Palaeontological Impact Assessment for the proposed Schoonspruit Dam, on Farm Vyeboom 414JU, near Komatipoort, Mpumalanga Province

Desktop Study

For

Rhengu Environmental Services

28 September 2018

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

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 Rhengu Environmental Services, Malelane, 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

Rhengu Environmental Services has been contracted to carry out an EMPr for the proposed construction of an earth dam for irrigation purposes, Schoonspruit on Farm Vyeboom 414JU, 8km west of Komatiepoort, Mpumalanga Province. The National Heritage Resources Act (Act 25 of 1999) and the National Environmental Management Act (Act 107 of 1998) requires that the proposed development must be preceded by the relevant impact assessment, in this case for palaeontology.

The site lies on non-fossiliferous ancient sediments of the Moodies Group and on shales and sandstones of the undifferentiated Permian-Triassic Karoo Supergroup, the latter being potentially fossiliferous. No fossils of the *Glossopteris* flora or vertebrates have been recorded from this part of South Africa. Since there is a very small chance that fossils could occur here a Chance Find Protocol should be added to the EMPr whereby once excavations have commenced the responsible person on the project will look out for fossils, rescue them and call for a professional palaeontologist to assess their scientific value. As far as the palaeontology is concerned the project can begin.

Table of Contents

1. Background

The applicant, L. M. Schoonspruit Farming (Pty) Ltd (Mr. Jan Lourens), in co-operation with Rhengu Environmental Services, is requesting the alteration of natural land for the construction of a dam on portion 3 of the farm Vyeboom 414 JU, Komatipoort. The proposed development is situated north of the N4 national road, approximately 8km west of Komatipoort Town. This area falls under the jurisdiction of the Ehlanzeni District Municipality, and Nkomazi Local Municipality.

The purpose of the dam is to provide for adequate water for irrigation. The final selected site is on 57ha of his farm; approximately 20ha of the dam will cover an old orchard and 38ha will flood some natural bush. The majority of the farm was historically disturbed by commercial farming activities such as banana, dragonfruit and sugarcane, and lies adjacent to other large commercial farms in the south, east and west, near the town of Komatipoort.

The National Heritage Resources Act (Act 25 of 1999) and the National Environmental Management Act (Act 107 of 1998) requires that the proposed development must be preceded by the relevant impact assessment, in this case for palaeontology.

