Palaeontological Impact Assessment for the proposed establishment of two Rehabilitation dams and extension of two existing Ash dams for Majuba Power Station Ash Disposal Facility, Mpumalanga Province.

Desktop Study

For

Heritage Contracts and Archaeological Consulting

02 June 2019

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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, Modimolle, 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

Executive Summary

A Palaeontological Impact Assessment was requested for the proposed establishment of two Rehabilitation dams and extension of two existing Ash dams for Majuba Power Station Ash Disposal Facility, Mpumalanga Province. 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 site is on highly disturbed soils and shales of the Permian Volksrust Formation, Ecca Group, Karoo Supergroup. These rocks are deep water mud suspension facies and do not typically preserve fossils. No fossils have been reported from this formation in this area but a marine bivalve was reported from near Newcastle. Since there is an extremely small chance of finding fossils a Fossil Chance Find Protocol has been added to this report. If no fossils are found when dam construction commences or are found and removed the palaeontological impact will be zero to very low.

Contents

1. Background

A Palaeontological Impact Assessment (PIA) was requested for the proposed establishment of two rehabilitation dams and extension of two existing ash dams for Majuba Power Station Ash Disposal Facility, in the Gert Sibande District Municipality, Mpumalanga Province. The Majuba Power Station is located on Portion 1, 2 and 6 of the farm Witkoppies 81 HS. The combined footprint measures approximately 20 hectares. It was noted in the HIA (Heritage Impact Assessment; van der Walt, Feb 2019) that a PIA would be necessary because the area has a high palaeosensitivity (orange) as shown on their SAHRIS map.

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 and is presented here.

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 0
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

A specialist report prepared in terms of the Environmental Impact Regulations of 2014 must contain:	Relevant section in report
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 site for the Majuba Power Station Ash Disposal Facility, Farm Witkoppies 81 HC, between Perdekop and Amersfoort, Mpumalanga. Map supplied by HCAC.

Figure 2: Google Earth Map of the dam sites (yellow) for Majuba Power Station.

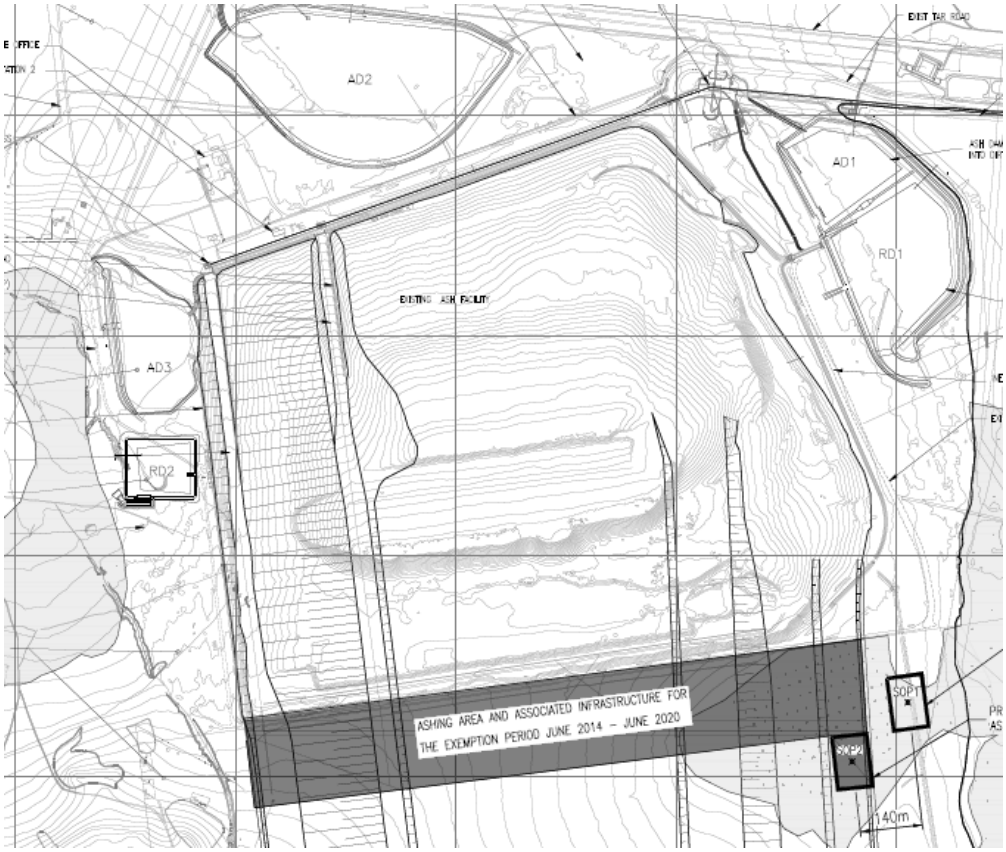

Figure 3: Site plan of four dams, AD3, AD2, AD1, RD1 for Majuba Ash Disposal Facility

