

**Palaeontological Impact Assessment for the
proposed Dawkinsville Cemetery, Klerksdorp,
North West Province**

Desktop Study (Phase 1)

For

Setala Environmental Consultants

25 March 2022

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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 Consultants, 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 by SAHRA (Case ID: 17938) for the proposed Dawkinsville Cemetery, east of Klerksdorp, North West Province because it lies on moderately sensitive rocks.

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 rocks of the Dwyka Group (Karoo Supergroup) that could preserve fragments of the early Glossopteris flora or invertebrates or fish. Such fossils have only been recorded from exposures near Douglas in the Northern Cape, in the mudstone facies. Therefore, 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 developer, environmental officer or other designated responsible person once excavation activities have commenced. As far as the palaeontology is concerned, the project should be authorised.

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1. Background

CSHELL 264 (Pty) Ltd intends to obtain environmental authorisation for the clearing of indigenous vegetation and the establishment of a cemetery on a portion of forty four hectares. The proposed establishment of a new cemetery (Dawkinsville Cemetery) will be on the Remainder of Portion 1 of the farm Townlands of Klerksdorp 424IP. The study area is located in the City of Matlosana Local Municipality (Klerksdorp) of the Northwest Province (Figures 1, 2). The area is currently vacant but has been used for agriculture in the past.

SAHRA has requested a palaeontological desktop study (Case ID: 17938) for this project because it lies on moderately sensitive rocks according to the SAHRIS Palaeosensitivity map.

A Palaeontological Impact Assessment was requested for the Dawkinville Cemetery 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 4
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