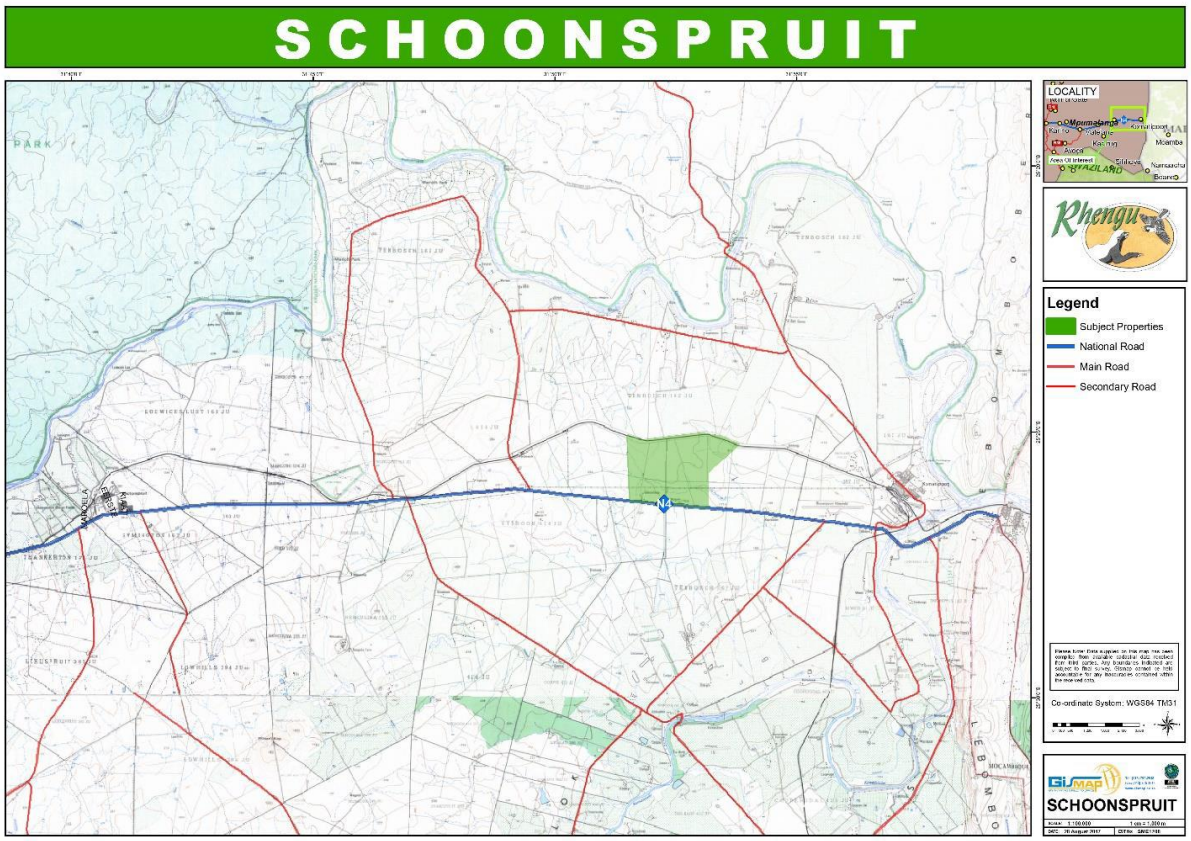

Figure 1: Detailed map of the proposed Schoonspruit Dam, on Farm Vyeboom 414JU, near Komatipoort Malelane, just north of the N4 highway, Mpumalanga.

A Heritage Impact Assessment has already been carried out by Adansonia Heritage Consultants (C. van Wyk Rowe) and the area found to have no visible heritage. SAHRA has

requested that a Palaeontological impact assessment be carried out as the area falls in a highly sensitive area according to the SAHRIS palaeosensitivity map (email on 18 September from N Khumalo – no CaseID no). This report is the requested palaeontological impact assessment for the 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 A
The expertise of that person to compile a specialist report including a curriculum vitae	Appendix A
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 **Error! Reference source not found.**
An identification of any areas to be avoided, including buffers	N/A
A map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;	N/A
A description of any assumptions made and any uncertainties or gaps in knowledge;	Section 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	Section 8
Any conditions for inclusion in the environmental authorisation	n/a
Any monitoring requirements for inclusion in the EMPr or environmental authorisation	Section 8
A reasoned opinion as to whether the proposed activity or portions thereof should be authorised	N/A
If the opinion is that the proposed activity or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan	N/A

A description of any consultation process that was undertaken during the course of carrying out the study	N/A
A summary and copies if any comments that were received during any consultation process	N/A
Any other information requested by the competent authority.	N/A

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;
3. Where appropriate, collection of unique or rare fossils with the necessary permits for storage and curation at an appropriate facility (*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.

