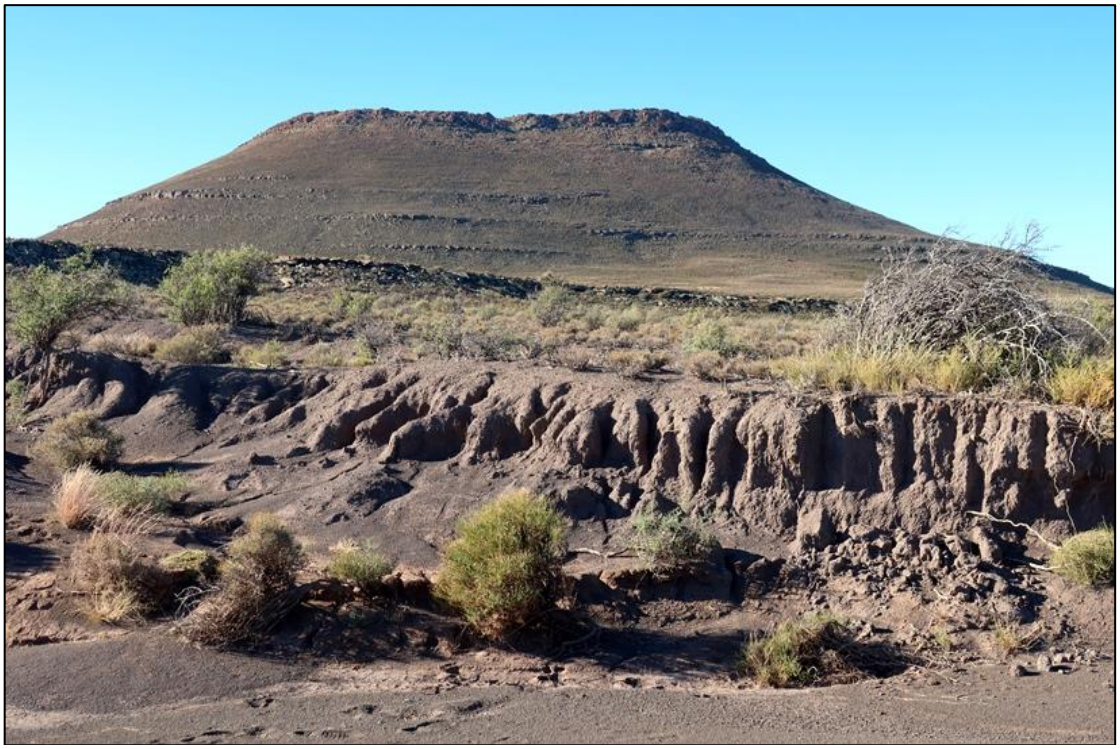

## PROPOSED HOOGLAND WIND FARMS AND GRID CONNECTION PROJECT

**SOUTHERN CLUSTER: HOOGLAND 3 WIND FARM, HOOGLAND 4 WIND FARM AND ASSOCIATED HOOGLAND SOUTHERN GRID CONNECTION, WESTERN & NORTHERN CAPE PROVINCES**

# Palaeontological Heritage


**DEFF Reference**: TBA
**Report Prepared by:** **John E. Almond (*Natura Viva* cc)**
**Issue Date:** January 2022
**Version No.:** 02

## EXECUTIVE SUMMARY

The company Red Cap Energy (Pty) Ltd and its affiliate companies is proposing to develop two wind energy facilities, the Hoogland 3 Wind Farm and Hoogland 4 Wind Farm, on adjoining sites in the Upper Karoo region south of Loxton, located in the Beaufort West Local Municipality (Central Karoo District), Western Cape Province and the Karoo Hoogland Local Municipality (Namaqua District), Northern Cape Province. Each wind farm would have a targeted nameplate capacity of up to a maximum of 420 MW and would involve the construction of no more than 60 turbines. The Hoogland Wind Farms will be connected *via* a 132 kV overhead power line to the Nuweveld Collector Substation on Red Cap's adjacent Nuweveld Wind Farms Project. Power will then be fed into the Eskom Droërivier Substation located near Beaufort West *via* the proposed Nuweveld Gridline.

The combined project area for the Hoogland 3 Wind Farm, Hoogland 4 Wind Farm and Hoogland Southern Grid Connection is underlain by continental sediments of the Lower Beaufort Group (Karoo Supergroup) of Middle to Late Permian age. Few fossil sites have been identified here previously. A limited number of new fossil sites were recorded during a ten day reconnaissance-level palaeontological heritage survey of the combined project areas (See Appendix 2 for details and satellite mapping). They include several skulls and post-cranial skeletal remains of tetrapods - mainly small-bodied therapsids such as dicynodonts and therocephalians, numerous tetrapod burrow casts, as well as low diversity trace fossil assemblages but only rare, poorly-preserved fossil wood with no other plant material.

Based on the new field data as well as desktop research it is concluded that well-preserved fossils of scientific and conservation interest are remarkably rare within the project area as a whole. This is attributed to (a) poor levels of bedrock exposure associated with generally low relief and pervasive cover by largely unfossiliferous superficial sediments; (b) extensive dolerite intrusion which has "sterilized" large volumes of potentially fossiliferous bedrocks through thermal metamorphism, leaching and secondary mineralisation, while the large dolerite outcrop areas in the uplands are completely fossil-free; (c) highly impoverished fossil biotas within the Poortjie Member (lowermost Teekloof Formation) stratigraphic interval that are associated with the catastrophic end Middle Permian Mass Extinction Event of ~260 Ma.

Most of the combined wind farm and grid connection project area has been provisionally rated as of Very High Palaeosensitivity (SAHRIS website, DFFE Screening Tool) due to the rich Permian fossil assemblages frequently recorded from the Lower Beaufort Group in the Main Karoo Basin. This sensitivity rating is *contested* here. The great majority of the fossil sites recorded within the project area are of limited scientific or conservation value (low Heritage Provisional Field Rating) and in practice the majority of the project area is of Low Palaeosensitivity. However, the occurrence of sparse, small and largely unpredictable fossil sites of High Sensitivity cannot be entirely discounted.

For the construction phase the palaeontological heritage impact significance of each of the proposed Hoogland wind farm and grid connection projects, including all the component infrastructure listed in the project descriptions, is assessed as **Low (-ve)** without mitigation and **Very Low (-ve)** following mitigation. No significant further impacts are anticipated in the Operational and Decommissioning Phases. The impact significance of the No-Go Alternative computes as **Very Low (-ve)** but on balance this would probably have a *neutral* impact on palaeontological heritage. Anticipated cumulative impacts of the closely spaced Hoogland and Nuweveld renewable energy projects in the Upper Karoo region to the south of Loxton are assessed as **Medium (-ve)** without mitigation, falling to **Low (-ve)** with full mitigation of all projects concerned. These levels of cumulative impact fall within acceptable limits.

In terms of palaeontological heritage there are no fatal flaws in the proposed Hoogland 3 Wind Farm, Hoogland 4 Wind Farm and Hoogland Southern Grid Connection renewable energy projects and there are no objections to their authorisation.

The great majority of the known fossil sites within the combined project area do not lie within or close to (≤ 20m) the proposed project footprints and no palaeontological mitigation is therefore required in their regard. The handful of sites situated close to the footprints as well as most additional, unrecorded fossil sites identified during the pre-construction or construction phase can be readily mitigated, if necessary, through a Chance Fossil Finds Protocol, as outlined in Appendix 4. Three small Very High Sensitivity palaeontological research areas previously identified during the Nuweveld WEF project on Leeu Kloof 43 lie within the Hoogland Southern Grid Connection corridor (red polygons in Figure A2-1). These are to be treated as No-Go areas for both the Nuweveld and Hoogland renewable energy projects.

The final, authorised layouts of the Hoogland 3 Wind Farm, Hoogland 4 Wind Farm and Hoogland Southern Grid Connection projects should be cross-checked against the available fossil database and other relevant resources (*e.g.* satellite imagery, geological maps) by a palaeontological specialist who should make recommendations for pre-construction phase mitigation, if any proves necessary. This might entail, for example, focused palaeontological walk-downs of selected, previously unsurveyed and potentially sensitive sectors of the project footprint, with judicious sampling or collection of threatened fossil material of scientific and / or conservation value. An approved Work Plan / Fossil Collection Permit from Heritage Western Cape / SAHRA respectively will be required by the specialist palaeontologist responsible for mitigation work.

These palaeontological mitigation measures, including the Chance Fossil Finds Protocol, should be incorporated into the EMPr for each of the Hoogland renewable energy projects.

## NATIONAL ENVIRONMENTAL MANAGEMENT ACT, 1998 (ACT NO. 107 OF 1998) AND ENVIRONMENTAL IMPACT REGULATIONS, 2014 (AS AMENDED) - REQUIREMENTS FOR SPECIALIST REPORTS (APPENDIX 6)

| **Regulation GNR 326 of 4 December 2014, as amended 7 April 2017, Appendix 6** | **Section of Report** |
|---|---|
| 1. (1) A specialist report prepared in terms of these Regulations must contain-<br>a) details of-<br>i. the specialist who prepared the report; and<br>ii. the expertise of that specialist to compile a specialist report including a curriculum vitae; | Appendix 1 |
| b) a declaration that the specialist is independent in a form as may be specified by the competent authority; | p. v |
| c) an indication of the scope of, and the purpose for which, the report was prepared; | 1 |
| (cA) an indication of the quality and age of base data used for the specialist report; | 2.3 |
| (cB) a description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change; | 7.2 & 7.3 |
| d) the date and season of the site investigation and the relevance of the season to the outcome of the assessment; | 2.3 |
| e) a description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of equipment and modelling used; | 2.3 |
| f) details of an assessment of the specific identified sensitivity of the site related to the proposed activity or activities and its associated structures and infrastructure, inclusive of a site plan identifying site alternatives; | 7 |
| 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; | Appendix 2 |
| i) a description of any assumptions made and any uncertainties or gaps in knowledge; | 2.4 |
| 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) or activities; | 5 & 6 |
| k) any mitigation measures for inclusion in the EMPr; | 8 |
| l) any conditions for inclusion in the environmental authorisation; | 8 |
| m) any monitoring requirements for inclusion in the EMPr or environmental authorisation; | 8 |
| n) a reasoned opinion-<br>i. (as to) whether the proposed activity, activities or portions thereof should be authorised;<br>(iA) regarding the acceptability of the proposed activity or activities; and<br>ii. if the opinion is that the proposed activity, activities 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; | 9 |
| o) a description of any consultation process that was undertaken during the course of preparing the specialist report; | n/a |
| p) a summary and copies of any comments received during any consultation process and where applicable all responses thereto; and | n/a |
| q) any other information requested by the competent authority. | |
| 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. | |

environmental affairs
Department:
Environmental Affairs
REPUBLIC OF SOUTH AFRICA

DETAILS OF THE SPECIALIST, DECLARATION OF INTEREST AND UNDERTAKING UNDER OATH

| | (For official use only) |
|---|---|
| File Reference Number: | |
| NEAS Reference Number: | DEA/EIA/ |
| Date Received: | |

Application for authorisation in terms of the National Environmental Management Act, Act No. 107 of 1998, as amended and the Environmental Impact Assessment (EIA) Regulations, 2014, as amended (the Regulations)

**PROJECT TITLE**

**PROPOSED HOOGLAND WIND FARMS: HOOGLAND 3 WIND FARM, HOOGLAND 4 WIND FARM & HOOGLAND SOUTHERN GRID CONNECTION**

**Kindly note the following:**

1. This form must always be used for applications that must be subjected to Basic Assessment or Scoping & Environmental Impact Reporting where this Department is the Competent Authority.
2. This form is current as of 01 September 2018. It is the responsibility of the Applicant / Environmental Assessment Practitioner (EAP) to ascertain whether subsequent versions of the form have been published or produced by the Competent Authority. The latest available Departmental templates are available at https://www.environment.gov.za/documents/forms.
3. A copy of this form containing original signatures must be appended to all Draft and Final Reports submitted to the department for consideration.
4. All documentation delivered to the physical address contained in this form must be delivered during the official Departmental Officer Hours which is visible on the Departmental gate.
5. All EIA related documents (includes application forms, reports or any EIA related submissions) that are faxed; emailed; delivered to Security or placed in the Departmental Tender Box will not be accepted, only hardcopy submissions are accepted.

**Departmental Details**

**Postal address:**
Department of Environmental Affairs
Attention: Chief Director: Integrated Environmental Authorisations
Private Bag X447
Pretoria
0001

**Physical address**:
Department of Environmental Affairs
Attention: Chief Director: Integrated Environmental Authorisations
Environment House
473 Steve Biko Road
Arcadia

Queries must be directed to the Directorate: Coordination, Strategic Planning and Support at:
Email: EIAAdmin@environment.gov.za

## SPECIALIST INFORMATION

| | | | | |
|---|---|---|---|---|
| Specialist Company Name: | NATURA VIVA CC | | | |
| B-BBEE | Contribution level (indicate 1 to 8 or non-compliant) | 4 | Percentage Procurement recognition | 100 |
| Specialist name: | Dr John Edward Almond | | | |
| Specialist Qualifications: | PhD (palaeontology) | | | |
| Professional affiliation/registration: | Palaeontological Society of Southern Africa, Association of Professional Heritage Practitioners (W Cape) | | | |
| Physical address: | 76 Breda Park, Breda Street, Oranjezicht, CAPE TOWN, RSA | | | |
| Postal address: | 76 Breda Park, Breda Street, Oranjezicht, CAPE TOWN, RSA | | | |
| Postal code: | 8001 | Cell: | 071 947 0577 | |
| Telephone: | 021 462 3622 | Fax: | n/a | |
| E-mail: | naturaviva@universe.co.za | | | |

## DECLARATION BY THE SPECIALIST

I, **Dr John Edward Almond**, declare that –

- I act as the independent specialist 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 the specialist report relevant to this application, 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 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;
- all the particulars furnished by me in this form are true and correct; and
- I realise that a false declaration is an offence in terms of regulation 48 and is punishable in terms of section 24F of the Act.

John E. Almond

Signature of the Specialist

**NATURA VIVA CC**

Name of Company

**30 January 2022**

Date

## Contents

## LIST OF TABLES



## LIST OF FIGURES

## LIST OF APPENDICES

# LIST OF ABBREVIATIONS

| | |
|---|---|
| **DFFE** | Department of Forestry, Fisheries and the Environment |
| **ECO** | Environmental Control Officer |
| **EMPr** | Environmental Management Programme |
| **ESO** | Environmental Site Officer |
| **Ma** | Millions of years ago |
| **PIA** | Palaeontological Heritage Impact Assessment |

# 1. INTRODUCTION

Dr John E. Almond has been appointed by SLR South Africa Consulting (Pty) Ltd, on behalf of Red Cap Energy (Pty) Ltd and their affiliate companies (Red Cap Hoogland 1 (Pty) Ltd, Red Cap Hoogland 2 (Pty) Ltd, Red Cap Hoogland 3 (Pty) Ltd and Red Cap Hoogland 4 (Pty) Ltd), hereafter referred to as "Red Cap", to undertake a combined desktop and field-based Palaeontological Heritage Assessment for the proposed construction of four wind farms and associated grid connection (together known as the Hoogland Projects) in an area located between Loxton and Beaufort West in the Northern and Western Cape Provinces (Figure 1.1).

The Hoogland 1 Wind Farm and Hoogland 2 Wind Farm are located to the north, closer to Loxton, and form the Northern Cluster of wind farms which will share a grid connection, named the Hoogland Northern Grid Connection. Hoogland 3 Wind Farm and Hoogland 4 Wind Farm are located closer to Beaufort West and comprise the Southern Cluster which will similarly share a separate grid connection, named the Hoogland Southern Grid Connection. The two Grid Connections are each in the form of 132 kV overhead power lines and will connect the Hoogland Wind Farms to the Nuweveld Collector Substation on Red Cap's adjacent Nuweveld Wind Farms Project. Power will then be fed into the Eskom Droërivier Substation located near Beaufort West *via* the proposed Nuweveld Gridline.

In terms of the EIA Regulations various aspects of the proposed development may have an impact on the environment and are considered to be listed activities. These activities require authorisation from the National Competent Authority (CA), namely the Department of Forestry, Fisheries and the Environment (DFFE), prior to the commencement thereof. Specialist studies have been commissioned to verify the sensitivity and assess the impacts of the wind farms under the Gazetted specialist protocols (GN R 320 and GN R 1150 of 2020).

The scope of this report is the Hoogland 3 Wind Farm and Hoogland 4 Wind Farm (the Southern Wind Farm Cluster) and the associated Hoogland Southern Grid Connection. Even though these are three separate applications, given their very similar geological underpinning and hence palaeontological heritage resources, they will be considered in the same specialist report.

