

**Palaeontological Impact Assessment for the proposed
social housing development in Khutsong Ext 8,
Carletonville, Gauteng Province**

Site Visit (Phase 2) Report

For

Afzelia Environmental Consultants (Pty) Ltd

21 August 2021

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Expertise of Specialist

The Palaeontologist Consultant is: Prof Marion Bamford
Qualifications: PhD (Wits Univ, 1990); FRSSAf, ASSAf
Experience: 32 years research; 24 years PIA studies

Declaration of Independence

This report has been compiled by Professor Marion Bamford, of the University of the Witwatersrand, sub-contracted by Afzelia Environmental Consultants (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:

A handwritten signature in blue ink that reads "MKBamford". The signature is written in a cursive style and is positioned above a horizontal blue line.

Executive Summary

A palaeontological Impact Assessment was requested for the Proposed Khutsong Extension 8 Housing Development situated near Carletonville within the Merafong City Local Municipality, West Rand District Municipality, Gauteng. The proposed development entails the construction of a total of 27 000 housing units within a total area of 391ha to accommodate the relocation of residents from the Khutsong Hostel, Khutsong Extensions 1 and 6, as well as the Khutsong informal Area. SAHRA has requested a site visit because the area is very highly sensitive (CaseID:16322).

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 site visit and ground survey Palaeontological Impact Assessment (PIA) was completed for the proposed development on 17 August 2021 by a palaeontologist.

The proposed site lies on the Malmani Subgroup dolomite, chert and chert breccia (Chuniespoort Group, Transvaal Supergroup) the could potentially have trace fossils such as stromatolites preserved in the dolomites. The site visit confirmed that there are no dolomites and no stromatolites visible in the project area. It is not known what lies below the surface, therefore a Fossil Chance Find Protocol should be added to the EMPr. Based on this information it is recommended that no further palaeontological assessment is required unless the Environmental Officer or other responsible person finds stromatolites once excavations have commenced.

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1. Background

A final scoping report has been submitted for the proposed Khutsong Extension 8 Housing Development situated near Carletonville within the Merafong City Local Municipality, West Rand District Municipality, Gauteng. The proposed development entails the construction of a total of 27 000 housing units within a total area of 391 ha to accommodate the relocation of residents from the Khutsong Hostel, Khutsong Extensions 1 and 6, as well as the Khutsong informal Area.

SAHRA has requested a site visit because the area is very highly sensitive (CaseID:16322).

A Palaeontological Impact Assessment is required for the Khutsong South Ext 8 Housing development in order 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 site visit and ground survey Palaeontological Impact Assessment (PIA) was completed by professional palaeontologists for the proposed development and is reported herein.

Table 1: Specialist report requirements in terms of Appendix 6 of the EIA Regulations (2017)

	A specialist report prepared in terms of the Environmental Impact Regulations of 2017 must contain:	Relevant section in report
ai	Details of the specialist who prepared the report	Appendix B
aii	The expertise of that person to compile a specialist report including a curriculum vitae	Appendix B
b	A declaration that the person is independent in a form as may be specified by the competent authority	Page 1
c	An indication of the scope of, and the purpose for which, the report was prepared	Section 1
ci	An indication of the quality and age of the base data used for the specialist report: SAHRIS palaeosensitivity map accessed – date of this report	Yes
cii	A description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change	Section 5
d	The date and season of the site investigation and the relevance of the season to the outcome of the assessment	N/A
e	A description of the methodology adopted in preparing the report or carrying out the specialised process	Section 2
f	The specific identified sensitivity of the site related to the activity and its associated structures and infrastructure	Section 4
g	An identification of any areas to be avoided, including buffers	N/A

h	A map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;	N/A
i	A description of any assumptions made and any uncertainties or gaps in knowledge;	Section 5
j	A description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives, on the environment	Section 4
k	Any mitigation measures for inclusion in the EMPr	Appendix A
l	Any conditions for inclusion in the environmental authorisation	Section 6, 8
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 7
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	N/A
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 if any comments that were received during any consultation process	N/A
q	Any other information requested by the competent authority.	Section 1



Figure 1: Google Earth map of the proposed Khutsong Ext 8 social housing development, near Carletonville with the section shown by the red outline. Map supplied by Afzelia.

