Palaeontological Impact Assessment for the proposed R101 Upgrade between Bela-Bela and Modimolle, Limpopo Province

Desktop Study (Phase 1)

For

Heritage Contracts and Archaeological Consulting

08 May 2021

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Expertise of Specialist

The Palaeontologist Consultant: 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 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

Signature: 

Executive Summary

A Palaeontological Impact Assessment was requested for the planned SANRAL R101 Road upgrade project, Section 8 from Bela-Bela to Modimolle, Limpopo Province. To comply with 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 existing road route lies on the Alma and Swaershoek Formations (Nylstroom Subgroup, Waterberg Group) in the northern and central sections from Modimolle southwards. These rocks are indicated as moderately sensitive because microbial mat structures have been recorded from younger rocks of the Waterberg Group in the main Waterberg Basin, but not in the Nylstroom Basin. The route passes over the Clarens Formation (Stormberg Group, Karoo Supergroup) in the southern part near Bela-Bela. Fossil vertebrates and plants have been found in this stratum but in the Main Karoo Basin so it is indicated as highly sensitive in the SAHRIS palaeosensitivity map. Therefore, a Fossil Chance Find Protocol should be added to the EMPr. Based on this information it is recommended that no palaeontological site visit is required unless fossils are found once excavations and drilling commence.

Table of Contents

1. Background

National Road R101 Section 8 is situated within two Local Municipalities (Bela Bela and Modimolle Mookgophong), both of which fall under the Waterberg District Municipality in the Limpopo Province. The project extends from Bela Bela at the intersection with Voortrekker Road (km 0.0) to Modimolle at the intersection with Road R33 (km 26.8).The general objective of this project is to successfully and optimally complete improvement of the road section. The aim of this improvement is to:

- Relieve traffic congestion to acceptable level of service by providing suitable cross sections;
- Improve road geometry (alignment) to provide better road safety;
- Provide non-motorised transport (NMT) and pedestrian facilities;
- Provide adequate pavement capacity for a 20-year design period; and
- Widen and lift bridges and other structures where required for hydraulic and traffic capacity.

Road R101-8 consists of a two lane, single carriageway road with gravel shoulders along most of the route. The road has an average surfaced width of 7.0 m. Climbing/passing lanes are provided from km 6.2 to km 7.5 (LHS) and km 14.4 to km 15.7 (RHS). Road R101-8 has an average road reserve width of approximately 35 meters.

In both Bela Bela (km 0.00 to km 0.10) and Modimolle (km 26.40 to km 26.80), the road widens to a four lane undivided single carriageway. A section in Modimolle (km 25.20 to km 26.40) consists of 3 lanes. Road R101-8 is defined as a mobility road, connecting development centres over long distances. It also connects other collector roads and can therefore be classified as a Class 2 rural major arterial in accordance with TRH 26 (COTO, 2012). According to the pavement management system (PMS) information, the road was constructed in 1964 as National Road N1 joining Pretoria and Polokwane. The N1 was, however realigned during 1995/1996 under a concession contract at which time this section was renumbered as R101. Road R101 serves as an alternative route to the N1 toll route. Proposed widening and lifting of the 2 existing bridges for capacity improvement will include the altering of the watercourse banks and thus will require a Water Use License.

A Palaeontological Impact Assessment was requested for the R101 road upgrade project. 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 development and is presented herein.

Table 1: Specialist report requirements in terms of Appendix 6 of the EIA Regulations (amended 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	Section 7, 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 7, Appendix A
ni	A reasoned opinion as to whether the proposed activity or portions thereof should be authorised	N/A
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.	N/A

Figure 1: Google Earth map of the proposed R101 road upgrade between Bela-Bela in the south and Modimolle in the north. Map supplied by HCAC.