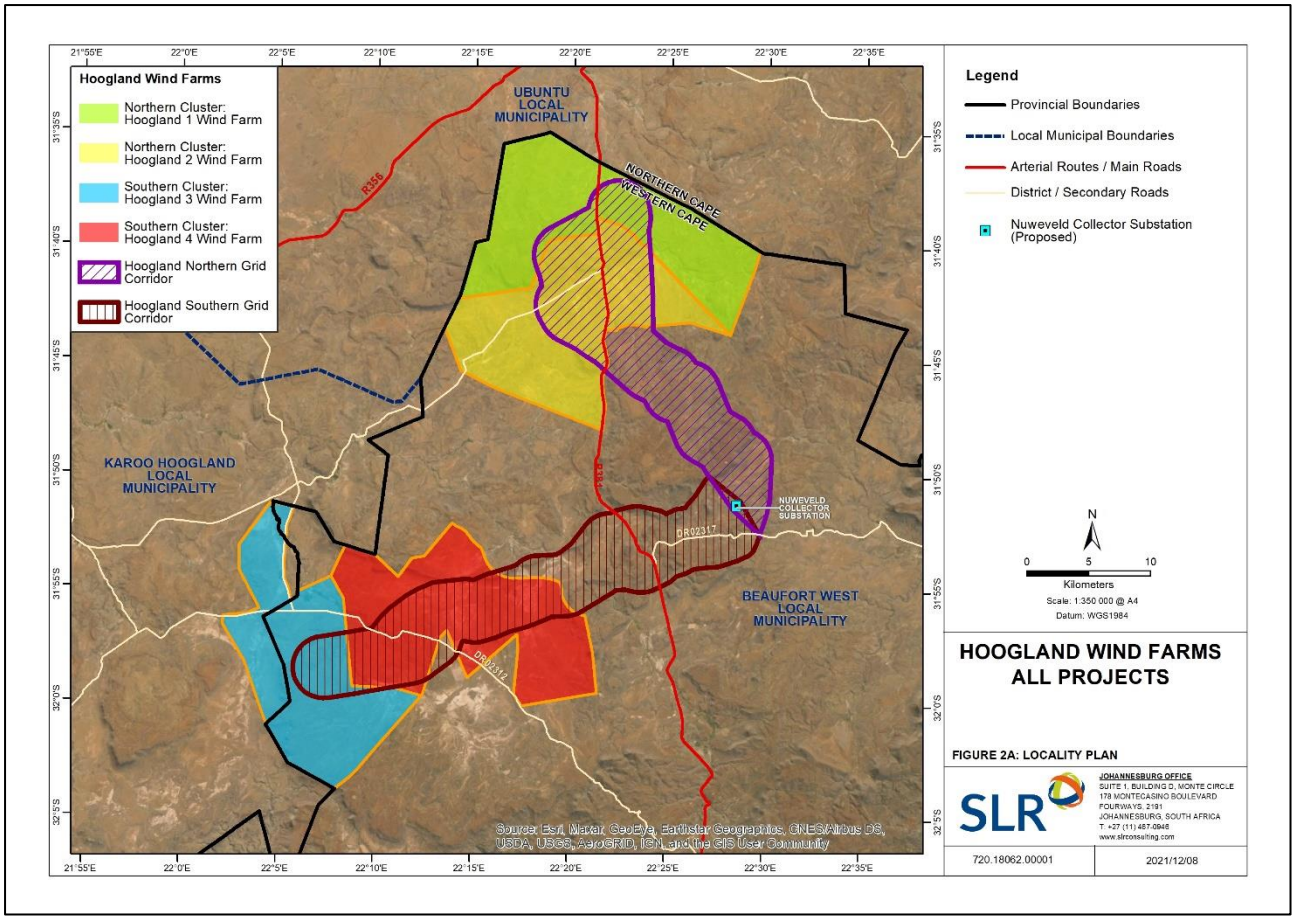


***Figure 1.1: Regional context map for the Hoogland Wind Farm projects and associated grid connections in the Upper Karoo region of the Western and Northern Cape***

# 2. ASSESSMENT METHODOLOGY

## 2.1. Specialist Credentials

Please see Appendix 1 for a short CV for the present author.

## 2.2. Terms of Reference

The present combined desktop and field-based PIA report assesses potential impacts to palaeontological heritage resources that may result from the proposed Hoogland 3 Wind Farm, Hoogland 4 Wind Farm and the associated Hoogland Southern Grid Connection. It will contribute to the over-arching Heritage Impact Assessments, coordinated by ASHA Consulting and SLR Consulting, as part of the Basic Assessment / Environmental Impact Assessment processes for these developments as well as to the relevant EMPrs.

## 2.3. Information sources and approach

This desktop and field-based palaeontological heritage study of the Hoogland Southern Wind Farm Cluster and associated Hoogland Southern Grid Connections projects was based on the following information resources:

1. A detailed project outline, kmz files, screening report and maps provided by SLR Consulting;

2. A desktop review of:

(a) the relevant 1:50 000 scale topographic maps (3222AA Reiersvlei, 3222AB Rosedene, 3122CC Vonkfontein and 3122CD Dunedin) as well as the 1:250 000 scale topographic map 3122 Victoria West,

(b) Google Earth© satellite imagery,

(c) published geological and palaeontological literature, including 1:250 000 geological maps (3122 Victoria West) and the relevant sheet explanations (Le Roux & Keyser 1988), as well as

(d) recent palaeontological heritage assessments (PIAs for the adjacent Red Cap Nuweveld projects, Hoogland 1 Wind Farm, Hoogland 2 Wind Farm and Hoogland Northern Grid Connection) in the Upper Karoo region near Loxton by the author (Almond 2020a-c, 2021, Almond in prep.)

3. The author's field experience with the formations concerned and their palaeontological heritage (*cf* Almond & Pether 2008 and PIA reports listed in the References); and

4. A ten-day field assessment of the combined Hoogland 3 Wind Farm, Hoogland 4 Wind Farm and Hoogland Northern Grid Connection project areas, including portions of all previously unsurveyed land parcels involved, by the author and an experienced field assistant (Ms Madelon Tusenius, *Natura Viva* cc), during the period 11 to 18 May as well as 24 to 26 May 2021. This study also makes reference to field data for sectors of the Southern Grid Connection corridor that overlap the project area of the Nuweveld Wind Farm cluster and that were previously assessed by Almond (2020a-c, 2021).

The season in which the site visit took place has no critical bearing on the palaeontological study.

*Study approach*

In preparing a palaeontological desktop study the potentially fossiliferous rock units (groups, formations, members *etc.*) represented within the study area are determined from geological maps and satellite images. The known fossil heritage within each rock unit is inventoried from the published scientific literature, previous palaeontological impact studies in the same region, and the author's field experience (consultation with professional colleagues as well as examination of institutional fossil collections may play a role here, or later following scoping during the compilation of the final report). This data is then used to assess the palaeontological sensitivity of each rock unit to development (provisional tabulations of palaeontological

sensitivity of all formations in the Northern Cape and Western Cape have already been compiled by J. Almond and colleagues; *e.g.* Almond & Pether 2008a, 2008b) and are shown on the palaeosensitivity map on the SAHRIS (South African Heritage Resources Information System) website. Based on the new desktop and field data, the provisional palaeosensitivity mapping shown by the DFFE Screening Tool is addressed (Appendix 3). The likely impact of the development on local fossil heritage is then determined on the basis of (1) the palaeontological sensitivity of the rock units concerned and (2) the nature and scale of the development itself, most notably the extent of fresh bedrock excavation and ground clearance envisaged. When rock units of moderate to high palaeontological sensitivity are present within the development footprint, a field assessment study by a professional palaeontologist is usually warranted.

The focus of palaeontological field assessment is *not* simply to survey the development footprint or even the development area as a whole (*e.g.* farms or other parcels of land concerned in the development). Rather, the palaeontologist seeks to assess or predict the diversity, density and distribution of fossils within and beneath the study area, as well as their heritage or scientific interest. This is primarily achieved through a careful field examination of one or more *representative* exposures of all the sedimentary rock units present (*N.B.* Metamorphic and igneous rocks rarely contain fossils). The best rock exposures are generally those that are easily accessible, extensive, fresh (*i.e.* unweathered) and include a large fraction of the stratigraphic unit concerned (*e.g.* formation). These exposures may be natural or artificial and include, for example, rocky outcrops in stream or river banks, cliffs, quarries, dams, dongas, open building excavations or road and railway cuttings. Consolidated as well as uncemented superficial deposits, such as alluvium, scree or wind-blown sands, may occasionally contain fossils and should also be included in the field study where they are well-represented in the study area. It is occasional practice for palaeontologists responsible for palaeontological impact assessments to collect representative, well-localised (*e.g.* GPS and stratigraphic data) samples of fossil material during field assessment studies. In order to do so, an approved Work Plan from Heritage Western Cape (HWC) is required or Fossil Collection Permit from SAHRA (Northern Cape Province sites).

Note that while fossil localities recorded during field work within the study area itself are obviously highly relevant, most fossil heritage here is embedded within rocks beneath the land surface or obscured by surface deposits (soil, alluvium, *etc.*) and by vegetation cover. In many cases where levels of fresh (*i.e.* unweathered) bedrock exposure are low, the hidden fossil resources have to be *inferred* from palaeontological observations made from better exposures of the same formations elsewhere in the region but outside the immediate study area. Therefore a palaeontologist might reasonably spend as much, or even far *more*, time examining road cuts and borrow pits close to, but outside, the study area / project footprint than within the study area / project footprint itself. Field data from localities even further afield (*e.g.* an adjacent province) may also be adduced to build up a realistic picture of the likely fossil heritage within the study area.

Given (1) the large project areas concerned with the Hoogland 3 Wind Farm, Hoogland 4 Wind Farm and Hoogland Southern Grid Connection projects and (2) the generally limited bedrock exposure in this region of the Great Karoo, the palaeontological heritage field study largely entailed the examination of selected potentially fossiliferous sites with good Beaufort Group mudrock exposure – especially along drainage lines as well as hillslopes and erosion gullies. Since previous field experience shows that in the lower part of the

Beaufort Group outcrop area important fossil sites may also occur in association with crevasse splay and channel sandstones, a representative selection of such sites as well as good sections through Late Caenozoic alluvial deposits were also examined. It is emphasised that it is simply *not* practicable to record all, or even a major portion, of fossil sites within such a large area within the course of a few days' fieldwork, and that the occurrence of fossils at surface in the Great Karoo has a large element of unpredictability. Several fossil sites were discovered simply by chance. It is therefore inevitable that the recent site visit can only hope to locate a *representative subsample* of surface fossil sites present within the wind farm and grid connection project areas. The absence of recorded sites within an area does *not* therefore mean that palaeontologically significant material is not present there, either on or beneath the ground surface.

## 2.4. Assumptions and Limitations

The accuracy and reliability of palaeontological specialist studies as components of heritage impact assessments are generally limited by the following constraints:

- Inadequate database for fossil heritage for much of the RSA, given the large size of the country and the small number of professional palaeontologists carrying out fieldwork here. Most development study areas have never been surveyed by a palaeontologist.

- Variable accuracy of geological maps which underpin these desktop studies. For large areas of terrain these maps are largely based on aerial photographs alone, without ground-truthing. The maps generally depict only significant ("mappable") bedrock units as well as major areas of superficial "drift" deposits (alluvium, colluvium) but for most regions give little or no idea of the level of bedrock outcrop, depth of superficial cover (soil *etc*), degree of bedrock weathering or levels of small-scale tectonic deformation, such as cleavage. All of these factors may have a major influence on the impact significance of a given development on fossil heritage and can only be reliably assessed in the field.

- Inadequate sheet explanations for geological maps, with little or no attention paid to palaeontological issues in many cases, including poor locality information.

- The extensive relevant palaeontological "grey literature" - in the form of unpublished university theses, impact studies and other reports (*e.g*. of commercial mining companies) - that is not readily available for desktop studies.

- Absence of a comprehensive computerised database of fossil collections in major RSA institutions which can be consulted for impact studies.

In the case of palaeontological desktop studies without supporting Phase 1 field assessments these limitations may variously lead to either:

- *underestimation* of the palaeontological significance of a given study area due to ignorance of significant recorded or unrecorded fossils preserved there, or

- *overestimation* of the palaeontological sensitivity of a study area, for example when originally rich fossil assemblages inferred from geological maps have in fact been destroyed by tectonism or weathering, or are buried beneath a thick mantle of unfossiliferous “drift” (soil, alluvium *etc*).

Since most areas of the RSA have not been studied palaeontologically, a palaeontological desktop study usually entails *inferring* the presence of buried fossil heritage within the study area from relevant fossil data collected from similar or the same rock units elsewhere, sometimes at localities far away. Where substantial exposures of bedrocks or potentially fossiliferous superficial sediments are present in the study area, the reliability of a palaeontological impact assessment may be significantly enhanced through field assessment by a professional palaeontologist, as in the case of the present study.

In the case of the combined Hoogland 3 Wind Farm, Hoogland 4 Wind Farm and Hoogland Southern Grid Connection project area exposure of potentially fossiliferous sedimentary bedrocks is often very poor, especially in areas of low relief where it is highly constrained by extensive superficial deposits, as well as, to a lesser extent, by shrubby vegetation, and in uplands underpinned by large dolerite intrusions. The project area is very extensive (> 34 500 ha for the Southern Wind Farm Cluster, and 21 000 ha for the Southern Grid Connection corridor), much of it with relatively few access roads. Unavoidably, only a small fraction of the entire project area could be surveyed on foot within the time available (*c*. 10 days).

Nevertheless, sufficient exposures of Karoo Supergroup bedrocks (including several of excellent quality) as well as sections through Late Caenozoic superficial deposits were examined during the course of the ten-day field study to assess the palaeontological heritage sensitivity of the main rock units represented within the combined Hoogland 3 Wind Farm, Hoogland 4 Wind Farm and Hoogland Southern Grid Connection study area (See palaeontological data table in Appendix 2). Since parts of the grid connection project area lying outside the Hoogland 3 Wind Farm and Hoogland 4 Wind Farm have already been recently assessed by the author (Almond 2021a-c, 2021), these sectors are only treated at a desktop level in the present report *i.e.* no further field work was undertaken for these areas.

Comparatively few academic palaeontological studies or palaeontological impact assessments have been carried-out hitherto in this region of the Great Karoo, so any new data from impact studies here are of scientific interest. Confidence levels for this impact assessment are rated as *medium*, despite the unavoidable constraints of limited time and access in the project area.

## 3. LEGAL REQUIREMENTS AND GUIDELINES

The present combined desktop and field-based palaeontological heritage report falls under Sections 35 and 38 (Heritage Resources Management) of the South African Heritage Resources Act (Act No. 25 of 1999), and it will also inform the EMPr for this project.

The various categories of heritage resources recognised as part of the National Estate in Section 3 of the National Heritage Resources Act include, among others:

- geological sites of scientific or cultural importance;
- palaeontological sites;
- palaeontological objects and material, meteorites and rare geological specimens.

According to Section 35 of the National Heritage Resources Act, dealing with archaeology, palaeontology and meteorites:

(1) The protection of archaeological and palaeontological sites and material and meteorites is the responsibility of a provincial heritage resources authority.

(2) All archaeological objects, palaeontological material and meteorites are the property of the State.

(3) Any person who discovers archaeological or palaeontological objects or material or a meteorite in the course of development or agricultural activity must immediately report the find to the responsible heritage resources authority, or to the nearest local authority offices or museum, which must immediately notify such heritage resources authority.

(4) No person may, without a permit issued by the responsible heritage resources authority—

(a) destroy, damage, excavate, alter, deface or otherwise disturb any archaeological or palaeontological site or any meteorite;

(b) destroy, damage, excavate, remove from its original position, collect or own any archaeological or palaeontological material or object or any meteorite;

(c) trade in, sell for private gain, export or attempt to export from the Republic any category of archaeological or palaeontological material or object, or any meteorite; or

(d) bring onto or use at an archaeological or palaeontological site any excavation equipment or any equipment which assist in the detection or recovery of metals or archaeological and palaeontological material or objects, or use such equipment for the recovery of meteorites.

(5) When the responsible heritage resources authority has reasonable cause to believe that any activity or development which will destroy, damage or alter any archaeological or palaeontological site is under way, and where no application for a permit has been submitted and no heritage resources management procedure in terms of section 38 has been followed, it may—

(a) serve on the owner or occupier of the site or on the person undertaking such development an order for the development to cease immediately for such period as is specified in the order;

(b) carry out an investigation for the purpose of obtaining information on whether or not an archaeological or palaeontological site exists and whether mitigation is necessary;

(c) if mitigation is deemed by the heritage resources authority to be necessary, assist the person on whom the order has been served under paragraph *(a)* to apply for a permit as required in subsection (4); and

(d) recover the costs of such investigation from the owner or occupier of the land on which it is believed an archaeological or palaeontological site is located or from the person proposing to undertake the development if no application for a permit is received within two weeks of the order being served.