3. Geology and Palaeontology

i. Project location and geological context

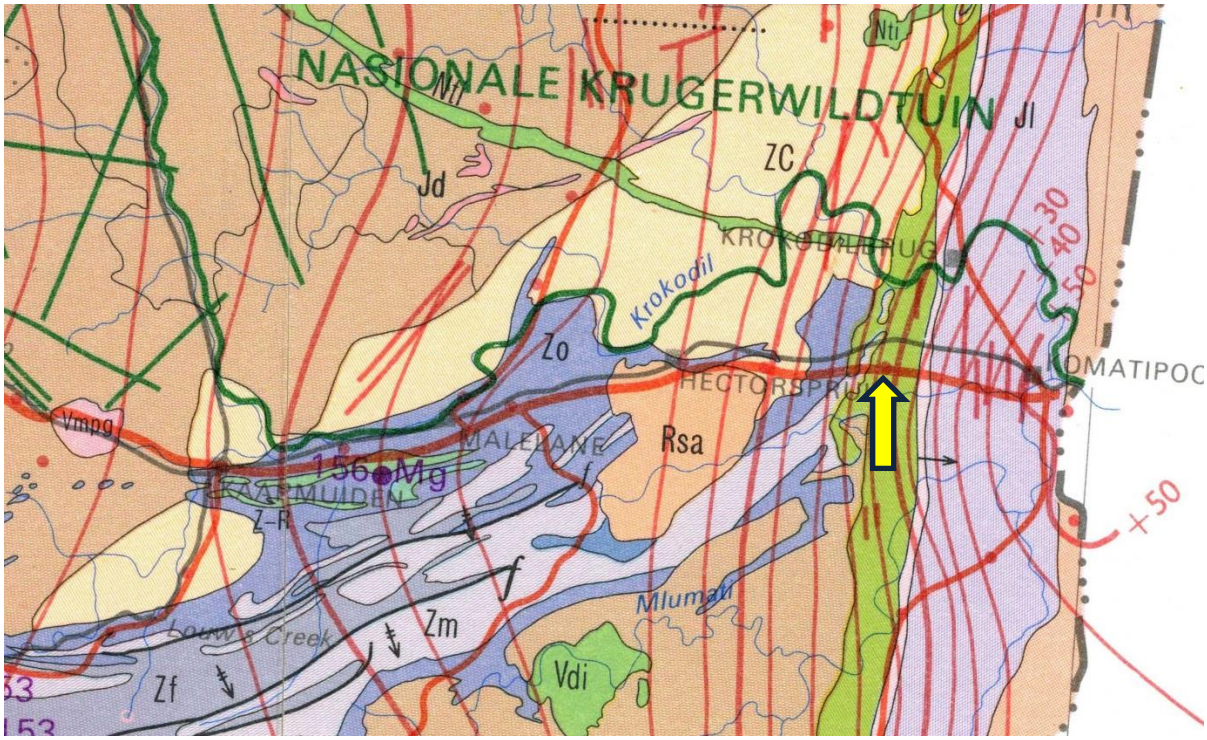

Figure 2: Geological map of the area around Malelane and Komatiepoort, Mpumalanga Province where the proposed Schoonspruit Dam will be constructed. The proposed site is indicated by the yellow arrow. Abbreviations of the rock types are explained in Table 2. Map enlarged from the Geological Survey 1: 1 000 000 map 1984.

Table 2: Explanation of symbols for the geological map and approximate ages (Cornell et al., 2006; Duncan and Marsh, 2006; Eriksen et al., 2006; Johnson et al., 2006; Partridge et al., 2006). SG = Supergroup; Fm = Formation.

Symbol	Group/Formation	Lithology	Approximate Age
Jm	Movene Fm, Lebombo Group	Basalt	Ca 195 – 160 Ma
Jj	Jozini Fm, Lebombo Group	Rhyodactite	Ca 178 Ma
Jl	Letaba Fm, Lebombo Group	Picritic basalt	Ca 183 Ma
Jt	Tshokwane granophyre	Granophyre	Ca 140 Ma
P-Tr	Permo-Triassic	Undifferentiated Karoo sediments, shale, coal, sandstone, mudstone	Ca 300 – 180 Ma
Tr-C	Clarens Fm, Stormberg Group, Karoo SG	Sandstone, siltstone	Ca 200 – 180 Ma
Rmp	Mpuluzi Granite	Quartz monzonite	

Symbol	Group/Formation	Lithology	Approximate Age
ZC	Unnamed	Granite	
ZB	Unnamed	Potassic granite and granodiorite	
Zm	Moodies Group, Barberton Sequence	Sandstone, shale, conglomerate	>3300 Ma
Zf	Figtree Group, Barberton Sequence	Greywacke, shale, chert, dacitic volcanic rocks	
Zo	Onverwacht Group, Barberton Sequence	Lava, pyroclastic rocks	

The proposed site lies partly on the sandstones, shales and conglomerates of the ancient Moodies Group and partly on sandstone and siltstone of the undifferentiated Permo-Triassic rocks of the Karoo Supergroup.

The Moodies Group forms part of the oldest rocks in South Africa, those of the Barberton Greenstone Belt (BGB), which is mid Archean in age (3600- 3100 Ma; Brandl et al., 2006). There are also a number of plutons and batholiths in the area that range in age from 3509 to 3104 Ma. The Barberton Greenstone Belt is one of the best studied granite-greenstone terranes in the world (Brandl et al., 2006) because it is one of the oldest known. It is composed of a unique sequence of the best-preserved, first-formed lithologies on the planet, and geologists have used it as a model to interpret other greenstone belts (ibid). The Barberton Supergroup comprises three major lithostratigraphic units (Fig 3) with the Onverwacht group at the base, the Figtree Group in the middle and the Moodies Group at the top. It is thought that these sediments formed in an oceanic setting, followed by island arc development as a consequence of some primitive form of Archaean plate tectonic processes (ibid).

Most research has been done on the southern part of the BGB and little on the northern part, where Malelane is situated. Currently the Onverwacht Group is divided into six formations as follows (basal to top): Sandspruit Formation, Theespruit Formation, Komatie Formation, Hoogenoeg Formation, Kromberg Formation, Mendon Formation (Brandl et al., 2006).

