Palaeontological Impact Assessment for the proposed Vanderkloof PV and BESS facilities, Letsemeng Local Municipality, Xhariep District, Free State Province

Desktop Study (Phase 1)

Subcontracted by

Beyond Heritage (Pty) Ltd

04 March 2025

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1. Executive Summary

A Palaeontological Impact Assessment was requested for the proposed Vanderkloof PV and BESS, located on the Portion 1 of Farm 113, Remainder of Farm 634, Remainder of Farm 39, Remainder of Farm 253, Remainder of Farm 1132, Portion 1 of Farm 1132 and Remainder of Farm 654 in the Letsemeng Local Municipality in the Xhariep District of the Free State Province. A study site of approximately 7478ha was assessed as part of this Environmental Process and the infrastructure associated.

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 sites lie on the potentially highly sensitive Tierberg Formation (Ecca Group, Karoo Supergroup) and Tertiary Calcrete, as well as moderately sensitive Quaternary Kalahari Group sands. No fossils have been reported from the sites. Nonetheless, 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, 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.

Northwest cluster (PV 1, 2 and part of 5; BESS and infrastructure) - ZERO to insignificant palaeontological impact.
Southeast cluster (PV 3, 4, rest of 5; BESS and infrastructure) - MODERATE to LOW palaeontological impact (not high because the land is covered with soils).

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

2. **Declaration of independence and summary of expertise**.

a. Declaration

This report has been compiled by Professor Marion Bamford, of the University of the Witwatersrand, sub-contracted by Beyond Heritage (Pty) Ltd, 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: 

b. Expertise

The Palaeontologist Consultant: Prof Marion Bamford
Qualifications: PhD (Wits Univ, 1990); FRSSAf, mASSAf, PSSA
Experience: 36 years research and lecturing in Palaeontology; over 28 years PIA studies and over 450 projects completed.

c. Specialist declaration of independence and statement of objectivity for the assessment.

Declaration of Independence
I, Marion Bamford, declare that –
General declaration:

- I act as the independent palaeontology practitioner in this application,
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant,
- I declare that there are no circumstances that may compromise my objectivity in performing such work,
- I have expertise in conducting palaeontological impact assessments, including knowledge of the Act, Regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, Regulations and all other applicable legislation,
- I will take into account, to the extent possible, the matters listed in section 38 of the NHRA when preparing the application and any report relating to the application,
- I have no, and will not engage in, conflicting interests in the undertaking of the activity,
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority,
- I will ensure that information containing all relevant facts in respect of the application is distributed or made available to interested and affected parties

and the public and that participation by interested and affected parties is facilitated in such a manner that all interested and affected parties will be provided with a reasonable opportunity to participate and to provide comments on documents that are produced to support the application,
- I will provide the competent authority with access to all information at my disposal regarding the application, whether such information is favourable to the applicant or not
- All the particulars furnished by me in this form are true and correct,
- I will perform all other obligations as expected from a heritage practitioner in terms of the Act and the constitutions of my affiliated professional bodies; and
- I realise that a false declaration is an offence in terms of regulation 71 of the Regulations and is punishable in terms of section 24F of the NEMA.

Disclosure of Vested Interest

- I do not have and will not have any vested interest (either business, financial, personal or other) in the proposed activity proceeding other than remuneration for work performed in terms of the Regulations.

d. **Summary of the specialist's expertise**

I, Marion Bamford, am a professional Palaeontologist with a PhD in Palaeontology (Wits University, 1990). I have more than 35 years of experience in palaeontological research and have published over 190 papers in peer-reviewed journals and published more than 14 scholarly book chapters. I review manuscripts for international and local journals and also review funding proposals for international funding bodies. Currently I am the Director of the Evolutionary Studies Institute, the only palaeontological institute in Southern Africa.

I have completed more than 450 palaeontological impact assessments (desktop and site visit studies) in the last 28 years for a variety of projects (solar energy projects, wind energy projects, powerlines, roads, infrastructure, housing and retail projects and from all over South Africa. I have been subcontracted by over 30 different companies. From my own projects and training provided by me and other staff in the ESI for Palaeontological Impact Assessments, I am familiar with the legislation.

Table of Contents

3. Project Background

The Applicant, Vanderkloof Solar (Pty) Ltd, is proposing the construction of a number of photovoltaic (PV), and Battery Energy Storage System (BESS) energy facilities (collectively known as Vanderkloof PV and BESS) located on the Portion 1 of Farm 113, Remainder of Farm 634, Remainder of Farm 39, Remainder of Farm 253, Remainder of Farm 1132, Portion 1 of Farm 1132 and Remainder of Farm 654 in the Letsemeng Local Municipality in the Xhariep District of the Free State Province. A study site of approximately 7478ha was assessed as part of this Environmental Process and the infrastructure associated for the facilities.

The Vanderkloof PV and BESS project includes six PV and five BESS Facilities (Figures 1-2). Each facility is described and illustrated separately below but the geology and palaeontology are described together (Section 5). The palaeontological impact of separate facilities is given in Section 6.

A Palaeontological Impact Assessment was requested for the Vanderkloof PV and BESS 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,	Section 2
aii	The expertise of that person to compile a specialist report including a curriculum vitae	Section 2
b	A declaration that the person is independent in a form as may be specified by the competent authority	Section 2
c	An indication of the scope of, and the purpose for which, the report was prepared	Section 3
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 6
d	The date and season of the site investigation and the relevance of the season to the outcome of the assessment	N/A

	A specialist report prepared in terms of the Environmental Impact Regulations of 2017 must contain:	**Relevant section in report**
e	A description of the methodology adopted in preparing the report or carrying out the specialised process	Section 4
f	The specific identified sensitivity of the site related to the activity and its associated structures and infrastructure	Section 6
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 7
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 8
k	Any mitigation measures for inclusion in the EMPr	Section 10, 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 10, Appendix A
ni	A reasoned opinion as to whether the proposed activity or portions thereof should be authorised	Section 8
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 8, 10
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.

