

**Palaeontological Impact Assessment for the proposed
sand Mining Permit Application on a Portion of the
Farm Eureka 200 in the District of Kimberley,
Northern Cape Province**

Desktop Study

For

**Dr Edward Matenga
Archaeological and Heritage Service Africa (Pty) Ltd**

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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 Dr Edward Matenga, Archaeological and Heritage Resources Africa (Pty) Ltd, South Africa. The views expressed in this report are entirely those of the author and no other interest was displayed during the decision making process for the Project.

Specialist: Prof Marion Bamford

Signature: 

Executive Summary

A palaeontological Impact Assessment was requested for the proposed sand mining on a Portion of the Farm Eureka 200, just southwest of the city of Kimberley, North West 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 area.

The proposed site lies on the sands and calcrete of the Kalahari Group, Quaternary age, alongside the N4 highway and railway line. Non-fossiliferous dolerite dykes of Jurassic age are nearby. There is a very small chance that fossils from Quaternary pans could have been preserved, for example silicified wood or heavy bones, but none has been recorded from here. Since there is a very small chance that fossils could be discovered once mining commences a Fossil Chance Find Protocol should be added to the EMP. Based on this information it is recommended that no palaeontological site visit is required unless the geologist or responsible person discovers fossils.

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1. Background

A mining permit application has been put forward by Mr Henley Booyesen to mine sand on a portion of the Farm Eureka 200, in the Kimberley District. The site is just to the east of the railway line and the N4 highway, south west of the town of Kimberley (Figure 1).

A Palaeontological Impact Assessment was requested for the project in order 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), so a desktop Palaeontological Impact Assessment (PIA) was completed for the proposed development and is presented here.

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

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

| | | |
|-----|---|------------|
| l | Any conditions for inclusion in the environmental authorisation | N/A |
| m | Any monitoring requirements for inclusion in the EMP or environmental authorisation | 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 EMP, 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 |