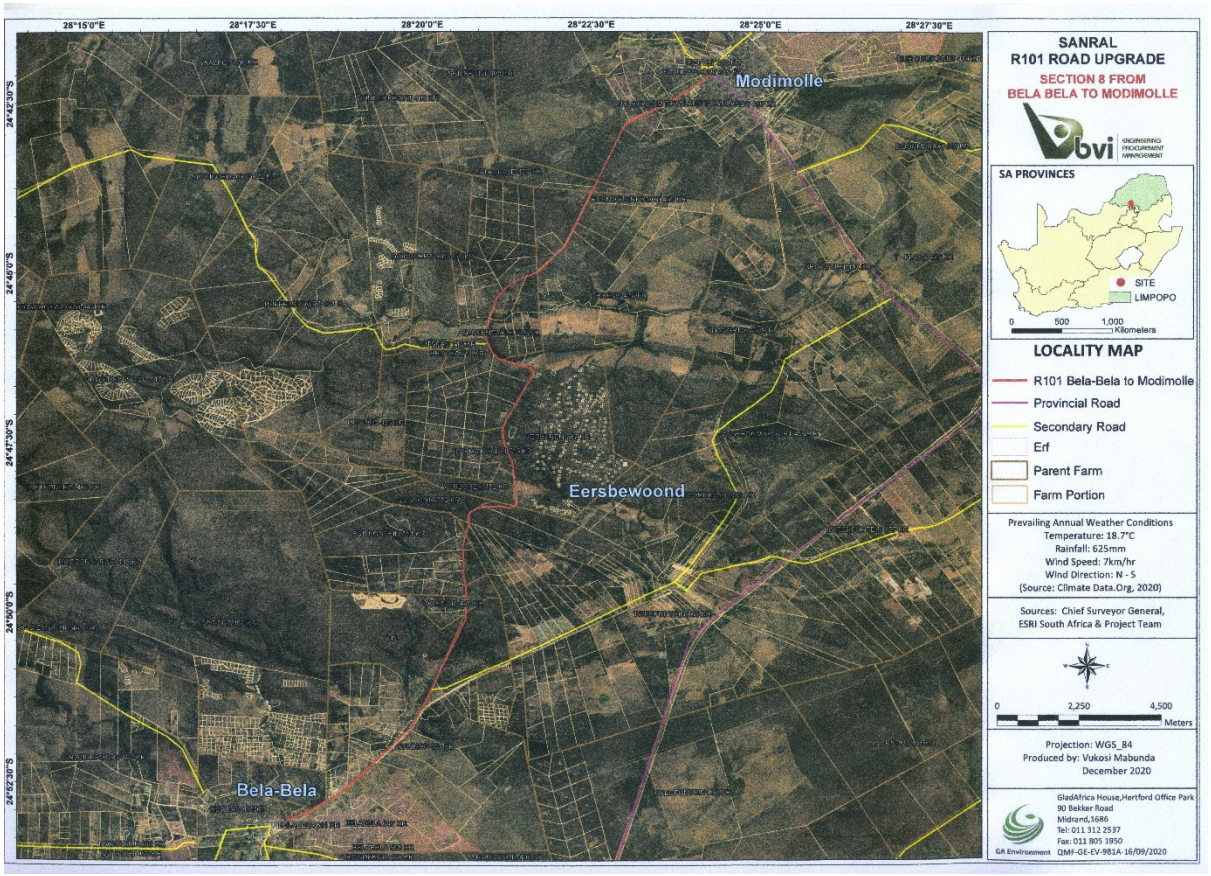

Figure 2: Detailed map showing the road route and infrastructure

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

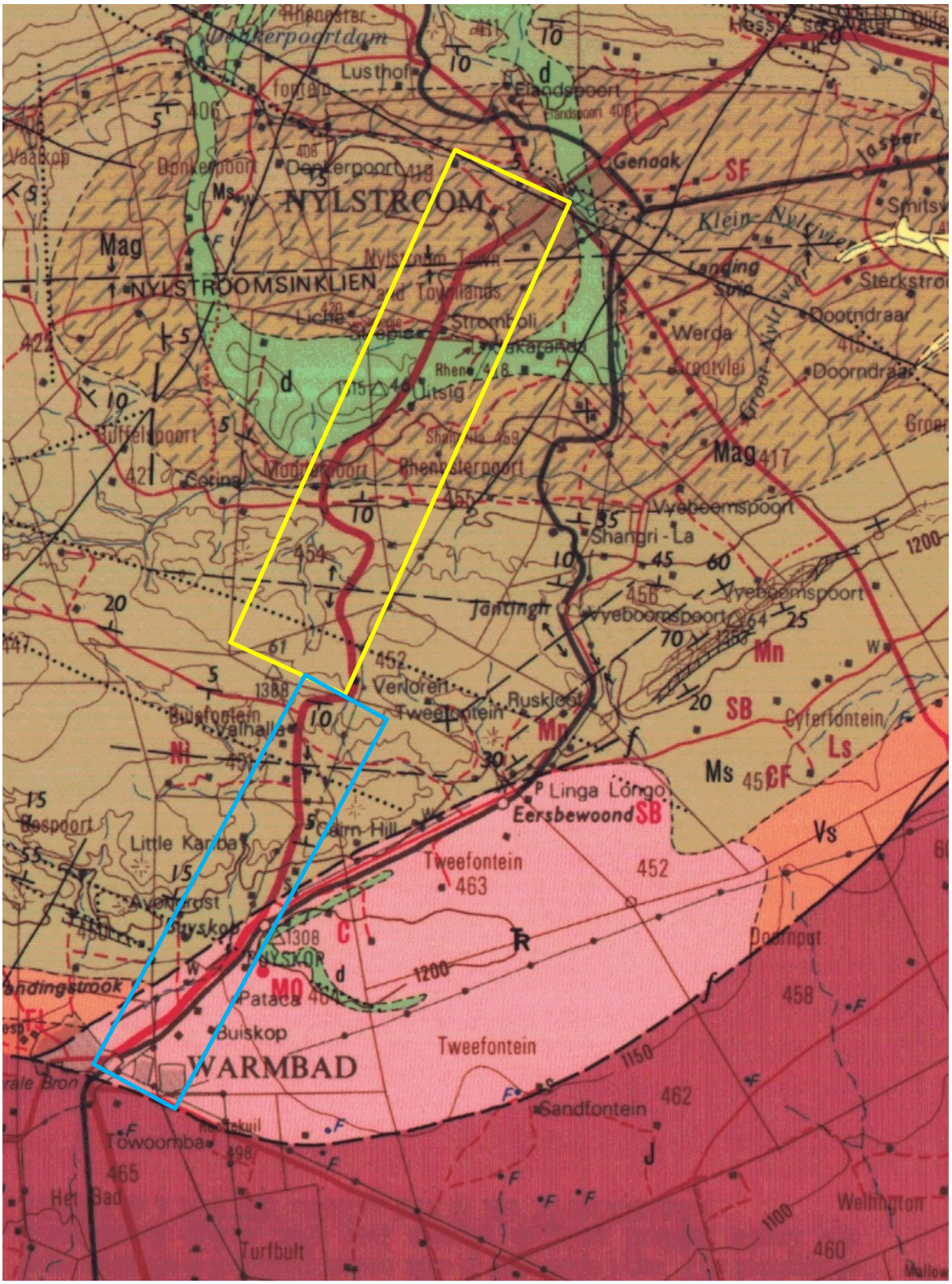

Figure 3: Geological map of the area between Bela-Bela (Warmbaths) and Modimolle (Nylstroom) with the northern section outlined in the yellow rectangle (see Figure 4) and the southern section in

the blue rectangle (see Figure 5). Abbreviations of the rock types are explained in Table 2. Map enlarged from the Geological Survey 1: 250 000 map 2428 Nylstroom.

Table 2: Explanation of symbols for the geological map and approximate ages (Eriksson et al., 2006. Johnson et al., 2006; McCarthy et al., 2006; Robb et al., 2006; van der Westhuizen 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
J	Letaba Fm, Karoo SG	Volcanic rocks, sandstone	Jurassic, approx. 180 Ma
Tr	Clarens Fm, Stormberg Group, Karoo SG	Fine-grained red-cream sandstone	Ca 190 Ma
d	diabase	Intrusive volcanic rocks	
Mag	Alma Fm, Nystroom Subgroup, Waterberg Group	Feldspathic and micaceous sandstone, greywacke, grit, mudstone, siltstone conglomerate	Ca 2000 Ma
Ms	Swaershoek Fm, Nylstoom Subgroup, Waterberg Group	Medium to coarse-grained sandstone, pebble sandstone, tuff, greywacke, siltstone, shale, conglomerate	Ca 2000 Ma
Vs	Schrikkloof Fm, Rooiberg Group	Volcanic rocks, sandstone, quartzite	Ca 2200 Ma

Bela-Bela and Modimolle are in the Nylstroom Basin of the Waterberg Group (with the much larger Waterberg Basin lying to the North and Northwest). The oldest rocks in the region are the volcanic rocks, sandstones and quartzites of the Rooiberg Group, exposed to the west and far northeast of Bela-Bela. A large exposure of Clarens Formation occurs in the Bela-Bela area.

