

**Palaeontological Impact Assessment for the proposed  
construction of Roosboom Township southwest of  
Ladysmith, KwaZulu Natal Province**

**Desktop Study**

**For**

**Heritage Contracts and Archaeological Consulting**

**24 March 2019**

**Prof Marion Bamford**

Palaeobotanist

P Bag 652, WITS 2050

Johannesburg, South Africa

[Marion.bamford@wits.ac.za](mailto: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 Heritage Contracts and Archaeological consulting, Modi Molle, 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 development of a residential township on Farm Roosboom 1102 GS on Portion 437 and Portion 502 to the south of Ladysmith, KwaZulu Natal. To comply with the South African Heritage Resources Agency (SAHRA) in terms of Section 38(8) of the National Heritage Resources Act, 1999 (Act No. 25 of 1999) (NHRA), a desktop Palaeontological Impact Assessment (PIA) was completed for the proposed project.

The proposed site lies on the Late Permian Beaufort Group, Adelaide Subgroup, Normandien Formation (previously called the Estcourt Formation), sandstones, shales and mudstones. Although fossils have not been reported from this site there is a small chance that typical late *Glossopteris* flora plants could occur in the sediments just below the surface. Surface exposures are likely to be very weathered. It is extremely unlikely that fossils would be preserved in the Quaternary sands and silcrete of the Masotcheni Formation. A Fossil Chance Find Protocol should be added to the EMP. Based on this information it is recommended that no palaeontological site visit is required unless fossils are revealed once excavations and drilling has commenced. As far as the palaeontology is concerned the project can proceed.

## Table of Contents

Expertise of Specialist.....	1
Declaration of Independence.....	1
1. Background.....	4
2. Methods and Terms of Reference .....	6
i. Project location and geological context.....	7
ii. Palaeontological context .....	8
4. Impact assessment.....	10
5. Assumptions and uncertainties .....	11
6. Recommendation.....	11
7. References.....	11
8. Chance Find Protocol .....	12
Appendix A (examples of fossils) .....	13
Appendix B (short CV of specialist) .....	17

# 1. Background

Eco Assessments CC was appointed by SSS Investments PTY LTD c/o the Alfred Duma Local Municipality, to conduct the Environmental Impact Assessment process for the establishment of a Residential Township on Portion 437 and Portion 502 of the farm Roosboom 1102GS, in terms of the applicable legislation.

## Locality

The subject site is located approximately 10km south of Ladysmith. The site lies 750m west of the R103 (Ladysmith/Colenso) Road and immediately south and adjacent of the existing township of Roosboom (see Fig 1.). The site extends an area of approximately 85ha and is bisected by a rocky ridge line, a non-perennial watercourse and a river. The site has a zoning of Agriculture and lies vacant. Several formal dwellings lie on the eastern extent of the site. The surrounding areas include agricultural holdings used largely for subsistence purposes.

## Development Detail

The proposed development is envisaged to comprise the following land uses:

- ± 1000 residential units;
- Subsidiary land uses that include crèches, primary school, religious centres and business;
- Public Open Space areas;
- Public Roads

The Township will be developed according to architectural guidelines and will provide for an aesthetically pleasing development. Relevant services available in the area include piped water and electrical supply. A specialist infrastructure investigation will assess the opportunity for link services or alternatively provide means to service the site for potable water supply, electrical demand, storm water attenuation and sewage treatment and/or disposal.

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)

<b>A specialist report prepared in terms of the Environmental Impact Regulations of 2014 must contain:</b>	<b>Relevant section in report</b>
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 <b>Error! Reference source not found.</b>
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
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

