Palaeontological Impact Assessment for the proposed Flimieda Ext 3 on Portions 127 and 128 of Farm Elandsheuvel 402 IP, Matlosana (Klerksdorp), North West Province

Desktop Study (Phase 1)

For

Setala Environmental (Pty) Ltd

07 August 2022

Prof Marion Bamford
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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 Setala Environmental (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 development of the Flimieda Ext 3 township on Portions 127 and 128 of Farm Elandsheuvel 402 IP, City of Matlosana Local Municipality (Klerksdorp), North West Province.

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 potentially fossiliferous Rietgat Formation (Platberg Group, Ventersdorp Group) that may preserve trace fossils such as stromatolites and microbial traces in the cherts. These have been reported from the Hartbeesfontein Basin, a few kilometres northeast of Klerksdorp. The dolomites and stromatolites are extensive but the microbial traces are microscopic. Nonetheless, a Fossil Chance Find Protocol should be added to the 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 or other designated responsible person once excavations for foundations and amenities have commenced. Since the impact will be low, as far as the palaeontology is concerned, the project should be authorised.

Table of Contents

1. Background

SAHRA (the South African Heritage Resources Agency) has requested that a Palaeontological Impact Assessment (PIA) be completed for the proposed Flimieda Ext 3 township on Portions 127 and 128 of Farm Elandsheuvel 402 IP, to the northwest of Matlosana (Klerksdorp), North West Province (SAHRA Case ID: 18735).

In order to address specific developmental needs within the jurisdiction of the City of Matlosana Municipality, Nova Investments (Pty) Ltd, Laflie Beleggings (Pty) Ltd & MSPJ Investments (Pty) Ltd intends to obtain environmental authorisation for indigenous vegetation clearance and township development on 182,5314 hectares on Portions 127 & 128 of the farm Elandheuvel 402 IP, City of Matlosana Municipality, Dr Kenneth Kaunda District Municipality, North West Province (Figures 1-2).

Setala Environmental (Pty) Ltd has been appointed by Nova Investments (Pty) Ltd, Laflie Beleggings (Pty) Ltd, and MSPJ Investments (Pty) Ltd to conduct an Environmental Authorisation (EA) Application for the proposed Township establishment on Portion 127 and 128 on the Farm Elandsheuvel 402 IP, Flimieda Ext 3, City of Matlosana Local Municipality, Dr. Kenneth Kaunda District Municipality, North West Province.

A Palaeontological Impact Assessment was requested for the Elandsheuvel-Flimieda township 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, 1999 (Act No. 25 of 1999) (NHRA), a desktop Palaeontological Impact Assessment (PIA) was completed for the proposed development and is reported herein.

Table 1: National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA) and Environmental Impact Assessment (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

	A specialist report prepared in terms of the Environmental Impact Regulations of 2017 must contain:	**Relevant section in report**
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	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
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

