Palaeontological Impact Assessment for the proposed Camden Collector Substation and Grid Connection, west of Camden, Mpumalanga Province

Site Visit Report (Phase 2)

For

Beyond Heritage

26 May 2022

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, ASSAf
Experience: 33 years research; 25 years PIA studies

Declaration of Independence

This report has been compiled by Professor Marion Bamford, of the University of the Witwatersrand, sub-contracted by Beyond Heritage, 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

Enertrag South Africa is proposing the development of the several Facilities as part of the larger Camden Renewable Energy Cluster project. Part of this project is the construction of an up to 400kV Collector Substation and Grid Connection infrastructure, to facilitate connection to the national grid via Camden Power Station. This facility will be on Camden Power Station 329 IT (Portion 0), Welgelegen 322 IT (Portions 1 and 2), Uitkomst 292 IT (Portion 2 and 12), and Mooiplaats 290 IT (Portion 14 and 20), to the west of Camden, Mpumalanga Province.

WSP has been appointed as the independent Environmental Assessment Practitioner (EAP) to undertake the requisite Environmental Impact Assessment (EIA) process for the Project. Beyond Heritage was appointed to assess the potential impact to heritage resources by the Project and Marion Bamford was sub-contracted to do the palaeontological impact assessment. This report is for the site visit assessment.

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 site visit (Phase 2) Palaeontological Impact Assessment (PIA) was completed for the proposed development.

The proposed Collector Substation and grid connection routes predominantly lie on the potentially fossiliferous Vryheid Formation (Ecca Group, Karoo Supergroup) that could preserve fossil plants of the Vryheid Formation. A short section of the route lies on the non-fossiliferous Jurassic dolerite. The site visit and walk through confirmed that there were NO Fossils present on the land surface. It is not known what lies below the ground surface, 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 contractor, developer, environmental officer or other designated responsible person once excavations for foundations and infrastructure have commenced. Since the impact will be low, as far as the palaeontology is concerned, the project should be authorised.

The Alternative 1 site for the Collector Substation is on the Vryheid Formation, but no fossils were found. The Alternative 2 site is on dolerite so no fossils would be expected to occur above or below ground, so this would be the preferred site a far as the palaeontology is concerned. The grid routes, however, are on both fossiliferous and non-fossiliferous land but no fossils were found. All alternatives are however considered feasible from a Palaeontological perspective.

The impact pre-mitigation is low, and post mitigation is very low positive.

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1. Background

The proposed Camden up to 400kV Collector substation and Grid Connection and is part of the larger Camden Renewable Energy Cluster project and is planned on Camden Power Station 329 IT (Portion 0), Welgelegen 322 IT (Portions 1 and 2), Uitkomst 292 IT (Portion 2 and 12), and Mooiplaats 290 IT (Portion 14 and 20), to the west of Camden, Mpumalanga Province (Figures 1-3).

The proposed Camden Renewable Energy Cluster of projects is being developed in the context of the Department of Mineral Resources and Energy's (DMRE) Integrated Resource Plan, and the Renewable Energy Independent Power Producer Procurement Programme (REIPPP), with further potential for private off-take by nearby mining and industrial operations.

The Cluster comprises eight (8) distinct projects, namely:

i. Camden I Wind Energy Facility (up to 200MW).
ii. Camden I Wind Grid Connection (up to 132kV).
iii. **Camden up to 400kV Grid Connection and Collector substation**.
iv. Camden I Solar up to 100MW.
v. Camden I Solar up to 132kV Grid Connection.
vi. Camden Green Hydrogen and Ammonia Facility, including grid connection infrastructure.
vii. Camden II Wind Energy Facility (up to 200MW).
viii. Camden II Wind Energy Facility up to 132kV Grid Connection.

<u>This report is the palaeontological impact for the Camden up to 400kV Grid Connection and Collector substation.</u>

Enertrag South Africa is a subsidiary of the German-based Enertrag AG, a hydrogen and renewable energy developer founded in 1992. Enertrag South Africa (hereafter "ENERTRAG SA") was established in 2017, with the intention to investigate and develop renewable energy projects in South Africa. The transition from coal-based energy supply to renewables in the Country is inevitable, as coal resources are becoming depleted, coal-based power stations reach the end of their economic life and considering international obligations and commitments to reduced emissions. This Complex serves as the first step to this transition.

The Camden up to 400kV Grid Connection and Collector substation is in the Msukaligwa Local Municipality of the Gert Sibande District Municipality, will be on the land parcels as listed above.

It is proposed that the broader Camden developments will connect to the nearby Camden Power Station substation (Camden substation and Uitkoms substation) through an up to 400kV powerline (either single or double circuit) either directly (alternate option), or via a Loop-In-Loop-Out (LILO) option into the existing Eskom Camden I – Incandu 400kV line traversing the Camden I project site (preferred option). Where direct connection is envisaged, the powerline will be approximately 8km in length.

Depending on location, the LILO into the Camden I – Incandu 400kV line will require a 400kV line of approximately 2km in length.