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

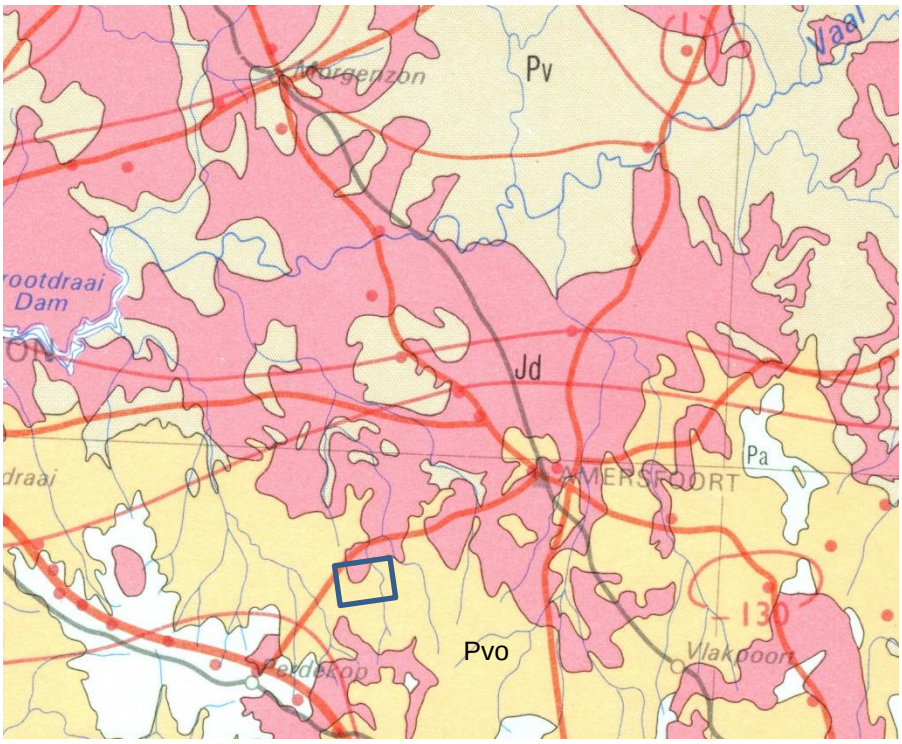

Figure 4: Geological map of the area between Perdekop and Amersfoort. The location of the proposed project is indicated within the blue outline. Abbreviations of the rock types are explained in Table 2. Map enlarged from the Geological Survey 1: 1 000 000 map 1984.

Table 2: Explanation of symbols for the geological map and approximate ages (Barbolini et al., 2016; Johnson et al., 2006). SG = Supergroup; Fm = Formation. Ma = million years. Formations in the development footprint are highlighted in grey.

Symbol	Group/Formation	Lithology	Approximate Age
Jd	Jurassic dolerite dykes	Dolerite	Ca 180 Ma
Pa	Adelaide Subgroup, Beaufort Group, Karoo SG	Mudstone, sandstone	266 - 252 Ma
Pvo	Volksrust Fm, Ecca Group, Karoo SG	shale	Late Permian 266 - 255 Ma
Pv	Vryheid Fm, Ecca Group, Karoo SG	Sandstone, shales, coal	Early Permian 269 – 266 Ma

The oldest rocks in the area are the sandstones, shales and coals of the early Permian Vryheid Formation of the lower part of the Karoo Supergroup and they represent the early infilling sediments of the large inland sea. Next in the sequence are the shales of the Volksrust Formation and it is on these sediments that the project lies. To the east are some outcrops of the Adelaide Subgroup, also part of the sequence. Intruding through the rocks are dolerite dykes that were emplaced in the Jurassic period and were associated with the Drakensberg volcanics. The whole area is covered by modern soils.

ii. Palaeontological context

The palaeontological sensitivity of the area under consideration is presented in Figure 5. The footprint for the proposed rehabilitation and ash dams for the Majuba Power Station Ash Disposal Facility is on Volksrust Formation shales, with Jurassic dykes nearby. The Volksrust Formation is indicated as having a high palaeosensitivity (orange). Dolerite is non-fossiliferous so is indicated as grey on the Palaeosensitivity map.