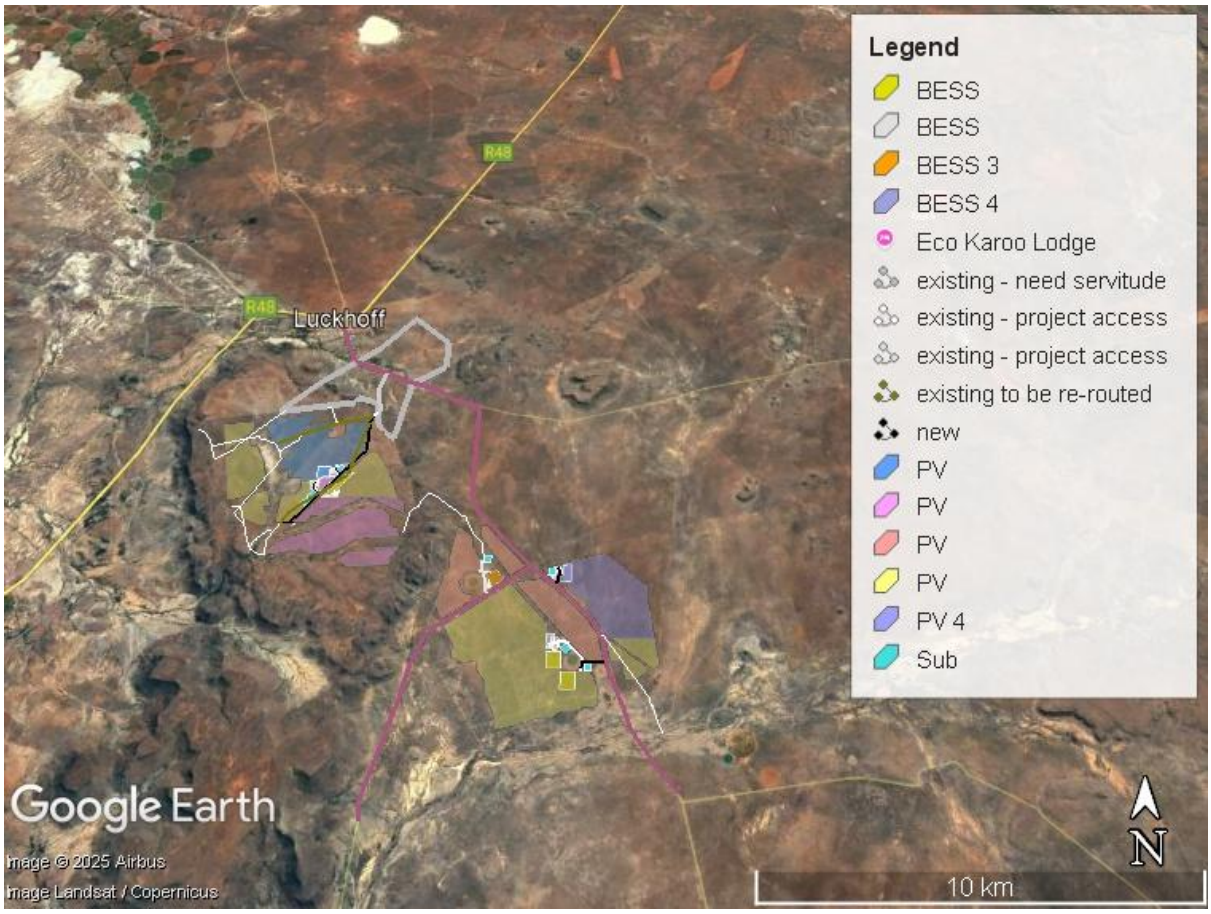

Figure 2: Google Earth Map of the proposed Vanderkloof PV and BESS project.

Vanderkloof PV 1

Vanderkloof PV1 is situated on Portion 1 of St. Elmo 113 and Remaining Extent of Annex Goemmansberg 634 and will consist of a **250MW** PV Development with a footprint of up to 426ha. The PV footprint will include interspersed internal roads, inverters and mini substations within the footprint of the PV field. Associated infrastructure for this 250MW PV facility will include:

- On site Substation of approximately 4ha.
- Temporary laydown areas of approximately 4ha within the PV footprint.
- Permanent Laydown areas of up to 1ha.
- Permanent auxiliary buildings (~0.5ha) including:
    - Guardhouses, workshops, operations and control centres – each with associated ablutions.
    - Offices, accommodation – each with associated canteens and ablutions.
- Temporary accommodation buildings with associated canteens and ablutions of up to 0.2ha.
- Main Access roads of up to 8m wide and approximately 14km long are required to cumulatively for the Vanderkloof PV and BESS projects. Approximately 6.5km of these roads are existing (to be upgraded) and approximately 7.5km are to consist of new roads).
- Perimeter fencing not exceeding 3m in height.
- Rainwater tanks.
- Diesel tanks (up to 80m^3 cumulatively for the entire Vanderkloof Solar PV and BESS Facilities)

Figure 3: Google Earth map for Vanderkloof PV 1 only (blue polygon) with related substations and buildings.

