Palaeontological Impact Assessment for the proposed Hugo Wind Energy Facility with associated infrastructure, near Montagu, Western Cape Province

Desktop Study (Phase 1)

For

TerraMare Archaeology (Pty) Ltd

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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 TerraMare Archaeology (Pty) Ltd, Plumstead, 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 Hugo Wind Energy Facility (WEF) and associated infrastructure, northeast of Montagu, Western Cape Province. The facility is expected to produce up to 360MW of electricity from up to 42 wind turbines.

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

The proposed site lies on the very highly sensitive Devonian Ceres Subgroup (Bokkeveld Group, Cape Supergroup) that might preserve a variety of benthic invertebrate shells or very rarely lycopods. The land is covered by soils so the visibility before excavations is poor. 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 until the final layout of the turbines and infrastructure have been determined. Then a site visit by a palaeontologist as recommended by HWC – or - a fossil chance find protocol could be followed. Only the sites on very highly sensitive rocks would need to be assessed and/or visited. There is no preferred site for the placement of the BESS, on-site substation and infrastructure.

The palaeontological assessment identified no fatal flaws to the project, and it is my reasoned opinion that the Hugo WEF can be granted environmental authorisation, subject to the conditions of the EMPr.

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

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1. Background

FE Hugo & Khoe (Pty) Ltd proposes the development of a wind energy facility and associated infrastructure, on a site between Touwsriver and Montagu in the Western Cape Province. The site is located within the Breede Valley Local Municipality in the Cape Winelands District Municipality.

The entire extent of the site falls outside of any Renewable Energy Development Zone (REDZ). The facility is to be known as Hugo Wind Energy Facility.

The project is planned as part of a cluster of renewable energy projects, which includes a second facility, Khoe Wind Energy Facility, located approximately 7 km to the south.

The grid connection for the facility is yet to be determined and will be assessed as a separate application.

Hugo WEF

The proposed Hugo WEF will comprise up to 42 turbines with a maximum output capacity of up to 360 MW (Table 1a; Figure 1 and Figure 2). The WEF will be located on the following land parcels: RE 147; RE/172; 0/173; RE/174; and 9/148 (Table 1b). The final design which will be requested for approval in the EA, will be determined based on the outcome of the specialist studies undertaken for the EIA phase of the development. The proposed turbine footprint and associated facility infrastructure will cover an area of up to 7900 ha, for both facilities, depending on the final design.

It is proposed that an on-site substation with a capacity up 132 kV with an up to 33 kV overhead / underground powerline will be installed. It is unknown at this stage how long the connection to the grid will be, or what route the cabling will be installed.

1A: TABLE OF SPECIFICATIONS OF PROPOSED DEVELOPMENT

WEF Technical Details Components	Description / Dimensions - Hugo	Description / Dimensions - Khoe
Maximum Generation Capacity	up to 360MW	up to 290MW
Type of technology	Onshore Wind	Onshore Wind
Number of Turbines	Up to 42	Up to 29
WTG Hub Height from ground level	up to 150m	up to 150m
Blade Length	up to 100m	up to 100m
Rotor Diameter	up to 200m	up to 200m
Structure height (Tip Height)	up to 250m	up to 250m
Structure orientation	Wind regiment dependant	Wind regiment dependant
Area occupied by both permanent and construction laydown areas		
	See layout	See layout

WEF Technical Details Components	Description / Dimensions - Hugo	Description / Dimensions - Khoe
Operations and maintenance buildings (O&M building) with parking area	up to 1 HA	up to 1 HA
Site Access	Via the R318	Via the R318
Area occupied by inverter transformer stations/substations	up to 2.5 HA	up to 2.5 HA
Capacity of on-site substation	132/33kv	132/33kv
Battery Energy Storage System footprint	up to 5 HA	up to 5 HA
BESS type	Lithium-ion as the preferred technology	Lithium-ion as the preferred technology
BESS Alternatives (site, technology, design and layout)	Same as above. See layout for design and position	Same as above. See layout for design and position
Length of internal roads	TBD	TBD
Width of internal roads	Access roads to the site and between project components with a width of approximately 4.5 m and a servitude of 13.5 m.	Access roads to the site and between project components with a width of approximately 4.5 m and a servitude of 13.5 m.
Internal Cabling	Cabling between the turbines, to be laid underground where practical.	Cabling between the turbines, to be laid underground where practical.
Water supply, volumes required	±26500m^3 for the construction, commissioning and test phase (±26 months), the majority being consumed during year-one of the construction. ±90m^3/annum for the life-of-WEF (20-25 years)	±24500m^3 for the construction, commissioning and test phase (±26 months), the majority being consumed during year-one of the construction. ±90m^3/annum for the life-of-WEF (20-25 years)
Waste Management, waste volumes, and how will it be managed	To be determined at a later stage- either through Municipal channels or private	To be determined at a later stage- either through Municipal channels or private
Details on where material and equipment will be sourced for construction	To be determined upon construction and latest market availability	To be determined upon construction and latest market availability