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 (as reported herein, and collect or rescue fossils if required);
3. Where appropriate, collection of unique or rare fossils with the necessary permits for storage and curation at an appropriate facility (*as indicated in section 4 below*); and
4. Determination of fossils' representivity or scientific importance to decide if the fossils can be destroyed or a just a representative sample collected and housed in a recognised repository.

3. Geology and Palaeontology

i. Project location and geological context

The Late Archaean to early Proterozoic Transvaal Supergroup is preserved in three structural basins on the Kaapvaal Craton (Eriksson et al., 2006). In South Africa are the Transvaal and Griqualand West Basins, and the Kanye Basin is in southern Botswana. The Griqualand West Basin is divided into the Ghaap Plateau sub-basin and the Prieska sub-basin. Sediments in the lower parts of the basins are very similar but they differ somewhat higher up the sequences. Several tectonic events have greatly deformed the south western portion of the Griqualand West Basin between the two sub-basins

The Transvaal Supergroup comprises one of world's earliest carbonate platform successions (Beukes, 1987; Eriksson et al., 2006; Zeh et al., 2020). In some areas there are well preserved stromatolites that are evidence of the photosynthetic activity of blue green bacteria and green algae. These microbes formed colonies in warm, shallow seas.

In the Transvaal Basin the Transvaal Supergroup is divided into two Groups, the lower Chuniespoort Group and the upper Pretoria Group (with ten formations; Eriksson et al., 2006). The Chuniespoort Group is divided into the basal Malmani Subgroup that comprises dolomites and limestones and is divided into five formations based on chert content, stromatolitic morphology, intercalated shales and erosion surfaces. The top of the Chuniespoort Group has the Penge Formation and the Duitschland Formation.

The Malmani Subgroup is up to 2000m thick and has been divided into five formations based on the composition of cherts, stromatolites, limestones and shales. At the base, overlying the Black Reef Formation, is the base is the Oaktree Formation that represents a transition from siliciclastic sedimentation to platform carbonates (Eriksson et al., 2006). It is composed of carbonaceous shales, stromatolitic dolomites and locally developed quartzites.

Next is the Monte Christo Formation that has an erosive breccia base and continues with stromatolitic and oolitic platformal dolomites. Above that is the Lyttleton Formation that is composed of shales, quartzites and stromatolitic and dolomites. The overlying Eccles Formation includes a series of erosion breccias that locally contain gold deposits. This mineralisation has been attributed to hydrothermal remobilisation of fluids by the Bushveld complex (Eriksson et al., 2006). The topmost formation is the Frisco Formation that is composed mainly of stromatolitic dolomites but these become more shale rich towards the top of the sequence because of the deepening depositional environment.

In this region the formations of the Malmani Supergroup have not been distinguished (Figure 2).