Minimum standards for the palaeontological component of heritage impact assessment reports (PIAs) have been published by SAHRA (2013) and by Heritage Western Cape (2021).

# 4. PROJECT DESCRIPTION

## 4.1 Project Location

The proposed renewable energy projects are located in an area located between Loxton and Beaufort West in the Beaufort West Local Municipality (Central Karoo District) of the Western Cape Province and the Karoo Hoogland Local Municipality (Namaqua District) of the Northern Cape Province (Figure 1.1).

Short project descriptions for the Hoogland 3 and Hoogland 4 Wind Farms and the Hoogland Southern Grid Connection as relevant to the PIA are included in Sections 4.2 to 4.3.

## 4.2 Wind farm components

Each wind farm requires several key components to facilitate the generation of electricity at a large scale. These include:

- Wind turbines;
- Roads;
- Underground cables and overhead medium voltage power lines (up to 33 kV);
- A substation (including and operations and maintenance area for control, operation, workshop, storage buildings / areas); and
- A battery storage facility in the vicinity of the substation.

Table 4-1 below summarizes these various wind farm components and their specifications, as well as a detailed breakdown of their impact footprints or sizes *per* wind farm. Temporary areas necessary for construction are also included. The location of these components in relation to each wind farm site is shown on Figure 4.1 and Figure 4.2

## 4.3. Site Layouts

Figure 4.1 and **Error! Reference source not found.** depict the site layout for Hoogland 3 Wind Farm and Hoogland 4 Wind Farm respectively. They differentiate between 'Roads and Cables' where cables run alongside proposed or existing roads, 'Off-road Cables' where cables will not run alongside proposed or existing roads, and the 'Internal Overhead Power Lines' where trenching is not possible and overhead cables must be spanned.

The site layout for each wind farm has been through various iterations during the Screening and Initial Design Phases. The current Pre-application layout makes provision for a number of potential turbine positions specific to each wind farm with associated infrastructure, as shown in the following figures.

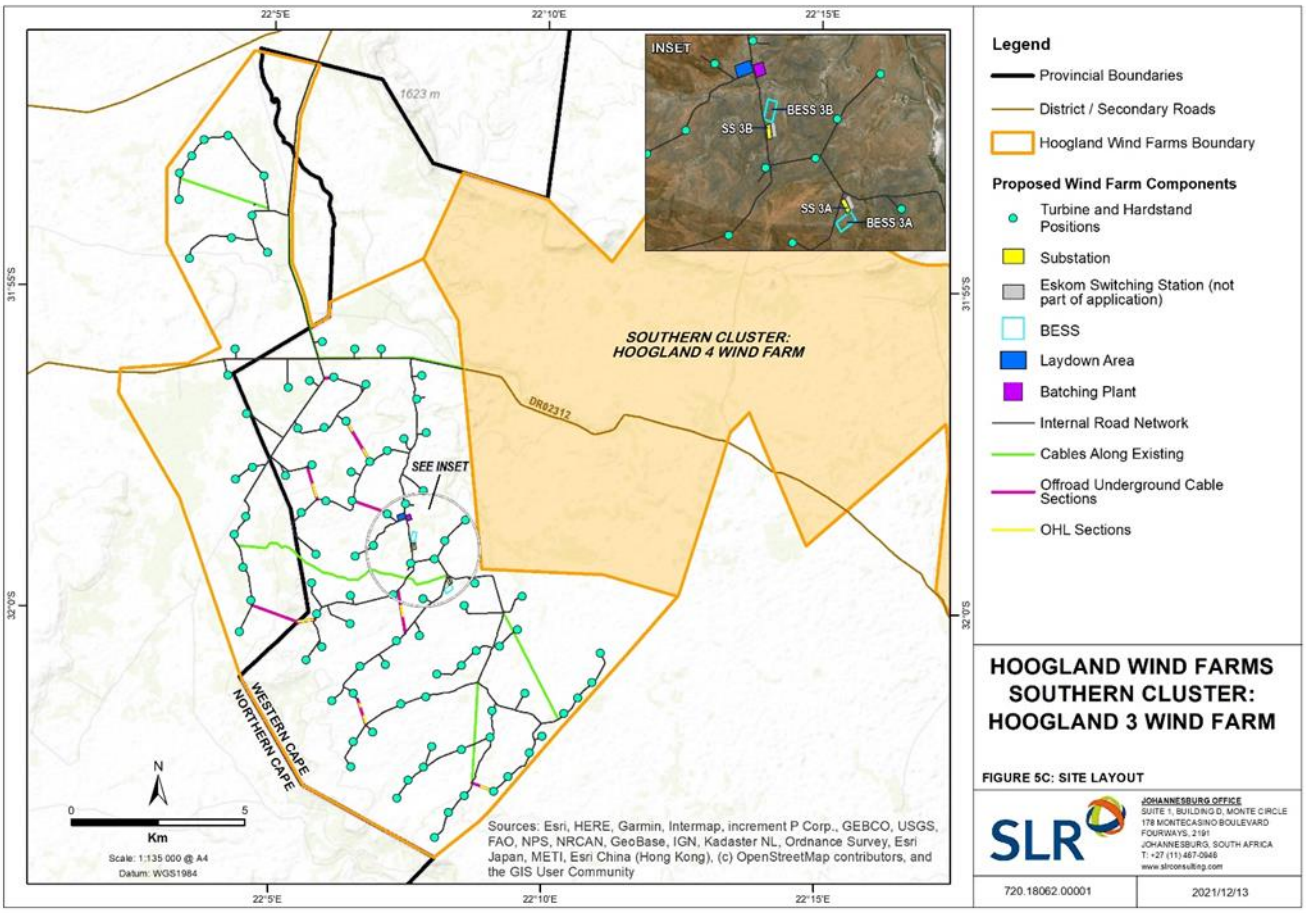


***Figure 4.1: Proposed layout for Hoogland 3 Wind Farm***

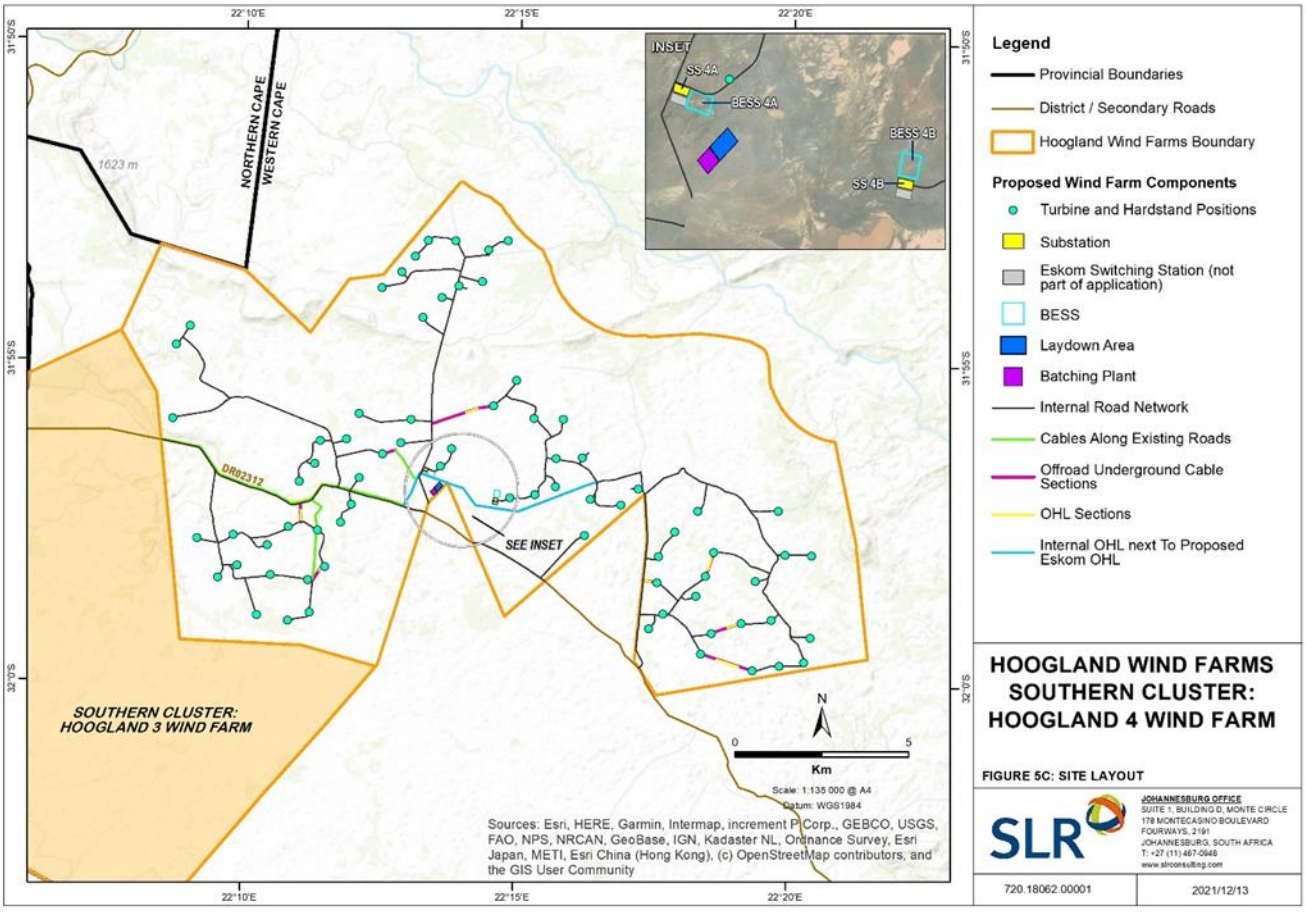


***Figure 4.2: Proposed layout for Hoogland 4 Wind Farm***

***Table 4-1: Summary of the components, specifications, and approximate areas of impact of each of the Hoogland Southern Cluster Wind Farms based on a maximum of 60 turbines****

| Project Components | Description | Hoogland 3 | Hoogland 4 |
|---|---|---|---|
| **Location** | Central coordinates: | 31°58'23.64"S, 22° 6'31.47"E | 31°56'29.28"S, 22°14'23.12"E |
| **Access** | For commuter traffic and some small loads, access from the south would be via Beaufort West via the N1 and R381 travelling between Beaufort West and Loxton. For abnormal loads the main access routes for each wind farm are as follows: | | |
| **Extent** | The total area of the site being considered for developing each wind farm: | 15,937 ha | 18,609 ha |
| **Number of wind turbines and generation capacity** | Up to a maximum of 60 wind turbines per wind farm will be developed. The targeted nameplate generation capacity for each wind farm is up to a maximum of 420 MW. | 60 | 60 |
| | However, the number of turbines included in the layout for approval for each wind farm is as follows: | 98 | 74 |
| **Wind turbine specifications** | ● Rotor diameter: 100 m to 195 m (50 m to 97.5 m blade / radius) | - | - |

| Project Components | Description | Hoogland 3 | Hoogland 4 |
|---|---|---|---|
| | ● Hub height: 80 m to 150 m<br>● Rotor top tip height: 130 m to 247.5 m (maximum based on 150 m hub + 97.5 m blade = 247.5 m)<br>● Rotor bottom tip height: minimum of 20 m (and not lower). | | |
| **Turbine Foundations** | Each turbine will have a circular foundation with a diameter of up to 35 m, alongside the 40 m hardstand (1,400 $m^2$). The permanent total footprint is as follows: | 8.4 ha (permanent) | 8.4 ha (permanent) |
| **Turbine Hardstands and Laydown Areas** | Each turbine will have a permanent crane pad of 80 m x 40 m placed adjacent to each turbine foundation. The total permanent footprints are as follows: | 19.2 ha (permanent) | 19.2 ha (permanent) |
| | An additional 20 m x 40 m of temporary hardstand area will also be required near each of the crane pads. Further, a blade laydown area of 104 m x 20 m and an additional embankment area (where necessary due to slopes) of approximately 104 m x 5 m will be required. A temporary crane boom assembly area of 120 x 15 m will also be accommodated.<br>Temporary areas are up to a maximum of a maximum of 5,200 $m^2$ per turbine. The total temporary footprints per wind farm are as follows: | 31.2 ha (temporary) | 31.2 ha (temporary) |
| **Cabling** | Turbines to be connected to on-site substation via up to 33 kV cables. Cables to be laid underground in trenches mainly adjacent to proposed wind farm roads (as part of the temporary impact of 'Site roads' below) but in some instances the cables will deviate from the road.<br>Such sections of off-road cables amount to the following length and footprint: | 5.3 km<br>3.2 ha<br>(temporary) | 7 km<br>4.2 ha<br>(temporary) |
| | Where it has been possible, cables have been routed along existing local roads.<br>Note that cables running next to public roads will not be able to run within the road reserve, but as close as possible to the road reserve in the adjacent private owned land.<br>These have the following length and footprint: | 24.2 km<br>14.5 ha<br>(temporary) | 11.5 km<br>6.9 ha<br>(temporary) |
| **Internal wind farm overhead power lines** | In limited instances, overhead monopole lines will be used where burying is not possible due to technical, geological, environmental or topographical constraints. Up to 33 kV overhead power lines supported by 132 kV monopole style pylons of up to 20 m high will be required, as well as tracks for access to the pylons.<br>The total length of the line and the footprint of the pylons and tracks are as follows: | 2.7 km<br>1.6 ha (permanent) | 5 km<br>3 ha (permanent) |
| | Where possible, to reduce areas of new impact, sections of overhead line have been routed next to proposed Eskom overhead lines. Such sections of overhead lines have the following additional length and footprint: | 0 km<br>0 ha (permanent) | 6.7 km<br>4.0 ha (permanent) |
| **Site roads** | The total road network for each wind farm* is as follows: | 112.6 km | 106.1 km |
| | Permanent roads will be 6 m wide and over above this may require side drains on one or both sides depending on the | *90.1 ha (permanent) | * 84.9 ha (permanent) |

| Project Components | Description | Hoogland 3 | Hoogland 4 |
|---|---|---|---|
| | topography. Many roads will have underground cables running next to them.<br>The permanent footprint of the road network for each wind farm is as follows: | | |
| | An up to 15 m wide road corridor may be temporarily impacted during construction and rehabilitated to allow for a 6 m road surface after construction.<br>The temporary footprint of the road network for each wind farm is as follows: | *101.3 ha (temporary) | *95.5 ha (temporary) |
| **Wind farm Substations** | Each wind farm will have a 150 m x 75 m substation yard that will include an Operation and Maintenance (O&M) building, Substation building and a High Voltage Gantry.<br>The area for the substation yards are as follows: | 1.1 ha (permanent) | 1.1 ha (permanent) |
| **Battery energy storage system (BESS)** | Each wind farm will also potentially have a ±3.5 ha area for a battery energy storage system (BESS) which may be adjacent or slightly removed from the substation depending on the local constraints.<br>The BESS may either be connected to the wind farm substation by an underground or overhead cable or may require its own substation which would be located within the BESS footprint and would be connected directly to the Eskom switching station via a short 132 kV overhead line. | 3.5 ha (permanent) | 3.5 ha (permanent) |
| **Operations and maintenance (O&M) area** | The O&M area will include all offices, stores, workshops and laydown area. The substation building will be housed in the substation yard. | Forms part of substation yard | Forms part of substation yard |
| **Security** | Security gate and hut to be installed at most entrances to each wind farm site (estimated as 4 entrances each at 20 $m^2$).<br>No fencing around individual turbines, existing fencing shall remain around perimeter of properties.<br>Temporary and permanent yard areas to be enclosed (with access control) with an up to 2.4 m high fence. | 80 $m^2$ | 80 $m^2$ |
| **Temporary areas required for the construction / decommissioning phase** | Each wind farm will have the following temporary construction areas:<br>● Temporary site camp/s areas of ±20,000 $m^2$<br>● Batching plant area of ±2,000 $m^2$<br>● General laydown area of ± 36,000 $m^2$<br>● Each wind farm will have a bunded fuel & lubricants storage facility at the site camp.<br>Individual turbine temporary laydown areas including crane boom laydown areas, blade laydown areas and other potential temporary areas are detailed above under “turbine hardstands”. | 6 ha (temporary) | 6 ha (temporary) |
| **Total disturbance footprint** | | 156.2 ha temporary and 123.9 ha permanent | 143.8 ha temporary and 124.1 ha permanent |

*Note these areas represent more than will be impacted given the road values are based on all the turbines shown in the layout for each individual wind farm being constructed wherein reality only 60 of these turbines will be developed per wind farm.