Table 1b: Hugo WEF land parcels

Landowner	Farm Name	Farm No.	Portion No.	SG Code
Blue Dot Prop 424	Ou de Kraal	145	RE	
Blue Dot Prop 424	Stinkfonteins Berg	147	RE	
Blue Dot Prop 424	Stinkfontein	172	RE	
Blue Dot Prop 424	Driehoek	173	0	
Blue Dot Prop 424	Presents Kraal	174	RE	
Dirk Uys Boerdery PTY LTD	Helpmekaar	148	9	

A Palaeontological Impact Assessment was requested for the Hugo WEF 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 2: 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).

	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

	A specialist report prepared in terms of the Environmental Impact Regulations of 2017 must contain:	**Relevant section in report**
f	The specific identified sensitivity of the site related to the activity and its associated structures and infrastructure	Section 4
g	An identification of any areas to be avoided, including buffers	N/A
h	A map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;	N/A
i	A description of any assumptions made and any uncertainties or gaps in knowledge;	Section 5
j	A description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives, on the environment	Section 4
k	Any mitigation measures for inclusion in the EMPr	Section 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

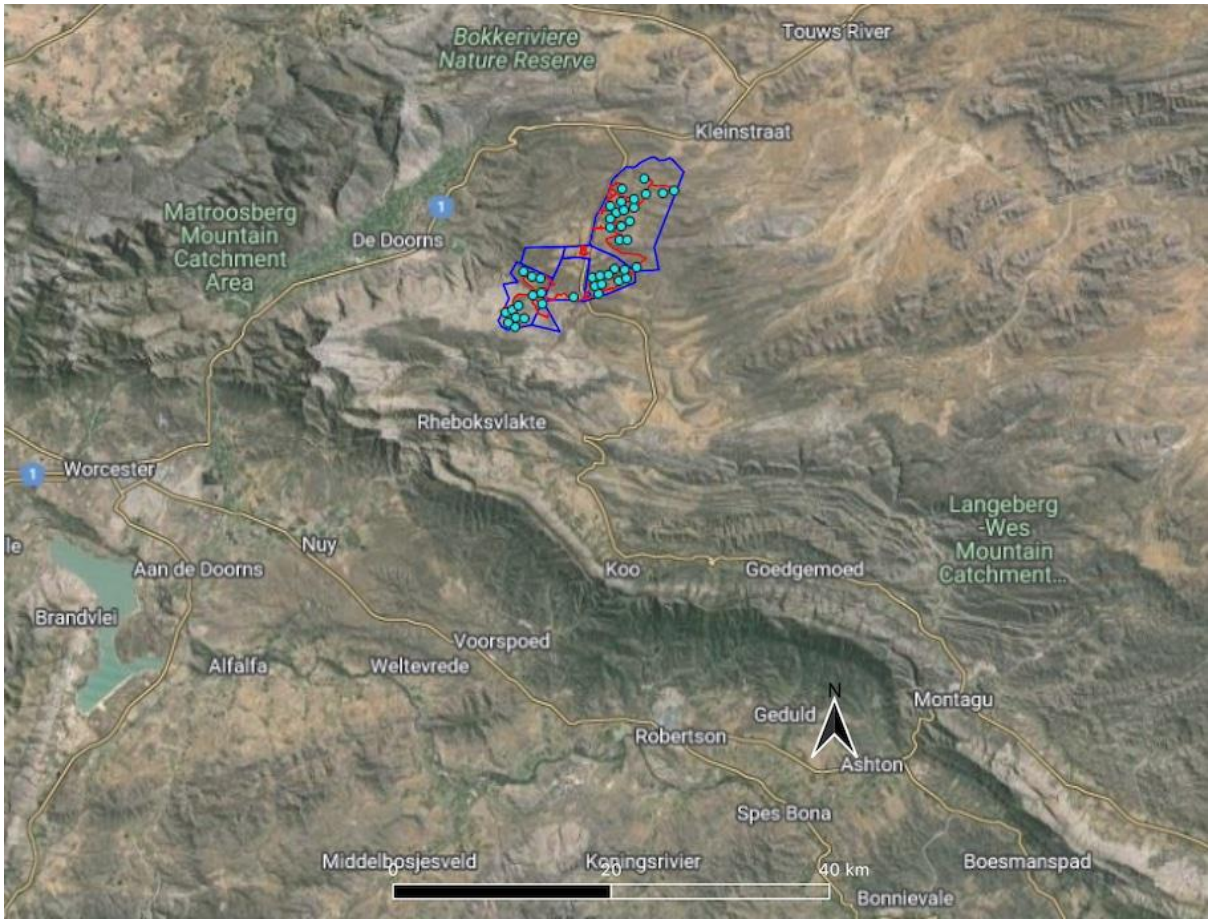

Figure 1: Google Earth map of the general area to show the relative land marks. The Hugo WEF project area is shown within the yellow outline.