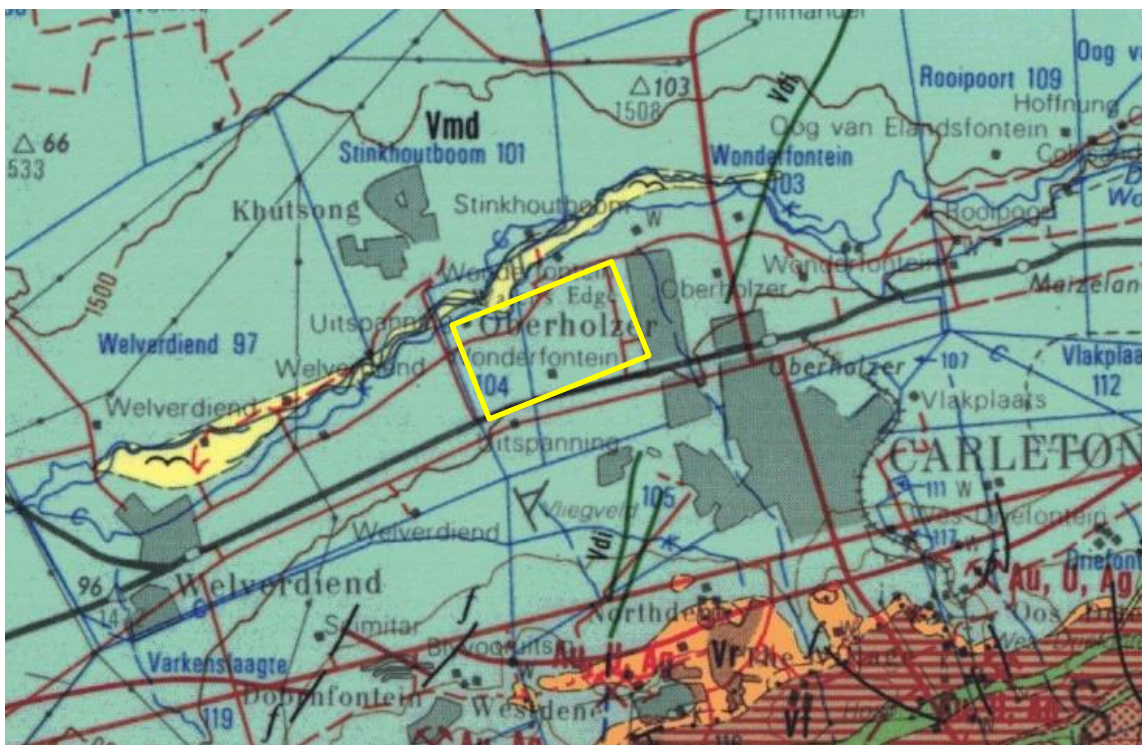


Figure 2: Geological map of the area around the proposed Khutsong Ext 8 social housing development, northeast of Carletonville, shown within the yellow rectangle. Abbreviations of the rock types are explained in Table 2. Map enlarged from the Geological Survey 1: 250 000 map 2626 West Rand.

Table 2: Explanation of symbols for the geological map and approximate ages (Eriksson et al., 2006; Zeh et al., 2020). SG = Supergroup; Fm = Formation; Ma = million years; grey shading = formations impacted by the project.

Symbol	Group/Formation	Lithology	Approximate Age
Q	Quaternary	Alluvium, sand, calcrete	Neogene, ca 2.5 Ma to present
Vt	Timeball Hill Fm, Chuniespoort Group, Transvaal SG	Quartzite	< 2420 Ma

Symbol	Group/Formation	Lithology	Approximate Age
Vr	Rooihoogte Fm,	Quartzite, conglomerate, shale, basalt	Ca 2650 – 2640 Ma
Vmd	Malmani Subgroup	Dolomite, chert, breccia	Ca 2750 – 2650 Ma
Rg	Government Subgroup, West Rand Group, Witwatersrand SG	Quartzite, shale	>2650 Ma

ii. Palaeontological context

The palaeontological sensitivity of the area under consideration is presented in Figure 3. The site for development is in the Malmani Subgroup that could preserve stromatolites in the dolomites.

Stromatolites are the trace fossils that were formed by colonies of green algae and blue-green algae (Cyanobacteria) that grew in warm, shallow marine settings. These algae were responsible for releasing oxygen via the photosynthetic process where atmospheric carbon dioxide and water, using energy from the sun, are converted into carbon chains and compounds that are the building blocks of all living organisms. The released carbon dioxide initially was taken up by the abundant reducing minerals to form oxides, e.g. iron oxide. Eventually free oxygen was released into the atmosphere and some was converted into ozone by the bombardment of cosmic rays. The ozone is critical for the filtering out of harmful ultraviolet rays.

Stromatolites are the layers upon layers of inorganic materials that were deposited during photosynthesis, namely calcium carbonate, magnesium carbonate, calcium sulphate and magnesium sulphate. These layers can be in the form of flat layers, domes or columns depending on the environment where they grew (Beukes, 1987). Some environments did not form stromatolites, just layers of limestone that later was converted to dolomite. The algae that formed the stromatolites are very rarely preserved, and they are microscopic so they can only be seen from thin sections studies under a petrographic microscope.

From the SAHRIS map below (Figure 3), the area is indicated as very highly sensitive (red) so a site visit was undertaken on 17 August 2021 by Mr Rick Tolchard.