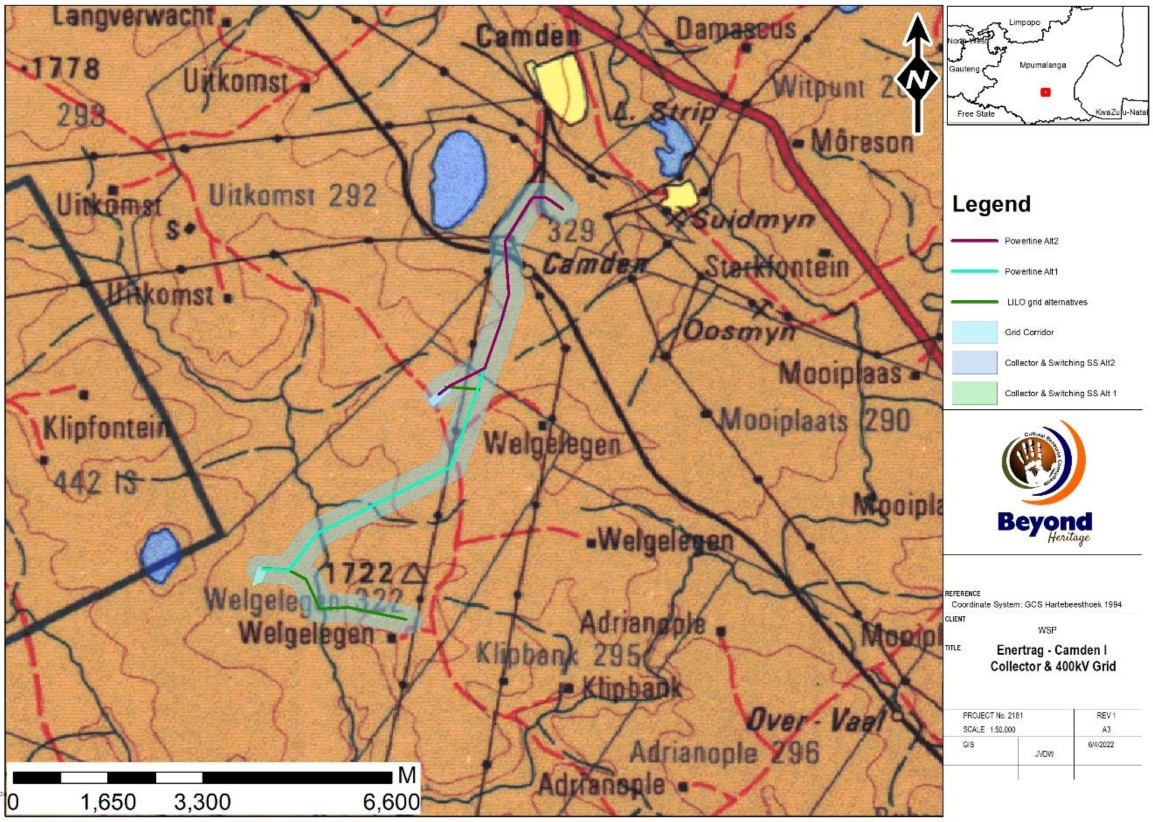

Figure 1: Regional Map of the proposed Eskom Collector Substation and grid connections. Alternative 1 (pink) and Alternative 2 (light blue). LILO (green).

The onsite Collector Substation (MTS) (two alternatives being provided for the purposes of assessment) will consist of a high voltage substation yard to allow for multiple (up to) 400kV feeder bays and transformers, control building, telecommunication infrastructure, access roads, etc. This substation will comprise the high-voltage components of the export solution for the broader Camden Cluster development and will comprise 132kV Collector substation components, which collect all the incoming 132kV power lines from the respective facilities, as well as the 400kV step-up infrastructure required for connection to the Camden Power Station. In addition, the expansion of the Camden Power Station substation as required forms part of this application.

The area for the onsite Collector Substation (MTS) will be up to 5ha and up to 1ha for the Camden Power Station substation expansion (if and as required). **The up to 400kV powerline and substation will have a 250m assessment corridor to allow for micro-siting (included in the assessment of this report).**

Two alternative new powerline routes are being investigated for direct connection into the Camden Power Station. In addition, two alternate routes are envisaged from the respective on-site Collector Substation for the Loop-In-Loop-Out option connection. Each of these will have a 250m assessment corridor to allow for micro-siting.