## 4.4. Grid Connection

The remaining electrical infrastructure forms part of the Hoogland Southern Grid Connection application and is subject to a separate environmental authorisation process. This includes switching stations (adjacent to each wind farm substation) and a 132 kV line supported largely by 132 kV monopole pylons that connects to the Nuweveld Collector Substation. This will be transferred to Eskom once operational.

The components of the Southern Grid Connection are summarized in Table 4-2 below. They include a switching station on Hoogland 3 Wind Farm and a switching station on Hoogland 4 Wind Farm which are connected by two sections of 132 kV line that combine and travel towards the Nuweveld Collector Substation. The two Southern Grid Connection switching stations will collectively have a total footprint of 2.25 ha. The Southern Grid Connection is ± 40 km in length and, assuming each pylon is spaced every 260 m and has a footprint of 80 $m^2$, the respective pylon footprint is 1.23 ha. For the Southern Grid Connection, it is anticipated that the total area required for the new access tracks is up to 18 ha.

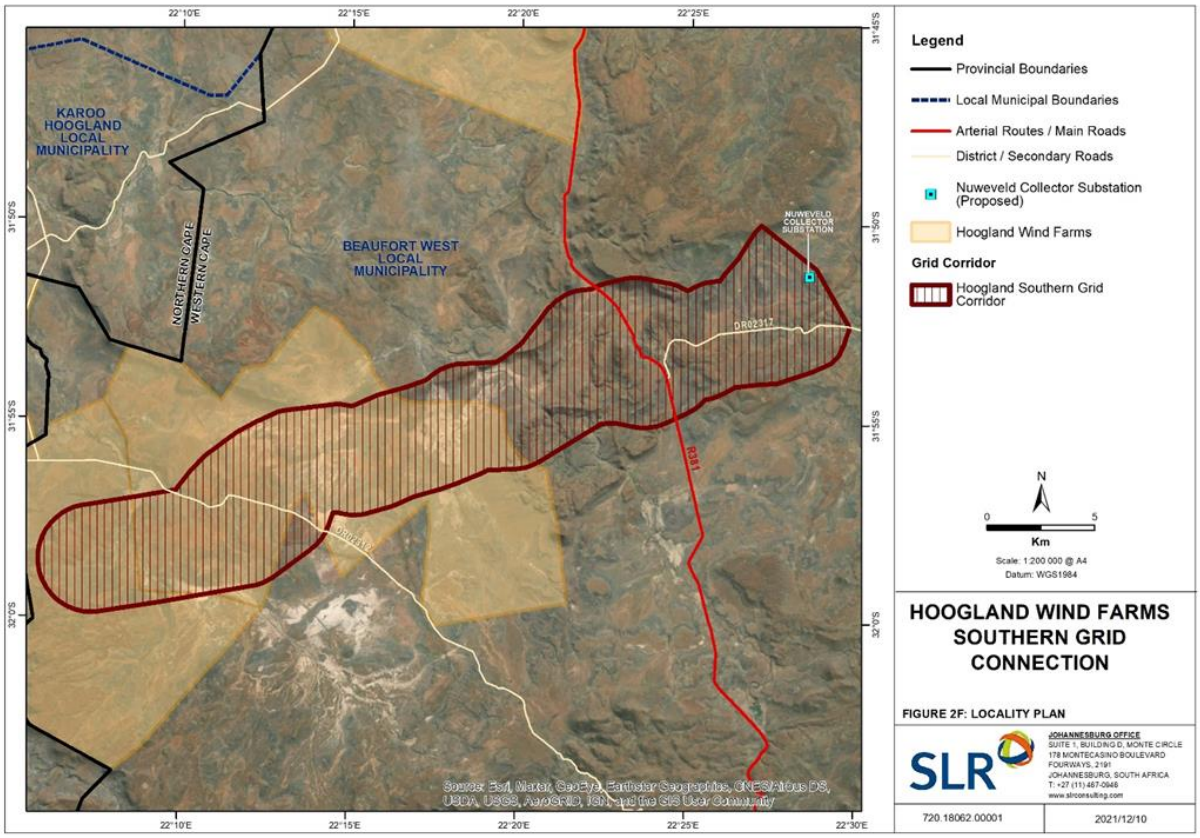


***Figure 4.3: Proposed corridor for Hoogland Southern Grid Connection***

***Table 4-2: Summary of the components and approximate areas of impact within the Southern Hoogland Grid Connection Corridor***

| Project Components | Description | Hoogland Southern Grid Connection |
|---|---|---|
| **Locations** | Switching station centre point (Hoogland 3A): | 31° 59' 32,677" S |

| Project Components | Description | Hoogland Southern Grid Connection |
|---|---|---|
| | | 22° 8' 17,653" E |
| | Switching station centre point (Hoogland 3B): | 31° 59' 0,915" S<br>22° 7' 38,208" E |
| | Switching station centre point (Hoogland 4A): | 31° 56' 43,596" S<br>22° 13' 18,334" E |
| | Switching station centre point (Hoogland 4B): | 31° 57' 11,258"" S<br>22° 14' 36,003" E |
| **Switching stations** | There will be an Eskom switching station on each wind farm with a footprint of approximately 150 x 7 m (11,250 $m^2$). Each grid connection will therefore have two switching stations in total. The switching station area will include all the standard switching station electrical equipment/components, such as bus bars, metering equipment, switchgear, and will also house control, operational, workshop and storage buildings/areas.<br>Total area for two switching stations: | 2.25 ha<br>(permanent) |
| **Overhead lines and pylons** | There will be a 132 kV overhead line supported by mostly monopole pylons approximately 32 m in height. The spans (distance between pylons) on the monopole pylons (without stays) are on average 260 m. Other types of pylons will be used where necessary.<br>The distance of each line, and respective pylon footprint is as follows: | 40 km<br>1.23 ha<br>(permanent) |
| **Access roads and tracks** | Existing access roads and tracks (upgraded to ± 2-4 m wide where needed) will be used as far as possible and new access tracks will also be ±2-4 m wide. It is anticipated that the total area required for the new access tracks is up to 18 ha. These are required for all project phases. | 18 ha<br>(permanent) |
| **Temporary areas** | Temporary laydown areas will be identified along the alignment, with the main equipment and construction yards being located along the alignment or based in one of the surrounding towns or on one of the wind farms. It is anticipated that the total area required for the temporary laydown areas is up to 5 ha. | 5 ha (temporary) |
| **Total disturbance footprint:** | **Temporary** | **5 ha** |
| **Total disturbance footprint:** | **Permanent** | **21.48 ha** |

# 5. BASELINE DESCRIPTION OF THE RECEIVING ENVIRONMENT

## 5.1. Geological context

The combined project area for the Hoogland 3 Wind Farm, Hoogland 4 Wind Farm and Hoogland Southern Grid Connection is located in the Upper Karoo region, centered some 50 km SSW of Loxton and around 60 km NNW of Beaufort West in the Beaufort West Local Municipality (Central Karoo District) of the Western Cape Province and Karoo Hoogland Local Municipality (Namaqua District) of the Northern Cape Province (Figure 1.1) (1: 250 000 topographic sheet 3122 Victoria West). The country here is semi-arid with sparse *bossieveld* vegetation and few trees, except along larger water courses (Figure 5**.1** to Figure 5**.11**). Rugged, rocky upland areas, notably in the central and southern Hoogland 3 Wind Farm, western Hoogland 4 Wind Farm and Southern Grid Connection project areas, are largely centered on major dolerite intrusions and associated resistant-weathering, baked country rocks within their extensive metamorphic aureoles. Examples include the major, west-east trending dolerite ridge rising up to 1600 m amsl., including Uitkykskop and Rooirant, that runs across the northern sector of the Hoogland 4 Wind Farm project area, the undulating Platfontein – Swartrug plateau of dolerite and metasediments in the southern portion of the Hoogland 3 Wind Farm project area whose south-western rim rises up to 1570 m amsl, as well as the dolerite sill exposed along the Sakrivier valley in the Southern Grid Connection project area. Extensive, low-lying, sandy to gravelly *vlaktes* at around 1360 to 1400 m with very little bedrock exposure make up most of the remainder of the project area (*e.g.* Karoo Plaats, Groenbergs Vlakte). The combined project area is largely drained to the north *via* the Sakrivier and its various tributaries (*e.g.* Rietfontein se Rivier).

High relief terrain with good exposure of unmetamorphosed sedimentary bedrocks is generally very limited in the Hoogland Southern Cluster project area. Hillslopes are usually mantled with doleritic colluvium while any sediments are extensively baked and altered by metasomatism *(i.e.* influenced by hot mineralising fluids) as a result of dolerite intrusion. Resistant-weathering, yellowish channel sandstones in the northwestern sector build low rocky *kranzes* with aprons of slabby rock rubble, while multi-hued mudrocks are occasionally well-exposed in river banks, stream gullies, dam overflow areas, steeper hillslopes and occasional low hills.

The sector of the Grid Connection corridor bridging the gap between the southern cluster of Hoogland WEFs and the previously assessed Nuweveld WEF project area (*cf* Almond 2020a-c, 2021) features a wide range of terrain and relief. This includes dissected, rubbly, doleritic and metasedimentary uplands bordering on the deeply-incised valley of the Sakrivier as well as wide, sandy alluvial *vlaktes* feeding into this river system from the northeast and the dolerite-capped Rooiberg Escarpment with sporadic exposure of sedimentary bedrocks on its slopes. Several areas of exceptionally good, fossiliferous mudrock exposures occur on the slopes of low *koppies* in the easternmost sector of the corridor (Almond 2020a-c, 2021).

**Figure 5.1: View eastwards across low relief terrain in the north-western sector of the Hoogland South WEF project area (Farm RE/336) with low Poortjie Member plateau in the fore- and middle-ground (HL03) and the higher, dolerite-capped escarpment at the western edge of HL04 on the skyline.**

**Figure 5.2: Undulating, low-relief terrain in the south-western sector of the WEF project area (Farm 4/28) with pervasive cover by sandy to gravelly soils and grassy karroid *bossieveld* vegetation.**

**Figure 5.3: Extensive gravel-strewn *vlaktes* in the northern sector of the HL04 WEF project area (Farm RE/37) with low doleritic hills to the west in the background.**

**Figure 5.4: Gently, gravel-mantled hillslopes to the SE of Modderpoort se Dam (Farm 1/28) showing very limited, isolated, gullied exposures of Lower Beaufort Group mudrocks.**

**Figure 5.5: Hillslope exposures of thermally metamorphosed, grey mudrocks and rusty-brown channel sandstones of the Poortjie Member, partially covered by doleritic colluvium, Farm 1/28 west of Modderpoort se Dam.**

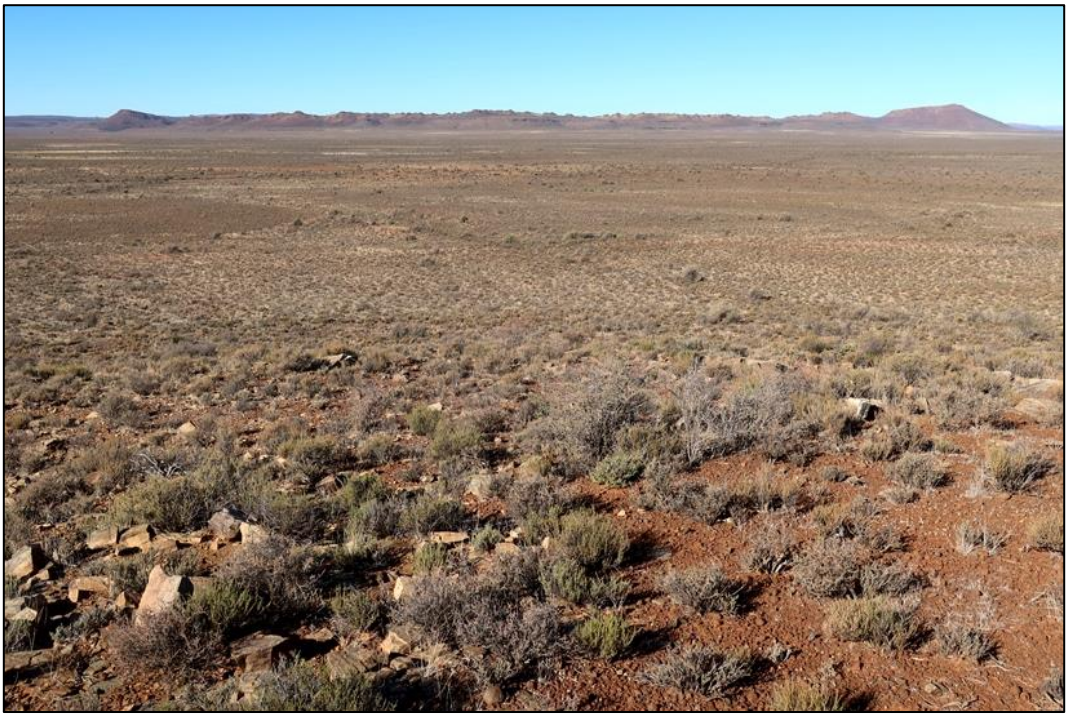

**Figure 5.6: View eastwards across low-lying, flat terrain on the eastern margins of the HL04 WEF project area (Farm RE/37) with low hills of dolerite and metamorphosed Lower Beaufort Group sediments on the skyline.**

**Figure 5.7: View to the NW into the deeply-incised valley of the Sakrivier on Farm 42, outside and south of the grid connection corridor, showing thick sandstone packages of the Poortjie Member flanking the river.**

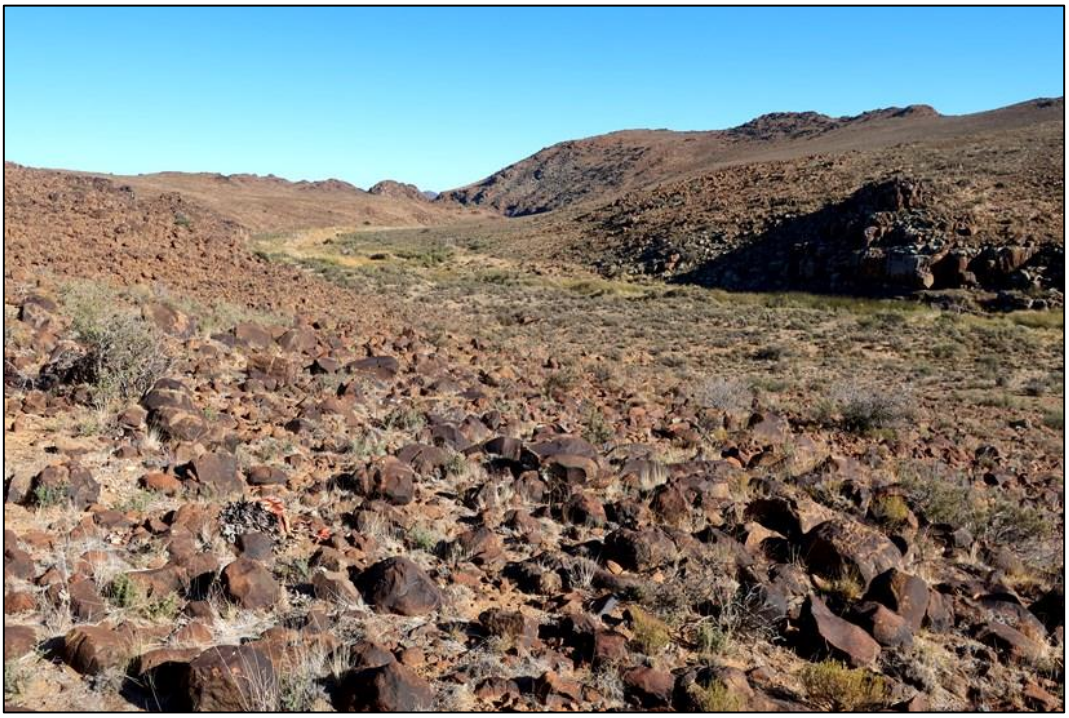

**Figure 5.8: View westwards along the Sakrivier Valley within the grid connection corridor on Farm 42. This stretch of the incised valley is dominated by a major dolerite intrusion.**

**Figure 5.9: Dissected upland terrain within the grid connection corridor on Farm 42 looking NE towards an unnamed dolerite peak (1693.4 m amsl). Potentially fossiliferous mudrock exposures here are limited to stream beds and occasional erosion gullies.**

**Figure 5.10: Alluvial *vlaktes* between dolerite hills within the grid connection corridor on Farms 21 and 40, viewed towards the SW from the R381 unpaved road between Beaufort West and Loxton.**

**Figure 5.11: View north-eastwards from the R381 towards the dolerite-capped escarpment bordering the Nuweveld WEF project area, grid connection corridor, Farm Snydersfontein 21.**

The geology of the combined Hoogland 3 Wind Farm, Hoogland 4 Wind Farm and Hoogland Southern Grid Connection project area is covered by 1: 250 000 geology sheets 3122 Victoria West and 3222 Beaufort West (Council for Geoscience, Pretoria), with short sheet explanations by Le Roux & Keyser (1988) and Johnson & Keyser (1979) respectively (Figure 5-12). (*N.B.* The geological context for the eastern sector of the Hoogland Southern Grid Connection project area which overlaps with the Redcap Nuweveld WEF and grid connection project areas has already been covered by Almond (2020a-c, 2021 and will not be repeated here).