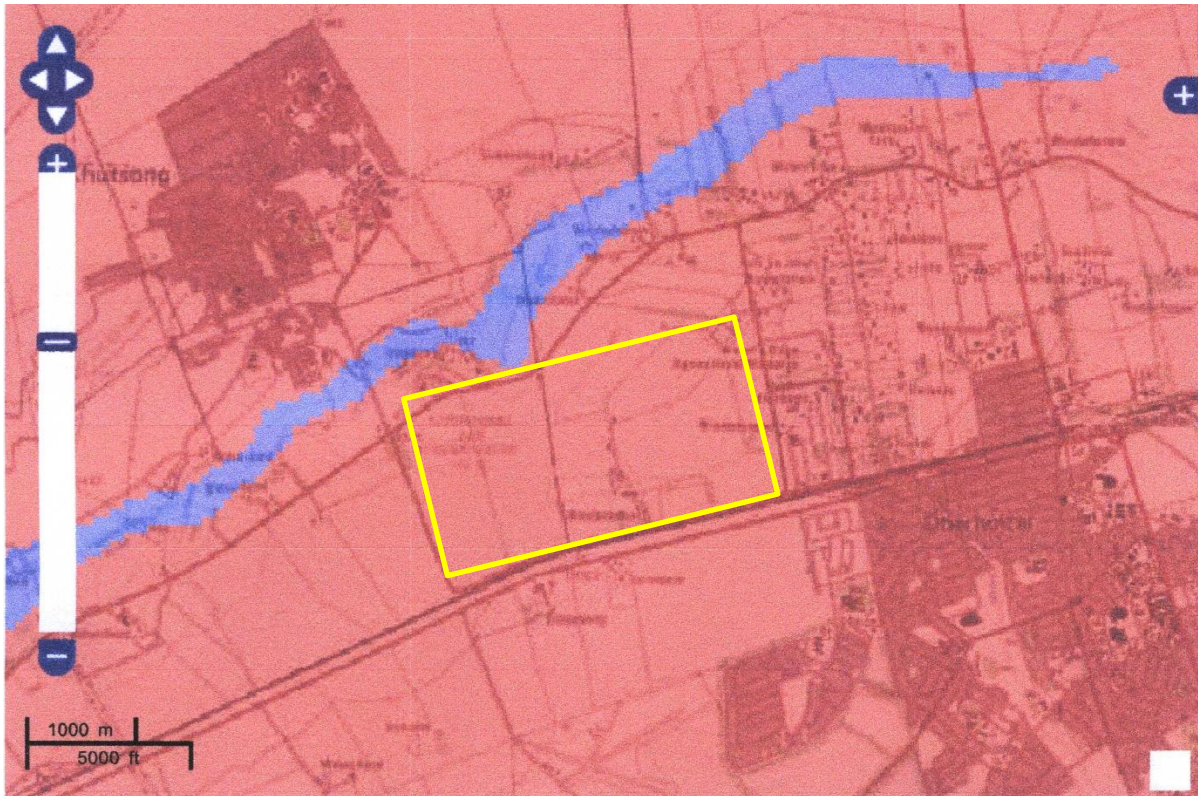


Figure 3: SAHRIS palaeosensitivity map for the site for the proposed Khutsong Ext 8 social housing development near Carletonville shown within the yellow rectangle. Background colours indicate the following degrees of sensitivity: red = very highly sensitive; orange/yellow = high; green = moderate; blue = low; grey = insignificant/zero.

iii Site visit observations

For the palaeontological survey, the ground was examined for the presence of dolomite with stromatolites. GPS coordinates refer to the site stops 1- 9 within the project boundary (see Figure 4). All photographs were taken by Tolchard and are referred to in the table below (Table 3). No fossils were found.

Table 3: Site visit stops as numbered in Figure 4, observations and relevant photographs.

GPS coordinates	Observations	Figure
S26°20'05.54117" E27°20'56.82229" 1508m	Stop 1. A - General view looking southwards of the large open area to be developed; B - close-up photograph of the ground showing bare soil and minimal vegetation; C - another close-up photograph – the grass has been burned so the visibility is excellent	5A, B, C.
S26°20'20.21261" E27°20'38.89757" 1497m	Stop 2. 5D - Sandy soil exposed at this stop 6A – general view from the site; B – burned grass showing soils and no dolomite or rocks;	5D, 6A, B

