## Palaeontological Impact Assessment for the proposed Mining Rights Application on Farm Kammagas No. 200 west of Springbok, Northern Cape Province

### **DESKTOP STUDY (PHASE 1)**

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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 Archaeological and Heritage Services Africa (Pty) Ltd, Pretoria, 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

MKBamfurk

Signature:

#### **Executive Summary**

A Palaeontological Impact Assessment was requested for the Mining Rights Application for Portion 5 of Farm Kammagas No 200, in the Nhama Khoi Local Municipality, about 50 km west northwest of Springbok, Northern Cape Province.

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 mining area lies on non-fossiliferous volcanic rocks of the Namaqua-Natal Province and fluvial Tertiary gravels and sands along the Buffels River. Although the area is shown to be of low significance on the SAHRIS palaeosensitivity map, fossil ferns have been recovered from the adjacent farm, Buffelsbank. 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 environmental officer or other designated responsible person when excavations and mining commence. As far as the palaeontology is concerned, it is recommended that the project be authorised.

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### 1. Background

Mafisa Mining (Pty) Ltd is applying for Mining Rights on a portion of Portion 5 of the Farm Kammagas No. 200 situated in the Nama Khoi Local Municipality and Namakwa District Municipality of the Namakwaland administrative district of the Northern Cape. The area in question is 442.7358 ha (Figure 1).

The property is registered in the name of the Gemeenskap van Komaggas by virtue of Title Deed T102440/1998. The mine is situated off the R335 between Springbok and Kleinzee about 50 km east of Springbok in the Namakwa district, Northern Cape Province. It is in the Namakwa District Municipality with an approximate centre Latitude S29.60442 ° and Longitude E17.48358 °.

#### Mining Method

Mafisa Mining will make use of the open cast mining method as described below. Mining is to take place as a continuation of earlier surface mining and briefly entails;

- the removal of overburden above the diamond bearing gravels and clays by excavator and dozer to expose the gravels and diamondiferous clays which overlie the bedrock;
- removal of the diamondiferous clays and gravels which will be sent to the plant for processing and diamond recovery; and
- the sweeping of the paleo bedrock floor by hand to recover pothole gravels for processing.
- Rehabilation will be done as a continuous process using the soils that were removed.

A Palaeontological Impact Assessment was requested for the above 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: 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:				
ai	Details of the specialist who prepared the report Appendix				
aii	The expertise of that person to compile a specialist report including a curriculum vitae Appendix				
b	A declaration that the person is independent in a form as may be specified by the competent authority	Page 2			
с	An indication of the scope of, and the purpose for which, the report was prepared	Section 1			

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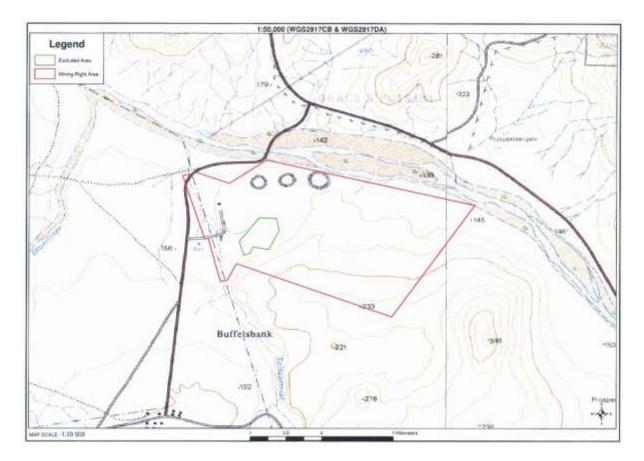


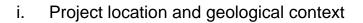
Figure 1: Topographic map of the proposed Mining Rights area on Portion 5 of Farm Kammagas No 200, Namaqualand, with the farm boundaries shown by the red outline. Map supplied by Matenga.