Vanderkloof PV 2

Vanderkloof PV2 is situated on Remaining Extent of Goedman's Berg 39 & Remaining Extent Troostenberg 253 and will consist of a **250MW** PV Development with a footprint of up to 381ha. The PV footprint will include interspersed internal roads, inverters and mini substations within the footprint of the PV field. Associated infrastructure for this 250MW PV facility will include:

- On site Substation of approximately 4ha.
- Temporary laydown areas of approximately 4ha within the PV footprint.
- Permanent Laydown areas of up to 1ha.
- Permanent auxiliary buildings (~0.5ha) including:
    - Guardhouses, workshops, operations and control centres – each with associated ablutions.
    - Offices, accommodation – each with associated canteens and ablutions.
- Temporary accommodation buildings with associated canteens and ablutions of up to 0.2ha.
- Main Access roads of up to 8m wide and approximately 14km long are required to cumulatively for the Vanderkloof PV and BESS projects. Approximately 6.5km of these roads are existing (to be upgraded) and approximately 7.5km are to consist of new roads).
- Perimeter fencing not exceeding 3m in height.
- Rainwater tanks.
- Diesel tanks (up to 80m^3 cumulatively for the entire Vanderkloof Solar PV and BESS Facilities).

Figure 4: Google Earth map for Vanderkloof PV 2 only (lilac polygon) with related substations and buildings.

Vanderkloof PV 3

Vanderkloof PV3 is situated on Remaining Extent Bergrivier 1132 & Portion 1 of Bergrivier 1132 and will consist of a **250MW** PV Development with a footprint of up to 445ha. The PV footprint will include interspersed internal roads, inverters and mini substations within the footprint of the PV field. Associated infrastructure for this 250MW PV facility will include:

- On site Substation of approximately 4ha.
- Temporary laydown areas of approximately 4ha within the PV footprint.
- Permanent Laydown areas of up to 1ha.
- Permanent auxiliary buildings (~0.5ha) including:
    - Guardhouses, workshops, operations and control centres – each with associated ablutions.
    - Offices, accommodation – each with associated canteens and ablutions.
- Temporary accommodation buildings with associated canteens and ablutions of up to 0.2ha.
- Main Access roads of up to 8m wide and approximately 14km long are required to cumulatively for the Vanderkloof PV and BESS projects. Approximately 6.5km of these roads are existing (to be upgraded) and approximately 7.5km are to consist of new roads).
- Perimeter fencing not exceeding 3m in height.
- Rainwater tanks.
- Diesel tanks (up to 80m^3 cumulatively for the entire Vanderkloof Solar PV and BESS Facilities).

Figure 5: Google Earth map for Vanderkloof PV 3 only (brown polygon) with related substations and buildings.

Vanderkloof PV 4

Vanderkloof PV4 is situated on Remaining Extent Brakleegte 654 and will consist of a **250MW** PV Development with a footprint of up to 432ha. The PV footprint will include interspersed internal roads, inverters and mini substations within the footprint of the PV field. Associated infrastructure for this 250MW PV facility will include:

- On site Substation of approximately 4ha.
- Temporary laydown areas of approximately 4ha within the PV footprint.
- Permanent Laydown areas of up to 1ha.
- Permanent auxiliary buildings (~0.5ha) including:
    - Guardhouses, workshops, operations and control centres – each with associated ablutions.
    - Offices, accommodation – each with associated canteens and ablutions.
- Temporary accommodation buildings with associated canteens and ablutions of up to 0.2ha.
- Main Access roads of up to 8m wide and approximately 14km long are required to cumulatively for the Vanderkloof PV and BESS projects. Approximately 6.5km of these roads are existing (to be upgraded) and approximately 7.5km are to consist of new roads).
- Perimeter fencing not exceeding 3m in height.
- Rainwater tanks.
- Diesel tanks (up to 80m^3 cumulatively for the entire Vanderkloof Solar PV and BESS Facilities).

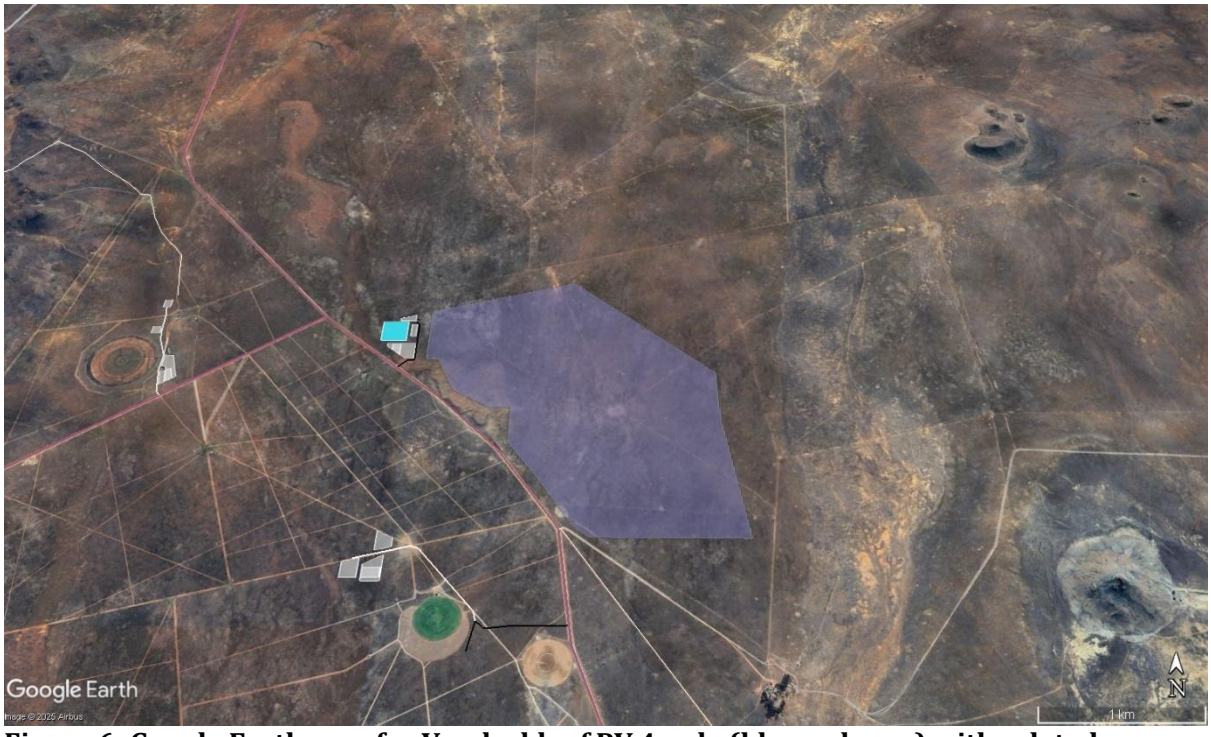

Figure 6: Google Earth map for Vanderkloof PV 4 only (blue polygon) with related substations and buildings.