S26°20'30.47160" E27°20'19.70817" 1504m	Stop 3 6C – rare example of stony ground but these are sandstone, not dolomite; D – sandy soil	6C, D
S26°20'30.25570" E27°20'15.84760" 1502m	Stop 4 A – general view of the site, note consistent almost flat topography; B – close-up of the sandy soil without any rocks	7A, B
S26°20'31.25992" E27°20'15.14845" 1503m	Stop 5 C – general view of the site, more or less flat; D – general view in the opposite direction.	7C, D
S26°20'34.48154" E27°20'10.96259" 1508m	Stop 6 A – small termite mound showing the gritty soils that have been brought to the surface; B – general view of this stop	8A, B
S26°20'58.89119" E27°20'40.10485" 1503m	Stop 7 C – general view of the site, flat and no rocks; D – sandy soils exposed	8C, D
S26°20'53.25121" E27°21'22.10475" 1502m	Stop 8 A – general view with a rare thorn bush; B – sandy soils with one stone that appears to have been transported here	9A, B
S26°20'49.81098" E27°21'53.06500" 1502m	Stop 9 C – general view of stop in the eastern part of the project boundary; D – burned grass so the sandy soils are well exposed. No rocks and no fossils	9C, D



Figure 4: Google Earth map of the Khutsong Ext 8 project boundary with the site visit stops, 1-9, marked. Refer to Table 3 and the site photographs in Figures 5-9.



Figure 5: Site photographs for Khutsong Ext 8 project taken by Rick Tolchard. A-C = Stop 1; D = Stop 2. Refer to Table 3 for the site descriptions.



Figure 6: Site photographs for Khutsong Ext 8 project taken by Rick Tolchard. A-B = Stop 2; C-D = Stop 3. Refer to Table 3 for site descriptions.



Figure 7: Site photographs for Khutsong Ext 8 project taken by Rick Tolchard. A-B = Stop 4; C-D = Stop 5. Refer to Table 3 for site descriptions