Portions of the following farms are affected:

Camden Power Station 329 IT (Portion 0)
Welgelegen 322 IT (Portions 1 and 2)
Uitkomst 292 IT (Portion 2 and 12)
Mooiplaats 290 IT (Portion 14 and 20)

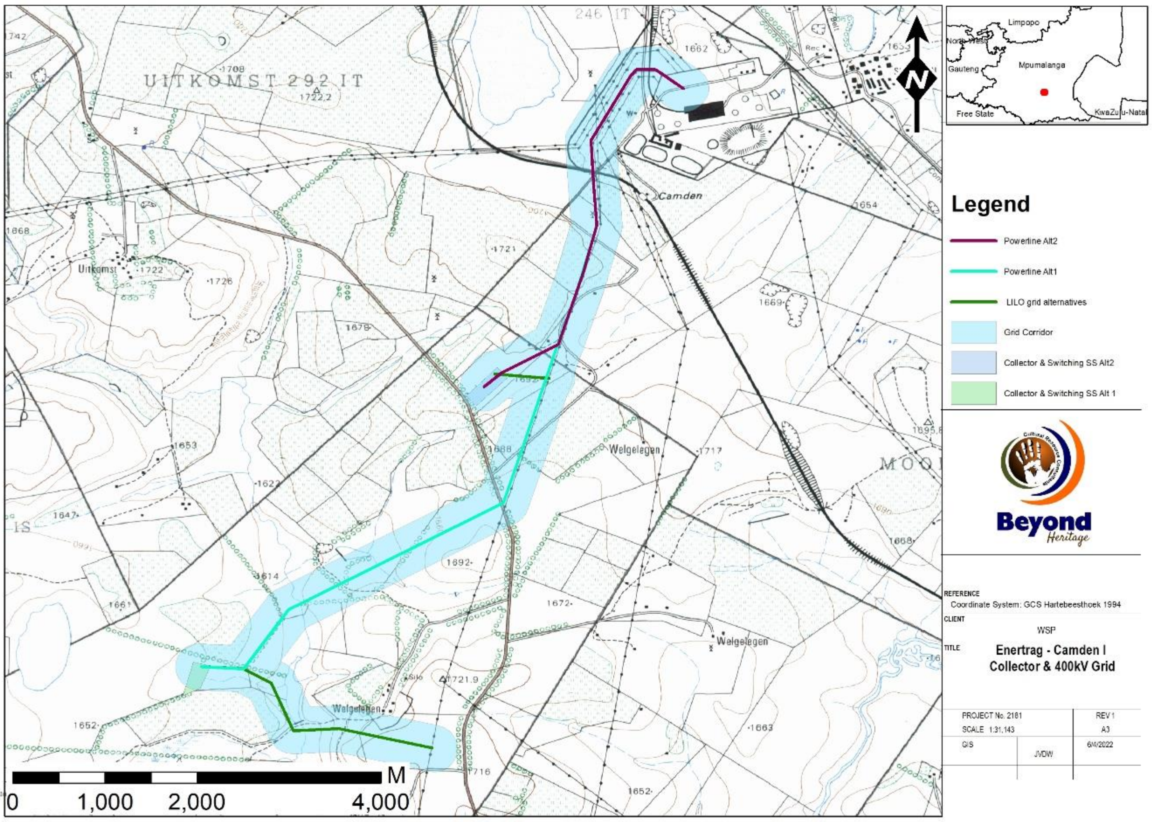

Figure 2: Locality map of the proposed Camden up to 400kV powerline and Collector Substation.

A Palaeontological Impact Assessment was requested for the proposed Camden up to 400kV powerline and Collector Substation. 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 site visit and walkthrough (Phase 2) Palaeontological Impact Assessment (PIA) was completed for the proposed development and is reported herein.