### 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



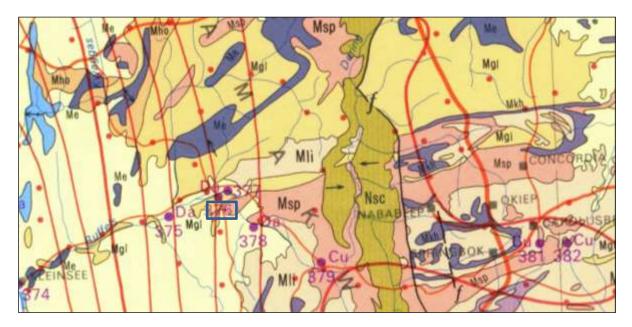


Figure 2: Geological map of the area around the Farm Kammagas No 200 with the proposed Mining Rights area indicated within the blue rectangle. Abbreviations of the rock types are explained in Table 2. Map enlarged from the Geological Survey 1: 1 000 000 map.

Table 2: Explanation of symbols for the geological map and approximate ages (Cornell et al., 2006; Gresse et al., 2006; Partridge 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 sand	Aeolian sand, sand dunes; alluvium, sand (sometimes diamondiferous)	Late Quaternary, ca last 50ka
Nsc	Schwarzrand Subgroup, Nama Group	Limestone, shale	Cambrian ca 530 Ma
Mli	Little Namaqualand Suite	Meta-crystic biotite gneiss, augen gneiss	Ca 1200 Ma
Mho	Hooghoor Suite	Pink gneiss	Ca 1200 Ma
Msp	Spektakel Suite	Aplogranite, porphyritic granite	Ca 1060 Ma
Mgl	Gladkop Suite	Grey fine-grained gneiss	Ca 2050 – 1700 Ma

The farm lies in the Namaqua-Natal Province in the Namaqua section (Figure 2, Table 2). The Namaqua-Natal Province is a tectono-stratigraphic province and forms the southern and western boundary of the ancient Kaapvaal Craton, and extends below the Karoo Basin sediments to the south (Cornell et al., 2006). It comprises rocks that were formed during the Namaqua Orogeny (mountain-building) some 1200 – 1000 million years ago. It has been

divided by geologists into a number of terranes (similar lithology and bounded by shear zones). There are three main lithologic units used to separate the terranes as well as the shear zones but still there is some debate about the terranes (ibid). Very simply, the lithologic units are older reworked rocks, juvenile rocks formed during tectonic activities and metamorphosed, and intrusive granitoids.

According to Cornell et al. (2006) the five terranes are:

- A Richtersveld Subprovince (undifferentiated terranes)
- B Bushmanland Terrane (granites)
- C Kakamas Terrane (supracrustal metapelite ca 2000 Ma
- D Areachap Terrane (supracrustal rocks and granitoids)
- E Kaaien Terrane (Keisian aged metaquartzites and deformed volcanic rocks).

The project lies in the Bushmanland Terrane with its northern boundary against the Richtersveld Subprovince and the eastern boundary against the Kakamas Terrance (ibid). According to Moore et al. (1990, in Cornell et al., 2006), the Bushmanland Terrane rocks can be divided into three distinct age group:

- 1. A basement complex (Achab Gneiss, Gladkop Suite) that is mainly composed of granitic rocks of Kheisian age (2050 1700 Ma).
- 2. A variety of supracrustal sequences of mixed sedimentary and volcanic origin and probably fitting into three broad age groups (ca 1900, 1600 and 1200 Ma).
- Suites of syn- and late-tectonic Namaquan intrusive rocks, generally of granitic to charnockitic composition. This group includes the Little Namaqualand Suite (ca 1200 Ma), the Spektakel Suite (ca 1060 Ma) and the basic rocks of the Koperberg and Wortel Suites and Nouzees Complex (1060 – 1030 Ma), as well as the ca 950 Ma pegmatites.

The Namaqua-Natal Province rocks are volcanic in origin and frequently metamorphosed. Several outcrops occur on the farms along the route and probably underlie the Gordonia sands and Tertiary Calcretes.

Today the Orange River drains the central part of southern Africa into the Atlantic Ocean in the west but the route of this river has not remained the same over time (de Wit, 1999; de Wit et al., 2000; Haddon and McCarthy, 2005). During the Cretaceous there were two major westward-draining rivers, the northerly on called the Kalahari River that exited where the Orange River does today, and the southerly Karoo River that drained the central Highveld and exited where the Olifants River does today (Figure 3). Subsequent tectonic uplift of the continent in the Late Cretaceous, and altered drainage has led to one river capturing another. By the Miocene, the capture of the middle Orange by the lower Orange River had already occurred (de Wit, 1999), and de Wit et al. (2000) believe that the Orange River has followed its present course since at least the late Oligocene. The terraces along the lower Orange River, therefore, represent different times and levels of the river, and deposits from different distant sources.