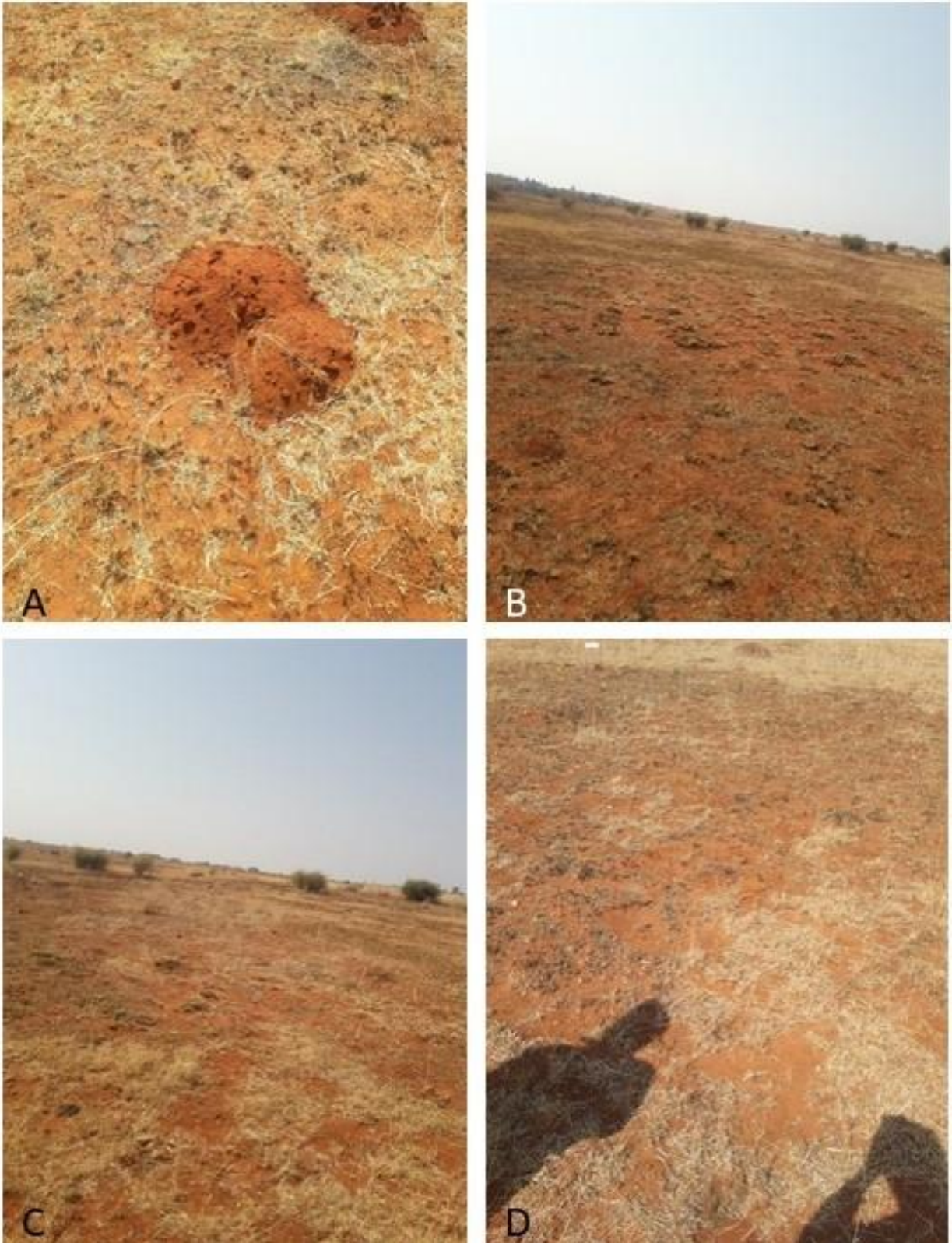


Figure 8: Site photographs for Khutsong Ext 8 project taken by Rick Tolchard. A-B = Stop 6; C-D = Stop 7. Refer to Table 3 for site descriptions



Figure 9: Site photographs for Khutsong Ext 8 project taken by Rick Tolchard. A-B = Stop 8; C-D = Stop 9. Refer to Table 3 for site descriptions

4. Impact assessment

An assessment of the potential impacts to possible palaeontological resources considers the criteria encapsulated in Table 4:

TABLE 4A: 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 4B: IMPACT ASSESSMENT

PART B: ASSESSMENT		
SEVERITY/NATURE	H	-
	M	Soils do not preserve fossils; so far there are no records from the Malmani Group dolomites of stromatolites in this region so it is unlikely that fossils occur on the site. The impact would be very unlikely. -
	L	
	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 trace fossils such as stromatolites from the Malmani Subgroup dolomites, the spatial scale will be localised within the site boundary.
	M	-
	H	-

PART B: ASSESSMENT		
PROBABILITY	H	-
	M	It is extremely unlikely that any fossils would be found in the loose sand that will be excavated. The site visit confirmed that there are no visible dolomites or stromatolites. Nonetheless, a Fossil Chance Find Protocol should be added to the eventual EMPr.-
	L	

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 much too old to contain body fossils; only trace fossils such as stromatolites could occur in the Malmani Subgroup dolomites. Since there is an extremely small chance that stromatolites might occur below ground, and could be disturbed once excavations commence, 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 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 only the dolomites might contain trace fossils such as stromatolites. The site visit confirmed that there are no surface dolomites and no surface stromatolites. The site is covered in sandy soils. While it is unlikely that the dolomites underground might have stromatolites, this is not known. The covering sands and soils of the Quaternary period would not preserve fossils.

6. Recommendation

Based on experience and the lack of any previously recorded fossils from the area, and the site visit observations, it is extremely unlikely that any fossils would be preserved in the loose sands of the Quaternary. No dolomites and no stromatolites were seen during the site survey. There is a very small chance that trace fossils may occur in the dolomites beneath the ground surface so a Fossil Chance Find Protocol should be added to the EMPr. If fossils are found once excavations for amenities and foundations have commenced then they should be rescued and a palaeontologist called to assess and collect a representative sample (see Section 8).

7. References

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

Beukes, N.J., 1987. Facies relations, depositional environments and diagenesis in a major early Proterozoic stromatolitic carbonate platform to basinal sequence, Campbellrand Subgroup, Transvaal Supergroup, southern Africa. *Sedimentary Geology* 54, 1-46.

Eriksson, P.G., Altermann, W., Hartzler, F.J., 2006. The Transvaal Supergroup and its precursors. 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.