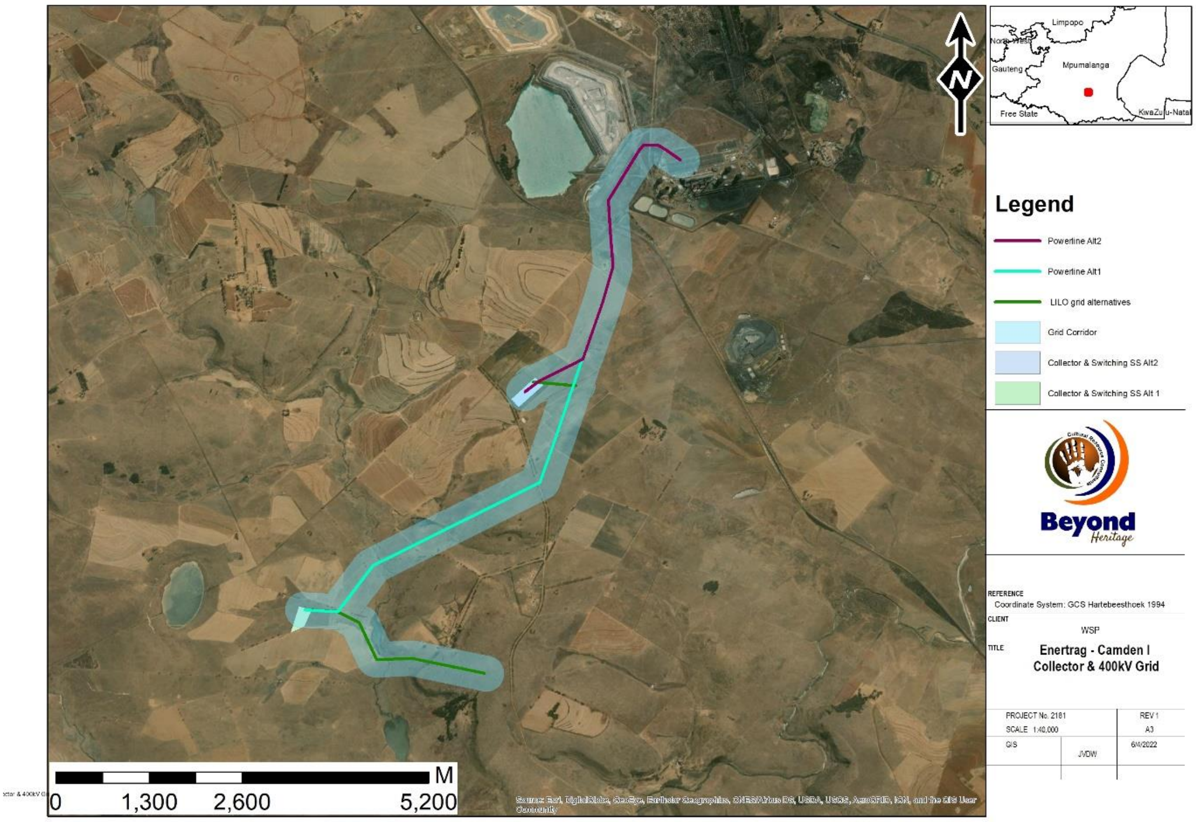

Figure 3: Aerial map of the proposed Camden up to 400kV powerline and Collector Substation.

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 2
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

	A specialist report prepared in terms of the Environmental Impact Regulations of 2017 must contain:	Relevant section in report
d	The date and season of the site investigation and the relevance of the season to the outcome of the assessment	April 2022; summer
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 0
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 if any comments that were received during any consultation process	N/A
q	Any other information requested by the competent authority.	N/A

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, as is the case here;
3. Where appropriate, collection of unique or rare fossils with the necessary permits for storage and curation at an appropriate facility (*not applicable to this assessment*); and
4. Determination of fossils' representivity or scientific importance to decide if the fossils can be destroyed or a representative sample collected (*not applicable to this assessment*).

