Palaeontological Impact Assessment for the proposed upgrade of the R30 from Klerksdorp to Buffelsvallei, Section 8, North West Province

SANRAL NRA R.030-080/1ENV

Desktop Study (Phase 1)

For

Shasha Heritage Consultants

29 November 2024

Prof Marion Bamford
Palaeobotanist
P Bag 652, WITS 2050
Johannesburg, South Africa
Marion.bamford@wits.ac.za

Expertise of Specialist

The Palaeontologist Consultant: Prof Marion Bamford
Qualifications: PhD (Wits Univ, 1990); FRSSAf, mASSAf, PSSA
Experience: 35 years research and lecturing in Palaeontology
27 years PIA studies and over 350 projects completed

Declaration of Independence

This report has been compiled by Professor Marion Bamford, of the University of the Witwatersrand, sub-contracted by Shasha Heritage Consultants, South Africa. The views expressed in this report are entirely those of the author and no other interest was displayed during the decision making process for the Project.

Specialist: Prof Marion Bamford

Signature: *MKBamford*

Executive Summary

A Palaeontological Impact Assessment was requested for the proposed upgrade by SANRAL of the R30 section 8, from Klerksdorp to Buffelsvallei and associated borrow pits, North West 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 R30 route lies mostly on the non-fossiliferous Klipriviersberg Group volcanic rocks. Part of the route and the three southern borrow pits lie on low to moderately sensitive rocks. The eastern and two northern pits lie on non-fossiliferous rocks. There is a very small chance that trace fossils may occur in the Rietgat and Kameeldoorns Formation quartzites and stromatolitic limestones but they have not been recorded from this area. Nonetheless, 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 or drilling have commenced then they should be rescued and a palaeontologist called to assess and collect a representative sample. The impact on the palaeontological heritage would be low, as far as the palaeontology is concerned, so the project should be authorised.

ASPECT	SCREENING TOOL SENSITIVITY	VERIFIED SENSITIVITY	OUTCOME STATEMENT/ PLAN OF STUDY	RELEVANT SECTION MOTIVATING VERIFICATION
Palaeontology	Moderate to low	Low	Palaeontological Impact Assessment	Section 7.2. SAHRA Requirements

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1. Background

Background information
Earthlink Environmental Service has been appointed by ROMH CONSULTING, representing the Applicant, the South African National Roads Agency SOC Limited, to oversee the environmental management process and ensure compliance during the construction phase of the Improvement of National Road R30 Section 8, which extends from Klerksdorp (km 0.0) to Buffelsvallei (km 37.0). This initiative is located in the North West Province, within the district municipality of Dr Kenneth Kaunda. The anticipated duration for construction monitoring is approximately 30 months, beginning in June 2025.

Project locality
The project is situated on National Road R30, Section 8 from Klerksdorp (km 0.0) to Buffelsvallei (km 37.0) for 37km (Figures 1-2)

The proposed establishment of 6 borrow pits (1,2,3,5,10,11) project is located within Dr Kenneth Kaunda District Municipality in the North West Province.The proposed borrow pit's exact locations and required ecological footprint is as follows:

- Borrow Pit 1- 26°48'48"S; 26°34'13"E (4.99 ha)
- Borrow Pit 2- 26°47'45"S; 26°33'10"E (4.98 ha)
- Borrow pit 3- 26°47'51"S; 26°43'31"E (4.99 ha)
- Borrow pit 5- 26°43'18"S; 26°43'44"E (4.99 ha)
- Borrow Pit 10- 26°34'24"S; 26°37'47"E (4.98 ha)
- Borrow pit 11- 26°33'52"S; 26°37'34"E (4.96 ha)
-

Project description
The major aspects of this project include the following:

- ✓ Improving the existing 37km single carriageway road,
- ✓ Increasing the existing road reserve width from 30 m to a range of 40 m to 45 m, with a maximum of 50m where required,
- ✓ Strengthening the existing pavement,
- ✓ Improving the existing road cross-section to adhere to SANRAL standards, from an existing road formation width of 7.6m to 13.4m comprising of 3.7 m lanes and 3 m surfaced shoulders,
- ✓ Vertical and horizontal geometric improvements that follow the existing alignment, aiming to achieve a design speed of 120km/h,
- ✓ Widening and (or) replacement of 1 river bridge and some major and minor culverts. The route has 8 major culverts and 97 minor culverts.
- ✓ Improving two major intersections to adhere to SANRAL standards, located at km 19.2 and km 35.4,
- ✓ Possible treatment of up to 1m width over and above the required width of final travel way to accommodate two-way through traffic during construction,
- ✓ Possible temporary bypass roads during construction where drainage structures need to be upgraded,