The Buffels River of today, that exits at Kleinzee, was possibly part of the palaeo-Orange river and might have been since the Miocene. The climate reconstructed for the Orange River most likely applied to the Buffels River but the degree of uplift and erosion could have

been different (Pickford, 2016). Nonetheless, the fluvial gravels, sands and alluvium along the river also have entrapped diamonds weathering out from the kimberlites pipes in Namaqualand and eastwards.

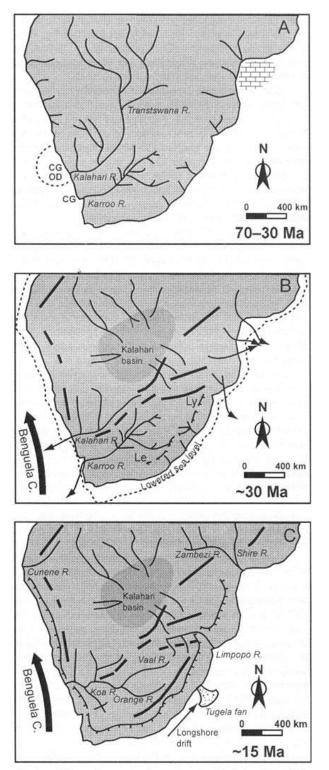


Figure 3: (From Burke and Gunnell, 2008; fig. 13) to show the palaeo-rivers of southern Africa at A – Late Cretaceous to Oligocene, 70-30 Ma; B – Oligocene, about 30 Ma; C – middle Miocene with a significant escarpment.

#### ii. Palaeontological context

The rocks of the Namaqua-Natal Province are volcanic in origin and have been metamorphosed so they do not preserve any fossils.

The ubiquitous Aeolian sands of the Gordonia Formation do not preserve fossils because they have been transported and reworked, but in some regions these too may have covered pan or spring deposits and these can trap fossils, and more frequently archaeological artefacts. Usually these geomorphological features of pans and springs can be detected using satellite imagery. No such features are visible.

Along the river there are diamondiferous gravels and although they are shown as have insignificant sensitivity there is a small chance that they are fossiliferous. Fossils have been collected from Buffelsbank and they are *in situ* stems of a fern and probably Oligocene in age (Bamford, 2000). The transported materials could include alluvial diamonds and some fossils, such as fragments of silicified woods or bones that came from eroded deposits close by or very distant. Their context would be unknown. It is more likely that fossils could be preserved in abandoned river channels or oxbows, such as is the case at Arrisdrift and Daberas (Pickford and Senut, 2003) farther upstream, but these are not adjacent to the present river channel where there is active water and sediment transport.

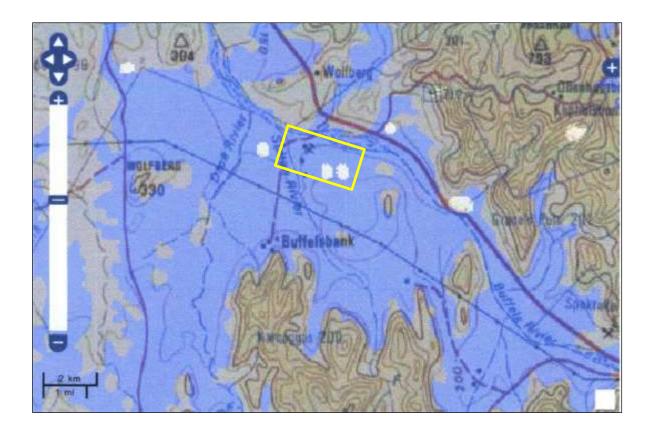


Figure 3: SAHRIS palaeosensitivity map for the Mining Rights area application on Farm Kammagas 200 shown within the yellow rectangle. Background colours indicate the following degrees of sensitivity: red = very highly sensitive; orange/yellow = high; green = moderate; blue = low; grey = insignificant/zero.