The Volksrust Formation is mostly made up of argillaceous (clay) shales and interfingers with the underlying Vryheid Formation and overlying Beaufort Group (Johnson et al., 2006). It is a very thick unit, very extensive and very fine-grained so it is interpreted as representing a transgressive, open shelf sequence composed mostly of mud deposited from suspension (ibid). As a consequence, fossils are extremely rare in this formation. One bivalve has been reported from this formation near Newcastle (Cairncross et al., 2005). Plants have not been described from the Volksrust Formation (Plumstead, 1969; Anderson and Anderson, 1985) and during field surveys only rarely are small organic fragments seen but they are too fragmentary and weathered to be identifiable (pers. obs.).

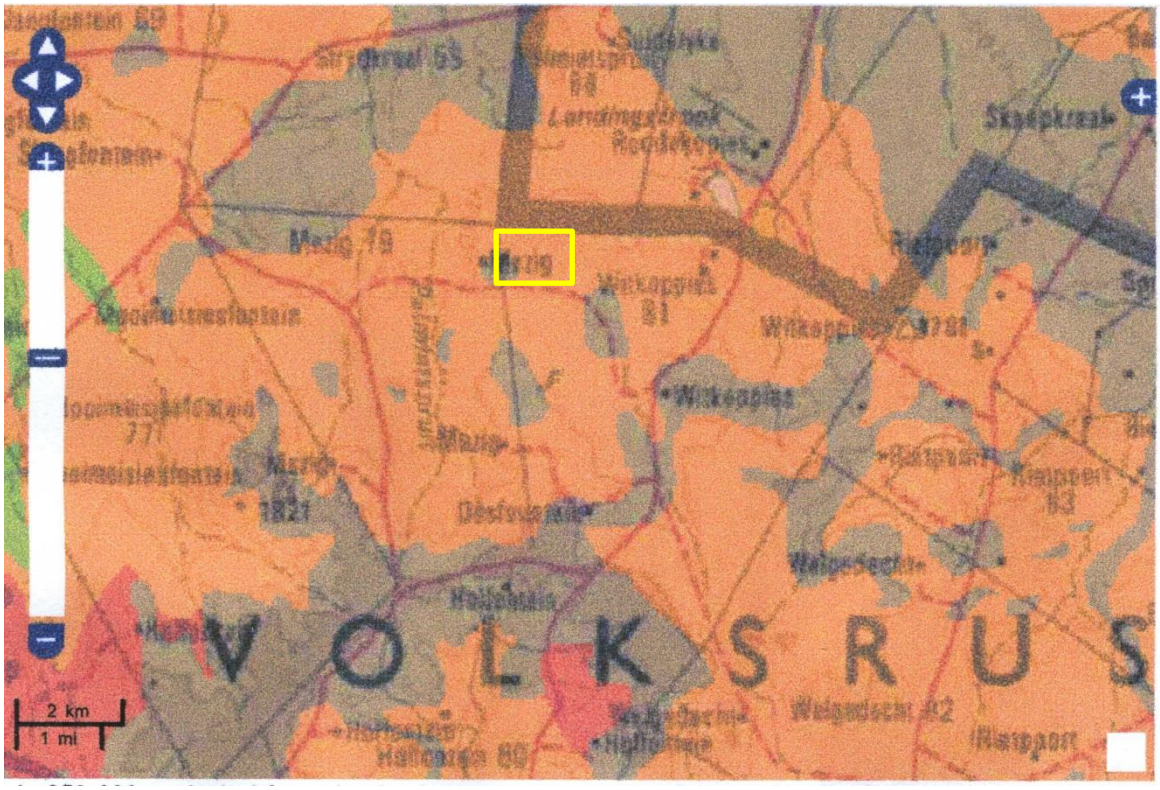

Figure 5: SAHRIS palaeosensitivity map for the site for the proposed rehabilitation and ash dams for the Majuba Power Station Ash Disposal Facility. Project area is within the yellow rectangle. Colours indicate the following degrees of sensitivity: red = very highly sensitive; orange/yellow = high; green = 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.
	L	Localised - Within the site boundary.
	M	Fairly widespread – Beyond the site boundary. Local

Criteria for ranking the SPATIAL SCALE of impacts	**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	Volksrust Fm shales do not preserve fossils but one marine bivalve has been reported, and organic fragments.
	L+	-
	M+	-
	H+	-
DURATION	**L**	-
	M	-
	H	Where manifest, the impact will be permanent.
SPATIAL SCALE	**L**	Since only the possible fossils within the area would very sporadic and very poorly preserved, the spatial scale will be localised within the site boundary.
	M	-
	H	-
PROBABILITY	**H**	**-**
	M	**-**
	L	It is extremely unlikely that any fossil plants or marine bivalves would be present in the Volksrust Fm.