Vanderkloof PV 5

Vanderkloof PV5 is situated on Portion 1 of St. Elmo 113, Remaining Extent of Goedman's Berg 39, Remaining Extent of Annex Goemmansberg 634, Remaining Extent Bergrivier 1132, Portion 1 of Bergrivier 1132 & Remaining Extent Brakleegte 654 will consist of a **1000MW** PV Development with a footprint of up to 1855 ha. The PV footprint will include interspersed internal roads, inverters and mini substations within the footprint of the PV field. Associated infrastructure for this 1000MW PV facility will include:

- Three on site Substation of approximately 12ha.
- Temporary laydown areas of approximately 16ha within the PV footprint.
- Permanent Laydown areas of up to 4ha.
- Permanent auxiliary buildings (~2ha) including:
    - Guardhouses, workshops, operations and control centres – each with associated ablutions.
    - Offices, accommodation – each with associated canteens and ablutions.
- Temporary accommodation buildings with associated canteens and ablutions of up to 0.8ha.
- Main Access roads of up to 8m wide and approximately 14km long are required to cumulatively for the Vanderkloof PV and BESS projects. Approximately 6.5km of these roads are existing (to be upgraded) and approximately 7.5km are to consist of new roads).
- Perimeter fencing not exceeding 3m in height.
- Rainwater tanks.
- Diesel tanks (up to 80m^3 cumulatively for the entire Vanderkloof Solar PV and BESS Facilities).

Figure 7: Google Earth map for Vanderkloof PV 5 only (blue polygon) with related substations and buildings.

Vanderkloof five BESS sites (one map).

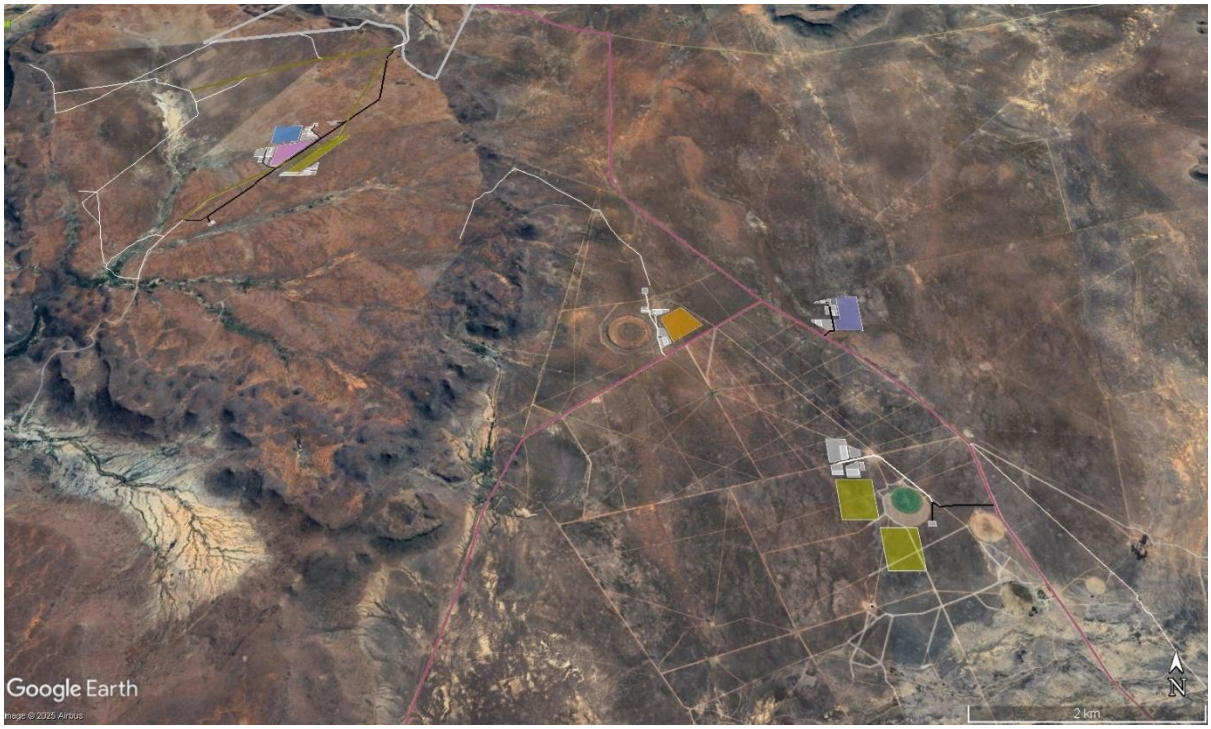

Figure 8: Google Earth map for Vanderkloof BESS 1-5 only (blue polygon) with related substations and buildings. BESS 1 – yellow; 2 – white; 3 - orange; 4 – blue; 5 - ??