3. Geology and Palaeontology

i. Project location and geological context

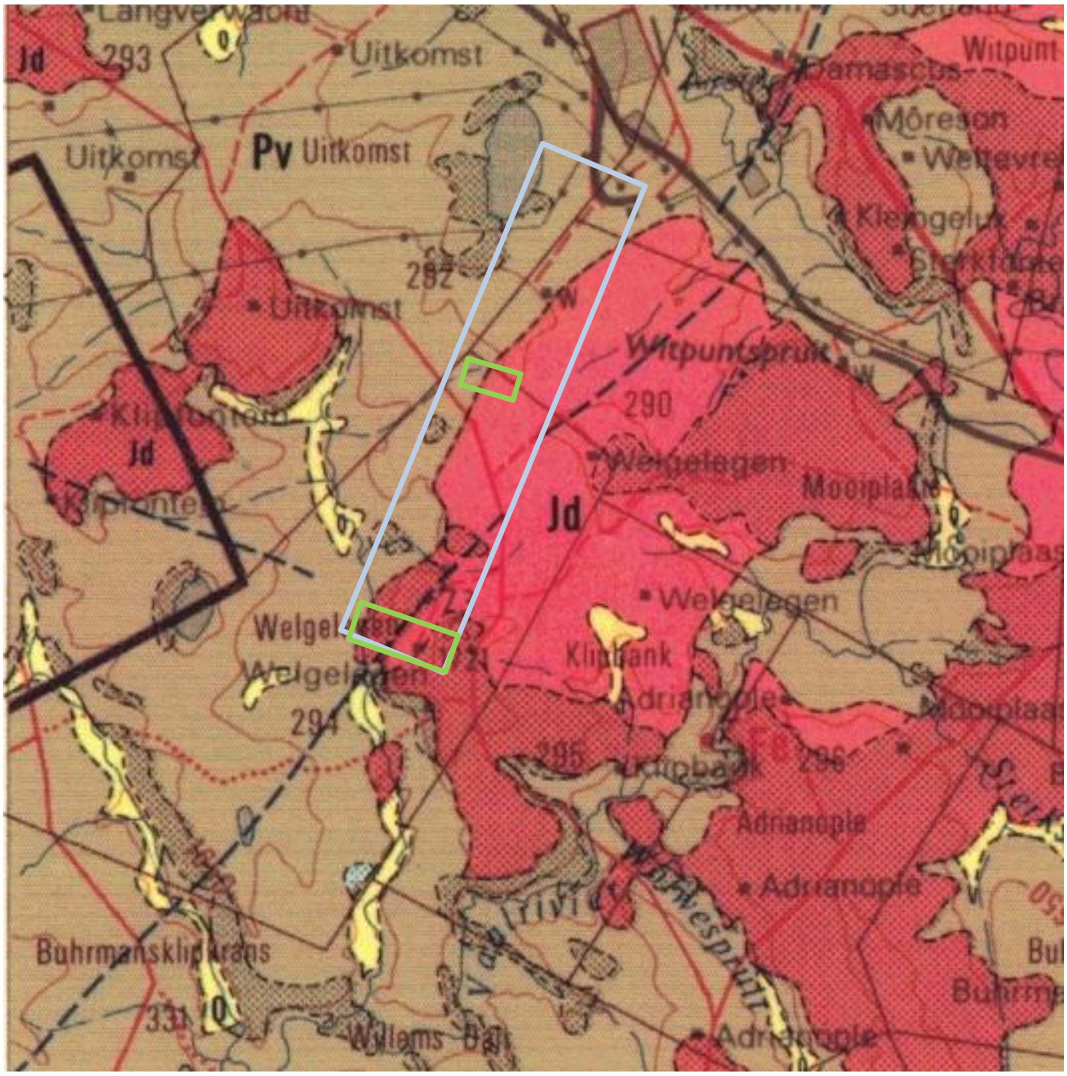

Figure 4: Geological map of the area around the approximate Camden up to 400kV powerline and Collector Substation site shown by the lilac outline. LiLo are within the

green blocks. Abbreviations of the rock types are explained in Table 2. Map enlarged from the Geological Survey 1: 250 000 map 2630 Mbabane.

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
Q	Quaternary	Alluvium, sand, calcrete	Neogene, ca 2.5 Ma to present
Jd	Jurassic dykes	Dolerite dykes, intrusive	Jurassic, approx. 180 Ma
Pv	Vryheid Fm, Ecca Group, Karoo SG	Shales, siltstone, sandstone, coal seams	Early Permian

The proposed routes lie in the northern part of the Karoo basin where the older Karoo Supergroup strata are exposed. Along the rivers and streams much younger reworked sands and alluvium overly the older strata. Extrusive dolerite of Jurassic age is abundant (Figure 4).

The Karoo Supergroup rocks cover a very large proportion of South Africa and extend from the northeast (east of Pretoria) to the southwest and across to almost the KwaZulu Natal south coast. It is bounded along the southern margin by the Cape Fold Belt and along the northern margin by the much older Transvaal Supergroup rocks. Representing some 120 million years (300 – 183Ma), the Karoo Supergroup rocks have preserved a diversity of fossil plants, insects, vertebrates and invertebrates.

During the Carboniferous Period South Africa was part of the huge continental landmass known as Gondwanaland and it was positioned over the South Pole. As a result, there were several ice sheets that formed and melted, and covered most of South Africa. Gradual melting of the ice as the continental mass moved northwards and the earth warmed, formed fine-grained sediments in the large inland sea. These are the oldest rocks in the system and are exposed around the outer part of the ancient Karoo Basin, and are known as the Dwyka Group (Johnson et al., 2006).

Overlying the Dwyka Group rocks are rocks of the Ecca Group that are Early Permian in age. There are eleven formations recognised in this group but they do not all extend throughout the Karoo Basin. In the Free State, Mpumalanga and KwaZulu Natal, from the base upwards are the Pietermaritzburg Formation, **Vryheid Formation** and the Volksrust Formation. All of these sediments have varying proportions of sandstones, mudstones, shales and siltstones and represent shallow to deep water settings, deltas, rivers, streams and overbank depositional environments.

Overlying the Ecca Group are the rocks of the Beaufort Group that has been divided into the lower Adelaide Subgroup for the Upper Permian strata, and the Tarkastad Subgroup for the Early to Middle Triassic strata. As with the older Karoo sediments, the formations vary across the Karoo Basin.

Large exposures of Jurassic dolerite dykes occur throughout the area. These intruded through the Karoo sediments around 183 million years ago at about the same time as the Drakensberg basaltic eruption.

Along the rivers and streams much younger transported sediments have been deposited. They were sourced from older weathered strata upstream (Partridge et al., 2006).

ii. Palaeontological context

The palaeontological sensitivity of the area under consideration is presented in Figure 5. The site for development is in the Vryheid Formation (red; very highly sensitive) for Alternative 1, and the non-fossiliferous Jurassic dolerite (grey) for Alternative 2; but the power line grid connection routes are on both strata. The Jurassic dolerite is an intrusive igneous rock and do does not preserve fossils, in fact, dykes can destroy any fossils that were in the rocks through which they have intruded.