The majority of the combined WEF and grid connection project area is underlain by continental (fluvial, lacustrine) sediments of the **Lower Beaufort Group** (**Karoo Supergroup**) of late Middle Permian to early Late Permian age (*c*. 262-257 Ma = million years ago (Johnson *et al.* 2006) that are assigned to the **Teekloof Formation** (Figure 5-37). The basal, sandstone-rich **Poortjie Member** is largely restricted to the northern half of the Hoogland 3 Wind Farm project area which features stepped terrain with low *kranzes* of yellowish-weathering channel sandstones displaying erosive, gullied bases and well-developed intraformational breccia-conglomerates. The overlying **Hoedemaker Member** of the Teekloof Formation is dominated by readily-weathered mudrocks with only a few, thin channel sandstone units and therefore generally underlies low-relief terrain, as mapped in the southern portion of the Hoogland 3 Wind Farm project area as well as most of the Hoogland 4 Wind Farm and Grid Connection project areas towards the east. Regional Early Jurassic igneous intrusion seems to have occurred preferentially into the Hoedemaker Member bedrocks and has generated an extensive network of dolerite sills and dykes, some of considerable volume, assigned to the **Karoo Dolerite Suite** of Early Jurassic age (*c*. 183 Ma) (McCarthy & Rubidge 2005, Johnson *et al.* 2006, Duncan & Marsh 2006). A large portion of the Hoedemaker Member country rocks have been intensely baked to vuggy (*i.e.* containing rounded hollows or *vugs*) hornfels and quartzite and otherwise altered by Karoo-age magmatism and associated metasomatism. It should be emphasized that the mapping of the various members within the Teekloof Formation in the region to the south of Loxton is often ambiguous and in need of revision.

Substantial thicknesses of gravelly and sandy to silty **Late Caenozoic alluvium** are associated with major drainage lines within the combined Hoogland Wind Farm project area (pale yellow areas in **Figure 5.6**) and also cover large portions of lower-lying terrain here. Older alluvial deposits, especially in areas overlying dolerite, have often been partially calcretised while calcretised spring sediments occur along several water courses where they may be associated with historical farmsteads, as on Platfontein 1/28 due south of Modderrpoort se Dam. Poorly-sorted, gravelly **colluvial and eluvial deposits** dominated by sandstone, hornfels, quartzite and dolerite rubble mantle plateau areas and most hillslopes. The rubbly doleritic colluvium is often stabilized by calcretisation while complex patterns of remobilisation and stabilisation of scree has generated striking stone stripes on some hillslopes. In general, topographic relief is subdued within most of the project area and exposure levels of potentially-fossiliferous Beaufort Group sediments, with few local exceptions, are correspondingly low to very low.

Representative exposures of the main rock units occurring within the combined Hoogland Southern Cluster project area, including Permian sediments and metasediments, Jurassic dolerites as well as Late Caenozoic superficial deposits, are illustrated in the following section of the report accompanied by short explanation of figure legends (Figures 5-12 to 5-37).

The main geological units represented on the geological maps include:

Middle Permian Abrahamskraal Formation (Lower Beaufort Group) – pale blue (Pa).

Middle to Late Permian Teekloof Formation (Lower Beaufort Group) – green / blue-green. On the Victoria West sheet this formation (Pt) is differentiated into the Ptp = Poortjie Member (Pt, stippled), Hoedmaker Member (Pth) and Oukloof Member (Pto, dark green) (Note the outcrop areas of these members are probably in need of revision). Small black symbols refer to historical fossil sites, very few of which are recorded within the Hoogland project areas.

Early Jurassic Karoo Dolerite Suite – red (Jd)

Late Caenozoic alluvium – yellow with “flying bird” symbol

N.B. Most younger superficial deposits are not mapped at 1: 250 000 scale but these obscure the older bedrocks over most of the WEF and grid project area

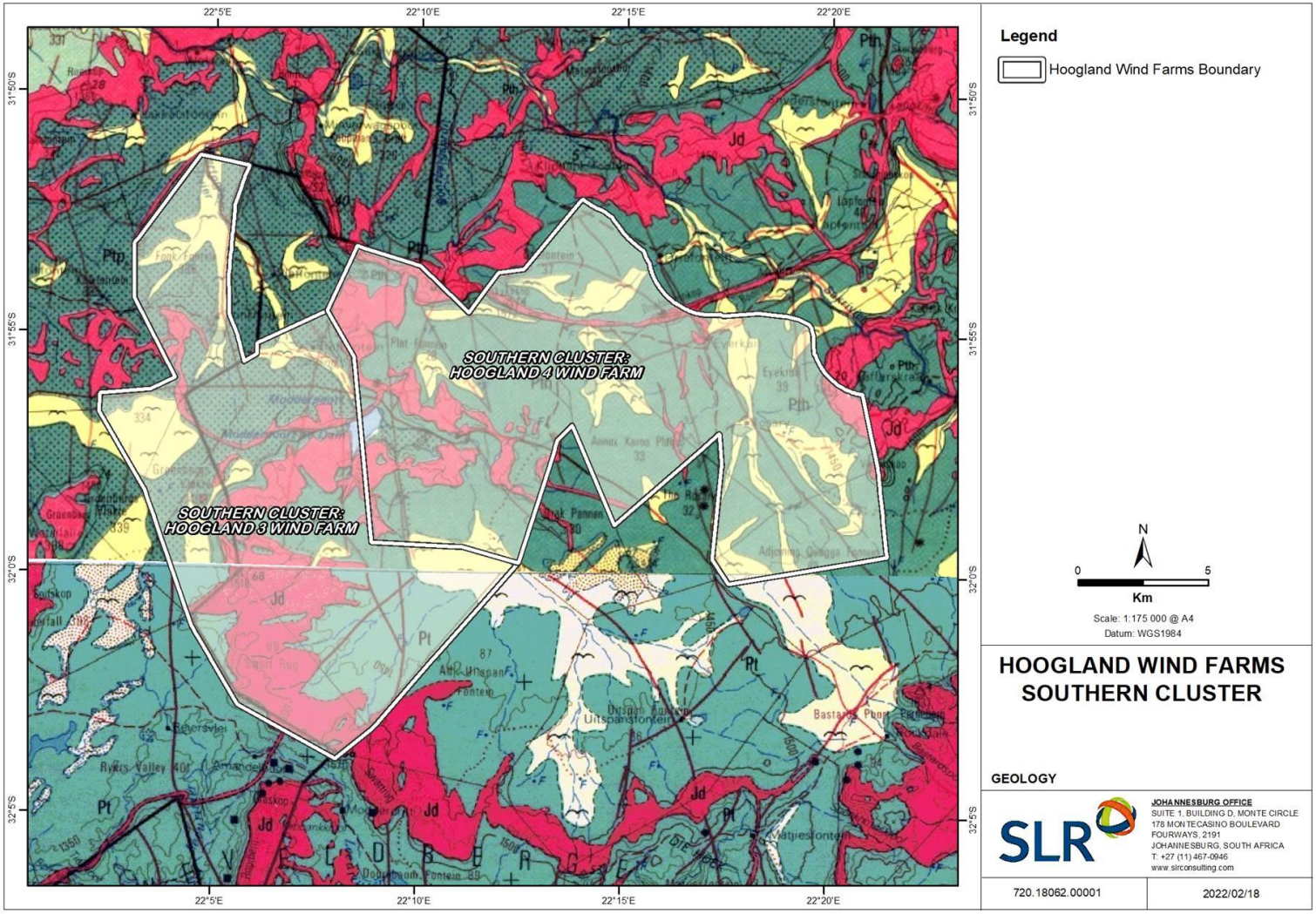


**Figure 5.12: Extract from adjoining 1: 250 000 geology sheets 3122 Victoria West (above) and 3222 Beaufort West (below) (Council for Geoscience, Pretoria) showing the location of the Hoogland south grid corridor project area (white polygon). Scale bar = 5 km (Map kindly generated by SLR Consulting).**

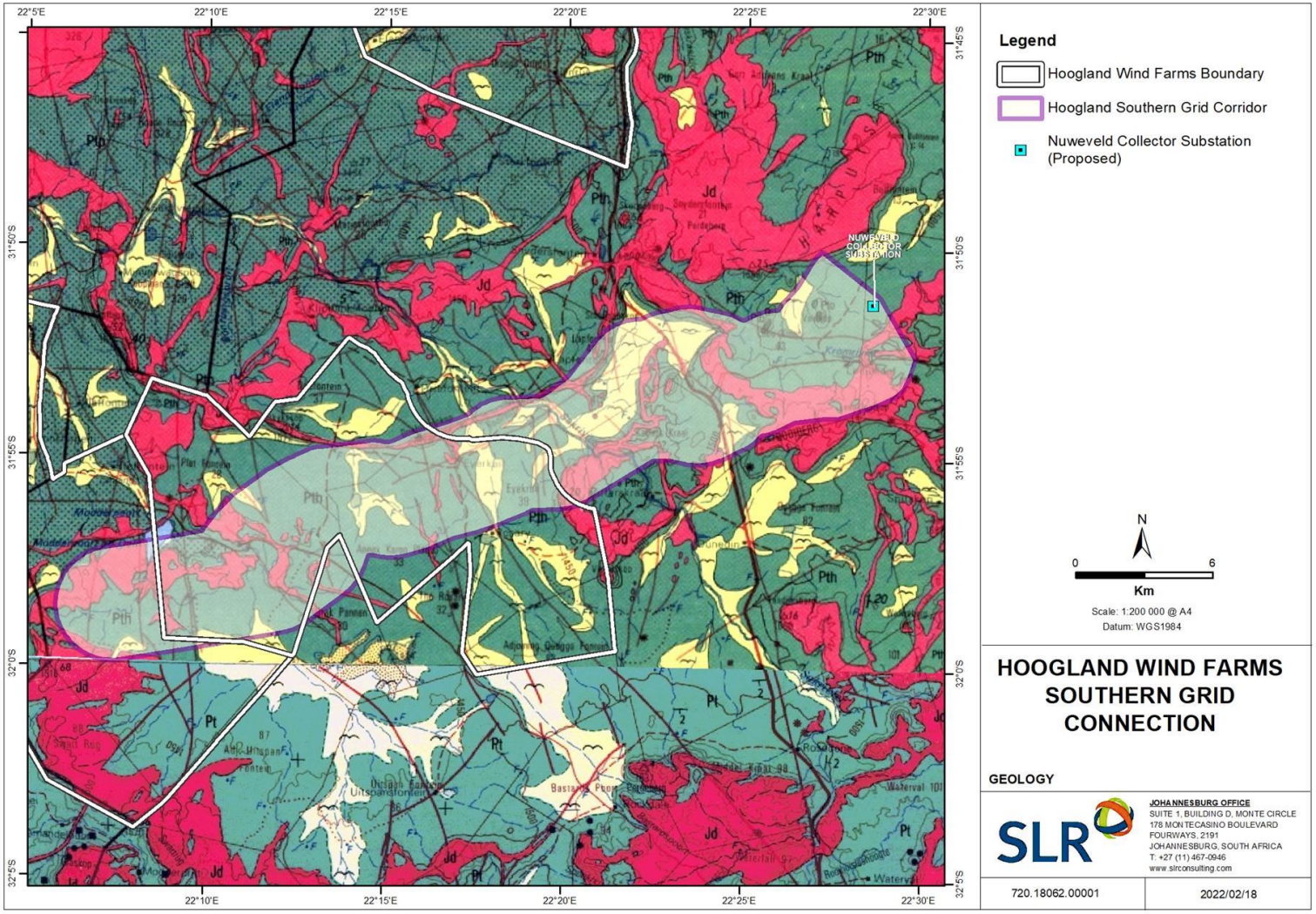


**Figure 5.13: Extract from adjoining 1: 250 000 geology sheets 3122 Victoria West (above) and 3222 Beaufort West (below) (Council for Geoscience, Pretoria) showing the location of the Hoogland 3 and 4 WEF project areas (white polygon). Scale bar = 5 km (Map kindly generated by SLR Consulting).**

**Figure 5.14: Steep riverine cliffs of baked, well-jointed Poortjie Member metasediments along the Sakrivier Valley, Farm 42, south of and outside the grid connection corridor.**

**Figure 5.15: Thick, erosive-based channel sandstone package of the Poortjie Member on Farm 2/28 showing large scale cross-bedding.**

**Figure 5.16: Cross-bedded mudclast breccias at the erosive base of a Poortjie Member channel sandstone body, Farm 2/28. The breccias occasionally contain reworked fragments of fossil bones and teeth as well as calcrete concretions.**

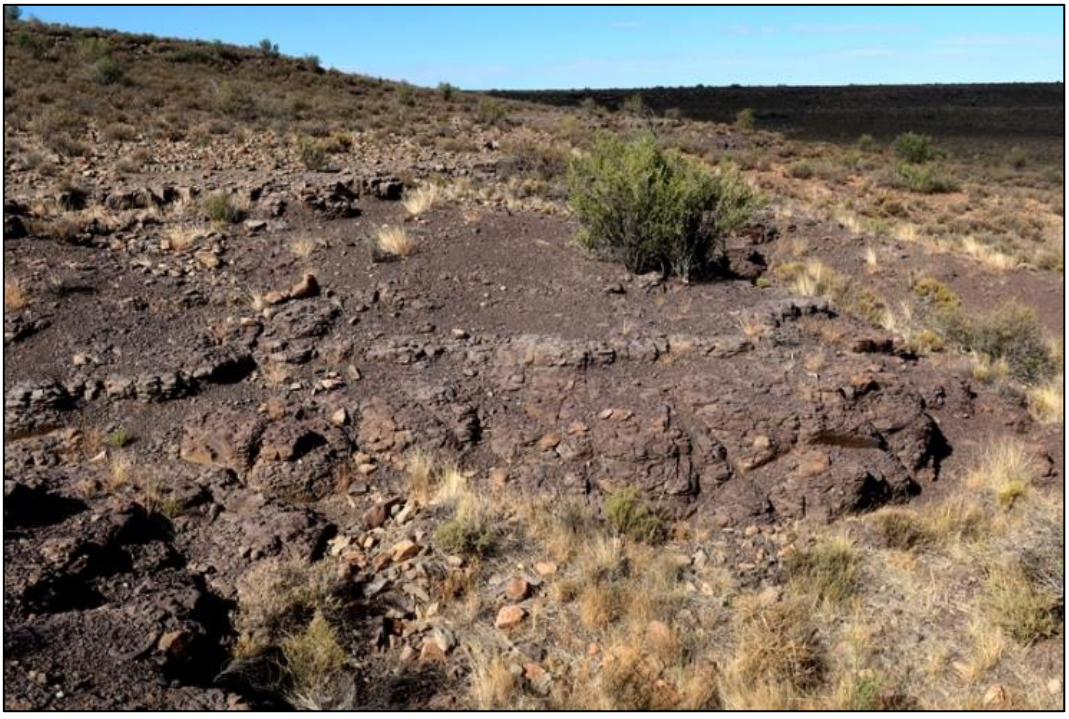

**Figure 5.17: Hillslope exposures of massive to bioturbated, purple-brown overbank mudrocks and wackes (impure sandstones) of the Poortjie Member on Farm RE/336. These beds contain sporadic to locally abundant tetrapod burrow casts.**

**Figure 5.18: Thin-bedded, ripple cross-laminated crevasse splay sandstone of the Poortjie Member on Farm RE/336. These beds were probably deposited into a shallow lake and feature a range of well-preserved invertebrate trace fossils.**