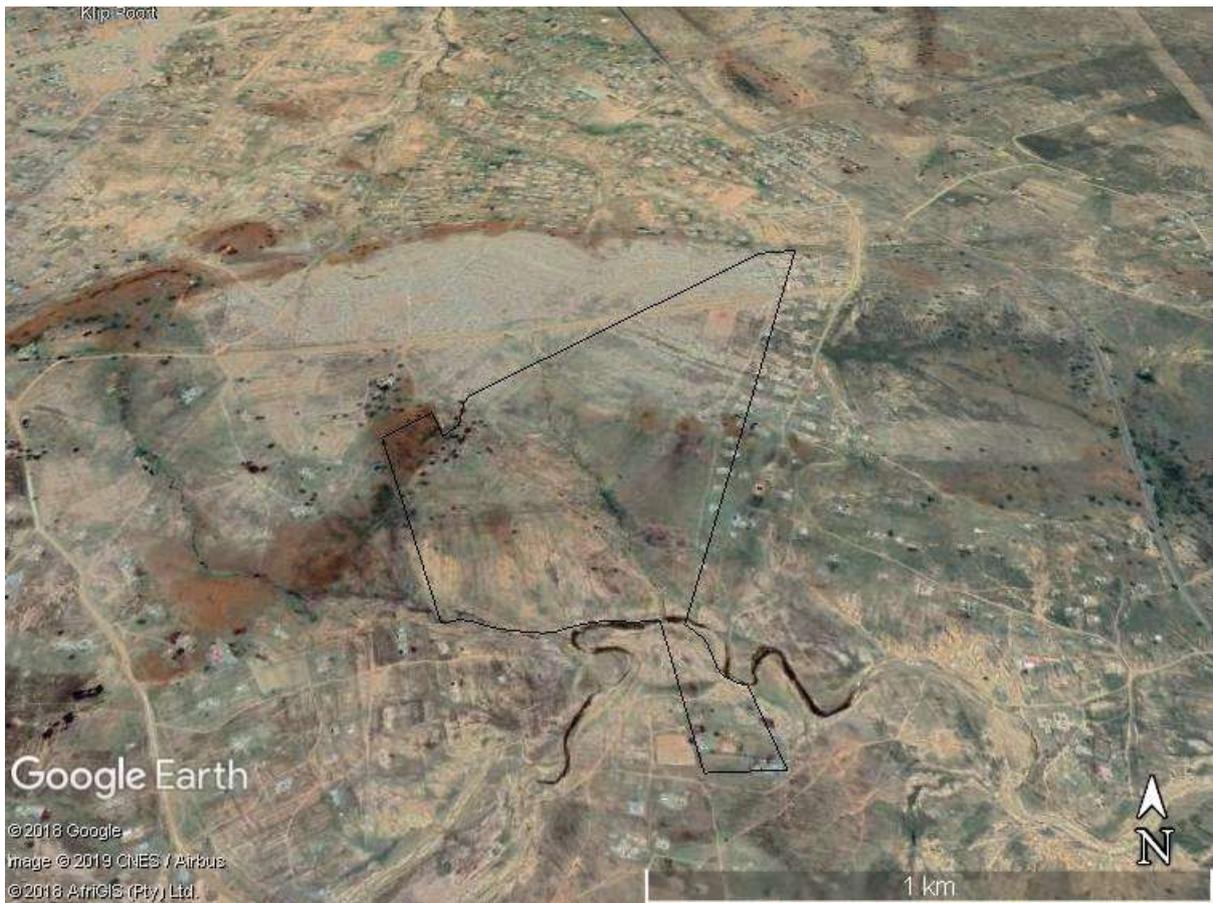


Figure 1: Google Earth map of the proposed development of a Residential Township on Portion 437 and Portion 502 of the farm Roosboom 1102GS, about 10km south southwest of Ladysmith. Map supplied by HCAC.

## 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

The site lies in the eastern sector of the Karoo Basin and there is a complex pattern of Beaufort Group deposits outcropping in the area, with younger intrusive Jurassic-aged dolerite dykes commonly occurring. Much younger sands of the Quaternary aged Masotcheni Formation overlie the older rocks.

The Adelaide Subgroup is the dominant rock in this area and comprises grey mudstone, dark-grey shale that is carbonaceous in places, siltstone and sandstone. In KwaZulu Natal the Adelaide Subgroup is represented by the Normandien Formation (Rubidge 2005). This has also been called the Estcourt Formation in older texts, for example, Plumstead (1969) and Anderson and Anderson (1985). The Normandien Formation was deposited by meandering streams and channels in a wide semi-arid floodplain. Intruding through all these sediments are dolerite dykes that formed during the Jurassic Drakensberg basaltic eruptions.