Vanderkloof BESS 1

Vanderkloof BESS 1 is situated on Remaining Extent of Annex Goemmansberg 634 and will have a capacity of up to 1000MWh. The total footprint of Vanderkloof BESS 1 will be approximately 12ha and will consist of:

- An up to 8ha electrolyte tank footprint or solid-state containerized battery area with interspersed internal roads, cabling routes, and energy management system (EMS) modules.
- On-site substation of approximately 2ha.
- Temporary laydown areas which will not exceed 1ha and will be situated within the assessed footprint.
- Permanent laydown area of approximately 0.3ha.
- Permanent auxiliary buildings of approximately 0.5ha including:
    - Guardhouses, workshops, operations and control centres – each with associated ablutions.
    - Offices, accommodation – each with associated canteens and ablutions.
- Temporary accommodation buildings with associated canteens and ablutions of up to 0.1ha.
- Main Access roads of up to 8m wide and approximately 14km long are required to cumulatively for the Vanderkloof PV and BESS projects. Approximately 6.5km of these roads are existing (to be upgraded) and approximately 7.5km are to consist of new roads).

- Perimeter fencing not exceeding 3m in height.
- Rainwater tanks.
- Diesel tanks (up to 80m^3 cumulatively for the entire Vanderkloof Solar PV and BESS Facilities).

Vanderkloof BESS 2

Vanderkloof BESS 2 is situated on Remaining Extent of Goedman's Berg 39 and will have a capacity of up to 1000MWh. The total footprint of Vanderkloof BESS2 will be approximately 12ha and will consist of:

- An up to 8ha electrolyte tank footprint or solid-state containerized battery area with interspersed internal roads, cabling routes, and energy management system (EMS) modules.
- On-site substation of approximately 2ha.
- Temporary laydown areas which will not exceed 1ha and will be situated within the assessed footprint.
- Permanent laydown area of approximately 0.3ha.
- Permanent auxiliary buildings of approximately 0.5ha including:
    - Guardhouses, workshops, operations and control centres – each with associated ablutions.
    - Offices, accommodation – each with associated canteens and ablutions.
- Temporary accommodation buildings with associated canteens and ablutions of up to 0.1ha.
- Main Access roads of up to 8m wide and approximately 14km long are required to cumulatively for the Vanderkloof PV and BESS projects. Approximately 6.5km of these roads are existing (to be upgraded) and approximately 7.5km are to consist of new roads).
- Perimeter fencing not exceeding 3m in height.
- Rainwater tanks.
- Diesel tanks (up to 80m^3 cumulatively for the entire Vanderkloof Solar PV and BESS Facilities).

Vanderkloof BESS 3

Vanderkloof BESS 3 is situated on Remaining Extent Bergrivier 1132 and will have a capacity of up to 1000MWh. The total footprint of Vanderkloof BESS 3 will be approximately 12ha and will consist of:

- An up to 8ha electrolyte tank footprint or solid-state containerized battery area with interspersed internal roads, cabling routes, and energy management system (EMS) modules.
- On-site substation of approximately 2ha.
- Temporary laydown areas which will not exceed 1ha and will be situated within the assessed footprint.
- Permanent laydown area of approximately 0.3ha.

- Permanent auxiliary buildings of approximately 0.5ha including:
    - Guardhouses, workshops, operations and control centres – each with associated ablutions.
    - Offices, accommodation – each with associated canteens and ablutions.
- Temporary accommodation buildings with associated canteens and ablutions of up to 0.1ha.
- Main Access roads of up to 8m wide and approximately 14km long are required to cumulatively for the Vanderkloof PV and BESS projects. Approximately 6.5km of these roads are existing (to be upgraded) and approximately 7.5km are to consist of new roads).
- Perimeter fencing not exceeding 3m in height.
- Rainwater tanks.
- Diesel tanks (up to 80m^3 cumulatively for the entire Vanderkloof Solar PV and BESS Facilities).

Vanderkloof BESS 4

Vanderkloof BESS 4 is situated on Remaining Extent Brakleegte 654 and will have a capacity of up to 1000MWh. The total footprint of Vanderkloof BESS 4 will be approximately 12ha and will consist of:

- An up to 8ha electrolyte tank footprint or solid-state containerized battery area with interspersed internal roads, cabling routes, and energy management system (EMS) modules.
- On-site substation of approximately 2ha.
- Temporary laydown areas which will not exceed 1ha and will be situated within the assessed footprint.
- Permanent laydown area of approximately 0.3ha.
- Permanent auxiliary buildings of approximately 0.5ha including:
    - Guardhouses, workshops, operations and control centres – each with associated ablutions.
    - Offices, accommodation – each with associated canteens and ablutions.
- Temporary accommodation buildings with associated canteens and ablutions of up to 0.1ha.
- Main Access roads of up to 8m wide and approximately 14km long are required to cumulatively for the Vanderkloof PV and BESS projects. Approximately 6.5km of these roads are existing (to be upgraded) and approximately 7.5km are to consist of new roads).
- Perimeter fencing not exceeding 3m in height.
- Rainwater tanks.
- Diesel tanks (up to 80m^3 cumulatively for the entire Vanderkloof Solar PV and BESS Facilities).