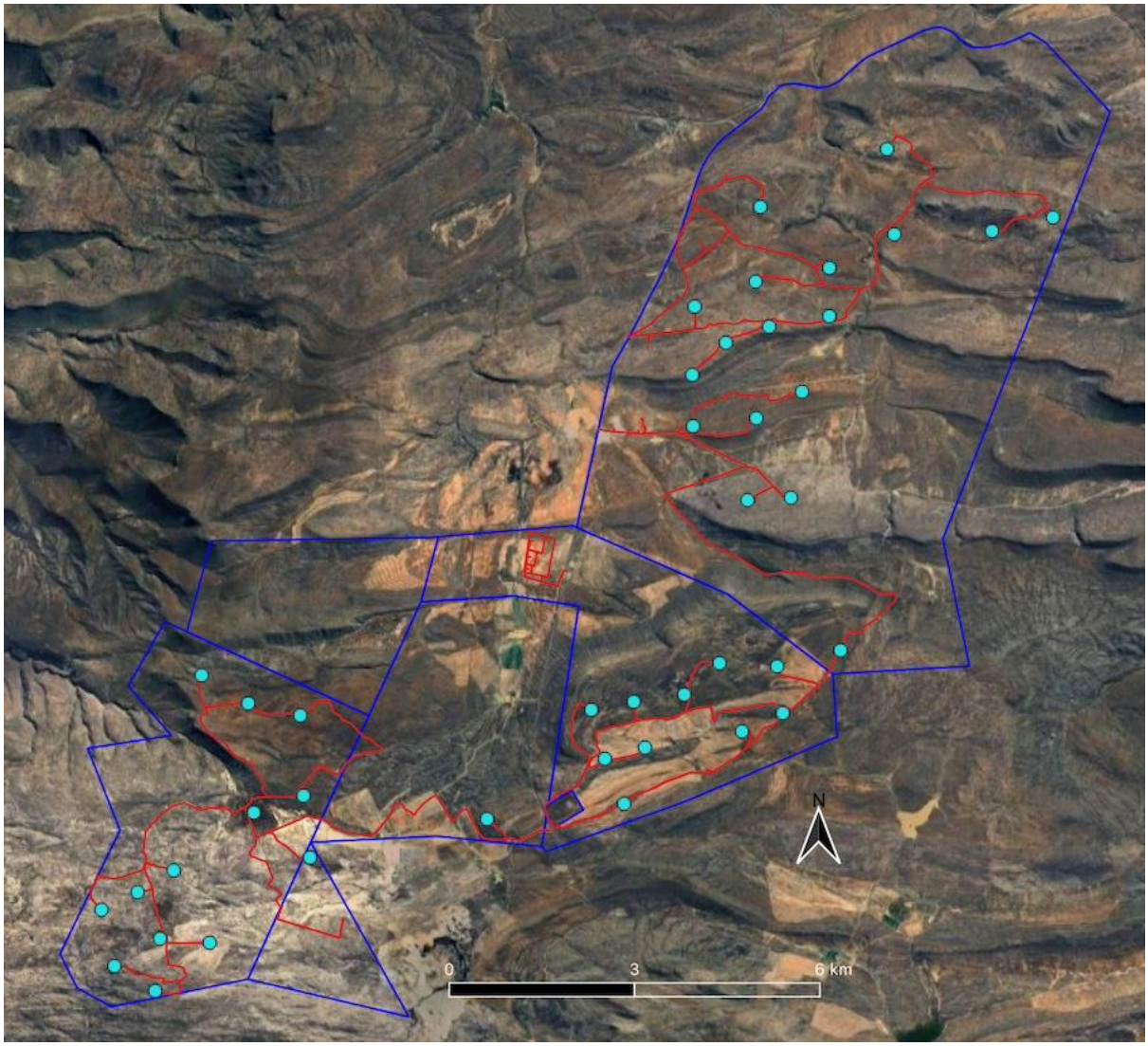

Figure 2: Google Earth Map of the proposed Hugo WEF turbine layout and infrastructure (blue points).

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; 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

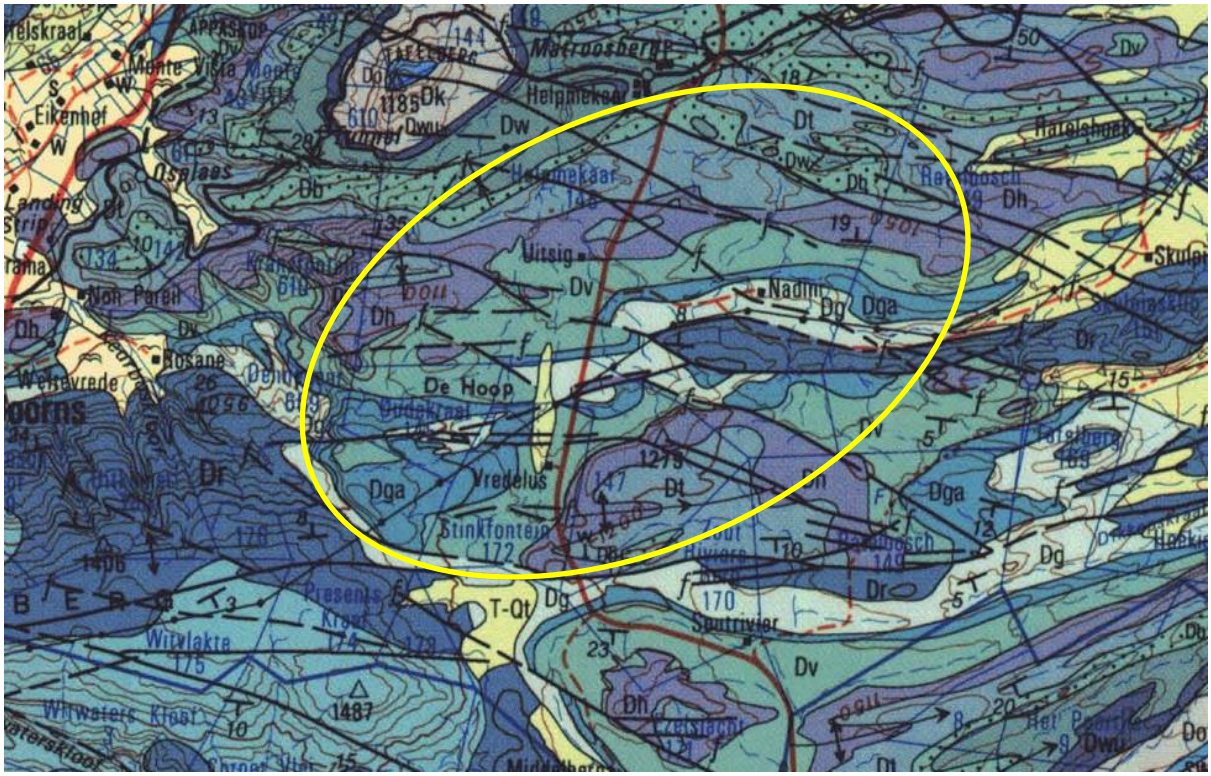

Figure 3: Geological map of the area around the Hugo WEF, between Worcester and Montagu with the project area indicated within the yellow outline. Abbreviations of the rock types are explained in Table 3. Map enlarged from the Geological Survey 1: 250 000 map 3319 Worcester.