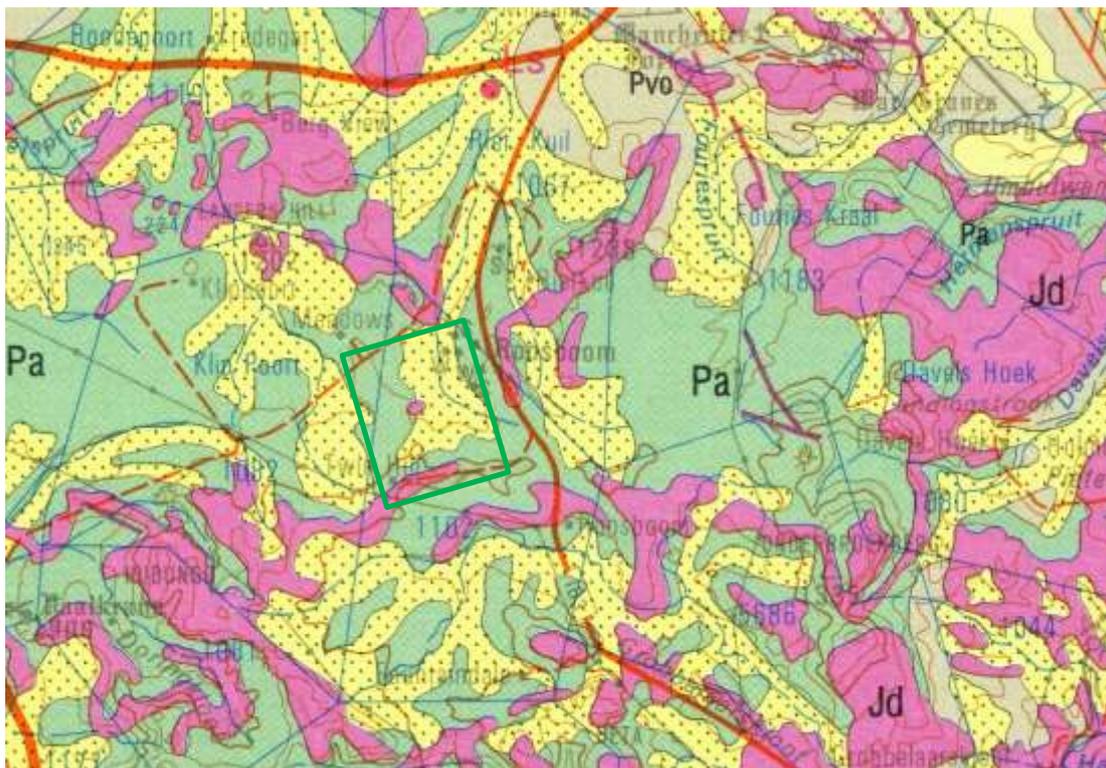


Figure 2: Geological map of the area around Ladysmith with the Farm Roosboom 1102 GS indicated within the green rectangle. Abbreviations of the rock types are explained in Table 2. Map enlarged from the Geological Survey 1: 250 000 map 1998, Harrismith 2828.

Table 2: Explanation of symbols for the geological map and approximate ages (Barbolini et al., 2016; Johnson et al., 2006; Rubidge, 2005). SG = Supergroup; Fm = Formation.

Symbol	Group/Formation	Lithology	Approximate Age
Q	Masotcheni Fm	Partly consolidated fine-grained sediments with silcrete nodules	Last 2.5 Ma
Jd	Jurassic	Dolerite dykes, intrusive	Jurassic, approx. 180 Ma
Pa	Adelaide subgroup Normandien Fm	Mudstones, shales	Upper Permian, Lower Beaufort
Pvo	Volksrust Fm	Deep water siltstone	Middle Permian, Upper Ecca 266 – 255 Ma
Pv	Vryheid Fm	Shales, sandstone, coal	Lower Permian, Middle Ecca <269 - 266 Ma 268 Ma

## ii. Palaeontological context

The Adelaide Subgroup, represented here by the Normandien Formation, is potentially fossiliferous. These upper Permian sediments could have preserved fossil plants of the Glossopteris Flora, including leaf impressions and fructifications of *Glossopteris*, and other extinct groups like the cordaitaleans, some lycopods, sphenophytes, wood and ferns, as well as early gymnosperms. Fossil plants have been recorded from near Harrismith, Colenso and Bergville.

The *Glossopteris* flora fossils are of interest to palaeobotanists but in general they are widely scattered and difficult to locate. This flora is well known but there is always a very small chance that some new taxa may be discovered. To date no fossils have been reported from the Ladysmith area although there are numerous sites farther to the west, such as Harrismith, and to the south such as Estcourt, Colenso, and Loskop (Plumstead, 1969; Anderson and Anderson, 1985; Prevec et al., 2009). Species are listed in Appendix A.