The Waterberg Group was deposited between 2000 and 1700 million years ago, well after the Great Oxidation Event (GOE, ca 2.5Ga) so oxygen was available and these shallow water deposits are known as red beds. It has been divided into three subgroups with only the basal group, the Nylstroom Subgroup, occurring in the study area (Figure 3). The Nylstroom and Matlabas Subgroups form a crude upward-fining sequence with rudites and arenites at the base and grading to lutites and well-sorted arenites at the top. The overlying Kransberg Subgroup forms a second, similar, upward-fining sequence in the Waterberg Basin (Barker et al., 2006.

Unconformably overlying the Alma Formation around Bela-Bela is the much younger Clarens Formation of the upper Stormberg Group, Karoo Supergroup. These sandstones are windblown rather than waterborne like the Waterberg Group. Alma Formation sands were deposited as alluvial fans, as were those of the Swaershoek Formation.

ii. Palaeontological context

The palaeontological sensitivity of the area under consideration is presented in Figures 4 and 5 3. From Modimolle southwards the strata are the Alma Formation and the Swaershoek Formation (indicated as green = moderately sensitive on the SAHRIS map) with a patch of diabase that is non-fossiliferous because it is an intrusive volcanic. Although no fossils have been recorded from these two formations in the Nylstroom Subgroup, microbial mats have been described from the overlying subgroup, the Matlabas Subgroup, that is not present in the Nyslstroom Basin.

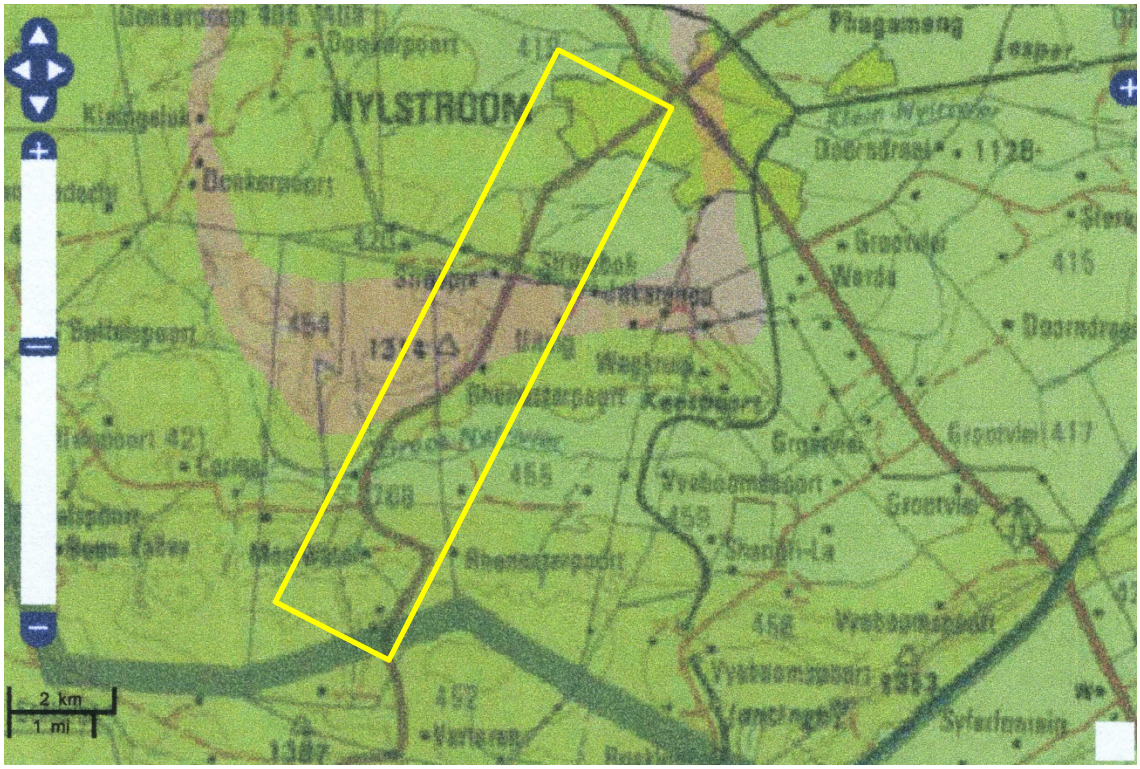

Figure 4: SAHRIS palaeosensitivity map for the site for the northern section of the R101 upgrade from Nylstroom (Modimolle) southwards shown within the yellow rectangle. Background colours indicate the following degrees of sensitivity: red = very highly sensitive; orange/yellow = high; green = moderate; blue = low; grey = insignificant/zero.