The Lebombo Mountains to the east of South Africa are igneous in origin and comprise easily distinguishable formations of different types of basalt and rhyolite (Duncan and Marsh, 2006). Running parallel to these mountains is a north-south exposure of Karoo sequence deposits that has not been well studied. The parallel Karoo rocks in this area are undifferentiated, mainly because there are no fossils in the sediments that can be used to identify the strata, as has been done for the main Karoo Basin (Rubidge et al., 1995; Johnson et al., 2006). To the east of the Permo-Triassic outcrops are sediments of the Triassic Clarens Formation.

ii. Palaeontological context

Although the Onverwacht Group are so old some microfossils have been reported from them, for example the oldest cyanobacteria or blue-green algae from the Kromberg Formation type site along the Komati River (Walsh, 1992; Altermann et al., 2006; Schopf 2006). Recently Kremer and Kazmierczak (2017) have found more microfossils from this general area in the Songimvelo Nature Reserve cherts (some 100km southwest of Malelane). They interpreted the presumably coccoidal cyanobacteria thriving as benthic and possibly, at least in part, as benthic planktonic communities from the Kromberg Formation. It should be noted that the microfossils are mostly less than 10 microns in diameter and can only be seen in thin section under a microscope at 1000x magnification.

The Moodies Group, however, is considered to be a foreland basin setting with braided alluvial plains, deltas, shallow water coastal systems and shelf facies (Erikssen et al., 2006) but because of its antiquity predates any organisms that could have occupied such a setting. Theses sediments contain no fossils but trace fossils of microbial mats have been reported (Nofke et al., 2006; Kremer and Kazmierczak, 2017) but from much farther south so not affected by this project.

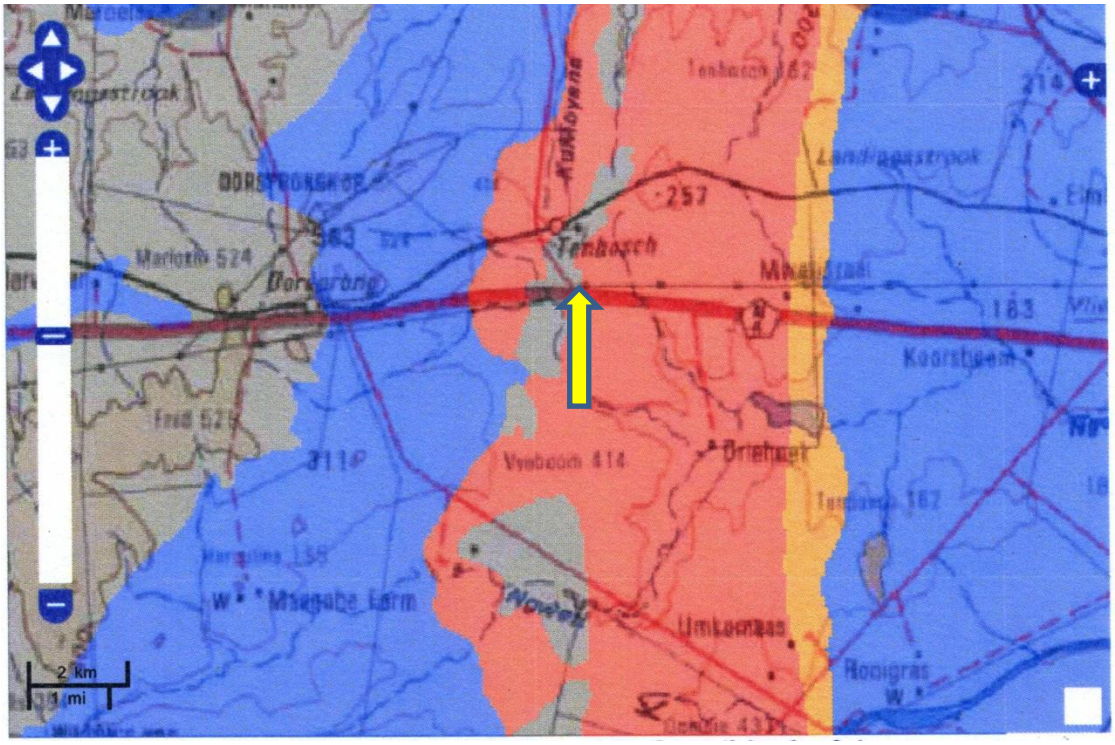

Figure 3: SAHRIS palaeosensitivity map of the region around farm Vyeboom, on the N$ about 8km west of Komatipoort. The site is indicated by the yellow arrow. Colours indicate the following degrees of sensitivity: red = very highly sensitive; orange/yellow = high; green = moderate; blue = low; grey = insignificant/zero.

To date no fossils have been recorded from the potentially fossiliferous Karoo sediments north of Swaziland but *Glossopteris* has been reported south of Swaziland in the Emakwezini Formation of the Beaufort Group (Johnson et al., 2006).