Vanderkloof BESS 5

Vanderkloof BESS 5 is situated on Remaining Extent of Goedman's Berg 39 & Portion 1 of Bergrivier 1132 and will have a capacity of up to 4000MWh. The total footprint of Vanderkloof BESS 4 will be approximately 48ha and will consist of:

- An up to 32ha electrolyte tank footprint or solid-state containerized battery area with interspersed internal roads, cabling routes, and energy management system (EMS) modules.
- Three on-site substation with a total footprint of approximately 6ha.
- Temporary laydown areas which will not exceed 4ha and will be situated within the assessed footprint.
- Permanent laydown area of approximately 1ha.
- Permanent auxiliary buildings of approximately 2ha including:
    - Guardhouses, workshops, operations and control centres – each with associated ablutions.
    - Offices, accommodation – each with associated canteens and ablutions.
- Temporary accommodation buildings with associated canteens and ablutions of up to 0.5ha.
- Main Access roads of up to 8m wide and approximately 14km long are required to cumulatively for the Vanderkloof PV and BESS projects. Approximately 6.5km of these roads are existing (to be upgraded) and approximately 7.5km are to consist of new roads).
- Perimeter fencing not exceeding 3m in height.
- Rainwater tanks.
- Diesel tanks (up to 80m^3 cumulatively for the entire Vanderkloof Solar PV and BESS Facilities).

4. 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*).

5. Geology and Palaeontology

i. Project location and geological context

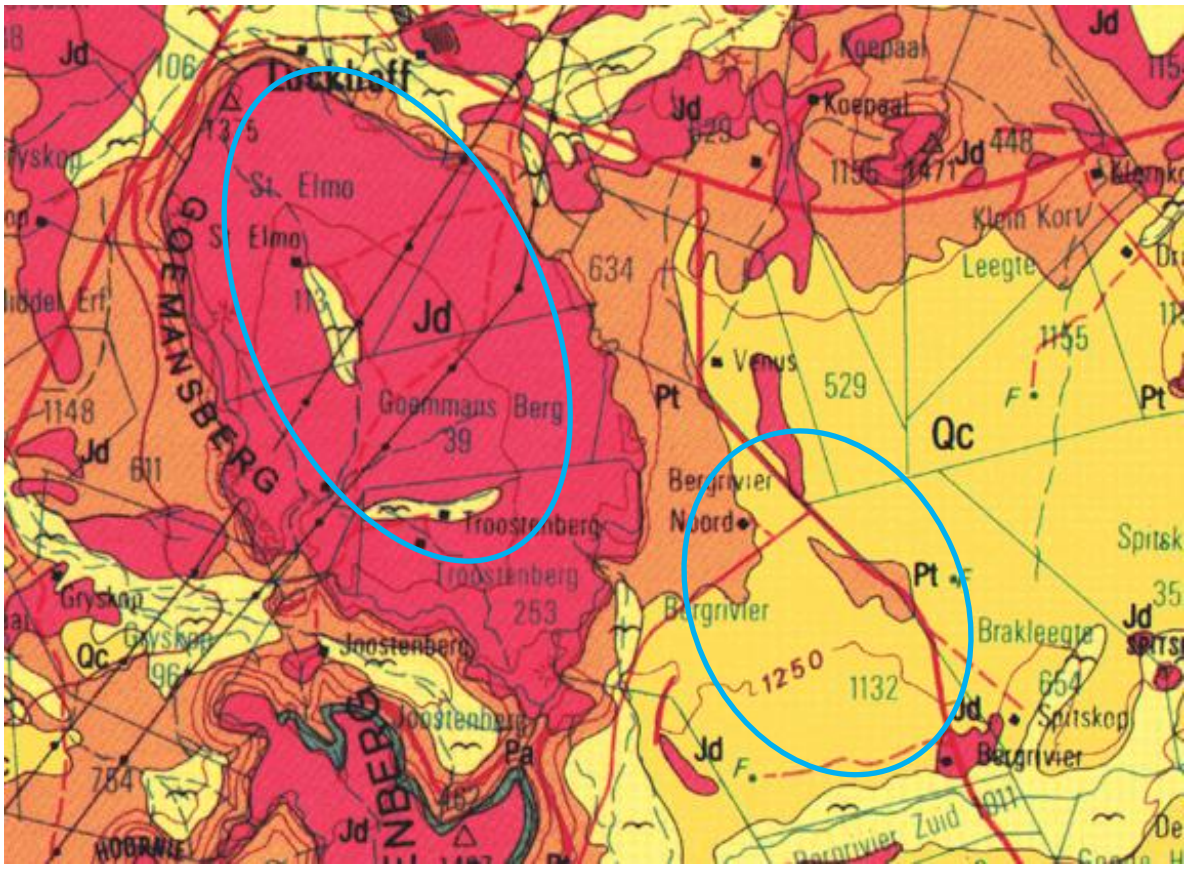

Figure 9: Geological map of the area around the Vanderkloof PV and BESS project with PV areas indicated. Abbreviations of the rock types are explained in Table 2. Map enlarged from the Geological Survey 1: 250 000 map 2924 Koffiefontein.

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

Symbol	Group/Formation	Lithology	Approximate Age
Qs	Quaternary	Alluvium, sand, calcrete	Quaternary ca 1.0 Ma to Present
Qc	Tertiary-Quaternary calcrete	Sand, surface limestone, calcrete	Tertiary to Quaternary
Jd	Jurassic dykes	Dolerite dykes, intrusive	Jurassic, Ca 183. 180 Ma
Pa	Adelaide Subgroup, Beaufort Group, Karoo SG	Mudstone, sandstone	Late Permian, ca 260 - 255 Ma
Pt	Tierberg/Fort Brown Fm, Ecca Group, Karoo SG	Brown to grey shale	Middle Permian ca 269 – 266 Ma

The project lies in the central part of the main Karoo Basin where the older strata are exposed (Figure 9). Large expanses of Jurassic dolerite intrusions are present. Overlying the older rocks are sands and alluvium.

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.

Overlying the basal Dwyka Group glacigene 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 west and central part are the following formations, from base upwards: Prince Albert Formation, Whitehill Formation, Collingham Formation, Laingsburg / Ripon Formations, **Tierberg** / Fort Brown Formations, and Waterford 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.