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

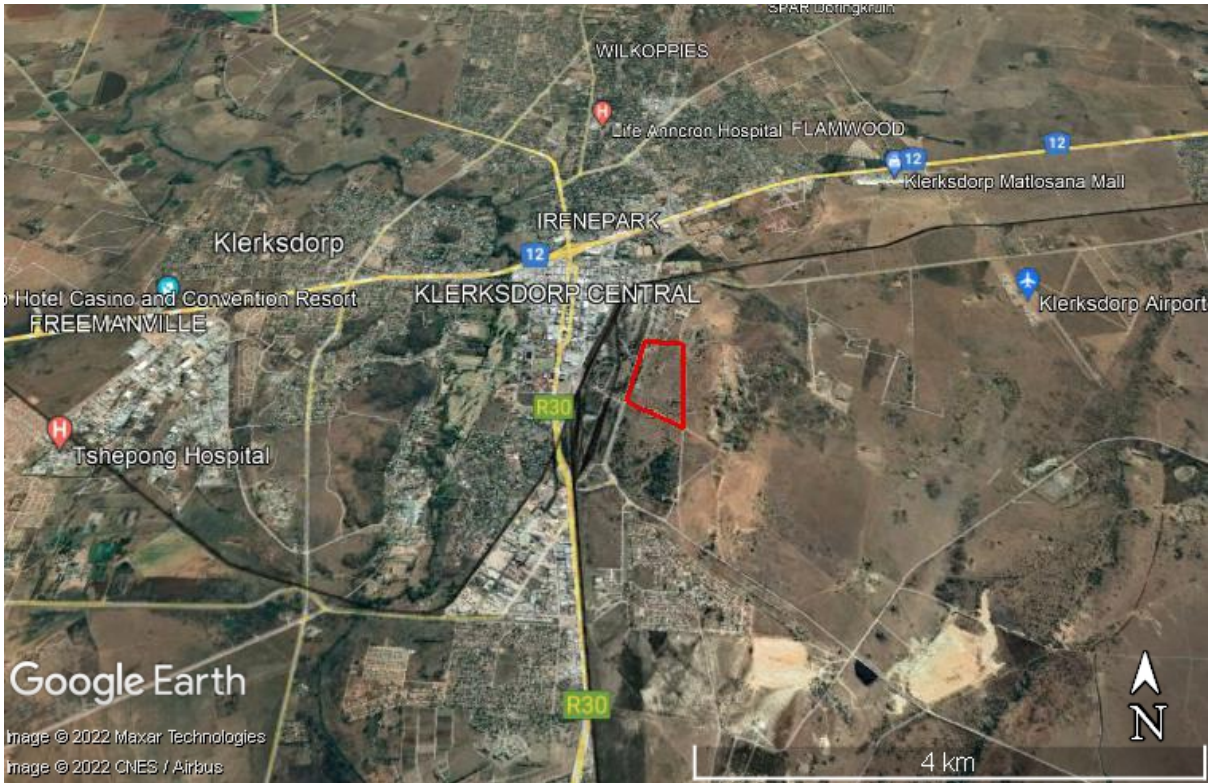


Figure 1: Google Earth map of the general area to show the relative land marks. The Dawkinsville Cemetery is shown by the red outline.



Figure 2: Google Earth Map of the proposed development of the Dawkinsville Cemetery east of Klerksdorp with the section shown by the red outline.

2. Methods and Terms of Reference

The Terms of Reference (ToR) for this study were to undertake a PIA and provide feasible management measures to comply with the requirements of SAHRA.

The methods employed to address the ToR included:

1. Consultation of geological maps, literature, palaeontological databases, published and unpublished records to determine the likelihood of fossils occurring in the affected areas. Sources included records housed at the Evolutionary Studies Institute at the University of the Witwatersrand and SAHRA databases;
2. Where necessary, site visits by a qualified palaeontologist to locate any fossils and assess their importance (*not applicable to this assessment*);
3. Where appropriate, collection of unique or rare fossils with the necessary permits for storage and curation at an appropriate facility (*not applicable to this assessment*); and
4. Determination of fossils' representivity or scientific importance to decide if the fossils can be destroyed or a representative sample collected (*not applicable to this assessment*).

3. Geology and Palaeontology

i. Project location and geological context

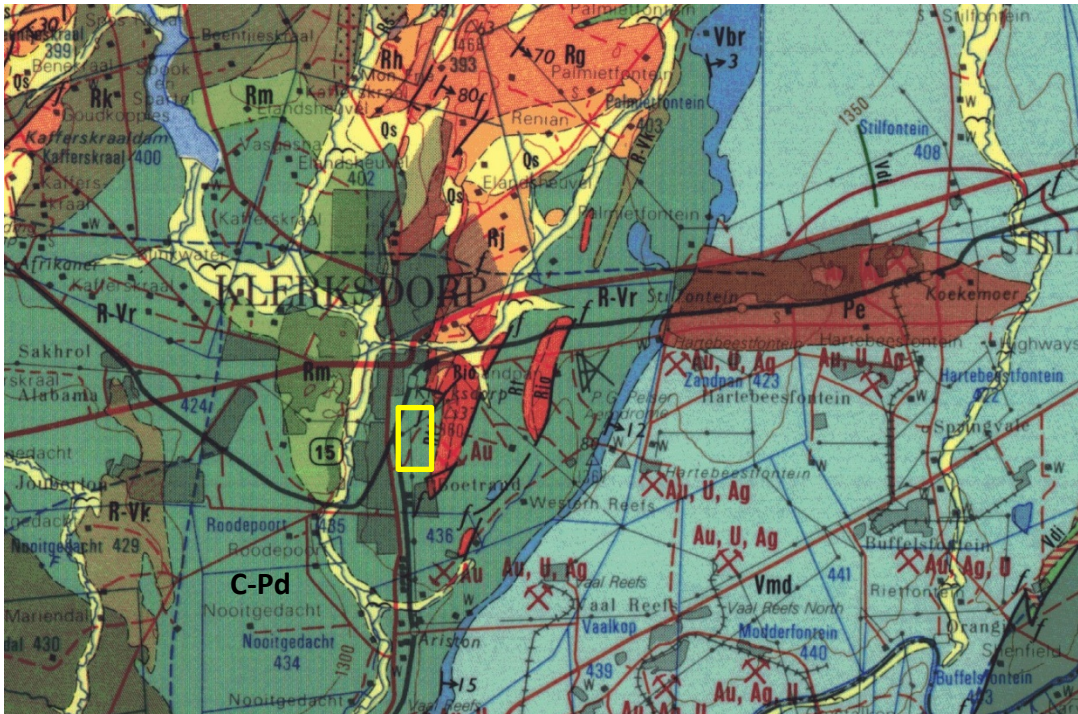


Figure 3: Geological map of the area around the Dawkinsville Cemetery indicated within the yellow rectangle. Abbreviations of the rock types are explained in Table 2. Map enlarged from the Geological Survey 1: 250 000 map 2626 West Rand.