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	There is a small chance of fossils being found here
	L+	-
	M+	
	H+	-
DURATION	**L**	-
	M	-
	H	Where manifest, the impact will be permanent.
SPATIAL SCALE	**L**	The spatial scale is extremely small.
	M	-
	H	-

PART B: ASSESSMENT		
PROBABILITY	H	-
	M	
	L	There is a very small chance of finding fossils in the shales and sandstones of the undifferentiated Karoo sediments bu none has been recorded in this region.

Based on the nature of the project, the surface soils will be excavated to a depth of several metres and will be used to form the dam wall. Associated structures are also planned from the local soil and part of this area has been disturbed by previous agricultural activities. Since there is only a very small chance of finding Karoo-aged fossil plants and vertebrates in the shales and sandstones a Chance Find Protocol should be added to the EMPr. Taking account of the defined criteria, the potential impact to fossil heritage resources is very 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 gneisses, schists, granites and basalts are typical for the country and, except for the sandstones of the Moodies Group, do not contain any fossil plant, insect, invertebrate and vertebrate material. There is a very small chance that the shales and sandstones of the undifferentiated Karoo Supergroup could contain fossil plants or vertebrates because they have been found in the same aged sediments south of Swaziland, but not here. No fossils, however, have been reported from this region.

6. Recommendation

Based on the age of the sediments and occurrence of fossils in the Karoo Supergroup in the main Karoo Basin and south of Swaziland, although no fossils have been recorded from this area, there is a very small chance that fossils would be identified once excavations begin for the dam and irrigation infrastructure. A Chance Find Protocol should be included in the EMPr so that the geologist or responsible person in charge of the project can look out for any fossil material, save it and call a professional palaeontologist for advice. As far as the palaeontological heritage is concerned the proposed dam construction can proceed.

7. References

Altermann, W. Kazmierczak, J. Oren, A., Wright, D.T., 2006. Cyanobacterial calcification and its rock-building potential during 3.5 billion years of earth history. Geobiology 4, 147-166.

Duncan, A.R., Marsh, J.S., 2006. The Karoo Igneous 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 501-520.

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.

Knoll, A.H., Bergmann, K.D., Strauss, J.V., 2016. Life: the first two billion years. Philosophical Transactions of the Royal Society B 371, 20150493.

Kremer, B., Kazmierczak, J., 2017. Cellularly preserved microbial fossils from ca 3.4 Ga deposits of South Africa: A testimony of early appearance of oxygenic life? Precambrian Research 285, 117-129.

Noffke, N., Erikssen, K.A., Hazen, R.M., Simpson, E.L. 2006. A new window into Early Archean life: Microbial mats in Earth's oldest siliciclastic tidal deposits (3.2 Ga Moodies Group, South Africa). Geology 34, 253–256.

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.

Walsh, M.M., 1992. Microfossils and possible microfossils from the Early Archean Onverwacht Group, Barberton Mountain Land, South Africa. Precambrian Research, 54, 271-293.

8. Chance Find Protocol

Monitoring Programme for Palaeontology – to commence once the excavations 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 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 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 Figure 4, 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. As required and to be agreed upon by the developer and the qualified palaeontologist sub-contracted for this project, the palaeontologist should visit the site to inspect the selected material and check the samples where feasible. The frequency of inspections should be determined by the finding of interesting material. However, if the onsite designated person is diligent and extracts the fossil material then inspections can be less frequent.

6. Fossil plants or vertebrates that are considered to be of good quality or scientific interest by the palaeontologist must be removed, catalogued and housed in a suitable institution where they can be made available for further study. Before the fossils are removed from the site a SAHRA permit must be obtained. Annual reports must be submitted to SAHRA as required by the relevant permits.

7. If no good fossil material is recovered then the site inspections by the palaeontologist can be reduced to annual events until construction has ceased. Annual reports by the palaeontologist must be sent to SAHRA.