There were two large basins dominating southern Africa during the Cenozoic, with the Kalahari Basin to the west and the Bushveld basin to the east. Both basins are bounded along their southern extent by the more or less west-east trending Griqualand-Transvaal Axis (Partridge et al., 2006). These sediments are not easy to date but recent attempts are gradually filling in the history of the sands, sand dunes and inter-dunes (Botha, 2021).

Quaternary Kalahari sands cover large parts of the rocks in this region, especially to the west. This is the largest and most extensive palaeo-erg in the world (Partridge et al., 2006) and is composed of extensive aeolian and fluvial sands, sand dunes, calcrete, scree and colluvium. Periods of aridity have overprinted the sands, and calcrete and silcrete are common. Most geological maps indicate these sands simply descriptively (aeolian sand, gravelly sand, calcrete) or they are lumped together as the Gordonia Formation because the detailed regional lithostratigraphic work has not been done, Nonetheless, these sands have eroded from the interior and have been transported by wind or water to fill the basin. Reworking of the sands or stabilisation by vegetation has occurred. Probable ages of dune formation are around 100 kya (thousand years), 60 kya, 27-23 kya and 17-10 kya (in Botha, 2021).

ii. Palaeontological context

The palaeontological sensitivity of the area under consideration is presented in Figures 10-11. The sites for development are on the non-fossiliferous Jurassic dolerite (grey), the highly sensitive Tierberg Formation and Quaternary calcrete (orange), with very small sections on the moderately sensitive Quaternary sands (green).

In the western part of the basin the **Tierberg Formation** is predominantly argillaceous. In the northwest of its occurrence where it is in contact with the Collingham or Whitehill Formations, it grades up into the arenaceous overlying Waterford Formation (Johnson et al., 2006). Trace fossils of *Nereites, Planolites* and *Zoophycus* can be found in the fine mudstones (Johnson et al., 2006).

Quaternary aeolian sands and alluvium are fairly mobile and very porous so they do not provide suitable conditions for preservation of organic matter (Cowan, 1995). Only in places where the sands have been waterlogged, such as palaeo-pans or palaeo-springs, or where there have been alternating phases wet-dry conditions, is there any chance of fossilisation. For example, roots can be encased in calcium-rich or silica-rich sands and crusts, known as rhizoliths or rhizocretions, and can form around the roots, invertebrates or bones around the margin of a pond, pan or spring (Klappa, 1980; Cramer and Hawkins, 2009; Peters et al., 2022).

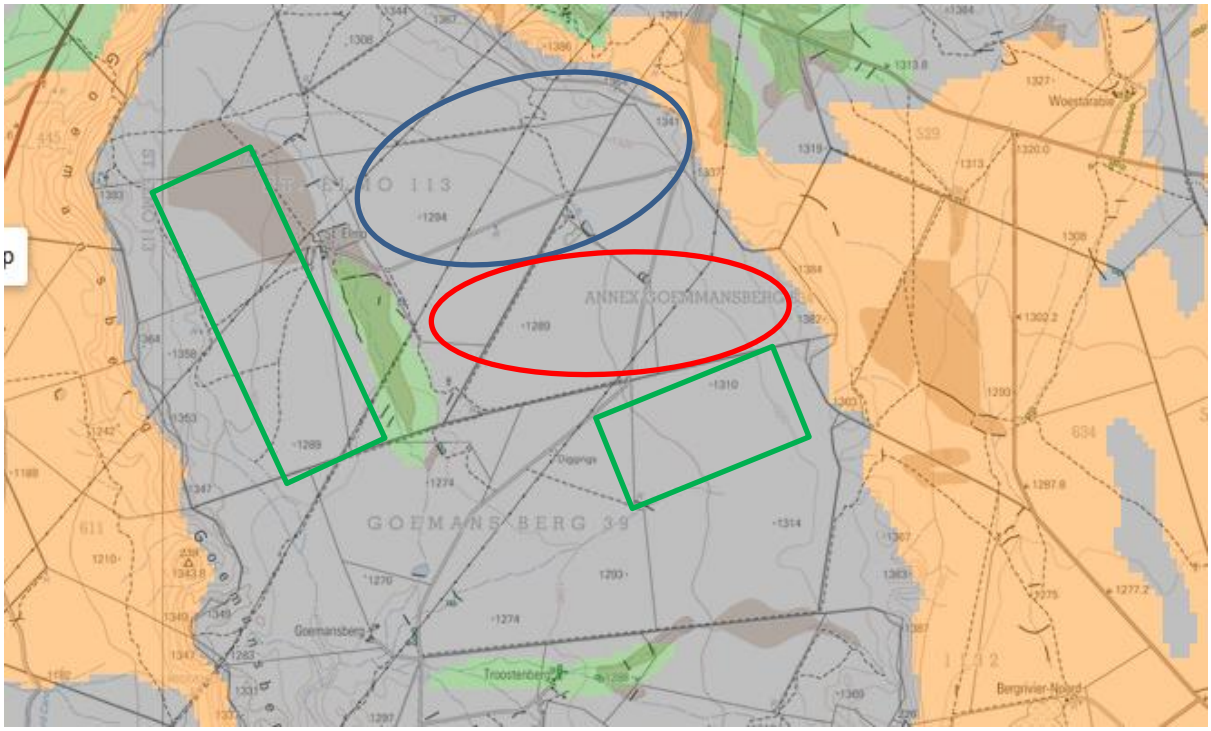

Figure 10: SAHRIS palaeosensitivity map for the northwest cluster for the proposed Vanderkloof PV and BESS project. Dark blue = PV 1; red = PV 2; green = PV 5. BESS are within the larger footprints. Background colours indicate the following degrees of sensitivity: red = very highly sensitive; orange/yellow = high; green = moderate; blue = low; grey = insignificant/zero.