Table 2: Explanation of symbols for the geological map and approximate ages (Eriksson et al., 2006; Johnson et al., 2006; McCarthy 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	Neogene, ca 2.5 Ma to present
Pe	Ecca Group, Karoo SG	Shales, sandstone siltstone, coal	Early Permian
C-Pd	Dwyka Group, Karoo SG	Tillites, diamictite, sandstone, mudstone	Late Carboniferous to Early Permian,
Vmd	Malmani Subgroup, Chuniespoort Group, Transvaal SG	Dolomite, chert	Ca 2750 – 2650 Ma
Vbr	Black Reef Fm, Transvaal SG	Quartzite, conglomerate, shale, basalt	Ca 2650 – 2640 Ma
R-Vr	Rietgat Fm, Platberg Group, Ventersdorp SG	Amygdaloidal lava, agglomerate, tuff	Ca 2714 Ma
Rj	Jeppetown Subgroup, West Rand Group, Witwatersrand SG	Shale, quartzite, lava	

Symbol	Group/Formation	Lithology	Approximate Age
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 Transvaal Basin where there are underlying older rocks of the Ventersdorp and Witwatersrand Supergroups. The sediments of the Karoo Supergroup unconformably overlie the lower Transvaal Supergroup rocks, the latter forming an uneven basement to the younger rocks. This is the northwestern margin of the Karoo Basin.

The Karoo Supergroup rocks cover a very large proportion of South Africa and extend from the northeast (east of Pretoria) to the southwest and across to almost the KwaZulu Natal south coast. It is bounded along the southern margin by the Cape Fold Belt and along the northern margin by the much older Transvaal Supergroup rocks. Representing some 120 million years (300 – 183Ma), the Karoo Supergroup rocks have preserved a diversity of fossil plants, insects, vertebrates and invertebrates.

During the Carboniferous Period South Africa was part of the huge continental landmass known as Gondwanaland and it was positioned over the South Pole. As a result, there were several ice sheets that formed and melted, and covered most of South Africa (Visser, 1986, 1989; Isbell et al., 2012). Gradual melting of the ice as the continental mass moved northwards and the earth warmed, formed fine-grained sediments in the large inland sea. These are the oldest rocks in the system and are exposed around the outer part of the ancient Karoo Basin, and are known as the Dwyka Group. They comprise tillites, diamictites, mudstones, siltstones and sandstones that were deposited as the basin filled. This group has been divided into two formations with Elandsvlei Formation occurring throughout the basin and the upper Mbizane Formation occurring only in the Free State and KwaZulu Natal (Johnson et al., 2006).

Overlying the Dwyka Group rocks are rocks of the Eccia Group that are Early Permian in age. Overlying the Eccia Group are the rocks of the Beaufort Group that has been divided into the lower Adelaide Subgroup for the Upper Permian strata, and the Tarkastad Subgroup for the Early to Middle Triassic strata. As with the older Karoo sediments, the formations vary across the Karoo Basin.

The site for the project is in the Dwyka Group tillites, sandstone, mudstone and shales, and these potentially could preserve fossils. Around 300-290 Ma the climate in southern Africa was still relatively cool, but there were well developed Carboniferous floras in the northern hemisphere. In South Africa, however, much of the land surface was covered by ice sheets. As they melted they dropped the moraine trapped in the ice, together with limited plant matter from the vegetation that gradually recovered and colonised the land surface. Terrestrial vertebrates had not evolved at this time. The late Carboniferous flora comprised *Glossopteris* leaves and seeds, wood, and other plants such as lycopods, sphenophytes and ferns.