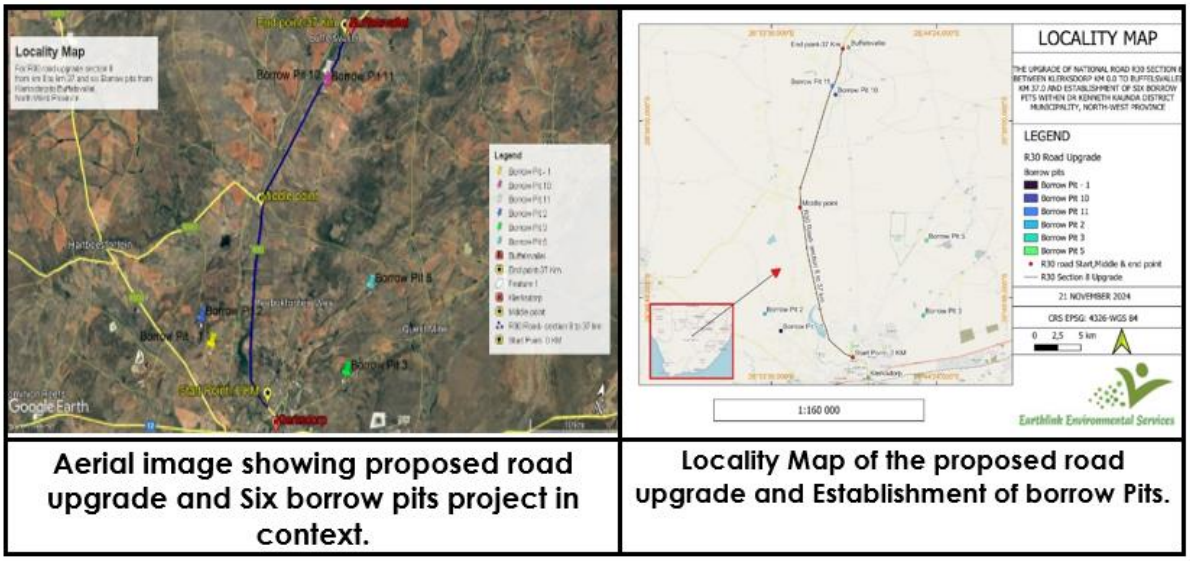
- ✓ Entry into eleven (11) potential borrow pits for sourcing G5 – G9 material during construction,
- ✓ A total of twelve (12) possible hard rock quarries within a 10 to 20 km radius from the route were identified.
- ✓ Stockpile areas and vegetation clearance outside road reserve in excess of 1 Hectare.

A Palaeontological Impact Assessment was requested for the proposed upgrade of Section 8 of the R30 project. To comply with the regulations of the South African Heritage Resources Agency (SAHRA) in terms of Section 38(8) of the National Heritage Resources Act, 1999 (Act No. 25 of 1999) (NHRA), a desktop Palaeontological Impact Assessment (PIA) was completed for the proposed development and is reported herein.

Table 1: National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA) and Environmental Impact Assessment (EIA) Regulations, 2014 (as amended) - Requirements for Specialist Reports (Appendix 6). Includes the requirements from GNR Appendix 6 of GN 326 EIA Regulation 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

	A specialist report prepared in terms of the Environmental Impact Regulations of 2017 must contain:	**Relevant section in report**
i	A description of any assumptions made and any uncertainties or gaps in knowledge;	Section 5
j	A description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives, on the environment	Section 4
k	Any mitigation measures for inclusion in the EMPr	Section 8, Appendix A
l	Any conditions for inclusion in the environmental authorisation	N/A
m	Any monitoring requirements for inclusion in the EMPr or environmental authorisation	Section 8, Appendix A
ni	A reasoned opinion as to whether the proposed activity or portions thereof should be authorised	Section 6
nii	If the opinion is that the proposed activity or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan	Sections 6, 8
o	A description of any consultation process that was undertaken during the course of carrying out the study	N/A
p	A summary and copies of any comments that were received during any consultation process	N/A
q	Any other information requested by the competent authority.	N/A
2	Where a government notice gazetted by the Minister provides for any protocol or minimum information requirement to be applied to a specialist report, the requirements as indicated in such notice will apply.	N/A



Aerial image showing proposed road upgrade and Six borrow pits project in context.

Locality Map of the proposed road upgrade and Establishment of borrow Pits.