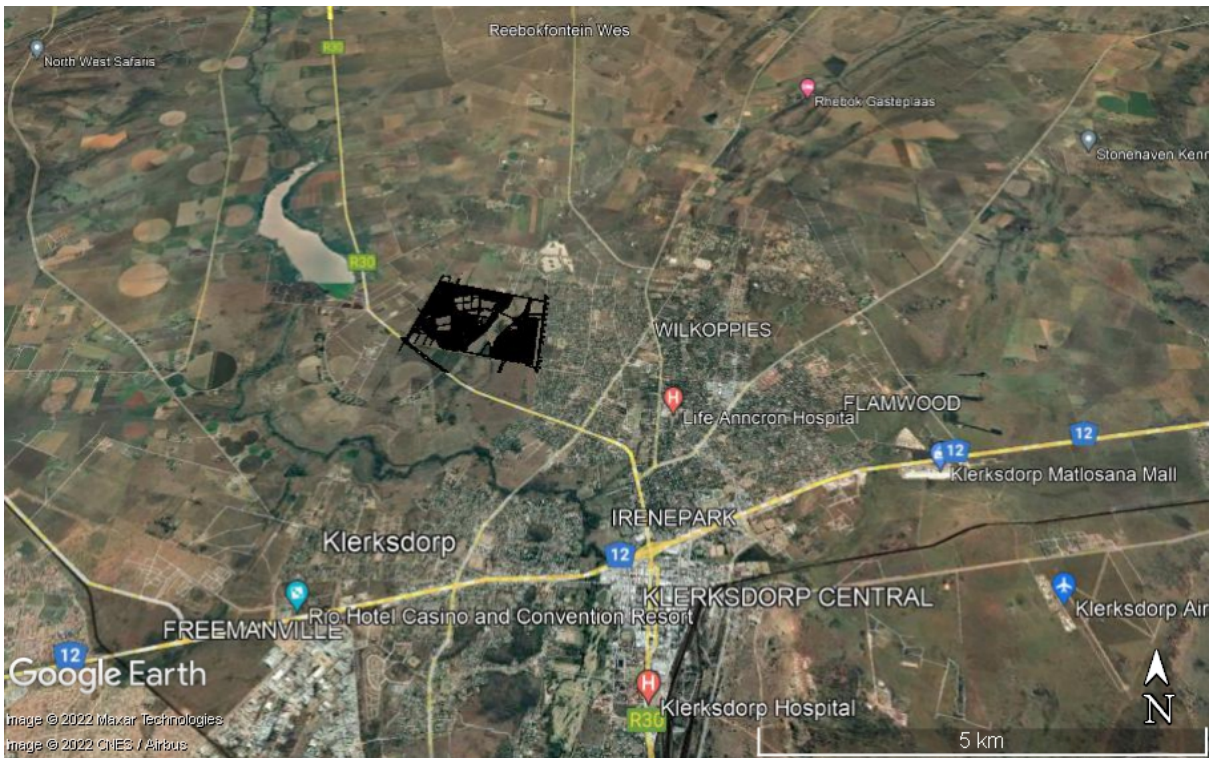

Figure 1: Google Earth map of the general area to show the relative land marks. The site for Flimieda Ext 3 township is shown by the black shapes.

Figure 2: Google Earth Map of the proposed development of a township Flimieda Ext 3, on Portions 127 and 128 of Farm Elandsheuvel 402 IP shown by the black blocks.

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 include 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 farm Elandsheuvel. The location of the proposed project is indicated within the yellow rectangle. Abbreviations of the rock types

are explained in Table 2. Map enlarged from the Geological Survey 1: 250 000 map 2626 West Rand.

Table 2: Explanation of symbols for the geological map and approximate ages (Gumsley et al., 2020; McCarthy et al., 2006; van der Westhuizen et al., 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	Quaternary, ca 1.0 Ma to present
R-Vr	Rietgat Fm, Platberg Group, Ventersdorp SG	Amygdaloidal lava, agglomerate, tuff	Neoarchean 2709 – 2683 Ma
Rm	Makwaaaie Fm, Platberg Group, Ventersdorp SG	Quartzitic feldspar porphyry	Neoarchean 2709 – 2683 Ma
Rk	Klipriviersberg Group, Ventersdorp SG	Andesite, tuff	Neoarchean 2791 - 2779 Ma
Rjo	Johannesburg Subgroup, Central Rand Group, Witwatersrand SG	Quartzite, conglomerate, shale	Ca 2950 Ma
Rj	Jeppestown Subgroup, West Rand Group, Witwatersrand SG	Shale, quartzite, lava	
Rg	Government Subgroup, West Rand Group, Witwatersrand SG	Quartzite, shale	
Rh	Hospital Hill Subgroup, West Rand Group, Witwatersrand SG	Shale quartzite	Ca 2950 Ma

The project lies in the margin of the Ventersdorp Supergroup and the Witwatersrand Supergroup. After the stabilisation of the Kaapvaal Craton, a series of four basins developed in it between 3000 and 2100 million years ago (Van der Westhuizen et al., 2006). The second last of these three basins contains the Ventersdorp Supergroup. It has the largest and most widespread sequence of volcanic rocks on the Kaapvaal Craton and so provides a unique volcano-sedimentary supracrustal record. The Ventersdorp Supergroup unconformably overlies the Witwatersrand Supergroup, and is itself unconformably overlain by the Transvaal Supergroup.

At the base of the Ventersdorp Supergroup is the predominantly volcanic Klipriviersberg Group that has been divided into five formations, from the base upwards the Alberton formation, Orkney Formation, Jeanette Formation, Lorraine Formation and Edenville Formation. Next is the Platberg Group with a mixture of volcanic and sedimentary formations, the Kameeldoorns, Goedgenoeg, Makwassie and **Rietgat Formations** (Van der Westhuizen). The two overlying formations, the Bothaville and Allanridge Formations, have recently been grouped into the Pniel Group (Meintjies and van der Westhuizen, 2018).