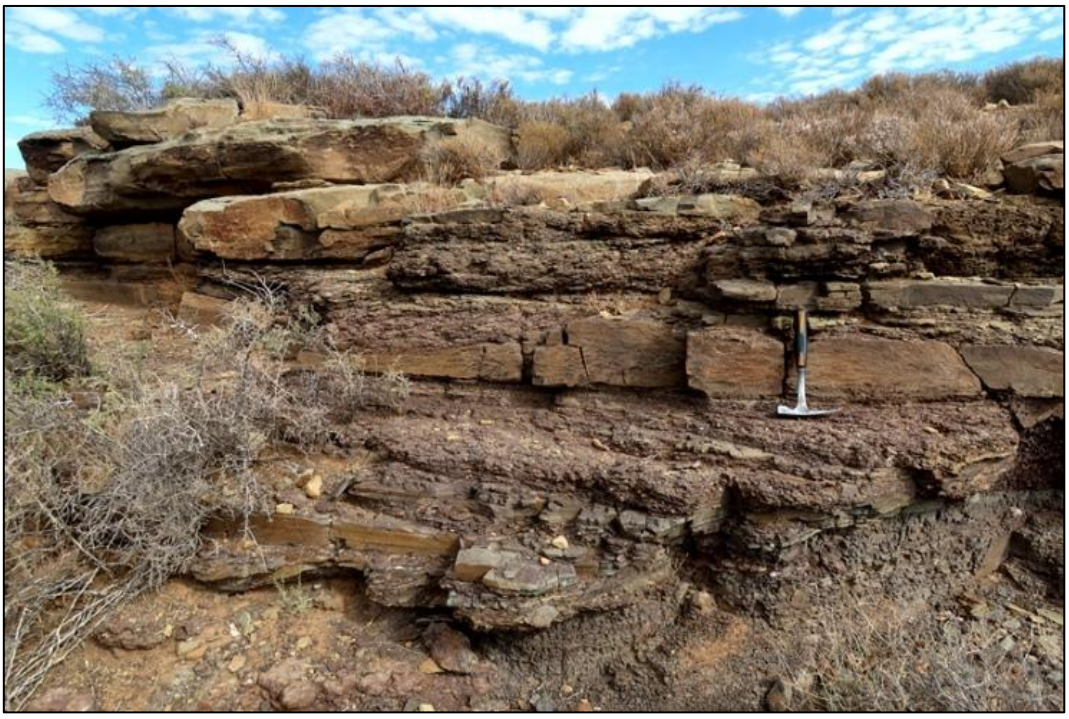

**Figure 5.19: Well-developed, multiple mudclast and calcrete glaebule basal breccio-conglomerate lenses in the Hoedemaker Member on Farm RE/37 (hammer = 30 cm).**

**Figure 5.20: Interbedded, tabular, baked sandstones and mudrocks of the Hoedemaker Member on Farm 2/28 (Hammer = 30 cm).**

**Figure 5.21: The prominent mountain Visserskop (1674 m amsl) on the SE margins of the HL04 WEF project area, Farm RE/83, showing a series of thin sandstone packages towards the base that are mapped within the Hoedemaker Member. The *koppie* is capped by a dolerite sill.**

**Figure 5.22: Stepped stream gulley exposure of baked Hoedemaker Member quartzites and hornfels with an overlying dolerite sill in the background, Farm 1/39.**

**Figure 5.23: Low, sandstone-capped hills of the Poortjie Member in the SE sector of the HL04 WF project area, Farm RE/83, with extensive slope exposure of overbank mudrocks. This portion of the project area has yielded important vertebrate fossil remains in the past but no significant new fossils were recorded here during the recent site visit.**

**Figure 5.24: Gullied hillslope exposures of massive to thin-bedded, grey-green and purple-brown mudrocks capped by channel sandstone of the Hoedemaker Member on Farm 2/39. These rocks have yielded sparse, dispersed fossil remains of small-bodied tetrapods.**

**Figure 5.25: Unusually extensive, gullied exposures of Hoedemaker Member purple-brown and grey-green overbank mudrocks in the dam overflow area on Farm 1/39. Numerous skeletal remains and burrow casts of fossil vertebrates are recorded from this area.**

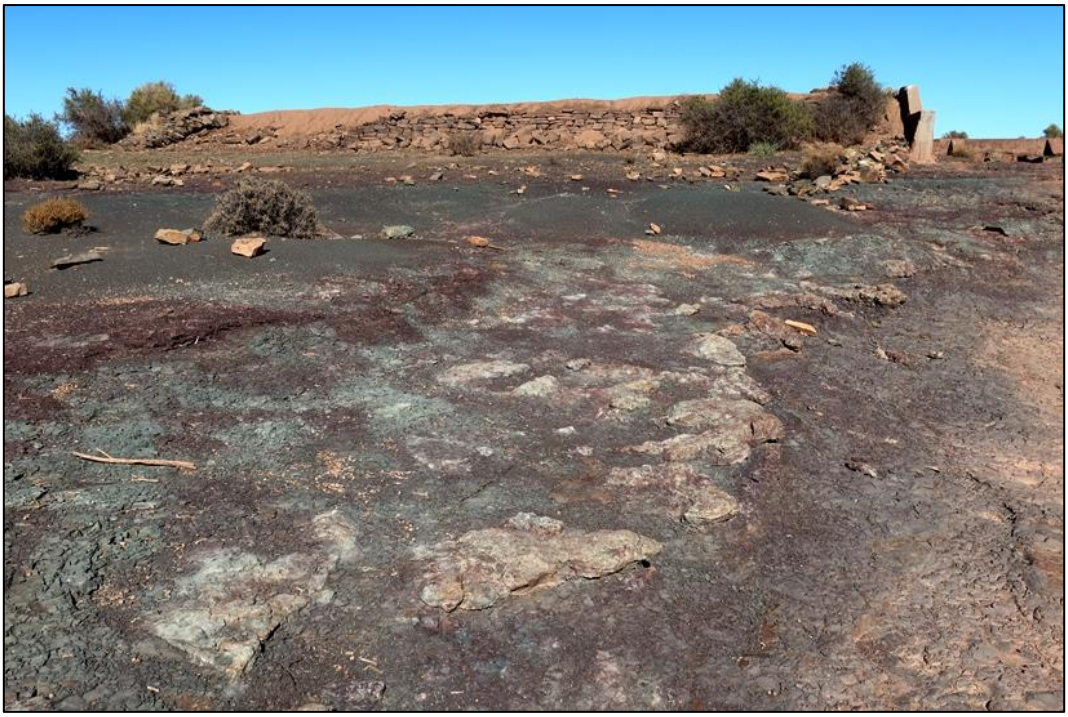

**Figure 5.26: Well-developed palaeosol horizon defined by pale grey calcrete concretions within the Hoedemaker Member, Farm 1/39. Fossil skeletal remains are often associated with such ancient arid climate soils.**

**Figure 5.27: Small wavelength wave ripples preserved on a crevasse splay sandstone bed top of the Hoedemaker Member on Farm 1/39 (hammer = 30 cm). This surface is associated with invertebrate trace fossils as well as possible tetrapod burrows.**

**Figure 5.28: Baked, grey-green overbank mudrocks and fine-grained wackes exposures along the banks and bed of a shallow stream gulley on Farm 4/28. This locality has yielded numerous thermally metamorphosed fossil skeletal remains as well as burrow casts of small tetrapods as well as thin layers of bone hash.**

**Figure 5.29: Dark, crumbly, vuggy, baked mudrocks exposed in the banks of the stream on Farm 4/28 illustrated above with dispersed, altered fossil remains (*e.g.* pale area just above green 15 cm scale).**

**Figure 5.30: Thick prism of pale, baked channel sandstone of the Beaufort Group underlying a major dolerite sill, eastern margins of Farm RE/83.**

**Figure 5.31: Striking striped pattern on hillslopes due to local remobilization of doleritic scree cover, Farm 2/28. Intervening paler areas are stabilized by shrubby and grassy vegetation.**

**Figure 5.32: Semi-consolidated, partially calcretised colluvial and alluvial debris dominated by dolerite clasts exposed along an erosive gulley, Farm RE/400.**

**Figure 5.33: Thick, fine-grained alluvial deposits associated with a tributary of the Sakrivier on the Farm Lapfontein 41 (Hammer = 30 cm). The older alluvium is partially consolidated by calcrete and contains termite tunnel trace fossils while the darker, younger alluvium contains unconsolidated gravel lenses.**

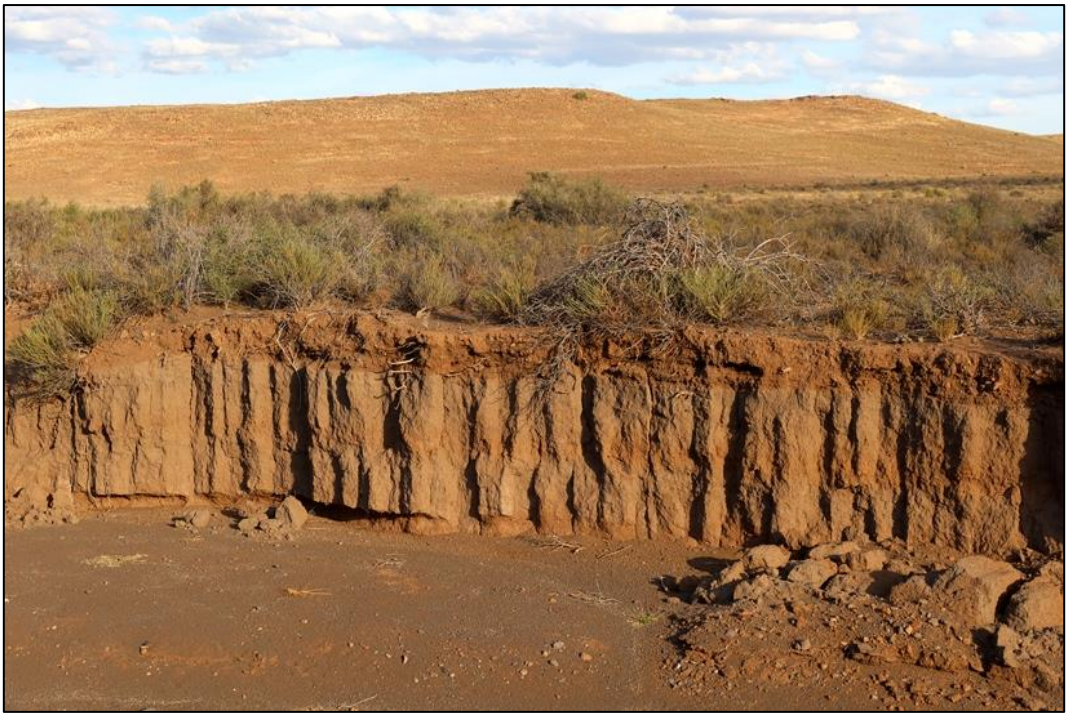

**Figure 5.34: Stream bank section through thick, well-bedded, semi-consolidated sandy alluvium along an incised drainage line on Farm 1/28.**

**Figure 5.35: Baked Hoedemaker Member bedrocks overlain by *c*. 1.5 m of gravelly and sandy alluvium on Farm 4/28 (hammer = 30 cm). The gravels are largely composed on dolerite, quartzite and hornfels clasts.**

**Figure 5.36: Extensive alluvial *vlaktes* in the eastern part of the HL04 WEF project area on Farm 1/28 with downwasted and sheet-washed surface gravels of dolerite, quartzite, hornfels and calcrete.**

**Figure 5.37: Large shallow pan areas with sun-cracked alluvial silts and sands in the southern sector of the HL04 WEF project area, Farm 33.**

### 5.2. Palaeontological heritage context

The Lower Beaufort Group of the Main Karoo Basin of South Africa is internationally famous for its remarkably rich fossil record of continental biotas (vertebrates, vascular plants, microfossils) of Middle Permian to Early Triassic age (*e.g.* Smith *et al.* 2012, 2020). These rocks and fossils span two critical mass extinction events in the history of life on Earth: the end Middle Permian Mass Extinction of *c*. 260 Ma and the Permo-Triassic Mass Extinction at *c*. 252 Ma (*cf* Rubidge 1995, 2002, McCarthy & Rubidge 2005, Day *et al.* 2015b, Day & Rubidge 2021). In general, the palaeosensitivity of the Lower Beaufort Group is accordingly rated as High to Very High (*e.g.* SAHRIS website), as also seen in the site sensitivity maps in screening reports for the Hoogland 3 Wind Farm, Hoogland 4 Wind Farm and Hoogland Southern Grid Connection based on the DFFE Screening Tool (See Appendix 3).

Based largely on tetrapod (4-legged vertebrate) fossils and the lithostratigraphy, the fossil assemblages within the Teekloof Formation cropping out in Hoogland 3 & 4 Wind Farm and Grid Connection project areas are assigned to the ***Endothiodon* AZ** which is mostly of Late Permian (late Capitanian to Mid Wuchiapingian) age (Smith *et al.* 2020, Day & Rubidge 2020, Day & Smith 2020). The newly defined *Endothiodon* AZ largely replaces the previously-defined *Pristerognathus* and *Tropidostoma* Assemblage Zones of Rubidge (1995) (See biostratigraphic chart in Figure 5-37 and illustrations of key tetrapod taxa in Figures 5-39 to 6-41). It is noted that fossils of the ***Cistecephalus* AZ** which may occur in the eastern sector of the grid connection corridor in association with small outcrop areas here of the Oukloof Member of the Teekloof Formation will not be directly impacted by the proposed development and are accordingly not considered further here (*cf* Almond 2020a-c, 2021).

Because of the regional paucity of good sedimentary bedrock exposures (especially of mudrock facies), the majority of the combined Hoogland Southern Cluster project area has remained palaeontologically unexplored until recently, with comparatively few fossil sites from the Beaufort Group marked on published geological and fossil database maps (Figure 5-12 and Figure 5-38). However, the Hoedemaker Member in the region south of Loxton has yielded several remarkable concentrations of therapsid ("mammal-like reptile") fossils of the *Endothiodon* Assemblage Zone (previously *Tropidostoma* AZ) in the neighbouring Nuweveld WEF project area (*cf* Smith 1993b, Almond 2020a-c, 2021). These palaeontological "hotspots" might reflect persistent sites of high-water tables and ponds on the ancient Karoo floodplain. Several of the key fossil sites fall within the Hoogland Southern Grid Connection Corridor (Appendix 2, Figure A2-1). Due to extensive baking of Hoedemaker Member sediments in the present Northern Hoogland Wind Farm project area, as well as very low exposure levels of this stratigraphic interval attributable to extensive cover by doleritic, quartzitic and hornfels surface gravels of colluvial / eluvial origin, comparable concentrations of *well-preserved* (as opposed to metamorphosed) therapsid fossils are not expected to occur widely in the Hoogland Southern Cluster project area.

A number of important vertebrate fossils – including rare gorgonopsians - have been collected in recent years from SE sector of the Hoogland 4 Wind Farm project area by teams from the Iziko Museums, Cape Town (J. Moolman, pers. comm., 2021). An internationally recognized Type Locality for the newly-defined *Tropidostoma – Gorgonops* Subzone - the upper part of the *Endothiodon* Assemblage Zone – has now been

designated on the farm Dunedin, located some 3 km east of the Hoogland 4 Wind Farm project area (Day & Smith 2020) (Figure A2-1). These records are responsible for the cluster of vertebrate fossil sites marked within the broader project area on recent palaeontological database maps (Figure 5-38).

New fossil records from the combined Hoogland 3 Wind Farm, Hoogland 4 Wind Farm and Hoogland Southern Grid Connection project areas are tabulated in Appendix 2 with GPS locality data, a brief description, proposed field rating and any relevant mitigation measures. Selected examples of new fossil finds are illustrated below in Figure 5-42 to Figure 5-78. Please note that the fossils recorded can only represent a small fraction of all fossil sites present at surface, let alone in the subsurface, here. The absence of recorded fossils in a given area does *not* mean they are not present.

The fossil assemblages recorded within each major sedimentary rock unit are very briefly summarized below. Given ongoing uncertainties regarding the mapping of the various members within the Teekloof Formation bedrocks, the precise stratigraphic positions of several of the fossil sites remain unclear. The published 1: 250 000 mapping (Figure 5-12) is provisionally followed in most cases.