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.

Zeh, A., Wilson, A.H., Gerdes, A., 2020. Zircon U-Pb-Hf isotope systematics of Transvaal Supergroup – Constraints for the geodynamic evolution of the Kaapvaal Craton and its hinterland between 2.65 and 2.06 Ga. *Precambrian Research* 345, 105760.
<https://doi.org/10.1016/j.precamres.2020.105760>

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 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 (stromatolites, plants, insects, bone, coal) should be put aside in a suitably protected place. This way the excavation and construction activities will not be interrupted.
3. Photographs of similar fossils and trace fossils must be provided to the developer to assist in recognizing the fossils in the dolomites, shales and mudstones (for example see Figure 10). 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 then the qualified palaeontologist sub-contracted for this project, should visit the site to inspect the selected material and check the dumped material where feasible.
6. Fossil plants or vertebrates or trace fossils 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.

Appendix A – Examples of Malmani Subgroup fossils



Figure 10: Examples of stromatolites, a - in the field in side view; b – surface view in the field; c – side view in section. (Photographs from MacRae, 1999. *Life etched in Stone*).

Appendix B – Details of specialist

Curriculum vitae (short) - Marion Bamford PhD January 2021

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	11	2
Masters	10	5
PhD	11	4
Postdoctoral fellows	10	4

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 –
Journal of African Earth Sciences: 2020 –

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
- 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
- Lielifontein 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

xi) Research Output

Publications by M K Bamford up to December 2019 peer-reviewed journals or scholarly books: over 150 articles published; 5 submitted/in press; 8 book chapters.

Scopus h index = 29; Google scholar h index = 36;

Conferences: numerous presentations at local and international conferences.

Mr Frederick Tolchard

Brief Curriculum Vitae – July 2021

Academic training

BA Archaeology – University of the Witwatersrand, graduated 2015

BSc (Honours) Palaeontology – University of the Witwatersrand, 2017 with distinction

MSc Palaeontology – University of the Witwatersrand, 2018 – 2019. Graduated 2020 with Distinction

PhD Palaeontology – Wits – 2020 - current

Field Experience

Honours Fieldtrip – Karoo biostratigraphy – April 2017

Research fieldwork – Elliot Formation with Prof Choiniere – April 2018, November 2018; April 2019

Publications

Tolchard, F., Nesbitt, S.J., Desojo, J.B., Viglietti, P.A., Butler, R.J. and Choiniere, J.N., 2019.

‘Rauisuchian’ material from the lower Elliot Formation of South Africa: Implications for late Triassic biogeography and biostratigraphy. *Journal of African Earth Sciences*, 160, 103610.

Viglietti, P.A., McPhee, B.W., Bordy, E.M., Sciscio, L., Barrett, P.M., Benson, R.B.J., Wills, F., Tolchard, F., Choiniere, J.N., 2020. Biostratigraphy of the Scalenodontoides Assemblage Zone (Stormberg Group, Karoo Supergroup), South Africa. *South African Journal of Geology* 123, 239-248.

PIA fieldwork projects

2018 May – Williston area – SARAQ project, Digby Wells

2018 September – Lichtenburg PVs – CTS Heritage

2018 November – Nomalanga farming – Digby Wells

2019 January – Thubelisha coal – Digby Wells

2019 March – Matla coal – Digby Wells

2019 March – Musina-Machado SEZ – Digby Wells

2019 June – Temo coal – Digby Wells

2019 September – Makapanstad Agripark – Plantago

2020 January – Hendrina, Kwazamakuhle – Kudzala

2020 February – Hartebeestpoort Dam - Prescali

2020 March – Twyfelaar Coal mine – Digby Wells

2020 March – Ceres Borrow Pits – ACO Associates

2020 March – Copper Sunset Sand – Digby Wells

2020 October – Belfast loop and Expansion – Nsovo

2020 October – VLNR lodge Mapungubwe – HCAC

2020 November – Delmore Park BWSS - HCAC

2020 December – Kromdraai commercial – HCAC

2021 January – Welgedacht Siding – Elemental Sustainability

2021 March – Shango Kroonstad – Digby Wells

2021 May – Copper Sunset sand mining – Digby Wells

2021 August – New Largo Pit - Golder