On the margins of the Kameeldoorns Formation (Platberg Group) clasts and blocks from faulting and formation of horsts have been incorporated with the sediments, while in the central part and deeper parts of the grabens, lacustrine conditions were present and cherts and dolomites were deposited (van der Westhuizen et al., 2006). These two lithofacies are indicated in the geological map (Figure 3). The Goedgenoeg and Makwassie Formations are mostly lavas but the upper formation of the Platberg Group, the Rietgat Formation, has alternating volcanic and sedimentary rocks, the latter comprising tuffaceous sedimentary material and stromatolitic limestone (idid).

ii. Palaeontological context

The palaeontological sensitivity of the area under consideration is presented in Figure 4. The site for development is in the Rietgat Formation (Platberg Group, Ventersdorp Supergroup).

The lavas and basalts are of igneous origin and do not preserve fossils. Fossils can be preserved in sedimentary rocks. At the time of the Ventersdorp Supergroup there were only micro-organisms such as algae and bacteria present. Algal colonies photosynthesised and used sunlight to convert the carbon dioxide and water to longer chain carbons, the building blocks of life forms. During this process oxygen was released into the atmosphere but was quickly taken up the raw minerals so they became oxidised. A common example is banded ironstone (iron deposits). In shallow marine or lacustrine conditions, the algae formed domes, called stromatolites. These are layer upon layer of minerals deposited by the algae and so are trace fossils as the algal cells are rarely preserved in the stromatolites.

In the Palaeotechnical report for the North West Province (Groenewald et al., 2014), the Rietgat Formation is indicated as moderately sensitive based on the occurrence of stromatolites in borehole core, not surface finds. They only suggest that stromatolites could occur in the older Kameeldoorns Formation but the SAHRIS palaeosensitivity has also indicated that this formation is moderately sensitive.

According to Wilmeth et al. (2019), the most extensive outcrops of Ventersdorp lacustrine stromatolites occur in the **Rietgat Formation** within the Hartbeesfontein Basin which is about 150 km west of Johannesburg. This basin is an intracratonic half-graben with stromatolites that form laterally-extensive facies ~100 km^2 in area, in beds up to 7m thick (Karpeta, 1989, 1993). Unlike many Ventersdorp or Fortescue locations, most Hartbeesfontein stromatolites are preserved entirely as chert, which has the potential to preserve microfossils and detailed microbial mat textures (Wilmeth et al., 2019). They interpret the palaeoenvironment as abundant and diverse microbial life actively photosynthesising in multiple lacustrine locations before the Great Oxidation Event. These are their so-called “oxygen oases” in non-marine environments.