Figure 1: Annotated maps of the R30 Section 8 road upgrade project

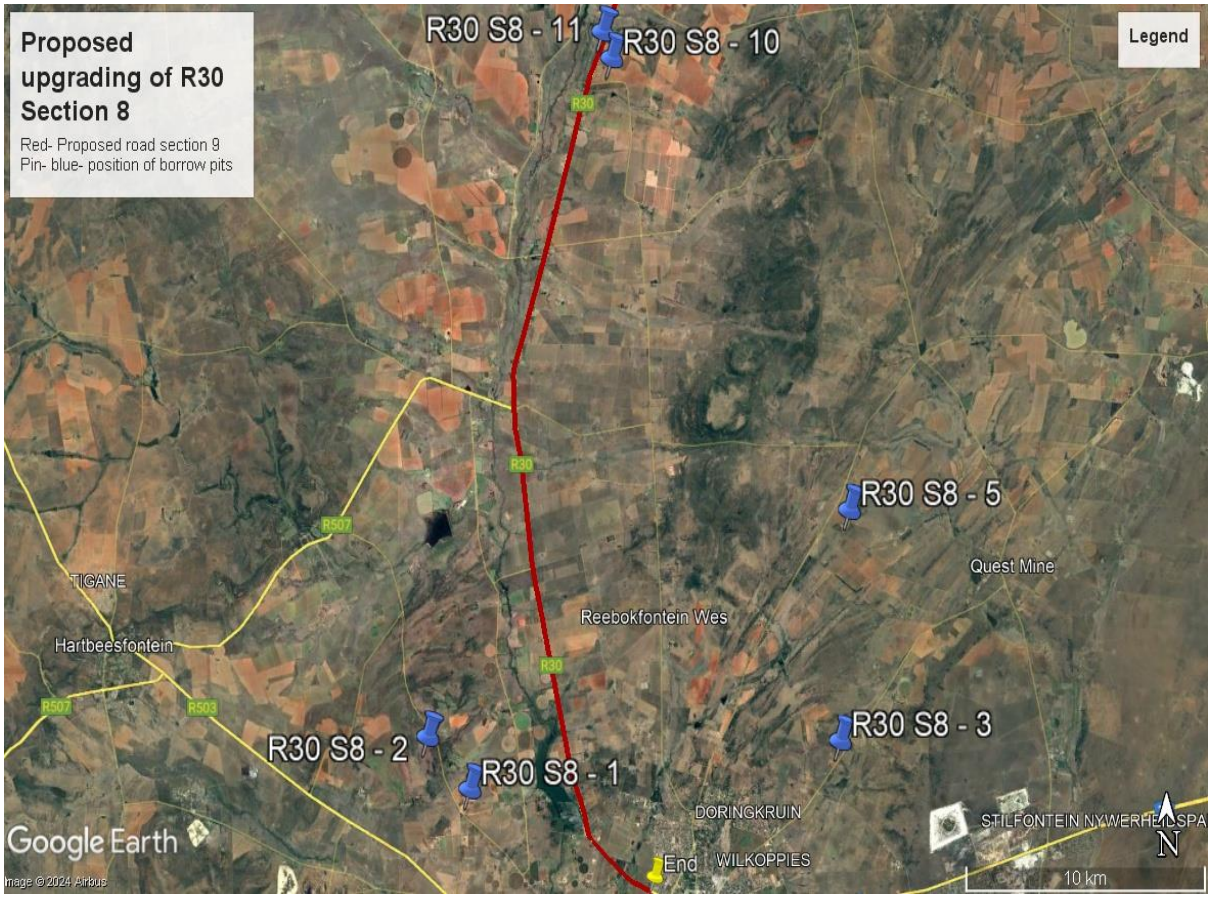


Figure 2: Google Earth map of the general area to show the relative land marks. The R30 from Klerksdorp (south) to Buffelsvallei (north) is the existing route. Borrow pits are indicated by blue pins.

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 include records housed at the Evolutionary Studies Institute at the University of the Witwatersrand and SAHRA databases; eg https://sahris.sahra.org.za/map/palaeo
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' representativity 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

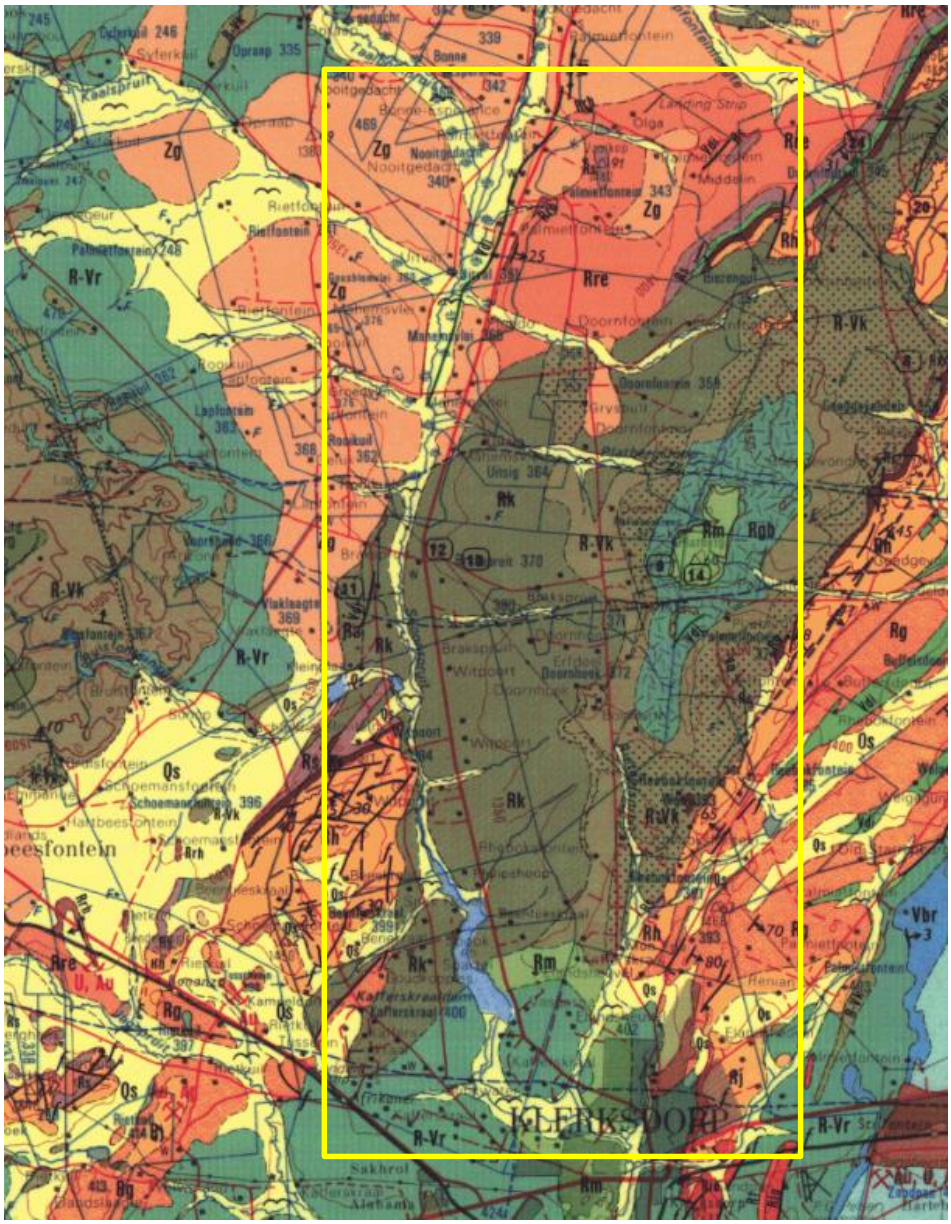


Figure 1: Geological map of the area around the R30 section 8 and borrow pits indicated within the yellow rectangle. Abbreviations of the rock types are explained in Table 2. Map enlarged from the Geological Survey 1: 250 000 map 2626 West Rand.