Simpson et al., 2013 described microbial mat features from exposures along a cliff face in the Waterberg Basin, using the six biogenicity criteria developed by Noffke et al., (2009). Noffke (2009) developed six criteria to determine the biogenicity of sedimentary features found in Precambrian strata. Although the criteria were developed for marine strata, the benchmarks are mostly applicable to Precambrian continental strata as well. Noffke's (2009) criteria necessary to assign biogenicity to features include:
(1) strata with a metamorphic grade less than lower greenschist facies;
(2) position in the stratigraphic section that corresponds to the transition from regression to transgression in marine sections (not applicable to true continental settings);
(3) interpreted depositional facies that enhance the development and preservation of microbial mats;

(4) feature distribution that correlates to the average hydraulic pattern;
(5) geometries and patterns that have modern analogues; and
(6) presence of, at minimum, one of nine specific microtextures. Microtextural criteria to aid in the identification of mat features include elongate laminae, laminae forming carpet-like textures, fossil fabric orientations matching the modern, ~45◦span, and laminations composed of iron oxides and hydroxides, titanium oxides, chlorite, and carbon (Noffke et al., 2008). Schieber (1998) asserts that positive identification requires that microbial filaments be found in thin section in life position.

Deformation is minimal in the Makgabeng Formation (Simpson et al., 2013). Makgabeng Formation microbial mat microscopic textures satisfy most of the criteria outlined in Noffke et al. (2008) including filamentous laminae, oriented grains, textures lined with iron oxides and hydroxides and clay minerals (see Appendix A).

They uses Noffke's (2009) criteria to identify the microbial mat features in the ca 2 Ga palaeo-desert setting of the Makgabeng Formation (Matlabas Subgroup, Waterberg Group):
A – Roll-up structures
B – Sand cracks
C – Wrinkle structures
D – tufted microbial mats
E – biological soils crusts
F – gas-escape features.