Fossil vertebrates of this age are common and have been used for the biozonation of the Beaufort Group (Rubidge et al., 1995). However, vertebrates seldom occur with the fossil plants. The Normandien Formation is equivalent to the Dicynodon Assemblage Zone so one would expect to find therocephalians, biarmosuchians, gorgonopsians dicynodonts and cynodonts (list in Appendix A) if fossil plants are absent.

Jurassic dolerite dykes do not preserve fossils as the heat and intrusive action tends to destroy any fossils in the host rock.

Quaternary sands seldom preserve fossils as they are either Aeolian in origin or from recent fluvial activity, in other words they are not in primary context. Fossil pans, spring mounds or stabilised sand dunes may preserve fossils but these features are not indicated on the Google Earth map.

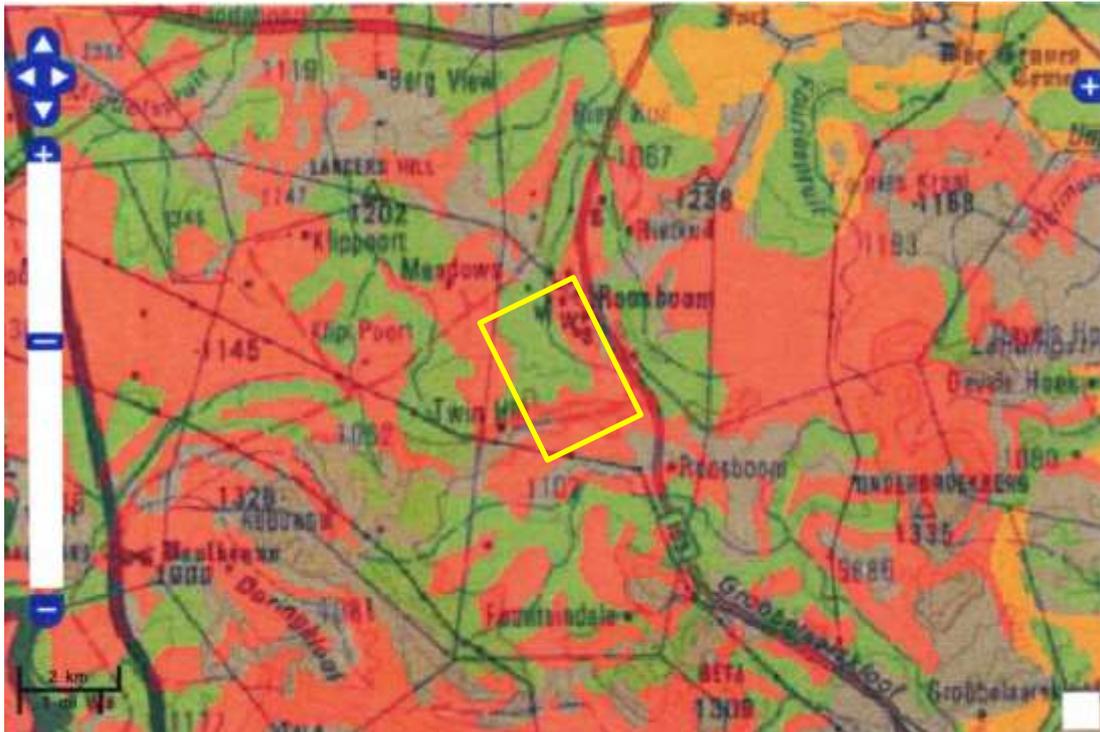


Figure 3: SAHRIS palaeosensitivity map for the site for the Farm Roosboom 1102 GS for the proposed development of a residential township. Colours indicate the following degrees of sensitivity: red = very highly sensitive; orange/yellow = high; green = moderate; blue = low; grey = insignificant/zero.

The area has been disturbed from previous urban and agricultural activities so any surface fossils are likely to be very weathered (naturally) or destroyed by previous activities. Along the ephemeral streams there could be downcutting into underlying sediments that contain fossil plants. There is, however, a very small chance that fossil plants could be found where new excavations are made for the building foundations, clean water and sewage pipes, electricity supply lines and access roads where the Quaternary sands occur (green on the SAHRIS map – Fig 3, and yellow on the geological map – Fig 2). There is a greater chance of finding fossil plants of the *Glossopteris* flora in the Normandien Formation (red on the SAHRIS map and teal on the geology map). There is no chance of finding fossils in the dolerite dykes (purple on the geology map).