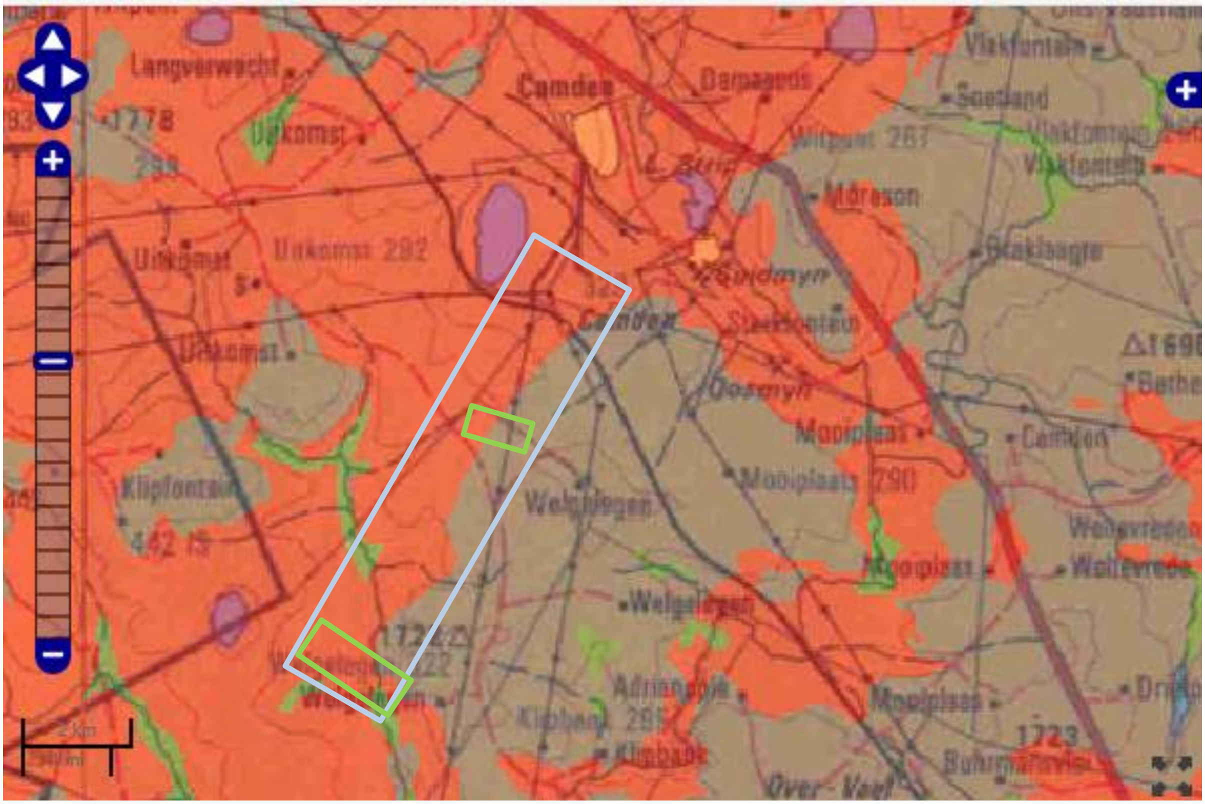

Figure 5: SAHRIS palaeosensitivity map for the site for the proposed Camden up to 400kV powerline and Collector Substation within the lilac rectangle. The two LiLo are within the green blocks. Background colours indicate the following degrees of sensitivity: red = very highly sensitive; orange/yellow = high; green = moderate; blue = low; grey = insignificant/zero.

The Vryheid Formation is potentially very rich in fossils of the *Glossopteris* flora. This flora includes Glossopteris leaves, seeds, roots, stems and reproductive structures, as well as other plants such as lycopods, sphenophytes, ferns, cordaitaleans and early gymnosperms (Plumstead, 1969; Anderson an Anderson, 1985; Bamford, 2004). Coal seams were formed from peats comprising these plants that were altered by heat and pressure to make coal. The coal itself, however, does not preserve any recognisable plant structure, but the shales associated with the seams can preserve recognisable impressions of the ancient plants (Plumstead, 1969).

iii. Site visit observations

The sites and routes were visited and walked through in April 2022. The agricultural land is either cultivated now, has recently been cultivated or is used for grazing. Nonetheless, it is disturbed and covered with soils and medium height grasses. There are no rocky outcrops of shale, just some dolerite outcrops (no fossils expected). No fossils were seen in the Vryheid Formation either (Figure 6).

Figure 6: Site visit photographs for the Collector substation site alternatives and grid connections. A – Land being grazed so grass is short but still no outcrops or fossils were seen. B – View across the landscape showing dolerite ridges. C – Previously cultivated land with no rocky outcrops and no fossils.

4. Impact assessment

The assessment of impacts and mitigation evaluates the likely extent and significance of the potential impacts on identified receptors and resources against defined assessment criteria, to develop and describe measures that will be taken to avoid, minimise or compensate for any adverse environmental impacts, to enhance positive impacts, and to report the significance of residual impacts that occur following mitigation.

The key objectives of the risk assessment methodology are to identify any additional potential environmental issues and associated impacts likely to arise from the proposed project, and to propose a significance ranking. Issues / aspects will be reviewed and ranked against a series of significance criteria to identify and record interactions between activities and aspects, and resources and receptors to provide a detailed discussion of impacts. The assessment considers direct[1], indirect[2], secondary[3] as well as cumulative[4] impacts.