Table 3: Explanation of symbols for the geological map and approximate ages (Penn-Clarke et al., 2018a; Thamm and Johnson, 2006). SG = Supergroup; Fm = Formation; Ma = million years; grey shading = formations impacted by the project.

Symbol	Group/Formation	Lithology	Approximate Age
T-Qc	Tertiary-Quaternary	Calcrete	Quaternary Ca 1.0 Ma to Present
Dw	Waaboomberg Fm, Bidouw Subgroup, Bokkeveld Group, Cape SG	Mudrock, siltstone, sandstone	Middle Devonian Ca 382 Ma
Db	Boplaas Fm, Ceres Subgroup, Bokkeveld Subgroup, Cape SG	Sandstone	Middle Devonian
Dt	Tra-Tra Fm, Ceres Subgroup, Bokkeveld Subgroup, Cape SG	Mudrock, siltstone	Middle Devonian

Symbol	Group/Formation	Lithology	Approximate Age
Dh	Hex River Fm, Ceres Subgroup, Bokkeveld Subgroup, Cape SG	Sandstone	Middle Devonian
Dv	Voorsteenhoek Fm, Ceres Subgroup, Bokkeveld Subgroup, Cape SG	Mudrock, siltstone	Middle Devonian Ca 393-382 Ma
Dga	Gamka Fm, Ceres Subgroup, Bokkeveld Subgroup, Cape SG	Sandstone	Early Devonian
Dg	Gydo Fm, Ceres Subgroup, Bokkeveld Subgroup, Cape SG	Mudrock, siltstone	Early Devonian
Dr	Rietvlei Fm, Nardouw Subgroup, Table Mountain Group, Cape SG	Sandstone	Early Devonian Ca 419-393 Ma

The project lies in the central part of the Cape Supergroup rocks where the Early and Middle Devonian rocks of the Ceres Subgroup (Bokkeveld Group, Cape Supergroup) are well represented (Figure 4).

The **Cape Supergroup** comprises a series of siliciclastic sediments that were deposited in a passive margin basin and is underlain by Cambrian rocks of the Saldanian Orogeny and Pan African depositional cycles. It is overlain by the Karoo Basin sequence (Thamm and Johnson, 2006). Representing some 170 million years of earth history, and up to 10km of strata, the Cape Supergroup has since been deformed by the Cape Orogeny. It extends along the southern Cape coast for about 1000km (ibid). There are three major subdivisions, the basal Table Mountain Group, Bokkeveld and Witteberg Groups ranging from the Early Ordovician (ca 500 Ma) to the Early Carboniferous (ca 330 Ma). The subgroups and formations differ slightly between the western and eastern regions.

The Table Mountain Group is sandstone dominated and was deposited in shallow marine, glacial and fluvial environments. No subgroup name is given to the basal formations but the upper formations, Silurian to Devonian, are grouped into the Nardouw Subgroup.
Five formations are recognised in the Ordovician component of this Group and west of ca 21°E are from the base upwards, the Pieknierskloof, Graafwater, Peninsula, Pakhuis and Cedarberg Formations. East of 21° only three formations are recognised, namely the Sardinia, Peninsula and Cedarberg Formations.

The Nardouw Subgroup comprises three formations, with the basal Goudini and Skurweberg Formations. The upper formation west of 21°E is known as the **Rietvlei Formation**, and to the east as the Baviaanskloof Formation.

The **Bokkeveld Group** has fossiliferous shale and sandstone units with a series of upward coarsening cycles that were attributed to repeated basin-ward progradation of wave-dominated deltas (Thamm and Johnson, 2006). Penn-Clarke et al. (2018) have reinterpreted the setting to rather have been a succession that accumulated in a storm-and-wave dominated deltaic palaeoenvironment.