8. If no fossils are found and the excavations have finished then no further monitoring is required.

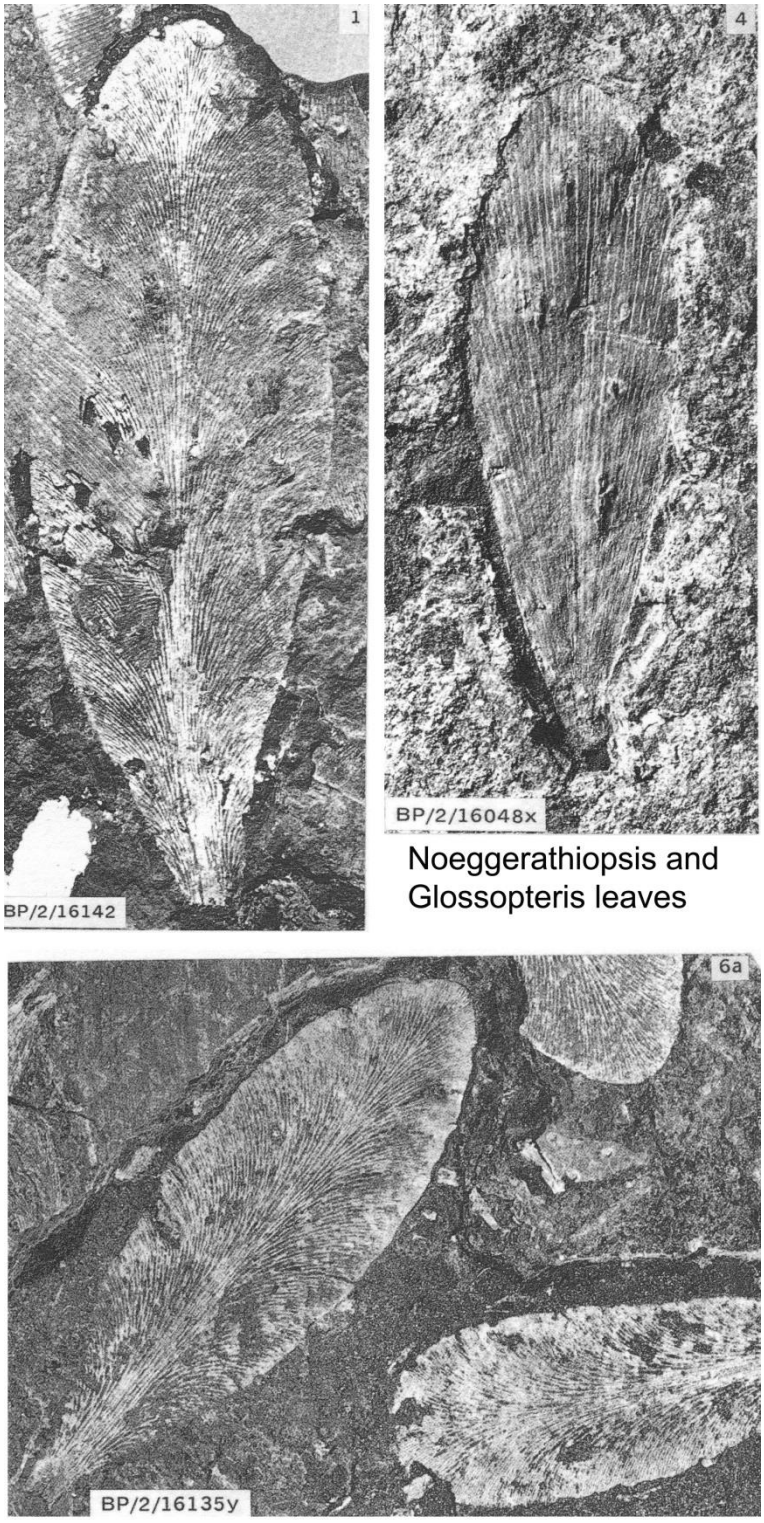

Figure 4: Examples of *Glossopteris* leaves from the main Karoo basin (specimens housed in the Evolutionary Studies Institute, University of the Witwatersrand).