Table 2: Explanation of symbols for the geological map and approximate ages (Eriksson et al., 2006. Johnson et al., 2006; McCarthy et al., 2006; 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	Sands and alluvium	Quaternary Last 100ka
Vdi	Diabase	Intrusive volcanic dykes and sills	Post Transvaal SG

Symbol	Group/Formation	Lithology	Approximate Age
Va	Allanridge Fm, Pniel Group, Ventersdorp SG	Mafic lave, tuff, amygdaloidal	Neoarchean 2710-2680 Ma
Vb	Bothaville Fm, Pniel Group, Ventersdorp SG	Conglomerate, shale, quartzite	Neoarchean 2710-2680 Ma
R-Vr	Rietgat Fm, Platberg Group, Ventersdorp SG	Mafic lava, tuff, shales, siltstone, quartzite, greywacke, stromatolitic limestone	Neoarchean 2710-2680 Ma
Rm	Makwassie Fm, Platberg Group, Ventersdorp SG	Intermediate lava, porphyritic	Neoarchean Ca 2710 Ma
Rgb	Goedgenoeg Fm, Platberg Group, Ventersdorp SG	Intermediate lava, mafic lava	2754 – 2709 Ma
R-Vk	Kameeldoorns Fm, Platberg Group, Ventersdorp SG	Conglomerate, breccia, quartzite, greywacke, shale, siltstone	2754 – 2709 Ma
Rk	Klipriviersberg Group, Ventersdorp SG	Mafic lava, tuff, amygaloidal or porphyritic in places	2791 – 2779 Ma
Rg	Government Subgroup, West Rand Group, Witwatersrand SG	Quartzite, greywacke, conglomerate, shale, tillites, hornfels	Archaean Ca 2970-2714 Ma
Rh	Hospital Hill Subgroup, West Rand Group, Witwatersrand SG	Ferruginous shale, quartzite; banded ironstone	Archaean Ca 2970-2714 Ma
Zg	Basement granites	Granite, gneiss	Palaeoarchean >3500 Ma

The road route lies in the northwestern part of the Transvaal Basin where some of the strata of the Transvaal Supergroup are exposed. They overlie older volcanic rocks of the Ventersdorp Supergroup which in turn overlie even older rocks of the Witwatersrand Supergroup. Unconformably overlying these ancient rocks are the transported and reworked sands and alluvium that accumulated in river valleys and depressions during the Quaternary (Figure 3).

WITWATERSRAND SUPERGROUP

Since the discovery of gold on the farm Langlaagte on the Witwatersrand in 1886 there has been rapid exploration of what is now known as the largest deposit of gold in the world located in the central portion of the Kaapvaal Craton (McCarthy, 2006). The gold-bearing reefs (conglomerates) were mapped and claims staked out for the mining of this material. How the gold was accumulated is still debated but the layout and extent are known from drill core and geophysical mapping (Tucker et al., 2018). According to Tucker et al., (2018) the Witwatersrand Basin was formed in response to a series of crustal plate movements from the north and west in a foreland basin setting. This basin provided a shallow marine environment and was then filled with quartzite and shale, some with iron included.

The Witwatersrand Supergroup has been divided into the lower West Rand Group (WRG) and the upper, mostly arenaceous Central Rand Group (CRG) which has gold reefs at its base. Three models have been proposed for the accumulation of the gold, namely a placer

source, a hydrothermal source and a combination of the two called the modified placer theory, with combined source being the more popular theory currently. Prokaryotic bacteria or algae are assumed to have had role to play but there is no direct evidence of them. Subsequent to the deposition of this sequence, there were three major events that modified and metamorphosed the Witwatersrand group. Firstly, the was severe faulting and folding, especially along the western and northern sides of the Basin caused by lateral crustal plate movements. Secondly, the Vredefort meteorite impact resulted in metasomatic alteration because of the fluid movement within the deposit, and thirdly, and even more severe effect was the emplacement of the Bushveld Complex, which is the largest layered igneous intrusion of its kind on Earth. The heat generated by this intrusion probably exceeded that of the Vredefort impact and also resulted in fluidisation and mobility of the gold and other minerals. Since these rocks are ancient and have been altered, they are not considered to preserve any recognisable life forms.

In the Witwatersrand Supergroup the lower West Rand Group has been divided, from the base upwards, into the Hospital Hill Subgroup, the Government Subgroup and the Jeppestown Subgroup. The upper Central Rand Group comprises the Johannesburg Subgroup and the upper Turffontein Subgroup

VENTERSDORP SUPERGROUP

Unconformably overlying the Witwatersrand Supergroup rocks are the Ventersdorp Supergroup rocks that represent the largest and most widespread sequence of volcanic rocks on the Kaapvaal Craton and so provide a unique volcano-sedimentary supracrustal record. At the base of the Ventersdorp Supergroup is the predominantly volcanic Klipriviersberg Group that has been divided into five formations, from the base upwards the Alberton, Orkney, Jeanette, Lorraine and Edenville Formations. Next is the Platberg Group with a mixture of volcanic and sedimentary formations, the Kameeldoorns, Goedgenoeg, Makwassie and Rietgat Formations (Van der Westhuizen et al., 2006). The two overlying formations, the Bothaville Formation conglomerates and shales, and the Allanridge Formation volcanic rocks, have recently been grouped into the Pniel Group (Meintjies and van der Westhuizen, 2018).