The middle Devonian Bokkeveld Group has been divided into the basal **Ceres Subgroup** with five formations that stretch across the whole of the southern Cape. From the base upwards these formations are the Gydo, Gamka, Voorstehoek, Hex River, Tra-Tra and Boplaas Formations (Thamm and Johnson, 2006; Penn-Clarke et al., 2018a, b). To the west of 21°E the upper Bokkeveld **Bidouw Subgroup** five formations are recognised, the Waboomberg, Wupperthal, Klipbokkop, Osberg and Karoopoort Formations. To the east of 21°E the equivalent is the Traka Subgroup with three formations, the Karies, Adolphspoort and Sandpoort Formations (ibid).

In some of the low-lying areas where the conditions have alternated between wet and dry cycles during the Tertiary and Quaternary calcrete has formed.

ii. Palaeontological context

The palaeontological sensitivity of the area under consideration is presented in Figures 5-6. The site for development mostly is in the very highly sensitive rocks of the various formations of the Ceres Subgroup.

The time period of the Ordovician – Silurian – Devonian (about 485 – 350 Ma) is when the first terrestrial plants, bony fish and insects evolved and spread on the land, from precursors in the seas. The Cape Supergroup represents this period, and although southern Africa (in the middle of Gondwanaland) was positioned over or close to the South Pole, and was covered by a series of ice sheets (Visser, 1989; Isbell et al., 2012), some of the fine-grained shallow water and marginal mudstones and siltstones have fossils preserved within them (Plumstead, 1969; Theron, 1972; MacRae, 1999; Thamm and Johnson, 2006; Penn-Clarke et al., 2018). With the repeated cycles of sealevel rise and fall and resulting shifts from marine to shoreline to fluvial and delta settings and back again, there is a complex series of environments with the resident faunas.

The Ordovician lower Table Mountain Group preserves trace fossils, and invertebrates such as brachiopods, trilobites, eurypterids, conodonts and chitinozoans. There are records of invertebrate fossils, known as the Malvinokaffric Faunal Assemblage, in the Silurian – early Devonian upper Nardouw Subgroup and the whole of the Bokkeveld Group, while the Witteberg Group has records of fish and plants as well as invertebrates such as brachiopods, bivalves, gastropods and trilobites. More recent research has shown that the Malvinokaffric fauna of Gondwanaland (Bokkeveld Group) is somewhat different from the northern hemisphere fauna (Penn-Clarke et al., 2018b).

Witteberg Group plants comprise fragments of the lycopods *Palaeostigma sewardii* and *Haplostigma irregularis* (both taxa need revising). Collections were made by Johannes Theron and farms are listed in Anderson and Anderson (1985, p. 21). From the Waaipoort Formation plant remains, such as lycopod stems and ferns, and invertebrate remains such as giant eurypterids and palaeoniscoid and acanthodian fish, have been described (in Thamm and Johnson, 2006).

The Ceres Subgroup has abundant marine benthic (bottom-dwelling) invertebrate fossils such as brachiopods, bivalves, trilobites, cephalopods, crinoids, ophiutoids, hyoliths, cricoconarids, corals and gastropods (Hiller and Theron, 1988; Theron and Johnson, 1991; Thamm and Johnson et al., 2006; Penn-Clarke et al., 2018a). These marine fossils

occur mostly in the mudrock units while plant fossils occur in the sandstone units. Some units also show extensive bioturbation based on the presence of trace fossils of burrows, such as *Planolites, Skolithos* and *Arenicolites*.

There is no preferred site, as far as the palaeontology is concerned, for the BESS and on-site substation with infrastructure.