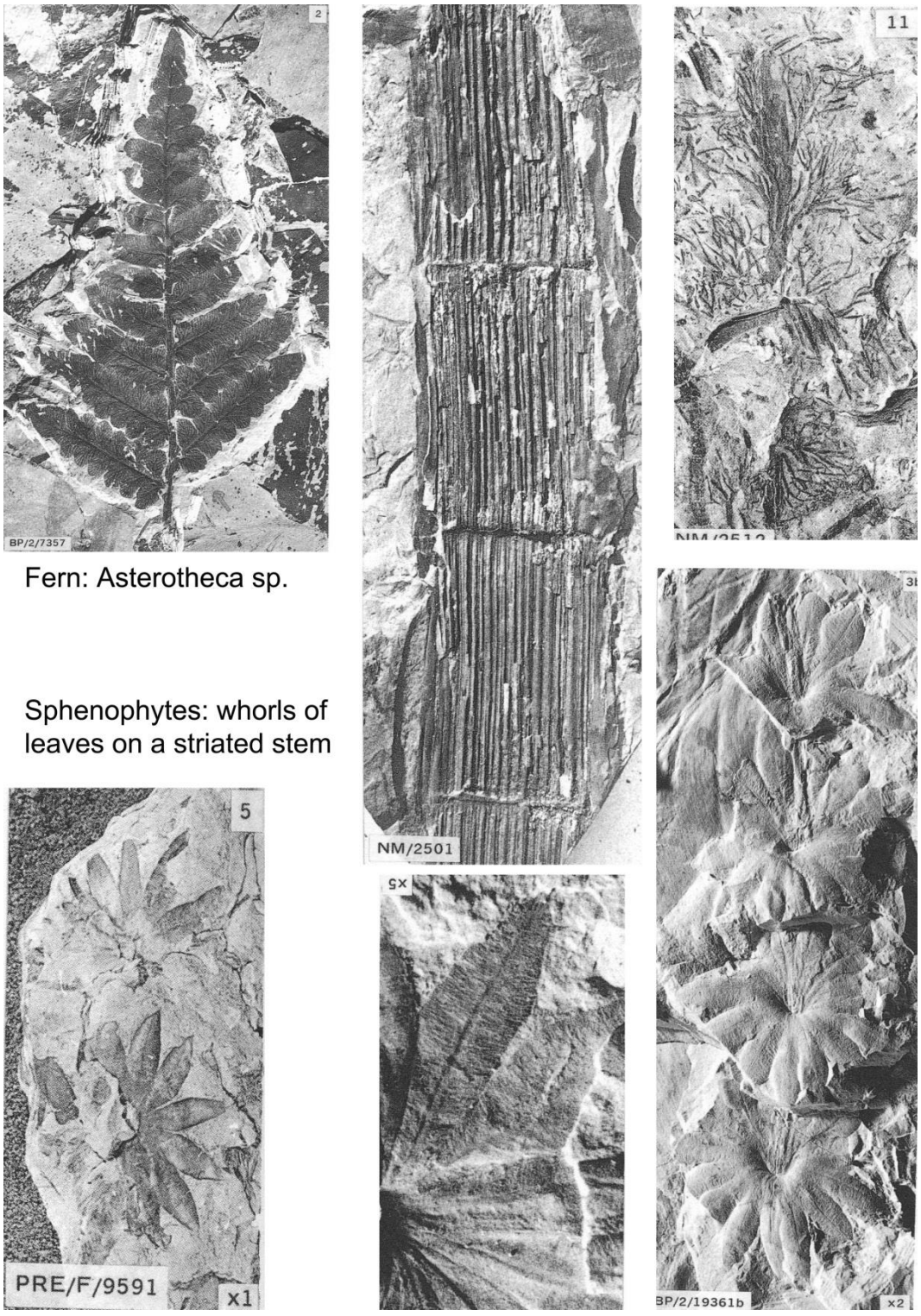

Figure 5: Examples of fossil plants from the Karoo *Glossopteris* flora (specimens housed in the Evolutionary Studies Institute, University of the Witwatersrand).