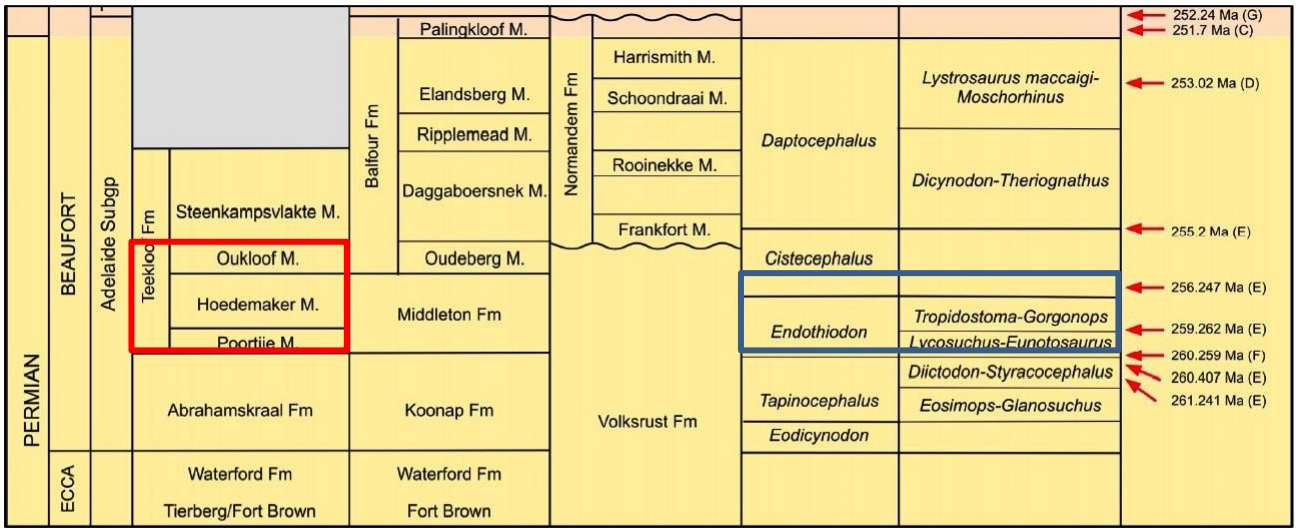


**Figure 5.38: Chart showing the latest, newly revised fossil biozonation of the Lower Beaufort Group of the Main Karoo Basin (abstracted from Smith *et al.* 2020). Rock units and fossil assemblage zones mapped within the combined Hoogland 3 Wind Farm, Hoogland 4 Wind Farm and Hoogland Southern Grid Connection project areas are outlined in red and blue respectively. Note that fossils of the *Cistecephalus* AZ may occur in the eastern sector of the grid connection corridor in association with small outcrop areas of the Oukloof Member of the Teekloof Formation (*cf* Almond 2020a-c, 2021)**

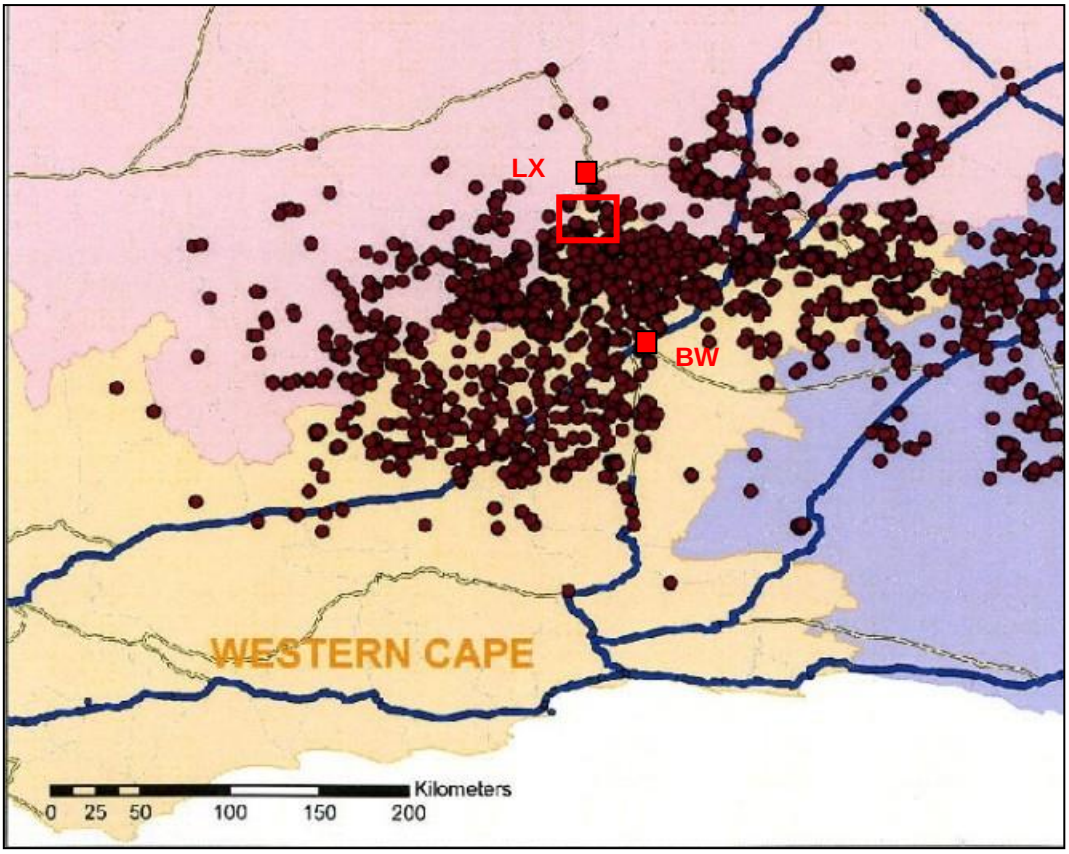


**Figure 5.39: Distribution of recorded vertebrate fossil sites within the southern portion of the Main Karoo Basin (modified from Nicolas 2007). The *approximate* location of the combined Hoogland 3, Hoogland 4 and Hoogland Southern Grid Connection project area between Beaufort West (BW) and Loxton (LX) is indicated by the small red rectangle. The lower density of previously recorded fossil sites within the northern portion of the combined WEF project area compared to areas of higher relief and bedrock exposure situated closer towards the Great Escarpment to the south is seen here. The lack of unmetamorphosed Hoedemaker Member bedrocks in the project area is probably also a factor. The higher concentration of recorded sites in the southern sector of the project area probably reflects palaeontological fieldwork by Iziko Museums (Cape Town) in the newly-defined Type Area for the upper part of the *Endothiodon* Assemblage Zone (east of and *outside* the WEF project area) as well as in the SE sector of the Hoogland 4 Wind Farm project area.**

**Poortjie Member**

Only very limited body fossil remains within the Hoogland Southern Cluster project area have been recorded from sandstone and mudrock facies within the Poortjie Member, the lowermost subunit of the Teekloof Formation. Even where levels of bedrock exposure are locally very good, fossils are generally rare within these beds, probably as a consequence of the end Middle Permian environmental crisis and associated global mass extinction event (Day & Rubidge 2021).

Scrappy, poorly-preserved skeletal remains of small-bodied tetrapods are found within baked mudrocks and pedocrete concretions on Farm 1/28 to the west of Modderpoort se dam. A concentration of interesting trace fossils occurs within the **Hoogland 5 Fossil Site** associated with good hillslope exposures of Poortjie Member mudrocks and sandstones on the western margins of Farm RE/336 (Hoogland 3 Wind Farm project area, Figure 6.3, Figure 5.62 to Figure 5.64, Figure 5.70 to Figure 5.73). Comparable occurrences are expected to

occur more widely in dissected hilly terrain elsewhere on this farm. Breccio-conglomerates at the base of or within channel sandstone bodies here contain very sparse, fragmentary reworked bone as well as occasional rusty-brown moulds of substantial woody plant axes.

A range of small-scale, hypichnial, endichnial and epichnial invertebrate burrows with simple to pelleted infills as well as microbial mat textures and possible casts of reedy plant stems are associated here with a thin but laterally extensive unit of thin-bedded, ripple-cross-laminated sandstone which was probably deposited as a crevasse-splay into a floodplain lake or pond. The underlying massive, purple-brown siltstones with ferruginous carbonate concretions contain numerous small-scale tetrapod burrow casts similar to those encountered at a similar stratigraphic level within the Hoogland Northern Cluster project area (Almond 2021, in prep). The subcylindrical to dorso-ventrally flattened burrow casts are variously subhorizontal to gently- or steeply-inclined. They are 15 to 30 cm wide higher up but sometimes show a rounded terminal expansion which probably represents a living chamber. Dense comb-like scratch marks may be inscribed on the upper burrow surface while the sandy infill is often multi-layered with several superimposed, smoothed floors marked by intense bioturbation textures. As in the Hoogland Northern Cluster occurrences, skeletal remains of potential burrow-makers are generally not recorded within the densely burrowed horizons. These moderately varied ichnoassemblages within the Poortjie Member could make a useful contribution to palaeoecological studies of the late Middle Devonian mass extinction and recovery interval. The tetrapods – probably small-bodied dicynodonts - responsible for the burrow casts appear to have inhabited well-watered and - vegetated riverine areas or the margins of reedy ponds and lakes on the floodplain which also supported a range of infaunal invertebrate life.

**Hoedemaker Member**

The majority of fossil skeletal remains recorded from the Hoogland Southern Cluster are assigned, at least provisionally, to the Hoedemaker Member. As noted previously, key vertebrate fossil sites within this stratigraphic unit have already been recorded within the easternmost sector of the Grid Corridor (Nuweveld WEF project area, Figure A2-1) as well as the SE sector of the Hoogland 4 Wind Farm project area. Since most of the Hoedemaker Member exposures examined have been extensively baked and altered by metasomatism associated with dolerite intrusion, almost all the fossils found recently are very poorly preserved (*e.g.* friable, leached, secondarily mineralized) and of limited scientific or conservation value.

A high concentration of articulated and semi-articulated skeletal fossils and associated burrow casts of small-bodied tetrapods are recorded along the bed and banks of a shallow stream on the northern portion of Farm 4/28 (Hoogland 3 Wind Farm project area), referred to here as the **Hoogland 2 Fossil Site** (Figure 6.2, Figure 5.54, Figure 5.55 & Figure 5.57). Although invariably poorly preserved, and correspondingly difficult to identify, the cranial and postcranial remains found here are of potential interest in palaeoecological or palaeoethological terms. While many or most of the animals are probably dicynodonts such as the ubiquitous genus *Diictodon*, the very occasional specimen preserved within a burrow cast with what appears to be a long tail suggests that at least some of them are small-bodied therocephalians or cynodonts, although a temnospondyl amphibian affinity also needs to be considered (*cf* Damiani *et al.* 2003 and Fernandez *et al.*

2013 for substantially younger, Early Triassic, records of cynodonts and temnospondyls preserved within fossil burrows). The tertrapod skeletons associated with the burrow casts are generally small and delicate in construction; they might therefore represent juveniles, secondary occupants or even prey rather than the primary burrow makers. On possible larger burrow cast descending around one meter into the sediment and ending in a broader terminal chamber has been tentatively recognized (Figure 5.68).

Pale patches comprising a very thin layer of comminuted bone hash overlying baked wacke are also found at this site (Figures 5-59 & 5-60). So far, only tiny bone fragments have been identified within the layers, but they should be searched further for tooth and even fish scale material as well. The bone material may have been washed by sheet floods into shallow ponds or depressions, perhaps following episodes of mass die-off of small-bodied tetrapods on the ancient floodplain. Some might be coprolitic in origin. It is interesting to note that several isolated dicynodont or unidentified skulls in the vicinity are very small and may represent juveniles associated with a burrow complex or warren. Occasional helical burrows associated with small (adult) dicynodont skeletal remains are recorded from the Hoedemaker Member at Dunedin, just east of and outside the present project area (*cf* Smith 1987b, Almond 2020a-c) (Figure 5.65).

Excellent gullied exposures of grey-green and purple-brown Hoedemaker Member overbank mudrocks with well-developed calcrete pedocrete horizons and desiccation cracks that are exposed in a dam outflow area near Rosary farmstead on Farm 1/39 (Hoogland 4 Wind Farm project area) (Figures 5-24 & 5-25) contain numerous examples of small tetrapod burrow casts, a few containing poorly-preserved skeletal remains, as well as occasional better preserved isolated skulls and semi-articulated post-cranial material of medium-sized dicynodonts (**Hoogland 1 Fossil Site**) (Figures 6-1, 5-43 to 5-45, 5-55). Overlying thin crevasse-splay sandstones display beautifully wave-rippled palaeosurfaces with low diversity invertebrate trace fossil assemblages and probable reedy plant stem casts. Curious, elongated to irregular, rounded depressions lined with mud observed here might represent tetrapod burrows of medium-sized dicynodonts that have intersected the now-buried, wave-rippled sandstone from above (Figures 5-26 & 5-66).

**Late Caenozoic superficial deposits**

These younger deposits blanketing the Lower Beaufort Group bedrocks are largely unconsolidated and unfossiliferous. The commonest fossils recorded within them are local concentrations of ill-defined, calcretised rhizoliths (plant root casts) and / or invertebrate burrows (*e.g.* of termites) within older, semi-consolidated alluvial deposits. They occur both in orange-hued sandy alluvium found in many doleritic areas as well as thicker, gravelly to sandy alluvium encountered along major drainage lines such as the Sakrivier. Examples recorded on Farm Lapfontein 41 within the grid connection corridor include simple to branching, horizontal to oblique tunnels as well as poorly-preserved putative termitaria (termite nests) (Figure 5.77 to Figure 5.79). A single, fragmentary limb bone of a large-bodied mammal – perhaps a bovid or equid – embedded within calcretised alluvial sands on the same farm suggests the potential for scientifically valuable Pleistocene mammalian assemblages within these older alluvial deposits associated with major ancient drainage lines (Figure 5.76). Fragmentary shells of freshwater unionid bivalves occur among modern river gravels but no subfossil or fossil examples have been identified here so far (Figure 5-79).

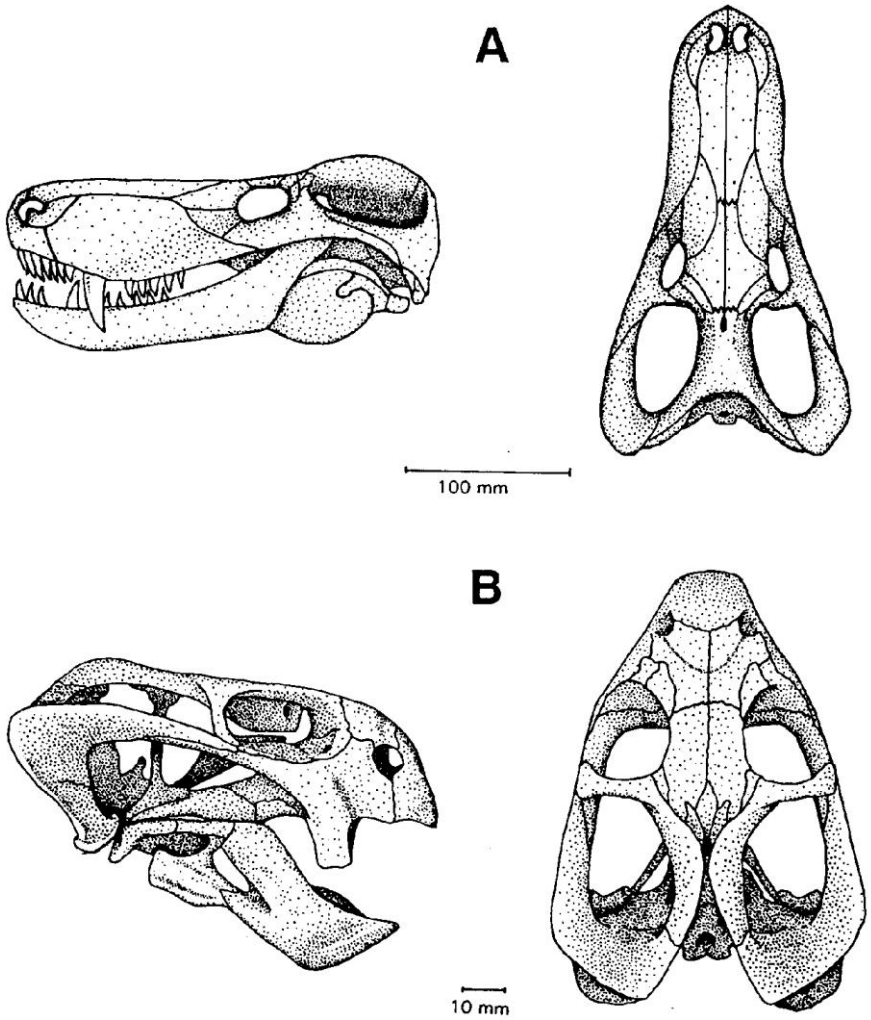


**Figure 5.40: Common therapsids from the Poortjie Member of the Teekloof Formation: (A) the medium-sized therocephalian carnivore *Pristerognathus*, and (B) the small-bodied dicynodont *Diictodon* (From Smith & Keyser 1995a). Within the present project area, most of the fossil skeletal material is likely to be *Diictodon*, which is probably also responsible for many of the tetrapod burrows found here. Much rarer carnivore remains represent small to medium-sized therocephalians like *Pristerognathus*. These tetrapod fossil assemblages were previously included within the *Pristerognathus* Assemblage Zone but have recently been transferred to the new *Endothiodon* Assemblage Zone.**