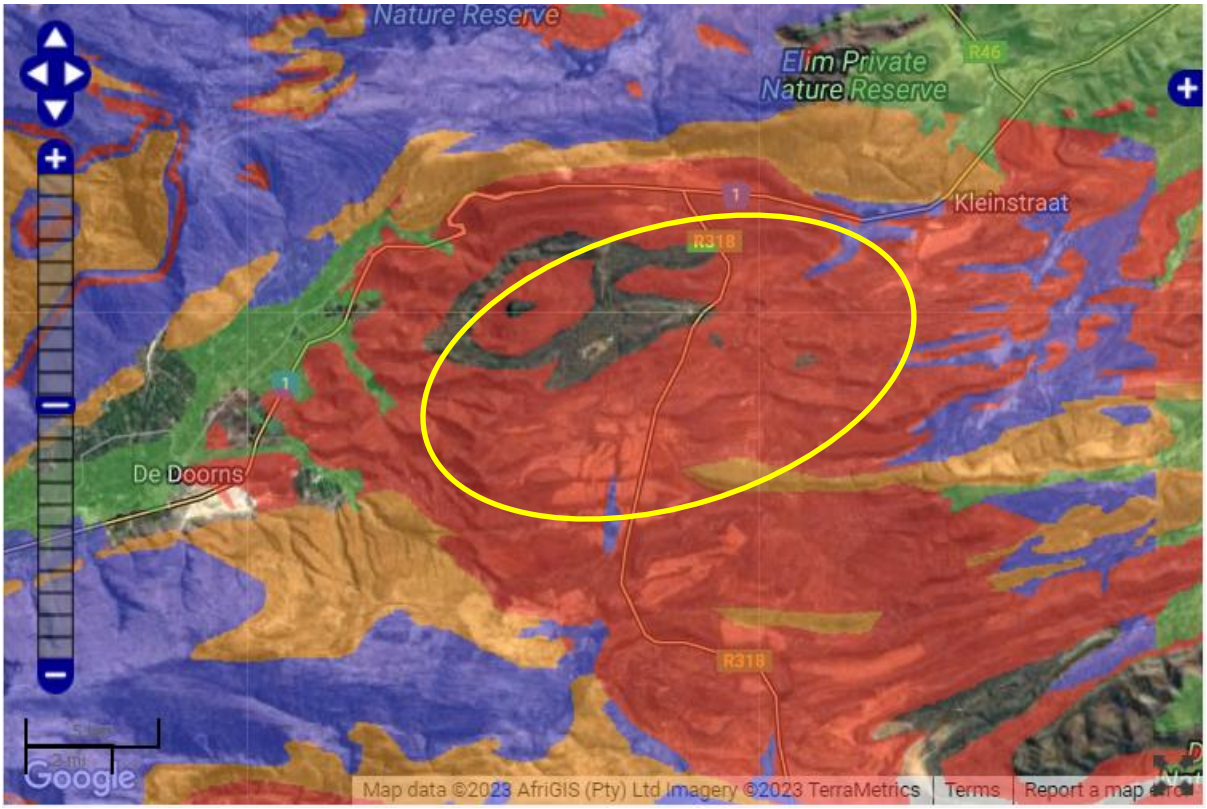

Figure 4: SAHRIS palaeosensitivity map for the site for the Hugo WEF (yellow outline). Background colours indicate the following degrees of sensitivity: red = very highly sensitive; orange/yellow = high; green = moderate; blue = low; grey = insignificant/zero.

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	Soils do not preserve fossils; so far there are no records from the Ceres Subgroup of plant or invertebrate fossils in this region but it is possible that fossils occur on the site. The impact would be low to 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 invertebrate or plant fossils in the mudstones, the spatial scale will be localised within the site boundary.
	M	-
	H	-

PART B: Assessment		
PROBABILITY	H	-
	M	**No fossils will be found in the overlying soils but it is possible that fossil occur in the unweathered mudstones of the Ceres Subgroup. Therefore, a fossil chance find protocol must be added to the EMPr for when excavations commence, with the knowledge of HWC.**
	L	-

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 the correct type and age to preserve invertebrates and lower plants. However, the land is covered by soils and these do not preserve fossils. Since there is a chance that fossils from the Ceres Subgroup 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 moderate to 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 quartzites, mudstones, sandstones, shales and sands are typical for the country and some might contain fossil plants, traces of bioturbation and invertebrate. The overlying soils and sands of the Quaternary period would not preserve fossils.

6. Recommendation

Based on experience and the lack of any previously recorded fossils from the area, it is extremely unlikely that any fossils would be preserved in the overlying soils of the Quaternary. There is a moderate to small chance that fossils may occur in the mudstones, of the Ceres Subgroup that lie below the soils or in rocky outcrops.