To date no fossils have been reported from the Ladysmith area but there is a small chance that fossil plant fragments could occur in the building area. Fossils are not likely to be seen on the land surface because of extensive weathering and previous agricultural or urban activities.

#### 4. Impact assessment

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

**TABLE 3A: CRITERIA FOR ASSESSING IMPACTS**

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

**TABLE 3B: IMPACT ASSESSMENT**

<b>PART B: ASSESSMENT</b>		
<b>SEVERITY/NATURE</b>	<b>H</b>	-
	<b>M</b>	-
	<b>L</b>	There is a small chance that fossil plants occur in the Normandien Formation, Adelaide Subgroup sandstones and shales but any surface occurrences would have been disturbed by previous agricultural and urban activities. The impact would be very unlikely.
	<b>L+</b>	-
	<b>M+</b>	-
	<b>H+</b>	-
<b>DURATION</b>	<b>L</b>	-
	<b>M</b>	-
	<b>H</b>	Where manifest, the impact will be permanent.
<b>SPATIAL SCALE</b>	<b>L</b>	Since only the possible fossils within the area would be fossil plants from the <i>Glossopteris</i> flora in the sandstones and shales, the spatial scale will be localised within the site boundary.
	<b>M</b>	-
	<b>H</b>	-
<b>PROBABILITY</b>	<b>H</b>	-
	<b>M</b>	-
	<b>L</b>	It is unlikely that any fossils would be found in the surface sediments but there may be plant fragments in the underlying shales or mudstones. No surface fossils are likely to be found. Therefore a fossil chance find protocol should be added to the eventual EMP.

Based on the nature of the project, surface activities may impact upon the fossil heritage if preserved in the development footprint. Underlying rocks of the Normandien Formation, namely the mudstones or shales, might preserve fossil plants but this will be evident once excavations commence. Although no fossils have been recorded from near Ladysmith there is a small chance that fossils occur here and may be disturbed so 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, mudstones, sandstones, shales and sands are typical for the country and do contain fossil plant, insect, invertebrate and vertebrate material. The sands of the Quaternary Masotcheni Formation and the Jurassic dolerite dykes would not contain any fossils.

## 6. Recommendation

Based on experience and the lack of any previously recorded fossils from the area, it is unlikely that any fossils would be preserved on the surface. There is a very small chance that fossil plant fragments may occur in the Normandien Formation shales and sandstones so a Chance Find Protocol should be added to the EMPr: if fossils are found once excavations for foundations, pipes and services has commenced then they should be rescued and a palaeontologist called to assess and collect a representative sample.

## 7. References

Anderson, J.M., Anderson, H.M., 1985. Palaeoflora of Southern Africa: Prodrum of South African megafloras, Devonian to Lower Cretaceous. A.A. Balkema, Rotterdam. 423 pp.

Barbolini, N., Bamford, M.K., Rubidge, B., 2016. Radiometric dating demonstrates that Permian spore-pollen zones of Australia and South Africa are diachronous. *Gondwana Research* 37, 241-251.

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.

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.

Prevec, R, Labandeira, C.C., Neveling, J., Gastaldo, R.A., Looy, C., Bamford, M., 2009. Portrait of a Gondwanan ecosystem: A new Late Permian locality from KwaZulu-Natal, South Africa. Review of Palaeobotany and Palynology 156, 454-493.

Rubidge, B.S., 2005. 27th Du Toit Memorial Lecture: re-uniting lost continents — fossil reptiles from the ancient Karoo and their wanderlust. South African Journal of Geology 108: 135-172.

Rubidge, B.S., Johnson, M.R., Kitching, J.W., Smith, R.M.H., Keyser, A.W., Groenewald, G.H., 1995. Biostratigraphy of the Beaufort group (Karoo Supergroup). In: Biostratigraphic Series 1, South African Committee for Stratigraphy.

## 8. Chance Find Protocol

### **Monitoring Programme for Palaeontology – to commence once the excavations for foundations, water and sewage pipes, electricity supply poles or roads 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, wood, bone, coal) should be put aside in a suitably protected place. This way the building 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. If there is any possible fossil material found by the developer/environmental officer/engineers 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 the site inspections by the palaeontologist will not be necessary. 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.