On the margins of the Kameeldoorns Formation (Platberg Group) clasts and blocks from faulting and formation of horsts have been incorporated with the sediments, while in the central part and deeper parts of the grabens, lacustrine conditions were present and cherts and dolomites were deposited (van der Westhuizen et al., 2006). These two lithofacies are indicated in the geological map (Figure 3). The Goedgenoeg and Makwassie Formations are mostly lavas but the upper formation of the Platberg Group, the Rietgat Formation, has alternating volcanic and sedimentary rocks, the latter comprising tuffaceous sedimentary material and stromatolitic limestone (ibid).

TRANSVAAL SUPERGROUP

In the Transvaal Basin the Transvaal Supergroup is divided into two Groups, the lower Chuniespoort Group and the upper Pretoria Group. They are not present in the project footprint but occur to the southeast.

QUATERNARY

Younger ands and alluvium that have eroded from the older rocks have accumulated in some of the river valleys and depressions during the Quaternary period. These sediments are hard to date as they have been weathered, eroded and transported.

ii. Palaeontological context

The palaeontological sensitivity of the area under consideration is presented in Figure 4. The road route lies mostly on the non-fossiliferous Klipriviersberg Group.

The lavas and basalts are of igneous origin and do not preserve fossils. Fossils can be preserved in sedimentary rocks. At the time of the Ventersdorp Supergroup there were only micro-organisms such as algae and bacteria present. Algal colonies photosynthesised and used sunlight to convert the carbon dioxide and water to longer chain carbons, the building blocks of life forms. During this process oxygen was released into the atmosphere but was quickly taken up the raw minerals so they became oxidised. A common example is banded ironstone (iron deposits).

In the Palaeotechnical report for the North West Province (Groenewald et al., 2014), the Rietgat Formation is indicated as moderately sensitive based on the occurrence of stromatolites in borehole core, not surface finds. They only suggest that stromatolites could occur in the older Kameeldoorns Formation but the SAHRIS palaeosensitivity has also indicated that this formation is moderately sensitive.

According to Wilmeth et al. (2019), the most extensive outcrops of Ventersdorp lacustrine stromatolites occur in the Rietgat Formation within the Hartbeesfontein Basin which is about 150 km west of Johannesburg. This basin is an intracratonic half-graben with stromatolites that form laterally extensive facies ~100 km^2 in area, in beds up to 7m thick (Karpeta, 1989, 1993). Unlike many Ventersdorp or Fortescue locations, most Hartbeesfontein stromatolites are preserved entirely as chert, which has the potential to preserve microfossils and detailed microbial mat textures (Wilmeth et al., 2019). They interpret the palaeoenvironment as having abundant and diverse microbial life actively photosynthesising in multiple lacustrine locations before the Great Oxidation Event. These are their so-called “oxygen oases” in non-marine environments.

Stromatolites are the trace fossils that were formed by colonies of green algae and blue-green algae (Cyanobacteria) that grew in warm, shallow marine settings. These algae were responsible for releasing oxygen via the photosynthetic process where atmospheric carbon dioxide and water, using energy from the sun, are converted into carbon chains and compounds that are the building blocks of all living organisms. The released carbon dioxide initially was taken up by the abundant reducing minerals to form oxides, e.g. iron oxide. Eventually free oxygen was released into the atmosphere and some was converted into ozone by the bombardment of cosmic rays. The ozone is critical for the filtering out of harmful ultraviolet rays.