Therefore, a Fossil Chance Find Protocol should be added to the EMPr. If fossils are found by the environmental officer, or other responsible person once excavations have commenced then they should be rescued and a palaeontologist called to assess and collect a representative sample, unless HWC recommends and alternative approach. It should be noted that soil cover is likely to obscure any fossils.

The impact on the palaeontological heritage would be moderate to low but the impact can be mitigated by a palaeontologist or ECO collecting and removing any important fossils (See Section 8: Fossil Chance Find Protocol).

The palaeontological assessment identified no fatal flaws to the project, and it is my reasoned opinion that the Hugo WEF can be granted environmental authorisation, subject to the conditions of the EMPr.

ASPECT	SCREENING TOOL SENSITIVITY	VERIFIED SENSITIVITY	OUTCOME STATEMENT/ PLAN OF STUDY	RELEVANT SECTION MOTIVATING VERIFICATION
Palaeontology	Very High	Moderate to 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 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 (trace fossils, invertebrates, plants, insects or bone) 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 an HWC or SAHRA permit must be obtained. Annual reports must be submitted to HWC 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 HWC 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 Bokkeveld Group

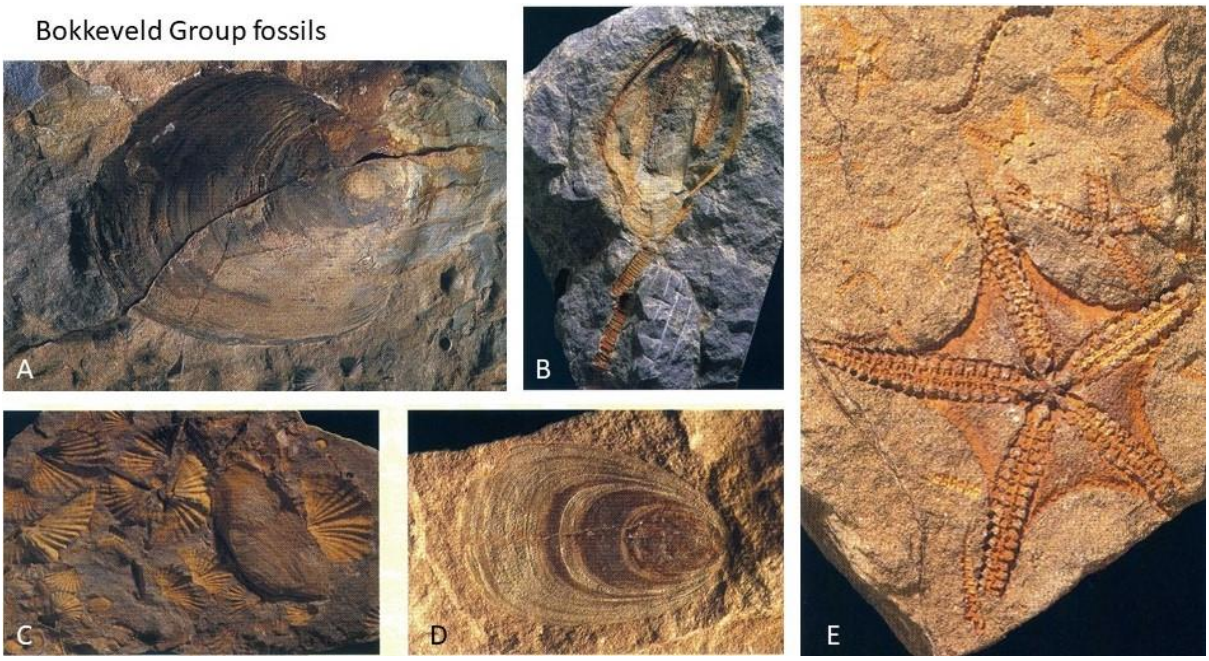

Figure 7: Photographs of fossil invertebrates from the Bokkeveld Group, including the Ceres Subgroup), Cape Supergroup.

10. Appendix B – Details of specialist

Curriculum vitae (short) - Marion Bamford PhD January 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 January 2024 peer-reviewed journals or scholarly books: over 175 articles published; 5 submitted/in press; 14 book chapters.
Scopus h-index = 32; Google Scholar h-index = 40; -i10-index = 121 based on 7261 citations.
Conferences: numerous presentations at local and international conferences.