## Appendix A : Lists and examples of fossils from the Normandien Formation, Adelaide Subgroup, Beaufort Group, Karoo Supergroup

Table 4: List of fossil plants.

Plant group –Normandien (Estcourt ) Fm	Genus and Species
Mosses	<i>Buthelezia mooiensis</i>
Sphenophytes (horsetails)	<i>Sphenophyllum speciosum</i>
	<i>Raniganjia kilburnensis</i>
	<i>Phyllothea australis</i>
	<i>Phyllothea lawleyensis</i>
	<i>Phyllothea wetensis</i>
	<i>Schizoneura gondwanensis</i>
Ferns	<i>Sphenopteris lobifolia</i>
Glossopterids	<i>Plumsteadia natalensis</i>
	<i>Plumsteadia gibbosa</i>
	<i>Estcourtia vandijksii</i>
	<i>Estcourtia bergvillensis</i>
	<i>Rigbya arberioides</i>
	<i>Lidgettonia africana</i>
	<i>Lidgettonia moiriverensis</i>
	<i>Lidgettonia inhluzanensis</i>
	<i>Lidgettonia lidgettonioides</i>
	<i>Lidgettonia elegans</i>
	<i>Glossopteris symmetrifolia</i>
	<i>Glossopteris loskopensis</i>
	Ottokariaceae
	Lidgettoniaceae
Incertae sedis	<i>Noeggerathiopsis spathulata</i>
	<i>Pagiophyllum vandijkii</i>
	<i>Taeniopteris estcourtiana</i>
	<i>Benlightfootia mooiensis</i>

Table 5: List of fossil vertebrates.

Dicynodon Assemblage Zone (Rubidge et al., 1995)	
Captorhinida	<i>Pareiasaurus</i> <i>Milleretta</i> <i>Millerosaurus</i> <i>Anthodon</i> <i>Spondyloestes</i> <i>Owenetta</i>
Eosuchia	<i>Youngina</i>

	<i>Saurostemon</i>
Dicynodontia	<i>Pristerodon</i> <i>Diictodon</i> <i>Dicynodon</i> <i>Emydops</i> <i>Aulacocephalodon</i> <i>Oudenodon</i> <i>Pelanomodon</i> <i>Dianomodon</i>
Biarmosuchia	<i>Rubidgea</i> <i>Burnettia</i> <i>Ictidorhinus</i> <i>Lemurosaurus</i>
Gorgonopsia	<i>Lycaenops</i> <i>Cyonosaurus</i> <i>Prorubidgea</i> <i>Leontocephalus</i> <i>Broomicephalus</i> <i>Rubidgea</i> <i>Dinogorgon</i> <i>Clelandrina</i> <i>Paragalerhinus</i>
Terocephalia	<i>Ictidosuchoides</i> <i>Ictidosuchops</i> <i>Theriongnathus</i> <i>Homodontosaurus</i> <i>Scaloporhinus</i> <i>Scaloposuchus</i> <i>Nanictidops</i> <i>Akidnognathus</i> <i>Lycideops</i> <i>Cerdops</i> <i>Promosuchorhynchus</i> <i>Tetracynodon</i> <i>Moschorhinus</i>
Cynodontia	<i>Procynosuchus</i> <i>Cynosaurus</i> <i>Nanictosaurus</i>



Figure 4: example of fossil bone seen in a mudstone.



Figure 4: Fossil plants from the *Glossopteris* flora and a fossil skull.

## Appendix B – Details of specialist

### Curriculum vitae (short) - Marion Bamford PhD January 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](mailto:marion.bamford@wits.ac.za) ; [marionbamford12@gmail.com](mailto: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 – 1984 to present  
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	1
Masters	8	1
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 onwards – 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
- Ledjadja borrow pits 2018 for Digby Wells
- Amandelbult 2018 for SRK
- 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
- SARAO 2018 for Digby Wells
- Ventersburg B 2018 for NGT
- Hanglip Service Station 2018 for HCAC
- 

## **xi) Research Output**

Publications by M K Bamford up to January 2019 peer-reviewed journals or scholarly books: over 125 articles published; 5 submitted/in press; 8 book chapters.

Scopus h index = 27; Google scholar h index = 29;

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)