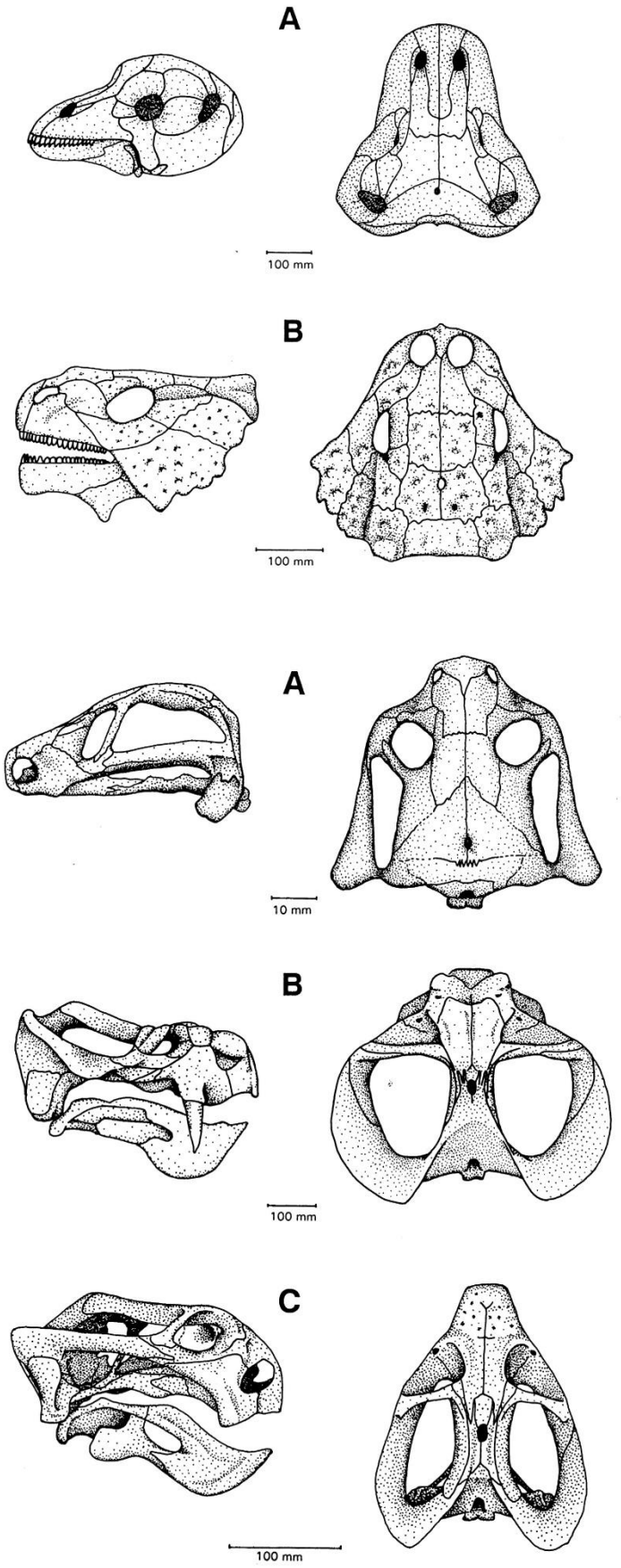

Figure 6: Examples of vertebrates that could be found (diagrams from Rubidge et al., 1995)

Appendix A – Details of specialist

Curriculum vitae (short) - Marion Bamford PhD
January 2018

I) Personal details

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

ii) Academic qualifications

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

iii) Professional qualifications

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

iv) Membership of professional bodies/associations

Palaeontological Society of Southern Africa
Royal Society of Southern Africa - Fellow: 2006 onwards
Academy of Sciences of South Africa - Member: Oct 2014 onwards
International Association of Wood Anatomists - First enrolled: January 1991

International Organization of Palaeobotany – 1993+
Botanical Society of South Africa
South African Committee on Stratigraphy – Biostratigraphy - 1997 - 2016
SASQUA (South African Society for Quaternary Research) – 1997+
PAGES - 2008 –onwards: South African representative
ROCEEH / WAVE – 2008+
INQUA – PALCOMM – 2011+onwards

vii) Supervision of Higher Degrees

All at Wits University

Degree	Graduated/completed	Current
Honours	5	2
Masters	6	3
PhD	9	3
Postdoctoral fellows	5	3

viii) Undergraduate teaching
Geology II – Palaeobotany GEOL2008 – average 65 students per year
Biology III – Palaeobotany APES3029 – average 25 students per year
Honours – Evolution of Terrestrial Ecosystems; African Plio-Pleistocene Palaeoecology; Micropalaeontology – average 2-8 students per year.

ix) Editing and reviewing
Editor: Palaeontologia africana: 2003 to 2013; 2014 – Assistant editor
Guest Editor: Quaternary International: 2005 volume
Member of Board of Review: Review of Palaeobotany and Palynology: 2010 –
Cretaceous Research: 2014 -

Review of manuscripts for ISI-listed journals: 25 local and international journals

x) Palaeontological Impact Assessments

Selected – list not complete:

- Thukela Biosphere Conservancy 1996; 2002 for DWAF
- Vioolsdrift 2007 for Xibula Exploration
- Rietfontein 2009 for Zitholele Consulting
- Bloeddrift-Baken 2010 for TransHex
- New Kleinfontein Gold Mine 2012 for Prime Resources (Pty) Ltd.
- Thabazimbi Iron Cave 2012 for Professional Grave Solutions (Pty) Ltd
- Delmas 2013 for Jones and Wagener
- Klipfontein 2013 for Jones and Wagener
- Platinum mine 2013 for Lonmin
- Syferfontein 2014 for Digby Wells
- Canyon Springs 2014 for Prime Resources

- Kimberley Eskom 2014 for Landscape Dynamics
- Yzermyne 2014 for Digby Wells
- Matimba 2015 for Royal HaskoningDV
- Commissiekraal 2015 for SLR
- Harmony PV 2015 for Savannah Environmental
- Glencore-Tweefontein 2015 for Digby Wells
- Umkomazi 2015 for JLB Consulting
- Ixia coal 2016 for Digby Wells
- Lambda Eskom for Digby Wells
- Alexander Scoping for SLR
- Perseus-Kronos-Aries Eskom 2016 for NGT
- Mala Mala 2017 for Henwood
- Modimolle 2017 for Green Vision
- Klipoortjie and Finaalspan 2017 for Delta BEC

xi) Research Output

Publications by M K Bamford up to January 2018 peer-reviewed journals or scholarly books: over 110 articles published; 5 submitted/in press; 8 book chapters.
Scopus h index = 22; Google scholar h index = 24;
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)