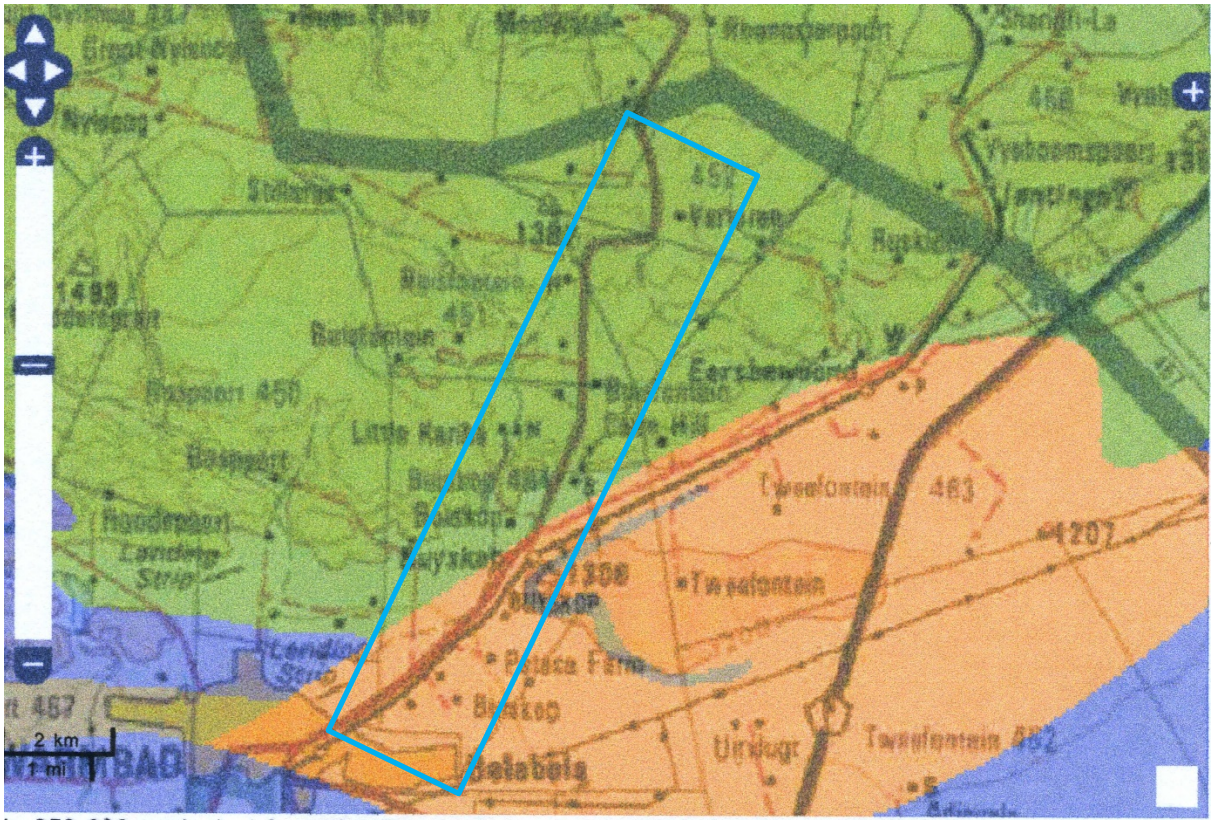

Figure 5: SAHRIS palaeosensitivity map for the site for the southern section of the R101 upgrade from Warmbaths (Bela-Bela) northwards shown within the blue rectangle.

Background colours indicate the following degrees of sensitivity: red = very highly sensitive; orange/yellow = high; green = moderate; blue = low; grey = insignificant/zero.

In the southern part of the R101 route, around Bela-Bela and northwards, is the Clarens Formation outcrop that is indicated as highly sensitive (orange colouration shown in Figure 5). The Early Jurassic age of the Clarens Formation means there is a chance of finding fossil vertebrates, for example, fish, amphibians, prosauropods, theropods, therapsids and insects (Johnson et al., 2006; Viglietti et al., 2020). Fossil plants have also been recorded but they are rare. The plants include sphenophytes, Bennettitaleans, conifer leaves and wood, seed ferns, pollen and algae (Plumstead, 1969; Anderson and Anderson, 1985; Bamford, 2004). Vertebrate and plant fossils are from the Main Karoo Basin and have not been recorded from the Nylstroom Basin.

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	-

PART B: ASSESSMENT		
	L	Soils do not preserve fossils; so far there are no records of microbial mats from the Nylstroom Subgroup, only from the younger Makgabeng Fm. Clarens Fm vertebrates and plants have been found in the Main Karoo Basin, not yet in the equivalent aged deposits in the Nylstroom Basin. It is very unlikely that fossils occur on the site. The impact would be very unlikely.
	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 be microbial mat structures in the northern and central part, and vertebrates and plants in the southern part, 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 sand that cover the surface. Rocky outcrops might have fossils. 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 body fossils, only microbial mat structures (Nylstroom Subgroup), or vertebrates and plants (Clarens Formation). There are no records however, of fossils in this region. Since there is a small chance that fossils may occur and 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 diabase, sandstones, shales and sands are typical for the country and might contain microbial mat structures or fossil plant, insect, invertebrate and vertebrate material. The overlying soils and sands of the Quaternary period would not preserve fossils.

6. Recommendation

Based on experience and the lack of any previously recorded fossils from the area, it is extremely unlikely that any fossils would occur in the northern section, the Nylstroom Subgroup, and very unlikely be preserved in the sandstones of the Clarens Formation. Therefore, a Fossil Chance Find Protocol should be added to the EMPr: if fossils are found

once excavations and drilling have 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: Prodromus of South African megafloras, Devonian to Lower Cretaceous. A.A. Balkema, Rotterdam. 423 pp.

Barker, O B., Brandl, G., Callaghan, C.C., Erikssen, P.G., van der Neut, M., 2006. The Soutspanberg and Waterberg Groups and the Blouberg Formation. 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 301-318.

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Viglietti, P.A., McPhee, B.W., Bordy, E.M., Sciscio, L., Barrett, P.M., Benson., R.B.J., Wills, S., Chapelle, K.E.J., Dollman, K.N., Mdekazi, C., Choiniere, J.N., 2020. Biostratigraphy of the Massospondylus Assemblage Zone (Beaufort Group, Karoo Supergroup). South African Journal of Geology 123, 249-262.

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 drilling/excavations commence.
2. When excavations begin the rocks and must be given a cursory inspection by the environmental officer or designated person. Any fossiliferous material (plants, insects, bone, coal) should be put aside in a suitably protected place. This way the 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 6-8). 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/miners 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.

Appendix A – Examples of fossils from the Waterberg Group and the Clarens Formation.