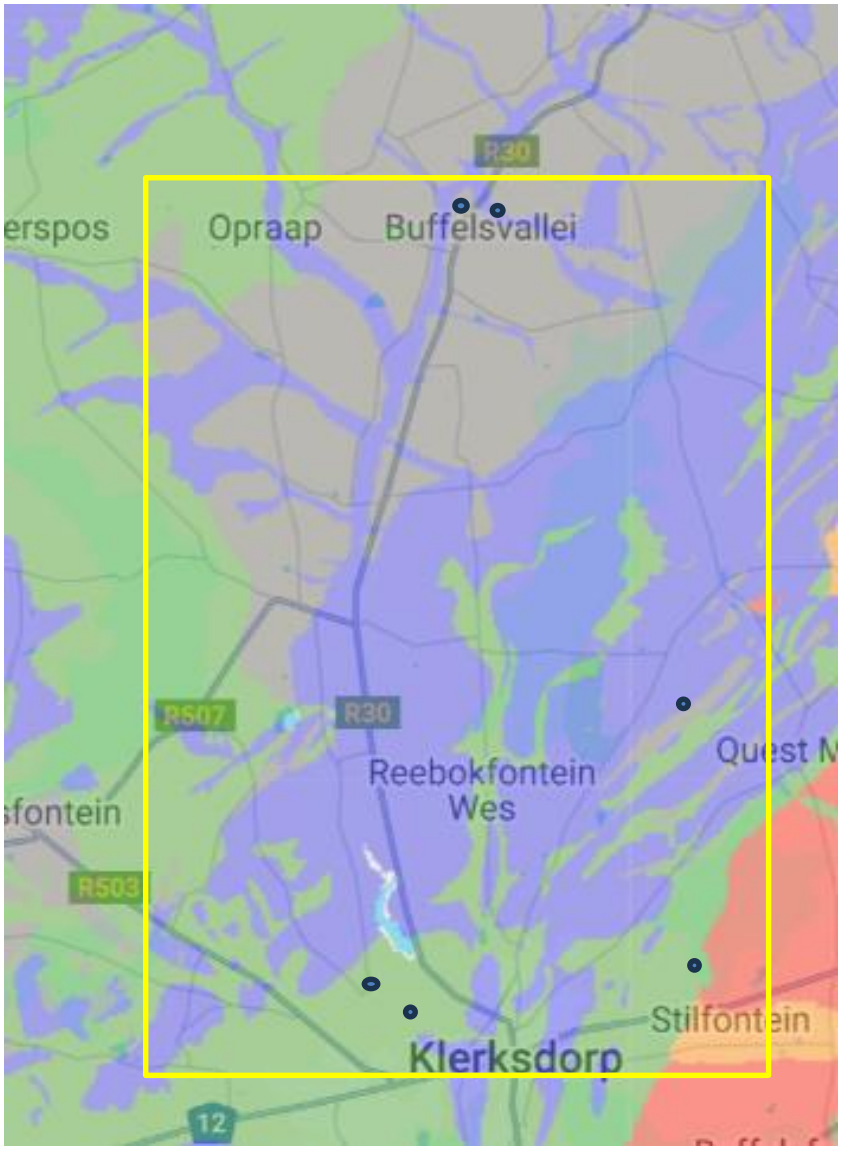


Figure 2: SAHRIS palaeosensitivity map for the site for the proposed R30 Section 8 road upgrade and associated borrow pits 1-5 in the south; 5 in the east and 10-11 in the north (dots) shown within the yellow rectangle. Background colours indicate the following degrees of sensitivity: red = very highly sensitive; orange/yellow = high; green = moderate; blue = low; grey = insignificant/zero.

Stromatolites are the layers upon layers of inorganic materials that were deposited during photosynthesis, namely calcium carbonate, magnesium carbonate, calcium sulphate and magnesium sulphate. These layers can be in the form of flat layers, domes or columns depending on the environment where they grew (Beukes, 1987). Some environments did not form stromatolites, just layers of limestone that later was converted to dolomite. The algae that formed the stromatolites are very rarely preserved, and they are microscopic so they can only be seen from thin sections studies under a petrographic microscope.

Microbialites (sensu Burne and Moore, 1987) are organo-sedimentary deposits formed from interaction between benthic microbial communities (BMCs) and detrital or chemical sediments. In addition, microbialites contrast with other biological sediments

in that they are generally not composed of skeletal remains. Archean carbonates mostly consist of stromatolites. These platforms could have been the site of early O2 production on our planet. Stromatolites are the laminated, organo-sedimentary, non-skeletal products of microbial communities, which may have included cyanobacteria, the first photosynthetic organisms to produce oxygen. Another type of trace fossil has been termed Microbially-induced sedimentary structures (MISS sensu Noffke et al., 2001) or simply 'fossil mats' (sensu Tice et al., 2011). These include swirls, rip-ups, crinkled surfaces and wrinkles that were formed by the mucus extruded by littoral algae or microbes and bound together sand particles. Davies et al. (2016) caution against the assumption that all such structures are microbially induced unless there is additional evidence for microbes in the palaeoenvironment

Nonetheless, stromatolites and microbialites are accepted as trace fossils of algal colonies. Microbialites (also called microbialally induced sedimentary structures – MISS) could be microbially or abiotically formed. The oldest stromatolites have been recorded from the Barberton Supergroup that was deposited between 3.55 to ca. 3.20 Ga, and stromatolites still form today in warm, shallow seas (Homan, 2019).

From the SAHRIS map for the R30 section 8 (Figure 5) part of the area is indicated as moderately sensitive (green) for the Rietgat and Kameeldoorns Formations, of low sensitivity (blue) for the Goedenoeg Formation and Witwatersrand Supergroup, and of insignificant to zero for the basement granites. The proposed borrow pits are on the same suite of rocks with southern pits 1-3 on moderately sensitive Rietgat Formation (that should show as low sensitivity. Borrow pit 5 is on non-fossiliferous diabase and the northern pits, 10-11, are on non-fossiliferous ancient granites.

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	Sands and volcanic rocks do not preserve fossils; so far there are no records from the Rietgat or Kameeldoorns Fm of traces, plant or animal fossils in this region so it is very unlikely that fossils occur on the site. The impact would be negligible
	L+	-
	M+	-
	H+	-
DURATION	**L**	-
	M	-
	H	Where manifest, the impact will be permanent.
SPATIAL SCALE	**L**	Since the only possible fossils within the area would be trace fossils in the sandstones, the spatial scale will be localised within the site boundary.
	M	-
	H	-
PROBABILITY	**H**	**-**
	M	**-**
	L	It is extremely unlikely that any fossils would be found in the loose soils and sands that cover the area or in the volcanic rocks of the Ventersdorp SG that will be excavated for stone.. 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 the wrong kind (volcanic) and/or much too old to contain body fossils. Furthermore, the material to be excavated in the borrow pits for stone is volcanic and this does not preserve fossils. Since there is an extremely small chance that trace fossils from the Rietgat or Kameeldoorns Formations 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 granites, basalts, dolomites, sandstones, shales and sands are typical for the country and most do not contain fossil plant, insect, invertebrate and vertebrate material. The sands of the Quaternary period would not preserve fossils. The Rietgat and Kameeldoorns Formation quartzites and stromatolitic limestones might contain trace fossils but they have not been recorded from this area.