Based on the nature of the project, surface activities may impact upon the fossil heritage if preserved in the development footprint. The site is already highly disturbed from earlier agricultural activities and more recently from mining activities (Figures 6-8). The geological structures suggest that the rocks are the correct age to contain fossils, but they do not occur in this kind of deep water facies. No fossils have been reported from the Volksrust Formation in Mpumalanga, but there is one reported from KZN. Nonetheless a Fossil Chance Find Protocol should be added to the final EMPr. Taking account of the defined criteria, the potential impact to fossil heritage resources is extremely low.

Table 4: Consolidated table of Aspects and Impacts Scoring

Spatial Scope	Rating	Duration	Rating	Severity	Rating
Activity specific	1	One day to one month	1	Insignificant/non-harmful	1
Area specific	2	One month to one year	2	Small/potentially harmful	2
Whole site/plant/mine	3	One year to ten years	3	Significant/slightly harmful	3
Regional/neighbouring areas	4	Life of operation	4	Great/harmful	4
National	5	Post closure	5	Disastrous/extremely harmful	5

Spatial Scope	Rating	Duration	Rating	Severity	Rating
Frequency of Activity		Rating	Probability of Impact		Rating
Annually or less		1	Almost never/almost impossible		1
6 monthly		2	Very seldom/highly unlikely		2
Monthly		3	Infrequent/unlikely/seldom		3
Weekly		4	Often/regularly/likely/possible		4
Daily		5	Daily/highly likely/definitely		5
Significance Rating of Impacts			Timing		
Very Low (1-25) Low (26-50) Low – Medium (51-75) Medium – High (76-100) High (101-125) Very High (126-150)			Pre-construction Construction Operation Decommissioning		
Adjusted Significance Rating					

Table 5: Summary of Assessment Ratings for Palaeontology

Criteria	Rating Before Mitigation	Rating After Mitigation
Status	Negative	Negative
Spatial Scope/Extent	Area specific	Area specific
Duration	Post closure	Post closure
Severity	Small/potentially harmful	Insignificant/non-harmful
Frequency of Activity	Annually or less	Annually or less
Significance	Low	Very low
Cumulative Impacts	Low	Very low

Calculations for Significance Assessment Matrix:

Consequence = Severity + Spatial scale + Duration
Pre-mitigation Consequence = 2 + 2 + 5 = 9
Post-mitigation Consequence = 1 + 2 + 5 = 8

Likelihood = Frequency of Activity + Frequency of Impact
Pre-mitigation Likelihood = 1 + 1 = 2
Post-mitigation Likelihood = 1 + 1 = 2

Significance Assessment Ratio: Reading Consequence and Likelihood on Table 32, for both Pre-mitigation and Post mitigation, the result is Very Low for both.

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 mudstones and shales are typical for the country and might contain organic fragments of fossil plants of the *Glossopteris* flora. It is extremely unlikely, and they would not be identifiable. It is extremely unlikely that any marine bivalves would be present this far away from the palaeosea.

6. Recommendation

Based on experience and the lack of any previously recorded fossils from the area, it is very unlikely that any fossils would be preserved in the Volksrust shales. The area is already highly disturbed from earlier agricultural and mining activities but If organic fragments are encountered then they should be given a cursory examination for fossils. As far as the palaeontology is concerned the project can proceed.

7. References

Anderson, J.M., Anderson, H.M., 1985. Palaeoflora of Southern Africa: Prodromus 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.

Cairncross, B., Beukes, N.J., Coetzee, L.L., Rehfeld, U., 2005. The Bivalve Megadesmus from the Permian Volksrust Shale Formation (Karoo Supergroup), northeastern Karoo Basin, South Africa: implications for late Permian Basin development. South African Journal of Geology 108. 547-556.

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.

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 (stromatolites,

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.

Figure 6: View of existing dam near the Ash Disposal Facility. Photograph from HCAC.

Figure 7: Exposed soil in the footprint area. Note exotic trees in the background. Photograph from HCAC.

Figure 8: Highly disturbed area close to the Majuba Power Station and the existing dam. Photograph from HCAC

Appendix A – 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 ; 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)