The Dwyka Group is made up of seven facies that were deposited in a marine basin under differing environmental settings of glacial formation and retreat (Visser, 1986, 1989; Johnson et al., 2006). In the north and east these are called the Mbizane Formation, and the Elandsvlei Formation in the south and west. Described below are the seven facies (Johnson et al., 2006 p. 463-465):

The massive diamictite facies comprises highly compacted diamictite that is clast-poor in the north. It was deposited in subaqueous or subglacial positions.

The stratified diamictite comprises alternating diamictite, mudrock, sandstone and conglomerate beds. They are interpreted as being rapidly deposited, sediment gravity flows but with some possible reworking of the subglacial diamictites.

The massive carbonate-rich diamictite facies is clast-poor and was formed by the rainout of debris, with the carbonate probably originating by crystallisation from interstitial waters.

The conglomerate facies ranges from single layer boulder beds to poorly sorted pebble and granule conglomerates. The boulder beds are interpreted as lodgement deposits whereas the poorly sorted conglomerates are a product of water-reworking of diamicton by high-density sediment gravity flows.

The sandstone facies were formed as turbidite deposits.

The mudrock with stones facies represents rainout deposits in the distal iceberg zone.

The mudrock facies consists of dark-coloured, commonly carbonaceous mudstone, shale or silty rhythmite that was formed when the mud or silt in suspension settled. This is the only fossiliferous facies of the Dwyka Group.

ii. Palaeontological context

The palaeontological sensitivity of the area under consideration is presented in Figure 4. The site for development is in the Dwyka Group rocks. The melting ice sheets deposited the debris that had been caught up in the moving ice. This debris is composed of drop stones and fragments of plants

The Dwyka *Glossopteris* flora outcrops are very sporadic and rare. Of the seven facies that have been recognised in the Dwyka Group fossil plant fragments have only been recognised from the mudrock facies. They have been recorded from around Douglas only (Johnson et al., 2006; Anderson and McLachlan 1976) although the Dwyka Group exposures are very extensive. Jurassic Dolerites do not contain fossils as they are igneous intrusives.

From the SAHRIS map below the area is indicated as moderately sensitive (green) and this applies to the Dwyka Group, so a desktop study is required.