A standard risk assessment methodology is used for the ranking of the identified environmental impacts pre-and post-mitigation (i.e. residual impact). The significance of environmental aspects is determined and ranked by considering the criteria[5] presented in **Table 4**.

Table 4: Impact Assessment Criteria and Scoring System

CRITERIA	SCORE 1	SCORE 2	SCORE 3	SCORE 4	SCORE 5
Impact Magnitude (M) The degree of alteration of the affected environmental receptor	Very low: No impact on processes	Low: Slight impact on processes	Medium: Processes continue but in a modified way	High: Processes temporarily cease	Very High: Permanent cessation of processes
Impact Extent (E) The geographical extent of the impact on a given environmental receptor	Site: Site only	Local: Inside activity area	Regional: Outside activity area	National: National scope or level	International: Across borders or boundaries
Impact Reversibility (R) The ability of the environmental receptor to rehabilitate or restore after the activity has caused environmental change	Reversible: Recovery without rehabilitation		Recoverable: Recovery with rehabilitation		Irreversible: Not possible despite action
Impact Duration (D) The length of permanence of the impact on the environmental receptor	Immediate: On impact	Short term: 0-5 years	Medium term: 5-15 years	Long term: Project life	Permanent: Indefinite
Probability of Occurrence (P) The likelihood of an impact occurring in the absence of pertinent environmental management measures or mitigation	Improbable	Low Probability	Probable	Highly Probability	Definite

[1] Impacts that arise directly from activities that form an integral part of the Project.
[2] Impacts that arise indirectly from activities not explicitly forming part of the Project.
[3] Secondary or induced impacts caused by a change in the Project environment.
[4] Impacts are those impacts arising from the combination of multiple impacts from existing projects, the Project and/or future projects.
[5] The definitions given are for guidance only, and not all the definitions will apply to all the environmental receptors and resources being assessed. Impact significance was assessed with and without mitigation measures in place.

CRITERIA	SCORE 1	SCORE 2	SCORE 3	SCORE 4	SCORE 5
Significance (S) is determined by combining the above criteria in the following formula:	$[S = (E + D + R + M) \times P]$ $Significance = (Extent + Duration + Reversibility + Magnitude) \times Probability$				
IMPACT SIGNIFICANCE RATING					
Total Score	**4 to 15**	**16 to 30**	**31 to 60**	**61 to 80**	**81 to 100**
Environmental Significance Rating (Negative (-))	**Very low**	**Low**	**Moderate**	**High**	**Very High**
Environmental Significance Rating (Positive (+))	**Very low**	**Low**	**Moderate**	**High**	**Very High**

Impact Mitigation

If fossils occur in the footprint of any section of the project, the route for the grid connection and the substation site, they can be removed (details in Section 8, Fossil Chance Find Protocol), and the project can continue. If no fossils are found then no mitigation is required.

Once fossils have been removed there will be not further impact on the palaeontological heritage. Therefore the impact is only applicable to the construction phase. The operation and de-commissioning phases will NOT impact the palaeontology.

If fossils are recovered, removed and placed in a recognised institution such as a museum or university palaeontology collection this will be a positive impact because the fossils will be available for research. Otherwise they would have remained unknown to science.

Summary of the Palaeontological Impact of the proposed up to 400 kV Collector Substation grid connection.

Palaeontological Impact	M	E	R	D	P	S	Result
Pre-mitigation (loss of fossils)	2	1	3	4	2	20	Low
Post-mitigation (recovery of fossils)	1	1	3	1	6	6	Very low (+ve)

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. The site visit and walk through confirmed that there are no fossils present on the land surface. It is not known if there are any fossils below the land surface. The sands of the Quaternary period and the Jurassic dolerite would not preserve fossils.

6. Recommendation

Based on the fossil record, but confirmed by the site visit and walk through, there are NO FOSSILS of the *Glossopteris* flora even though fossils have been recorded from rocks of a similar age and type in South Africa. It is extremely unlikely that any fossils would be preserved in the overlying soils and sands of the Quaternary. There is a very small chance that fossils may occur below the ground surface in the shales of the Vryheid Formation (Ecca Group, Karoo Supergroup) so 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 drilling for foundations and amenities have commenced, then they should be rescued and a palaeontologist called to assess and collect a representative sample.

The Alternative 1 site for the Collector Substation is on the Vryheid Formation, but no fossils were found. The Alternative 2 site is on dolerite so no fossils would be expected to occur above or below ground, so this would be the preferred site a far as the palaeontology is concerned. Regardless of preference, both sites are considered feasible from a Palaeontological perspective. The grid routes, however, are on both fossiliferous and non-fossiliferous land but no fossils were found. There is no preference.

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.

Bamford, M.K. 2004. Diversity of the woody vegetation of Gondwanan southern Africa. Gondwana Research 7, 153-164.

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.

Partridge, T.C., Botha, G.A., Haddon, I.G., 2006. Cenozoic deposits of the interior. 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 585-604.