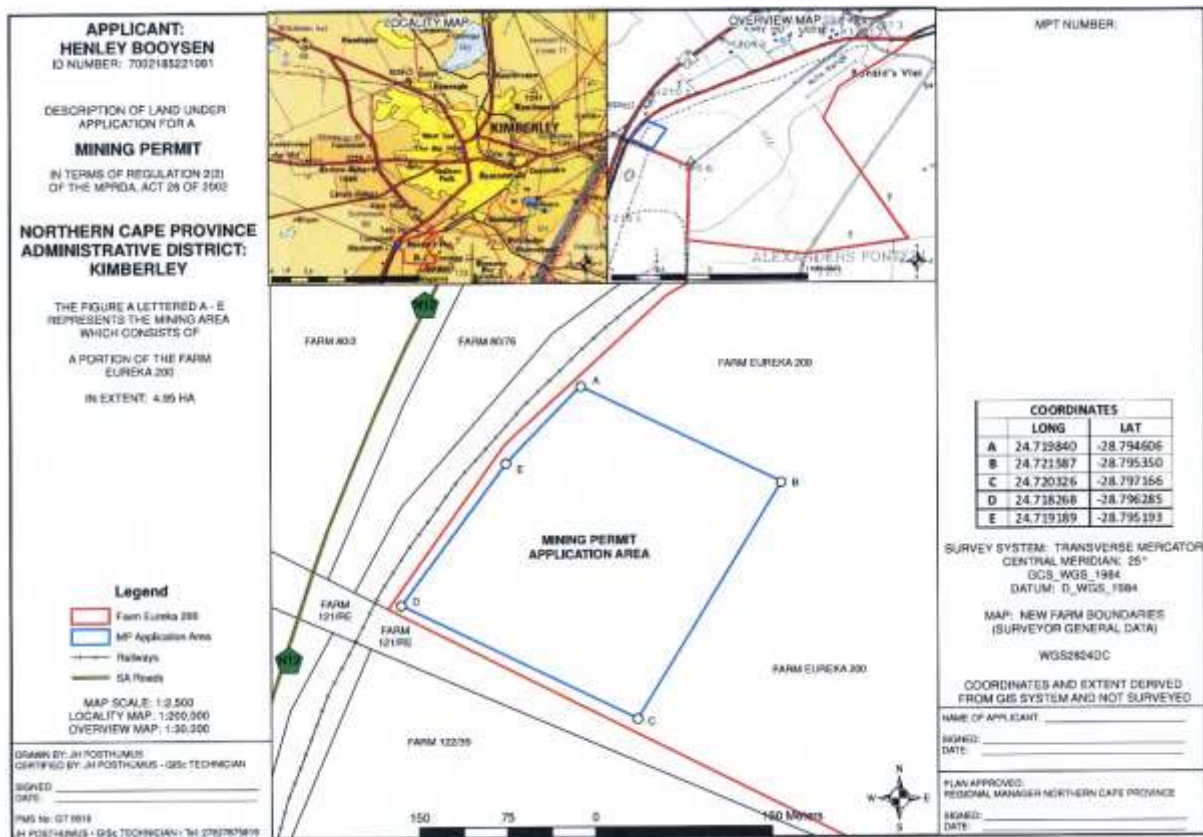


Figure 1: Site Earth map of the proposed mining rights application on Farm Eureka 200, Kimberley district. The proposed mining area is shown as the blue outline.

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 in this case).
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

The site lies to the north west of the main Karoo Basin and only remnants of the Karoo Sequence are present, for example, there is a small outcrop of the Whitehill Formation (Figure 2). There are also numerous outcrops of the intrusive Jurassic dolerite dykes. The sand to be mined is from the Kalahari Group that is of Quaternary age (Table 2). Large areas of Northwest Province are covered by these aeolian or alluvial sands.

The dolerite dykes that were emplaced during the Jurassic period and are associated with the massive basalt outpouring of the Drakensberg Mountains. The dykes do not preserve fossils because they are igneous in origin and, furthermore, tend to destroy fossils in their immediate vicinity. They will not be considered further.

Unconformably overlying the Karoo rocks are sands of the Kalahari Group (Quaternary) and in this region are of two main lithologies, namely the red and grey aeolian sands (symbol Qs) and sand, calcrete, pandune and surface limestone (Qc), as seen in Figure 2 and Table 2);.

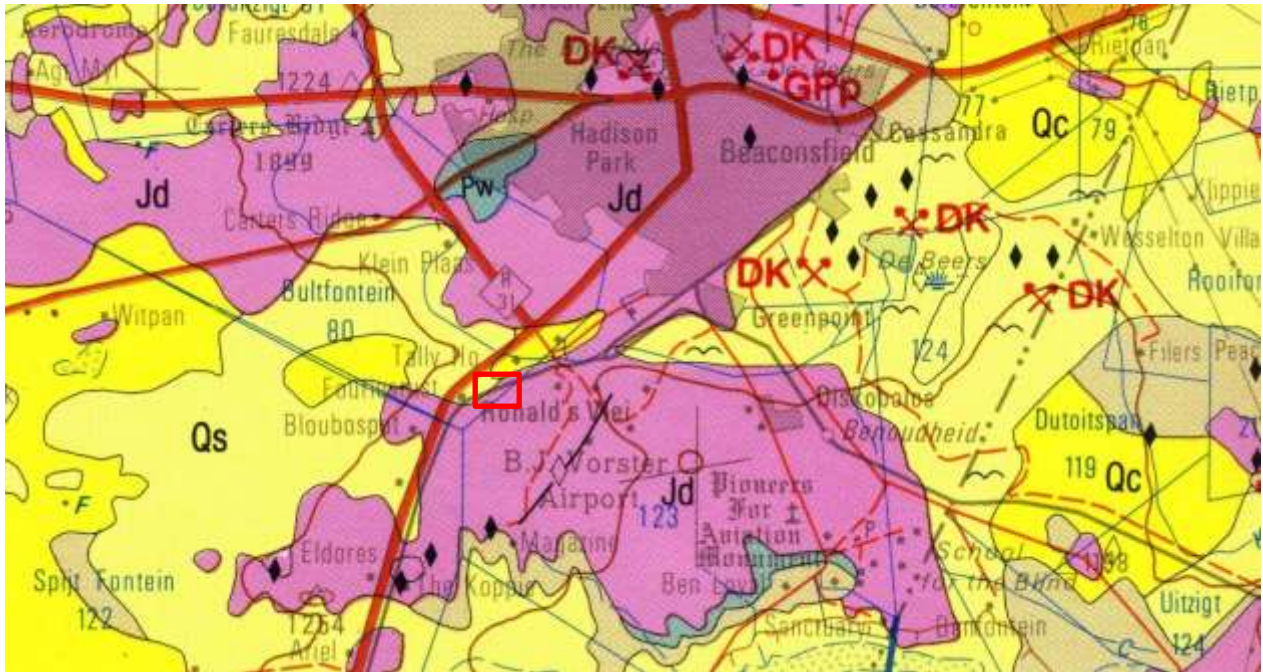


Figure 2: Geological map of the area around Kimberley. The location of the proposed project is indicated within the red rectangle. Abbreviations of the rock types are explained in Table 2. Map enlarged from the Geological Survey 1: 250 000 map 2824 Kimberley.