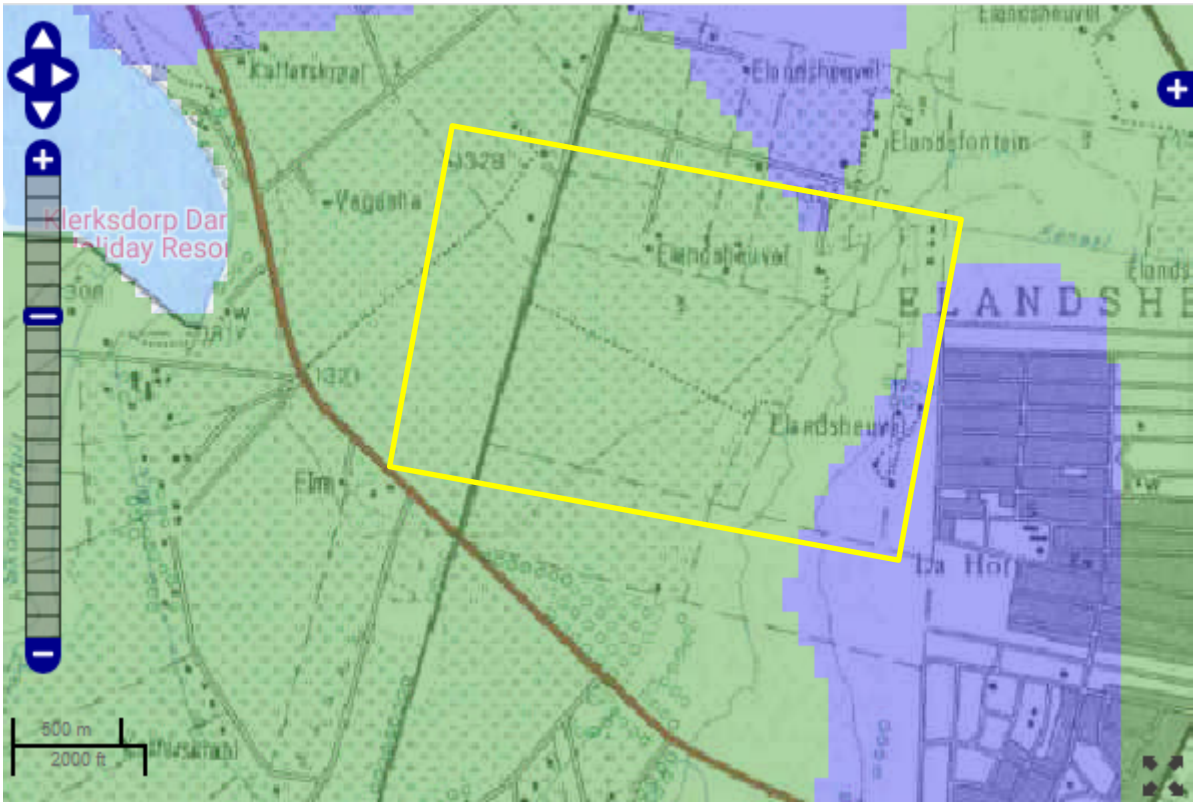

Figure 4: SAHRIS palaeosensitivity map for the site for the proposed Flimieda Ext 3 township on Portions 127 and 126 of Farm Elandsheuvel 402 IP shown within the yellow rectangle. Background colours indicate the following degrees of sensitivity: red = very highly sensitive; orange/yellow = high; green = moderate; blue = low; grey = insignificant/zero.

From the SAHRIS map above the area is indicated as moderately sensitive (green) based on the presence of stromatolites as well as cherts containing microbial traces in the Rietgat Formation.

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	Lavas do not preserve fossils; microbial traces in cherts or in the form of stromatolites occur in the Rietgat Fm in the Hartebeesfontein Basin so it is possible that microbial traces occur on the site. The impact would be negligible
	L+	-
	M+	-
	H+	-
DURATION	**L**	-
	M	-
	H	Where manifest, the impact will be permanent.
SPATIAL SCALE	**L**	Since the only possible fossils within the area would be traces fossils in the dolomites and cherts, the spatial scale will be localised within the site boundary.
	M	-
	H	-

PART B: Assessment		
PROBABILITY	H	-
	M	-
	L	It is extremely unlikely that any fossils would be found in the loose soils and sands that cover the area, but possible that trace fossils occur as stromatolites or in cherts. Therefore, 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 either much too old to contain body fossils but might preserve microbial traces or stromatolites. Since there is a small chance that trace fossils from the Rietgat Formation 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 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 some dolomites might have stromatolites and some cherts might have microbial traces. Such fossils have been reported from the Rietgat Formation in the Hartbeesfontein Basin about 10km to the northwest. 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 overlying soils and sands of the Quaternary. There is a small chance that trace fossils may occur, such as stromatolites in the dolomites and microbial traces in the cherts of the Neoarchaean Rietgat Formation so a Fossil Chance Find Protocol should be added to the EMPr. If fossils are found by the environmental officer, or other responsible person once excavations for foundations and amenities have commenced then they should be rescued and a palaeontologist called to assess and collect a representative sample. The impact on the palaeontological heritage would be low so the project should be authorised.

7. References

Groenewald, G., Groenewald, D., Groenewald, S., 2014. SAHRA Palaeotechnical Report. Palaeontological Heritage of North West Province. 22 pages.

Meintjes, P.G., van der Westhuizen, W.A., 2018. Stratigraphy and Geochemistry of the Goedgenoeg and Makwassie Formations, Ventersdorp Supergroup, in the Bothaville area of South Africa. South African Journal of Geology 121(4), 339-362..

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.