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 / 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 (trace fossils, fossils of plants, insects, bone or coalified material) 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 7). 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 Vryheid Formation

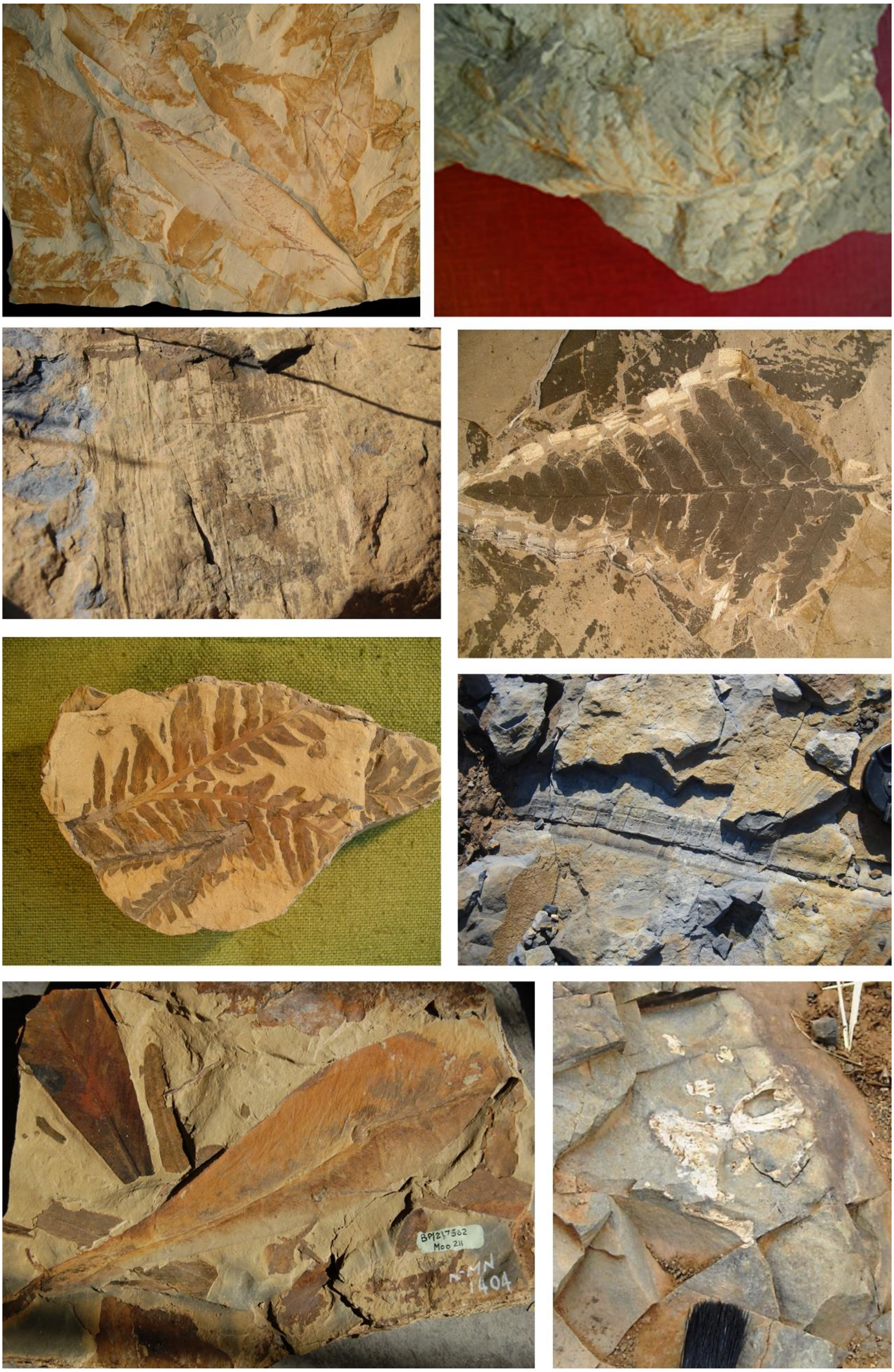

Figure 7: Photographs of fossil plants of the *Glossopteris* flora from the Vryheid Formation. Bottom right shows bones partially exposed, in the field.

10. Appendix B – Details of specialist

Marion Bamford (PhD)

Short CV for PIAs – Jan 2022

I) **Personal details**

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	14	1
PhD	11	6
Postdoctoral fellows	12	2

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 12 - 20 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 –
Associate Editor: Cretaceous Research: 2018-2020
Associate Editor: Royal Society Open: 2021 -
Review of manuscripts for ISI-listed journals: 25 local and international journals

x) **Palaeontological Impact Assessments**

Selected from recent project only – list not complete:

- 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
- Glosam Mine 2021 for AHSA

Xi) **Research Output**
Publications by M K Bamford up to January 2022 peer-reviewed journals or scholarly books: over 160 articles published; 5 submitted/in press; 10 book chapters.
Scopus h-index = 30; Google Scholar h-index = 36; -i10-index = 95
Conferences: numerous presentations at local and international conferences.