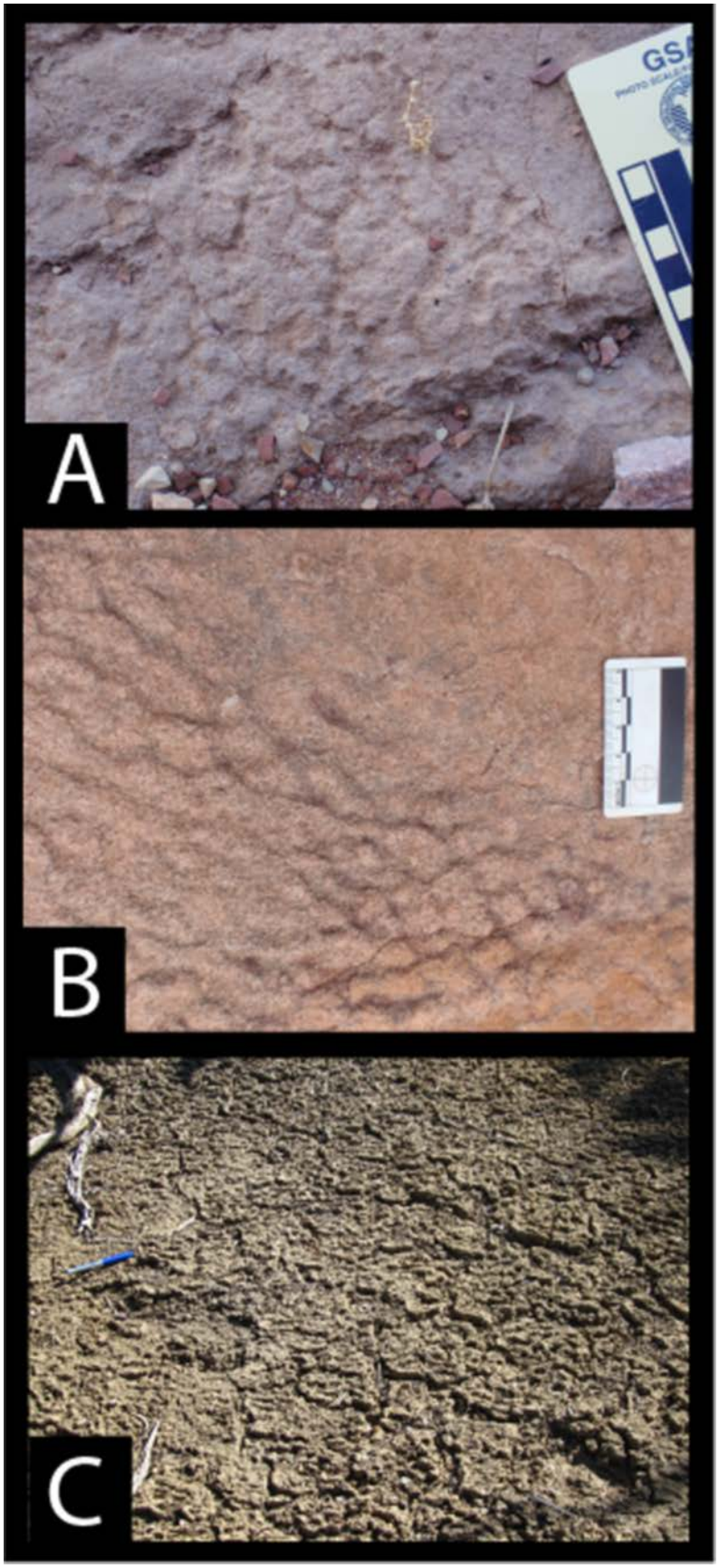

Figure 6: (Simpson et al., 2013 – Fig 14). Field photographs of modern and ancient biological soil crusts. (A) Preserved biological soil crust at the boundary between the dune and playa deposits in the Makgabeng Formation. Note the polygonal desiccation features and the

microtopography on the polygonal features. Scale is in centimeters. (B) Preserved biological soil crust at the boundary between the dune and playa deposits in the Makgabeng Formation. Note the lateral change in morphology of the desiccation features and the reduction in development to the left of the photograph. Scale is in centimeters. (C) Modern biological soil crust located at Grand Staircase Escalante National Monument, Utah, USA. This biological soil crust shows faint, weakly developed desiccation features with micro-topographic relief between the desiccation features.