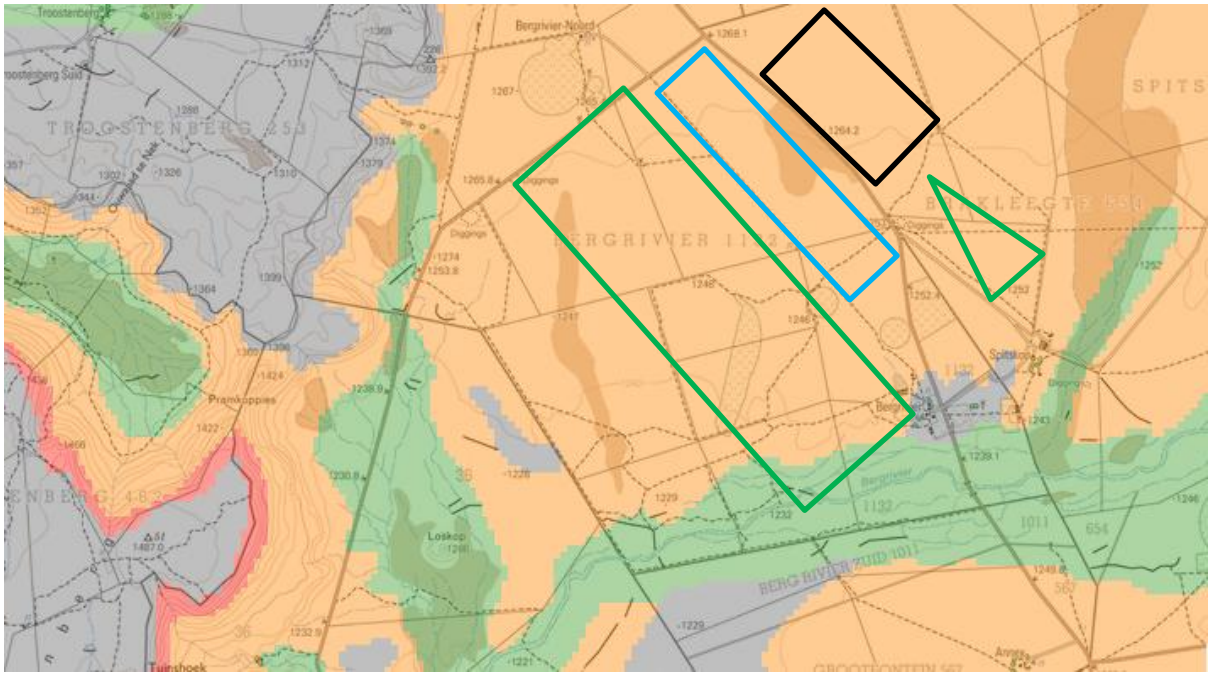

Figure 11: SAHRIS palaeosensitivity map for the southeast cluster for the proposed Vanderkloof PV and BESS project. Turquoise = PV 3; black = PV 4; green = PV 5. BESS are within the larger footprints. Background colours indicate the following degrees of sensitivity: red = very highly sensitive; orange/yellow = high; green = moderate; blue = low; grey = insignificant/zero.

From the SAHRIS maps above the area is indicated as ZERO to insignificant (grey) for the northwest cluster (PV 1, 2 and part of 5; BESS and infrastructure) and HIGH to MODERATE (orange; green) for the southeast cluster (PV 3, 4, 5; BESS and infrastructure).

6. 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	Dolerite, sands and soils do not preserve fossils; so far there are no records from the Tierberg Fm of 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 fossil invertebrates in the shales, the spatial scale will be localised within the site boundary.
	M	-
	H	-

PART B: Assessment		
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 dolerite. There is a small chance that invertebrates or fossil fragments could occur in the Tierberg Fm and Quaternary calcrete, respectively, therefore, a Fossil Chance Find Protocol should be added to the eventual EMPr.

Table 4: Summary of the palaeosensitivity for the PV and BESS components

	Formation occurring in the project footprint				
Project	**Farms**	**Jd**	**Pt**	**Qc**	**Action**
PV 1	Elmo, Goemmansberg	+			None
PV 2	Goedmans Berg, Troostenberg	+			None
PV 3	Berg River		+	+	FCFP*
PV 4	Brakleegte			+	FCFP
PV 5	Elmo, Goemmansberg, Goedmans Berg, Berg River, Brakleegte	+	+	+	FCFP
BESS 1	Goemmansberg	+			None
BESS 2	Goedmans Berg	+			None
BESS 3	Berg River		+	+	FCFP
BESS 4	Brakleegte			+	FCFP
BESS 5	Goedmans Berg	+			FCFP

*Fossil Chance Find Protocol (Section 10).

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 (dolerite) or the right kind and age (shales, sandstones) to contain fossils. Since there is a small chance that fossils from the Tierberg Formation and Tertiary calcretes 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 low.

7. 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 only some might contain fossil plant, insect, invertebrate and vertebrate material. The sands of the Quaternary period would not preserve fossils.

8. 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 fossils may occur in the mudstones, siltstones or shales of the Tierberg Formation (Ecca Group, Karoo Supergroup) and the Quaternary Calcrete, 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 for foundations and amenities 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.

Northwest cluster (PV 1, 2 and part of 5; BESS and infrastructure) - ZERO to insignificant palaeontological impact.
Southeast cluster (PV 3, 4, rest of 5; BESS and infrastructure) - MODERATE to LOW palaeontological impact (not high because the land is covered with soils).

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

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10. Fossil 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 fossil plants, vertebrates, invertebrates or trace fossils in the shales and mudstones (for example see Figure 12). 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.

11. **Appendix A** – Examples of fossils from the Tierberg Formation

Figure 12: Photographs of trace fossils that could be found in the Tierberg Formation, to assist the on-site responsible person.