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 overlying soils of the Quaternary. There is a very small chance that trace fossils may occur in the Rietgat and Kameeldoorns Formation quartzites and stromatolitic limestones but they have not been recorded from this area. Nonetheless, 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 or drilling have commenced then they should be rescued and a palaeontologist called to assess and collect a representative sample. The impact on the palaeontological heritage would be low, as far as the palaeontology is concerned, so the project should be authorised.

ASPECT	SCREENING TOOL SENSITIVITY	VERIFIED SENSITIVITY	OUTCOME STATEMENT/ PLAN OF STUDY	RELEVANT SECTION MOTIVATING VERIFICATION
Palaeontology	Moderate to Low	Low	Palaeontological Impact Assessment	Section 7.2. SAHRA Requirements

7. References

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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/mining commence.
2. When excavations begin the rocks and discard must be given a cursory inspection by the environmental officer or designated person. Any fossiliferous material (plants, insects, bone or 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 trace fossils, fossil plants, vertebrates, invertebrates or trace fossils in the shales and mudstones (for example see Figures5-6). 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.

9. Appendix A – Examples of fossils from the Ventersdorp and Transvaal Supergroups.

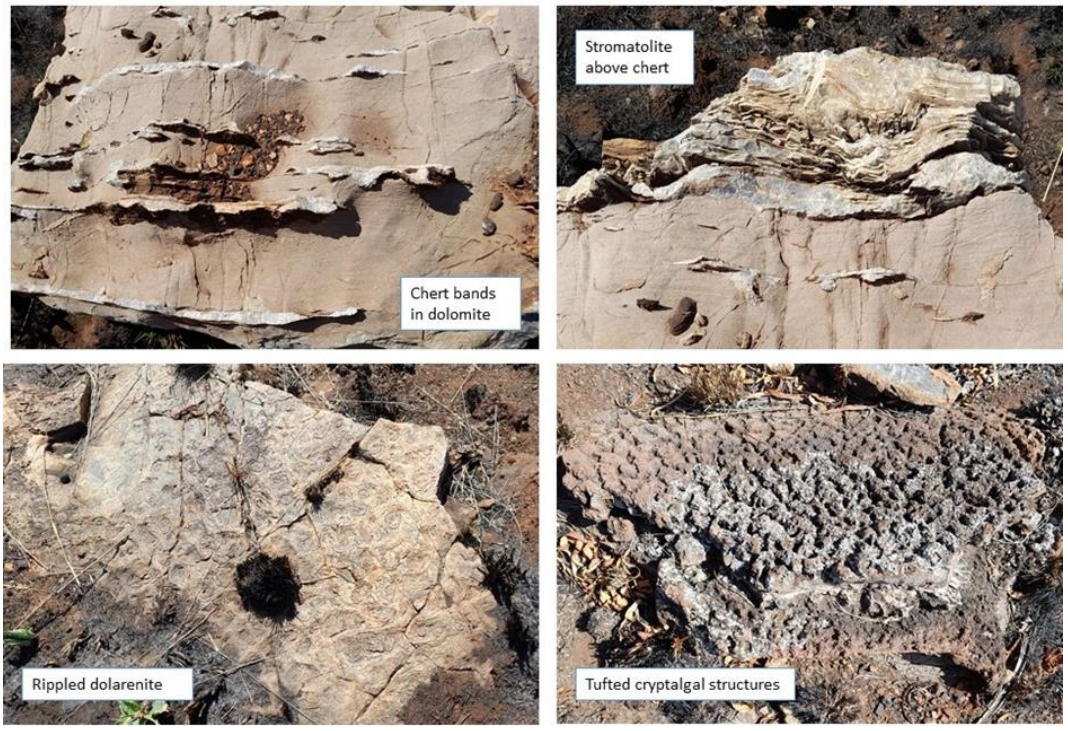

Figure 5: Photographs of different types of dolomite and stromatolites from the Malmani Subgroup, to assist in identifying potential fossils.