From the SAHRIS map (Figure 4) the area is indicated as having low sensitivity (blue) and this applies to the volcanic and metamorphosed volcanic rocks of the Namaqua-Natal Sequence. Along the river, however, there might be fossils entrapped in the sands.

### 4. Impact assessment

An assessment of the potential impacts to possible palaeontological resources considers the criteria encapsulated in Table 3:

PART A: DEFINITION AND CRITERIA				
	Н	Substantial deterioration (death, illness or injury). Recommended level will often be violated. Vigorous community action.		
	М	Moderate/ measurable deterioration (discomfort). Recommended level will occasionally be violated. Widespread complaints.		
Criteria for ranking of the SEVERITY/NATURE of environmental	L	Minor deterioration (nuisance or minor deterioration). Change not measurable/ will remain in the current range. Recommended level will never be violated. Sporadic complaints.		
impacts	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.		
	L	Quickly reversible. Less than the project life. Short term		
Criteria for ranking the DURATION of impacts	М	Reversible over time. Life of the project. Medium term		
2 of a first of impacto	Н	Permanent. Beyond closure. Long term.		
Criteria for ranking the	L	Localised - Within the site boundary.		
SPATIAL SCALE of	М	Fairly widespread – Beyond the site boundary. Local		
impacts	Н	Widespread – Far beyond site boundary. Regional/ national		
PROBABILITY	Н	Definite/ Continuous		
(of exposure to	М	Possible/ frequent		
impacts)	L	Unlikely/ seldom		

TABLE 3A: CRITERIA FOR ASSESSING IMPACTS

#### TABLE 3B: IMPACT ASSESSMENT

PART B: ASSESSMENT		
	Н	-
	М	-
SEVERITY/NATURE	L	Volcanic rocks do not preserve any fossils. Tertiary sands and alluvium along the river may preserve fossils but they would be transported. so far there are no records of fossils from the Farm Kammagas, but from the adjacent farm, Buffelsbank. It is very unlikely that fossils occur on the river banks. The impact would be very unlikely.
	L+	-
	M+	-
	H+	-
	L	-
DURATION	М	-
	Н	Where manifest, the impact will be permanent.

PART B: ASSESSMENT				
SPATIAL SCALE	L	Since the only possible fossils within the area would be transported fossil bones or plants from the rover gravels and sands, the spatial scale will be localised within the site boundary.		
	Μ	-		
	Н	-		
	Н	-		
	М	-		
PROBABILITY	L	It is extremely unlikely that any fossils would be found in the loose sand or gravels that will be mined. 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 and the wrong type to contain fossils, or young enough but transported. Furthermore, part of the area has already been mined so is disturbed. Since there is an extremely small chance that fossils from the river gravels of Tertiary age 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 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 gneiss, sandstones, shales and sands are typical for the country and do not contain fossil plant, insect, invertebrate and vertebrate material. The metamorphosed volcanic rocks of the Namaqua-Natal Sequence would not preserve fossils. Only if there are transported fossils amongst the river gravels and sands of Tertiary age or the Quaternary aeolian sands, would any fossils be entrapped.

### 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 Tertiary gravels and sands along the Buffels River. There is a small chance that fossils may occur because ferns have been collected from the adjacent farm, Buffelsbank. Therefore, a Fossil Chance Find Protocol should be added to the EMPr. If fossils are found by the environmental officer or other responsible person once excavations and mining have commenced then they should be rescued and a palaeontologist called to assess and collect a representative sample.

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### 8. Chance Find Protocol

# Monitoring Programme for Palaeontology – to commence once the excavations / drilling/mining activities begin.

- 1. The following procedure is only required if fossils are seen on the surface and when drilling/excavations/mining 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 5, 6). 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.

Appendix A – Examples of fossils from the Tertiary and Quaternary



Figure 5: Examples of fragmentary bones from a Quaternary fluvial deposit.



Figure 6: Examples of transported fragments of silicified woods from a Pleistocene fluvial deposit. Scale = 12 cm.

#### Appendix B – Details of specialist

### Curriculum vitae (short) - Marion Bamford PhD July 2021

#### I) Personal details

Surname First names Present employment	:	Bamford Marion Kathleen 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 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
- 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 July 2021 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)