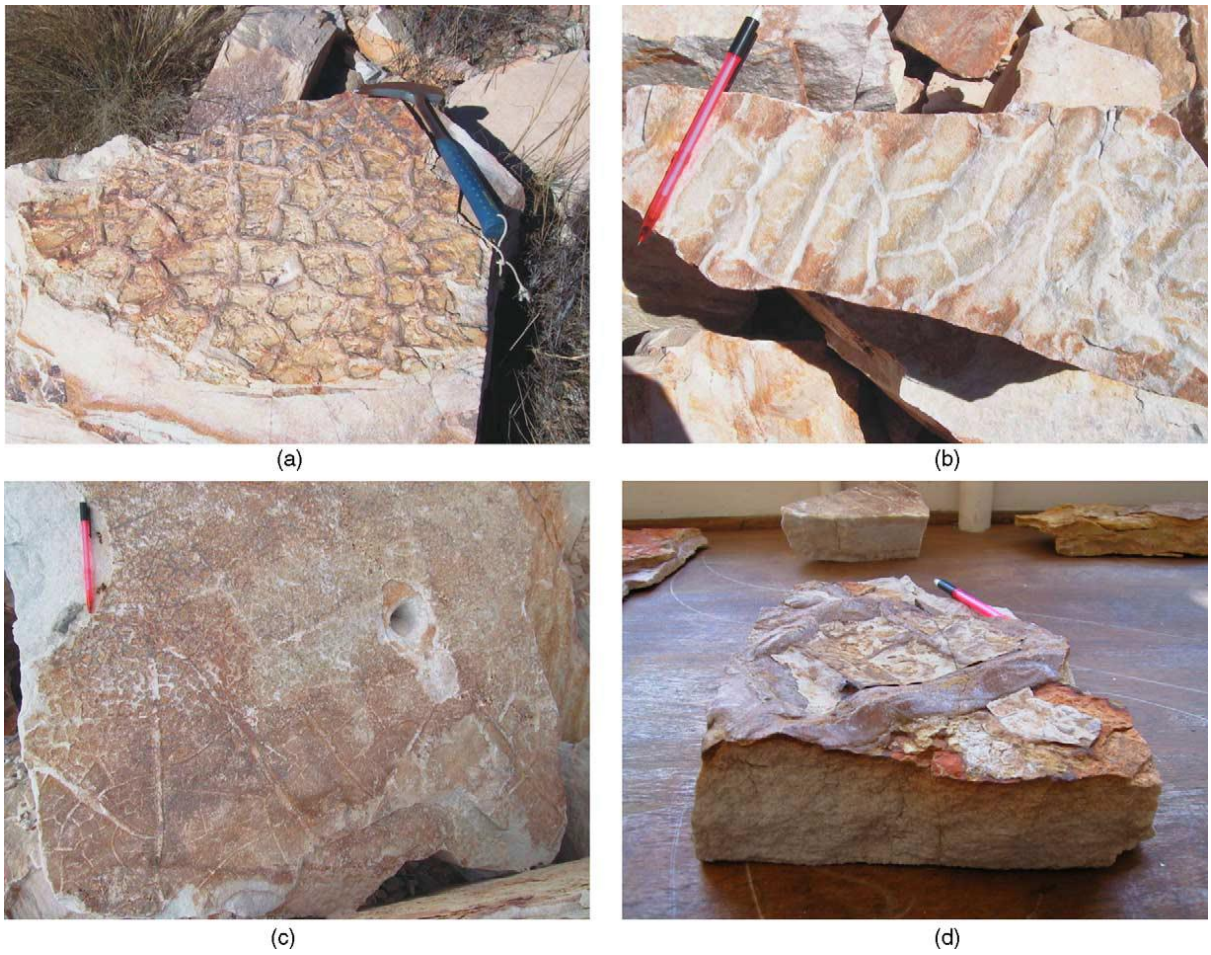

Figure 5: Trace fossils from the Magaliesberg Formation east of Pretoria (Parizot et al., 2005, figure 9). A – polygons; b – parallel ripples with traces called *Manchuriphycus* by Eriksson et al, 2012).