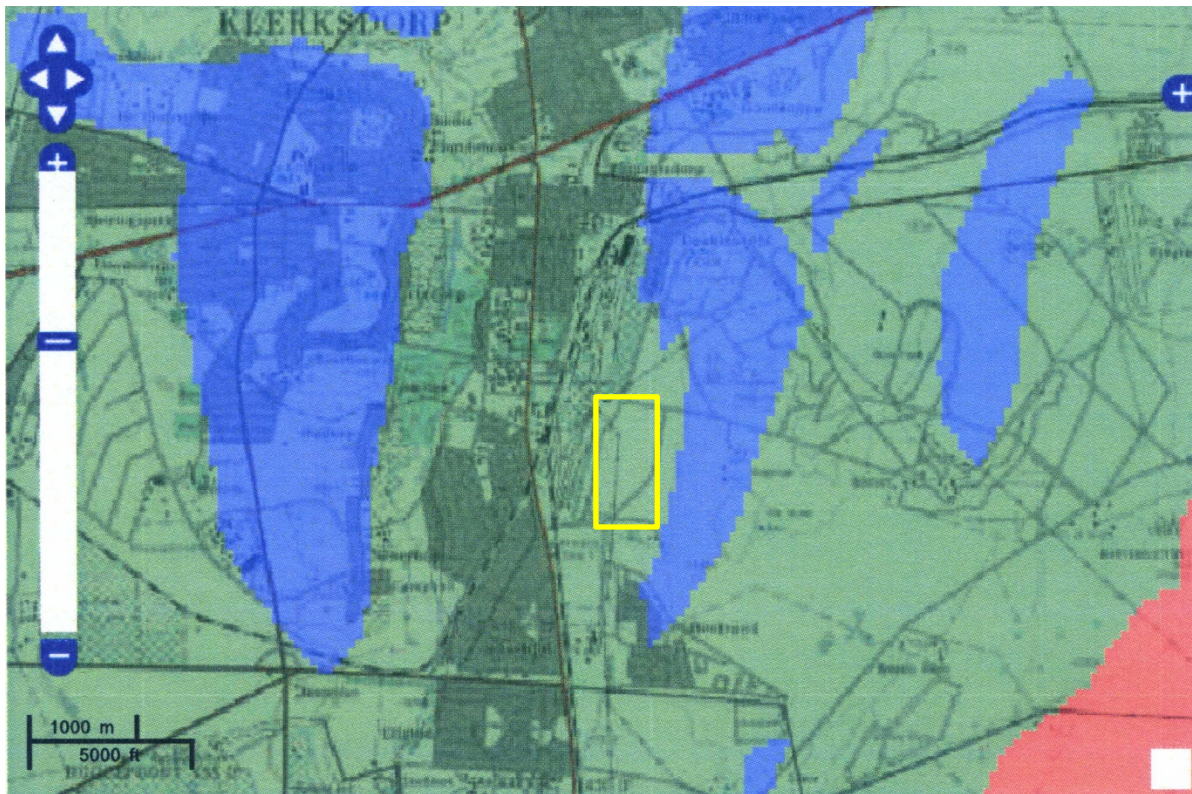


Figure 4: SAHRIS palaeosensitivity map for the site for the proposed Dawkinsville Cemetery shown within the yellow rectangle. Background colours indicate the following degrees of sensitivity: red = very highly sensitive; orange/yellow = high; green = moderate; blue = low; grey = insignificant/zero.

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	Soils do not preserve fossils; so far there are no records from the Dwyka Group of plant or invertebrate fossils in this region so it is very unlikely that fossils 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 fossil plants and invertebrates in the mudstones, the spatial scale will be localised within the site boundary.
	M	-
	H	-
PROBABILITY	H	-
	M	-
	L	It is extremely unlikely that any fossils would be found in the loose soils and sands that cover the area or in the underlying mudstones, tillites or diamictites that will be excavated. Nonetheless, a Fossil Chance Find Protocol should be added to the eventual EMPr.

Based on the nature of the project, surface activities may impact upon the fossil heritage if preserved in the development footprint. The geological structures suggest that the rocks are either much too old to contain fossils or are the correct age and type. However, the material to be excavated is soil and this does not preserve fossils. Since there is an extremely small chance that fossils from below ground of the Dwyka Group 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 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 dolomites, sandstones, shales and sands are typical for the country and only some might contain fossil plant, insect, invertebrate and vertebrate material. The sands of the Quaternary period would not preserve fossils. It is not known if fossils occur below ground but this seems unlikely.

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 sands and soils of the Quaternary. There is a very small chance that fossils may occur in the tillites and mudstones below ground of the early Permian Dwyka Group so a Fossil Chance Find Protocol should be added to the EMPr. If fossils are found by the contractor, environmental officer, or other responsible person once excavations 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, therefore, as far as the palaeontological heritage is concerned, the project should be authorised.

7. References

Anderson, A.M., McLachlan, I.R., 1976. The plant record in the Dwyka and Ecca Series (Permian) of the south-western half of the great Karoo Basin, South Africa. *Palaeontologia africana* 19, 31-42.

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.

McCarthy, T.S., 2006. The Witwatersrand 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 155-186.

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.

Visser, J.N.J., 1986. Lateral lithofacies relationships in the glaciogene Dwyka Formation in the western and central parts of the Karoo Basin. Transactions of the Geological Society of South Africa 89, 373-383.

Visser, J.N.J., 1989. The Permo-Carboniferous Dwyka Formation of southern Africa: deposition by a predominantly subpolar marine icesheet. Palaeogeography, Palaeoclimatology, Palaeoecology 70, 377-391.

8. Chance Find Protocol

Monitoring Programme for Palaeontology – to commence once the excavation 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 (plants, insects, bone, invertebrates) 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/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 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 Dwyka Group



Figure 5: Photographs of fossils that could be found in Dwyka Group sediments.

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
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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
- Klippoortjie 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
- 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.