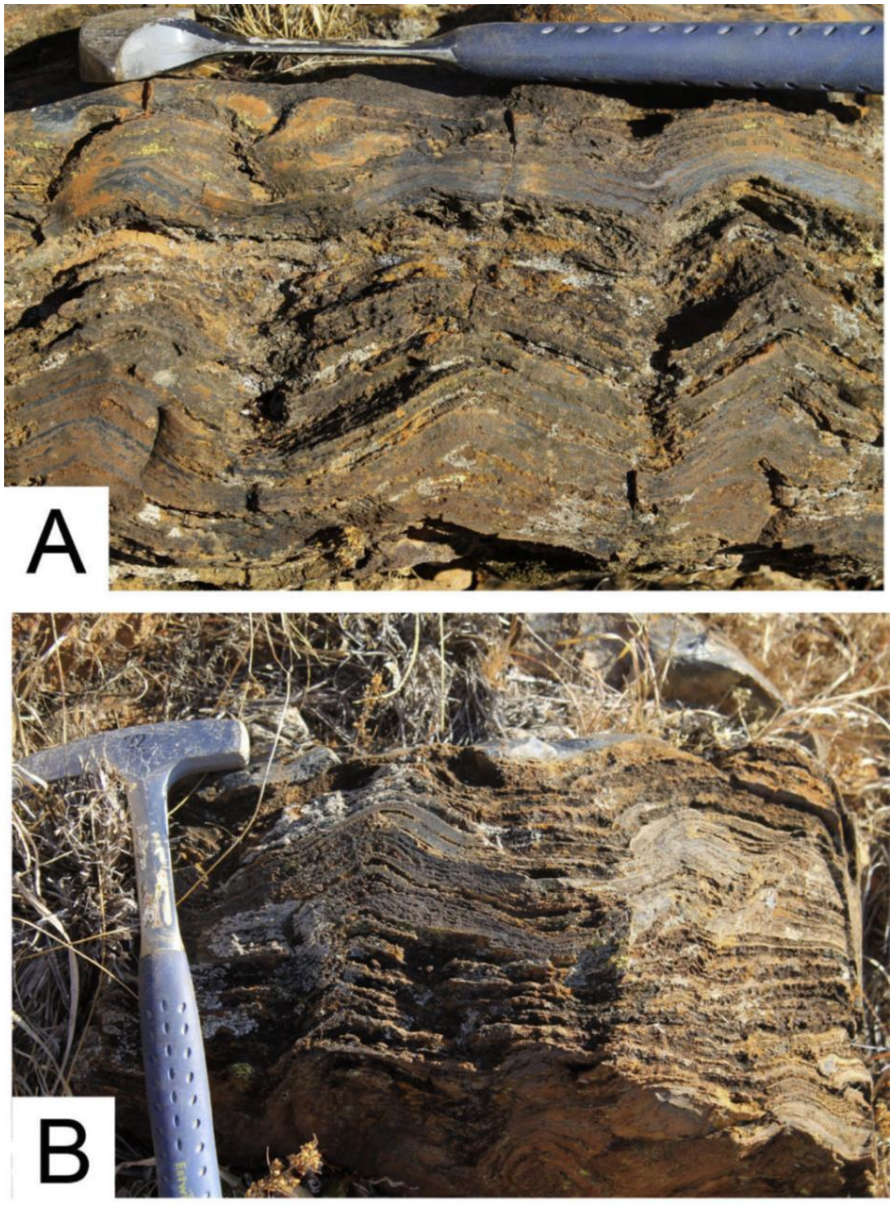

Figure 6: Rietgat Formation - Wilmeth et al., 2019, page 294. ***Fig. 4. Dolomitic stromatolites. Hammer is 30 cm for scale. A: Stromatolites at 18m in section BR. Note the transition between conical and domal forms up successive stromatolite laminae. B: Stromatolites at 20m in section BR.***

10. Appendix B – Details of specialist

Curriculum vitae (short) - Marion Bamford PhD July 2024

Present employment: Professor; Director of the Evolutionary Studies Institute. Member Management Committee of the NRF/DSI Centre of Excellence Palaeosciences, University of the Witwatersrand, Johannesburg, South Africa

Telephone : +27 11 717 6690
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

v) **Supervision of Higher Degrees**

All at Wits University

Degree	Graduated/completed	Current
Honours	13	0
Masters	13	3
PhD	13	7
Postdoctoral fellows	14	4

vi) **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 12 - 20 students per year.

vii) **Editing and reviewing**
Editor: Palaeontologia africana: 2003 to 2013; 2014 – Assistant editor
Guest Editor: Quaternary International: 2005 volume
Member of Board of Review: Review of Palaeobotany and Palynology: 2010 –
Associate Editor: Cretaceous Research: 2018-2020
Associate Editor: Royal Society Open: 2021 -
Review of manuscripts for ISI-listed journals: 30 local and international journals

viii) **Palaeontological Impact Assessments**
27 years' experience in PIA site and desktop projects
Selected from recent projects only – list not complete:

- 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
- Glosam Mine 2022 for AHSA
- Wolf-Skilpad-Grassridge OHPL 2022 for Zutari
- Iziduli and Msenge WEFs 2022 for CTS Heritage
- Hendrina North and South WEFs & SEFs 2022 for Cabanga
- Dealesville-Springhaas SEFs 2022 for GIBB Environmental
- Vhuvhili and Mukondeleli SEFs 2022 for CSIR
- Chemwes & Stilfontein SEFs 2022 for CTS Heritage
- Equestria Exts housing 2022 for Beyond Heritage
- Zeerust Salene boreholes 2022 for Prescali
- Tsakane Sewer upgrade 2022 for Tsimba
- Transnet MPP inland and coastal 2022 for ENVASS
- Ruighoek PRA 2022 for SLR Consulting (Africa)
- Namli MRA Steinkopf 2022 for Beyond Heritage
- Adara 2 SEF 2023 for CTS Heritage
- Buffalo & Lyra SEFs 2023 for Nextec
- Camel Thorn Group Prospecting Rights 2023 for AHSA
- Dalmanutha SEFs 2023 for Beyond Heritage
- Elandsfontein Residential 2023 for Beyond Heritage
- Waterkloof Samancor 2023 for Elemental Sustainability
- Zonnebloem WTP 2023 for WSP
- Elders Irrigation 2023 for SRK
- Leghoya WEFS 2023 for Red Cap & SLR

ix) **Research Output**
Publications by M K Bamford up to July 2024 peer-reviewed journals or scholarly books: over 185 articles published; 5 submitted/in press; 14 book chapters.
Scopus h-index = 33; Google Scholar h-index = 40; -i10-index = 130 based on 7992 citations.
Conferences: numerous presentations at local and international conferences.