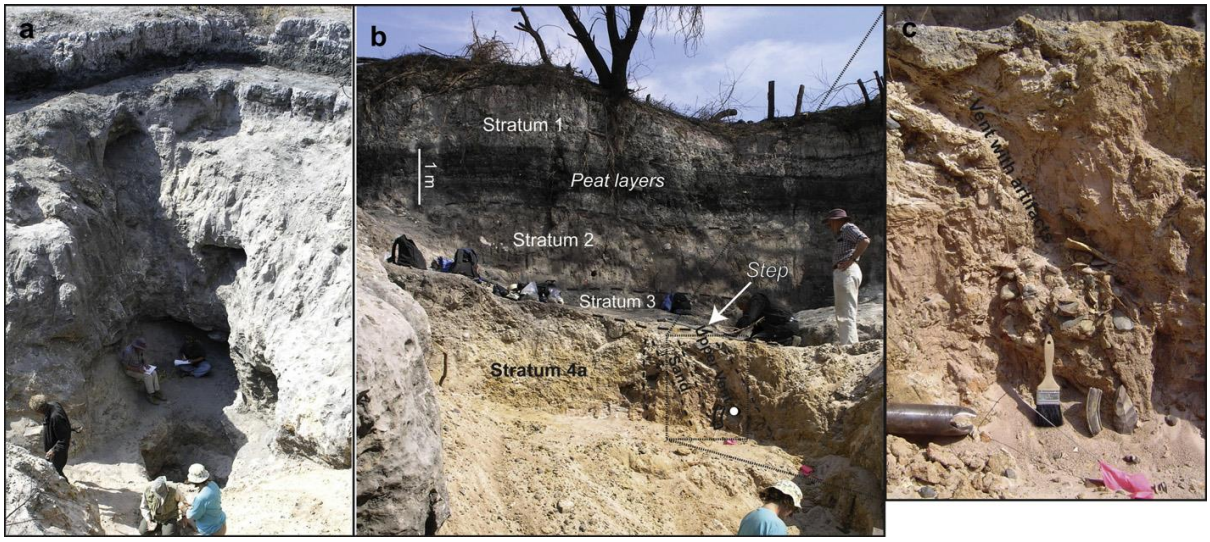

Figure 6: Fossil deposits that may occur around Quaternary pans (Kathu Pan, Porat et al., 2010, figure 3). Bones, teeth or plant fragments can be embedded in the calcrete or peat.

Appendix B – Details of specialist

Curriculum vitae (short) - Marion Bamford PhD
April 2019

I) Personal details

Surname	:	**Bamford**
First names	:	**Marion Kathleen**
Present employment	:	Professor; Director of the Evolutionary Studies Institute. Member Management Committee of the NRF/DST Centre of Excellence Palaeosciences, University of the Witwatersrand, Johannesburg, South Africa-
Telephone	:	+27 11 717 6690
Fax	:	+27 11 717 6694
Cell	:	082 555 6937
E-mail	:	marion.bamford@wits.ac.za ; marionbamford12@gmail.com

ii) Academic qualifications

Tertiary Education: All at the University of the Witwatersrand:
1980-1982: BSc, majors in Botany and Microbiology. Graduated April 1983.
1983: BSc Honours, Botany and Palaeobotany. Graduated April 1984.
1984-1986: MSc in Palaeobotany. Graduated with Distinction, November 1986.
1986-1989: PhD in Palaeobotany. Graduated in June 1990.

iii) Professional qualifications

Wood Anatomy Training (overseas as nothing was available in South Africa):
1994 - Service d'Anatomie des Bois, Musée Royal de l'Afrique Centrale, Tervuren, Belgium, by Roger Dechamps
1997 - Université Pierre et Marie Curie, Paris, France, by Dr Jean-Claude Koeniguer
1997 - Université Claude Bernard, Lyon, France by Prof Georges Barale, Dr Jean-Pierre Gros, and Dr Marc Philippe

iv) Membership of professional bodies/associations

Palaeontological Society of Southern Africa
Royal Society of Southern Africa - Fellow: 2006 onwards
Academy of Sciences of South Africa - Member: Oct 2014 onwards
International Association of Wood Anatomists - First enrolled: January 1991
International Organization of Palaeobotany – 1993+
Botanical Society of South Africa
South African Committee on Stratigraphy – Biostratigraphy - 1997 - 2016
SASQUA (South African Society for Quaternary Research) – 1997+
PAGES - 2008 –onwards: South African representative
ROCEEH / WAVE – 2008+
INQUA – PALCOMM – 2011+onwards

vii) Supervision of Higher Degrees

All at Wits University

Degree	Graduated/completed	Current
Honours	6	2
Masters	8	3
PhD	10	3
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: annually about 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
- Graspan mining rights 2019 for HCAC
- Klaserie Eco School 2019 for Henwood
- Matla Coal 2019 for Digby Wells
- Eilandia 2019 for ACO
- Overlooked Quarry for Cabanga

xi) Research Output

Publications by M K Bamford up to April 2019 peer-reviewed journals or scholarly books: over 130 articles published; 5 submitted/in press; 8 book chapters.
Scopus h index = 26; Google scholar h index = 30;
Conferences: numerous presentations at local and international conferences.

xii) NRF Rating

NRF Rating: B-2 (2016-2020)
NRF Rating: B-3 (2010-2015)
NRF Rating: B-3 (2005-2009)
NRF Rating: C-2 (1999-2004)