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

| Symbol | Group/Formation | Lithology | Approximate Age |
|--------|------------------------------------|---|--------------------------|
| Qs | Kalahari Group, Quaternary | Sand; red and grey aeolian sand, | Last 2.5 Ma |
| Qc | Kalahari Group, Quaternary | Sand, calcrete, calcified pandune and surface limestone | Last 2.5 Ma |
| Jd | Jurassic dykes | Dolerite dykes, intrusive | Jurassic, approx. 180 Ma |
| Pw | Whitehill Fm, Ecca Group, Karoo SG | White weathered carbonaceous shale | Early Permian |

ii. Palaeontological context

The palaeontological sensitivity of the area under consideration is presented in Figure 3. The site for development is in the Quaternary Kalahari sands and is indicated as moderately sensitive on the SAHRIS map (green; Figure 3). Most of the town of Kimberley lies on the dolerite of the Jurassic dykes and these are not likely to preserve any fossils (grey) as indicated in the palaeosensitivity map. The proposed sand mining site lies on the Quaternary Kalahari Group sands, and in particular on the aeolian sands and calcified pandune sands.

The Kalahari sands have been transported either by wind or water activity. Aeolian sands (wind transported) do not preserve fossils *in situ*, but water transported sands (alluvium) or pandune sands, may have entrained fossils from the immediate surroundings. Examples of such fossils are silicified wood and heavy bones (Figure 4-5).



Figure 3: SAHRIS palaeosensitivity map for the proposed sand mining on the farm Eureka 200 near Kimberley is 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 | Transported wood or bone fossils might occur in the Kalahari Group sands but the surface is highly disturbed. The impact would be very unlikely. |
| | 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 fossils of wood or bone, 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 sands, nonetheless a Fossil Chance Find Protocol should be added to the eventual EMPr. |

Based on the nature of the project, surface activities are unlikely to impact upon the fossil heritage because none has been reported from here, and no dunes or pandunes are evident from the Google Earth map. The geological structures suggest that the rocks/sands are the correct age to contain fossils but none has been reported from here. Since there is a very small chance that fossils may be preserved, 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 do contain fossil plant, insect, invertebrate and vertebrate material in the region. The dolerite does not preserve fossils. The aeolian sands do not preserve fossils but the calcified pandune deposits might preserve Quaternary aged fossils, for example silicified wood or bones. Sediments in this area are already very disturbed, naturally and by agriculture or urbanisation. It is not known what lies below the sands but only the sands will be mined.

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 aeolian sands. There is a small chance that fossils may occur in the sands that have been calcified or associated with pandune deposits, but this would only be discovered once excavations and mining have commenced. Since there is a very small chance that fossil wood or bones may occur in the Quaternary Kalahari Group sands, a Fossil Chance Find Protocol should be added to the EMPr: if fossils are found once excavations and mining 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: Prodrum of South African megafloras, Devonian to Lower Cretaceous. A.A. Balkema, Rotterdam. 423 pp.

Catuneanu, O., Hancox, P.J., Rubidge, B.S., 1998. Reciprocal flexural behaviour and contrasting stratigraphies: a new basin development model for the Karoo retroarc foreland system, South Africa. *Basin Research* 10, 417–439.

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 and mining 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, coal) should be put aside in a suitably protected place. This way the mining 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 Figures 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/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 the site inspections by the palaeontologist will not be necessary.
8. If no fossils are found and the excavations have finished then no further monitoring is required.

Appendix A – Examples of fossil plants and bones.



Figure 4: examples of silicified wood pieces from river gravels.



Figure 5: examples of fossil bones from a river setting.

Appendix B – Details of specialist

Curriculum vitae (short) - Marion Bamford PhD June 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-
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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 | 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 – 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
- 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

xi) Research Output

Publications by M K Bamford up to June 2019 peer-reviewed journals or scholarly books: over 130 articles published; 5 submitted/in press; 8 book chapters.

Scopus h index = 26; Google scholar h index = 30;

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)