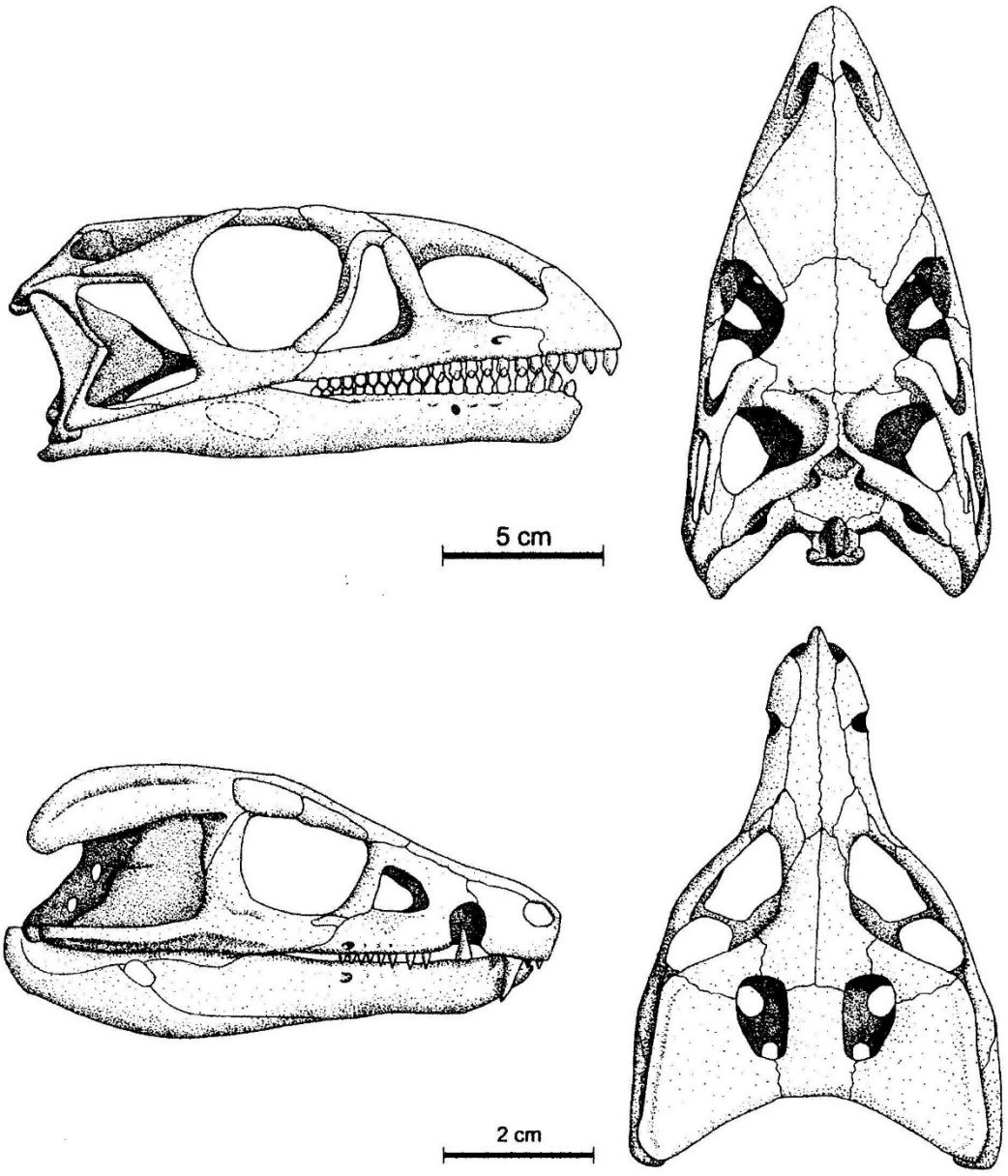

Figure 7: Diagrams of the skulls of typical fossils from the Clarens Formation, the Massospondylus Assemblage Zone: A = *Massospondylus carinatus* side view and top view; B = *Protosuchus haughtoni* (from Fig. 1 of Viglietti et al., 2020).

Figure 8: Selection of fossil plant impressions from the Molteno and Clarens Formations, Stormberg Group: *Dicroidium* sp., bennetttitalean, sphenophyte, *Ginkgoites* sp., *Asterotheca* (fern).

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	0
Masters	10	4
PhD	11	4
Postdoctoral fellows	10	5

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 –

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
- Lieliefontein 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; 10 book chapters.
Scopus h-index = 29; Google scholar h-index = 35; -i10-index = 92
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)