Van der Westhuizen, W.A., de Bruiyn, H., Meintjes, P.G., 2006. The Ventersdorp 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 187-208.

Wilmeth, D.T., Corsetti, F.A., Beukes, N.J., Awramik, S.M., Petryshyn, V., Spear, J.R., Celestian, A.J., 2019. Neoarchean (2.7 Ga) lacustrine stromatolite deposits in the Hartbeesfontein Basin, Ventersdorp Supergroup, South Africa: Implications for oxygen oases. Precambrian Research 320, 291-302.

8. Chance Find Protocol

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

1. The following procedure is only required if fossils are seen on the surface and when drilling/excavations commence.
2. When excavations begin the rocks and discard must be given a cursory inspection by the environmental officer or designated person. Any fossiliferous material (trace fossils, plants, insects, bone or 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 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 developer, contractor or 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, traces 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 Palaeoarchaean

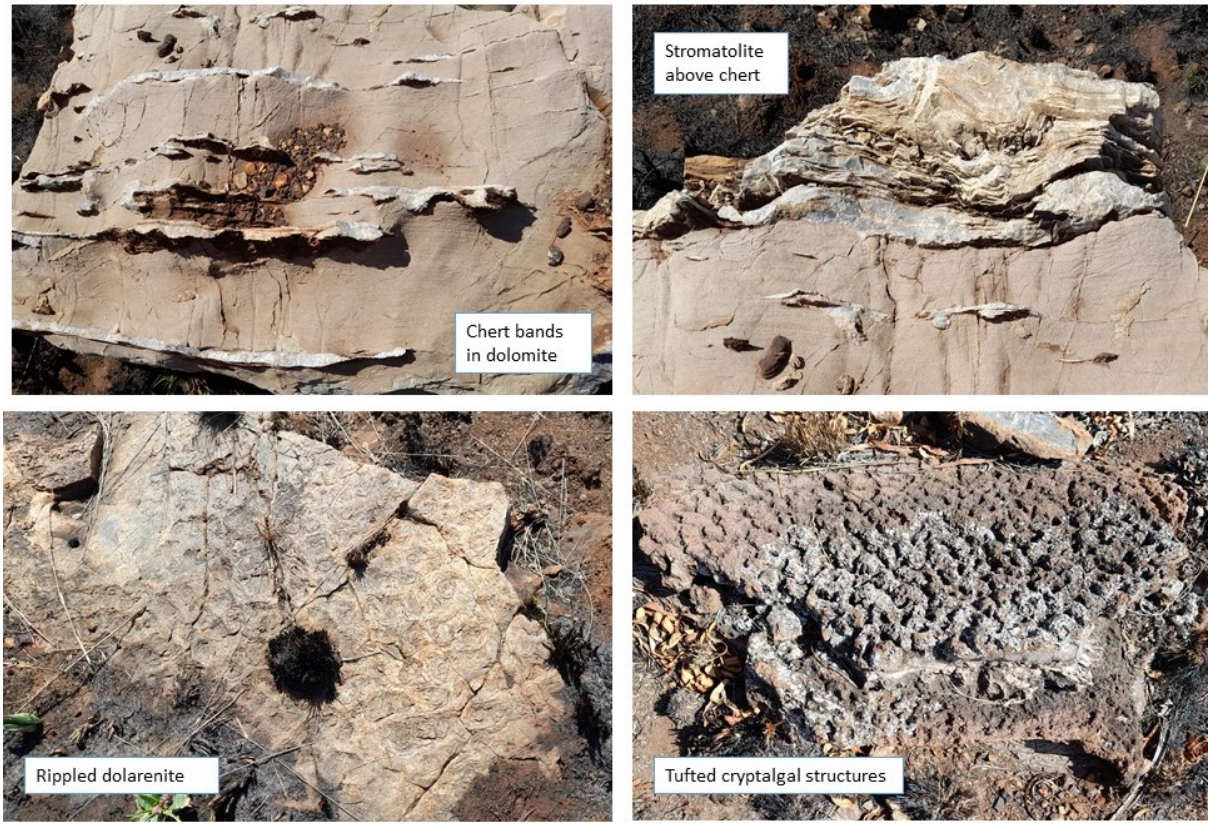

Figure 5: Photographs of different types of stromatolites as seen in the field.

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.