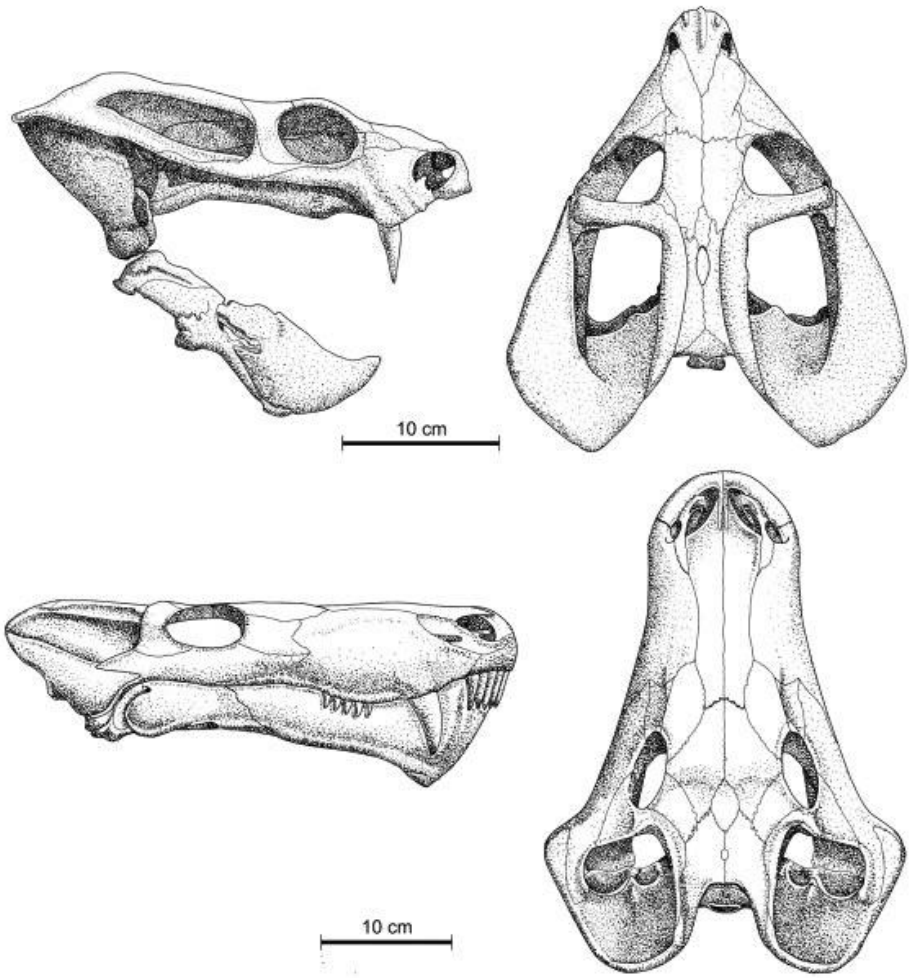


**Figure 5.41: Key therapsid taxa from the *Endothiodon* Assemblage Zone: the dicynodonts *Tropidostoma* (top) as well as the carnivorous gorgonopsian *Gorgonops* (middle) (Images abstracted from Day & Smith 2020).**

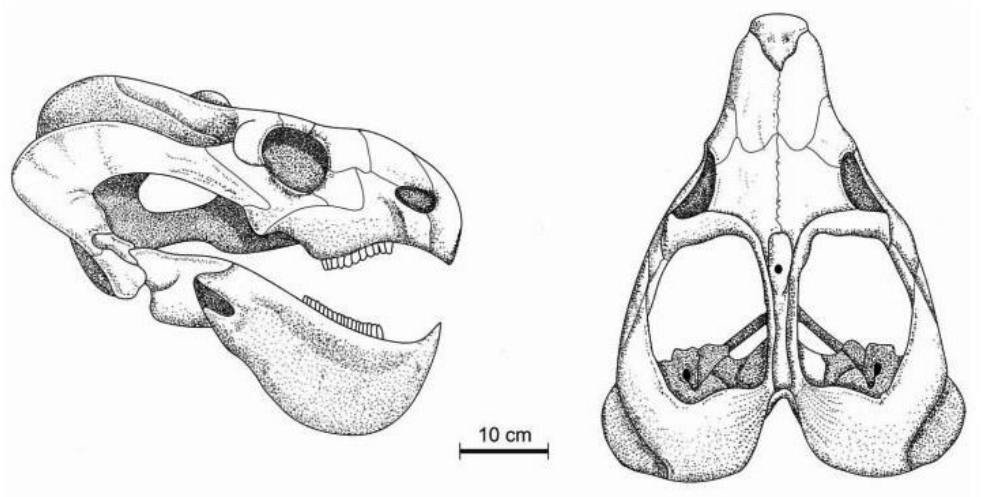


**Figure 5.42: Key therapsid taxa from the *Endothiodon* Assemblage Zone: the dicynodont Endothiodon (Image abstracted from Day & Smith 2020).**


**Figure 5.43: Small dicynodont skull (*c*. 10 cm long) weathering out of friable Hoedemaker Member mudrocks, Farm 2/28 (Loc. 289) (scale in cm and mm).**


**Figure 5.44: Skull of small dicynodont with wide skull table preserved dorsal side upwards, Hoedemaker Member mudrocks, Farm 1/39 (Loc. 215) (scale in cm and mm). Several small tetrapod burrows also occur in the vicinity.**

**Figure 5.45: Partially weathered-out skull, including palate and partial lower jaw, as well as vertebrae of a medium-sized dicynodont, Hoedemaker Member mudrocks, Farm 1/39 (Loc. 223).**

**Figure 5.46: Partially embedded skull of a medium-sized dicynodont exposed in oblique dorso-lateral view, Hoedemaker Member, Farm 1/39 (Loc. 225) (scale = 15 cm).**


**Figure 5.47: Skull and postcrania of a small tusked dicynodont (probably *Diictodon*) preserved within a calcrete concretion, Hoedemaker Member, Farm 42 (Loc. 304, outside and south of the grid connection project area) (scale in cm and mm).**

**Figure 5.48: Baked skull (*c*. 6 cm long) of a small dicynodont with articulated lower jaw, preserved within grey siltstone matrix, Hoedemaker Member, Farm 4/28 (Loc. 503).**

**Figure 5.49: Poorly preserved skeletal remains within a baked calcrete concretion, Poortjie Member, Farm 1/28 (Loc. 447) (scale in cm).**

**Figure 5.50: Several float blocks of pale yellowish baked sandstone containing poorly-preserved postcrania of a small dicynodont, including partial skull, Poortjie Member, Farm 1/28 (Loc. 450) (scale in cm).**


**Figure 5.51: Disintegrating baked postcranial skeleton of a small to medium-sized tetrapod weathering of thin sandstone horizon, probable Hoedemaker Member, Farm 1/28 (Loc. 293) (scale = 15 cm).**

**Figure 5.52: Poorly preserved skeletal remains, including possible teeth, of small tetrapod preserved within baked mudrocks, probably of the Hoedemaker Member, Farm 1/28 (Loc. 292).**

**Figure 5.53: Small (*c*. 5 cm long) fragment of reworked bone within mudflake and calcrete nodule intraclast breccia at the base of a Hoedemaker Member channel sandstone, Farm 2/28 (Loc. 273).**


**Figure 5.54: Delicate, semi-articulated postcrania of small tetrapod, including rib cage, backbone and limbs, within baked siltstones of the Hoedemaker Member, Farm 4/28 (Loc. 470) (scale in cm and mm).**

**Figure 5.55: Stretched-out postcrania, including rib cage and limb bones, of a small tetrapod within baked mudrocks of the Hoedemaker Member, Farm 4/28 (Loc. 462).**

**Figure 5.56: Smooth-floored, multi-layered sandstone burrow cast containing the partial backbone of a small tetrapod, Hoedemaker Member, Farm 1/39 (Loc. 211) (scale = 15 cm).**

**Figure 5.57: Baked, smooth-floored tetrapod burrow with delicate, articulated skeleton (ribs, limbs *plus* skull) of a small tetrapod inside (arrowed), Hoedemaker Member, Farm 4/28 (Loc. 474) (scale = 15 cm). See following figure for more detail.**

**Figure 5.58: Close-up of small tetrapod preserved within the burrow cast illustrated above. The presence of long tail (arrow) suggests cynodont or therocephalian (or even temnospondyl amphibian) rather than dicynodont affinities. Note the small size of the individual compared with the burrow casts; the animal may be a juvenile, or perhaps did not construct this burrow itself.**

**Figure 5.59: Small, possibly juvenile dicynodont skull (*c*. 4 cm long) preserved within baked Hoedemaker Member mudrocks, Farm 4/28 (Loc. 491) (scale in cm).**

**Figure 5.60: Pale patches comprising a thin layer of finely-comminuted bone hash overlying grey-green baked wacke, Hoedemaker Member, Farm 4/28 (Loc. 485) (scale = 15 cm). Teeth (including tusks) or fish scales have not been recognized here but might still be present.**

**Figure 5.61: Close-up of the thin layer of comminuted bone fragments shown in the previous illustration. The fragments are up to *c*. 2 cm across.**

**Figure 5.62: Hillslope exposure of purple-brown, massive, vertebrate-bioturbated mudrocks of the Poortjie Member with several, prominent-weathering tetrapod burrow casts, Farm RE/336 (Loc. 326).**

**Figure 5.63: Substantial (> 20 cm wide), gently inclined tetrapod burrow cast with comb-like sets of scratch marks on the upper surface and a multi-layered infill, Poortjie Member, Farm RE/336 (Loc. 329) (scale = 15 cm).**

**Figure 5.64: View from above of an inclined tetrapod burrow cast with scratch marks, *c*. 15 cm wide above and expanded distally to form a possible living chamber with several superimposed, bioturbated floors, Poortjie Member, Farm RE/336 (Loc. 328).**


**Figure 5.65: Poorly-exposed, helical tetrapod burrow cast, Hoedemaker Member on Farm 42, outside and south of the grid connection project area (Loc. 304) (scale = 30 cm). Remains of several small dicynodonts are recorded in the vicinity (*cf* Fig. **).**

**Figure 5.66: Steeply inclined tetrapod burrow cast of green-grey sandstone within baked purple-brown siltstones with pedocrete horizons of the Hoedemaker Member (or perhaps upper Poortjie Member) on Farm RE/37 (Loc. 265) (hammer = 30 cm).**

**Figure 5.67: Wave-rippled crevasse-splay sandstone palaeosurface showing elongate to irregular, rounded mud-infilled hollows – possibly superimposed tetrapod burrows, Hoedemaker Member on Farm 1/39 (Loc. 221) (hammer = 30 cm).**

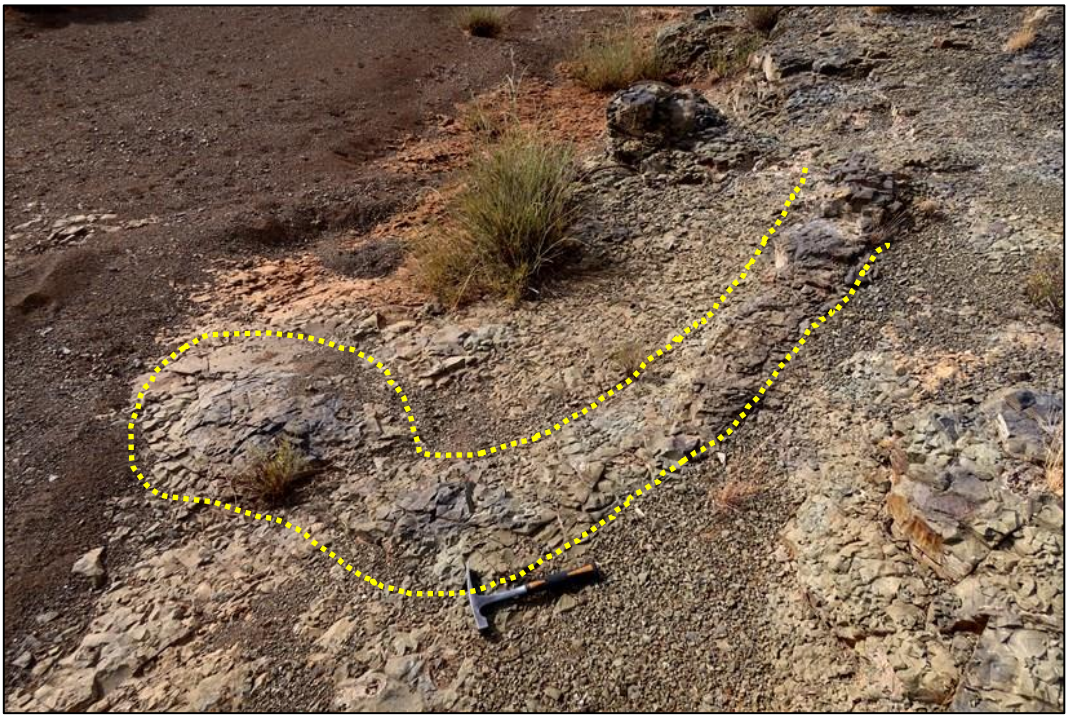

**Figure 5.68: Probable large, gently inclined tetrapod burrow cast (partially ferruginised above), expanding from a 30 cm wide tunnel to *c*. 45 cm wide terminal chamber and descending through *c*. 1 m of sediment, Hoedemaker Member on Farm 4/28 (Loc. 482) (hammer = 30 cm)**

**Figure 5.69: Vertical, subcylindrical, grey-green sandstone column penetrating baked purple-brown mudrocks beneath a mottled sandstone bed - possibly a dewatering structure but alternatively biogenic in origin (large burrow / tree trunk cast), probable Hoedemaker Member on Farm 1/28 (Loc. 282) (hammer = 30 cm).**

**Figure 5.70: Wave-rippled sandstone palaeosurface (wavelength *c*. 5 cm) with a small range of epichnial invertebrate trace fossils generated across a mudrock / sandstone interface, Poortjie Member on Farm RE/336 (Loc. 336).**

**Figure 5.71: Wave-rippled lacustrine sandstone bed top showing epichnial pellet-infilled burrows (*c*. 1 cm wide), Poortjie Member on Farm RE/336 (Loc. 335) (scale in cm).**

**Figure 5.72: Ripple cross-laminated crevasse-splay sandstone containing small (< 5mm wide) horizontal cylindrical burrows of invertebrates, Poortjie Member on Farm RE/336. (Loc. 334) (scale in cm and mm).**

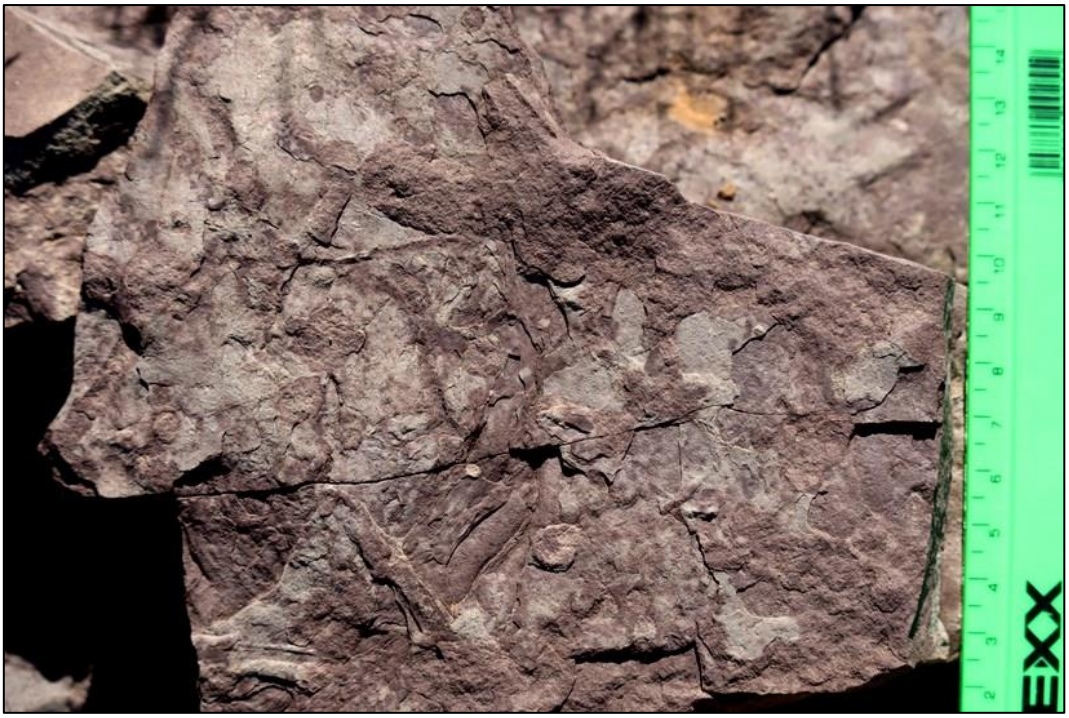

**Figure 5.73: Cylindrical endichnial invertebrate burrows within a thin, purplish, tabular, thin-bedded sandstone of the Poortjie Member on Farm RE/336 (Loc. 327) (scale in cm).**

**Figure 5.74: Equivocal *c.* 2 cm-wide burrows within a channel-associated mudflake breccia with sparse pale bone fragments (arrow) of the Hoedemaker Member on Farm 42 in the grid connection project area (Loc. 300) (scale in cm and mm).**

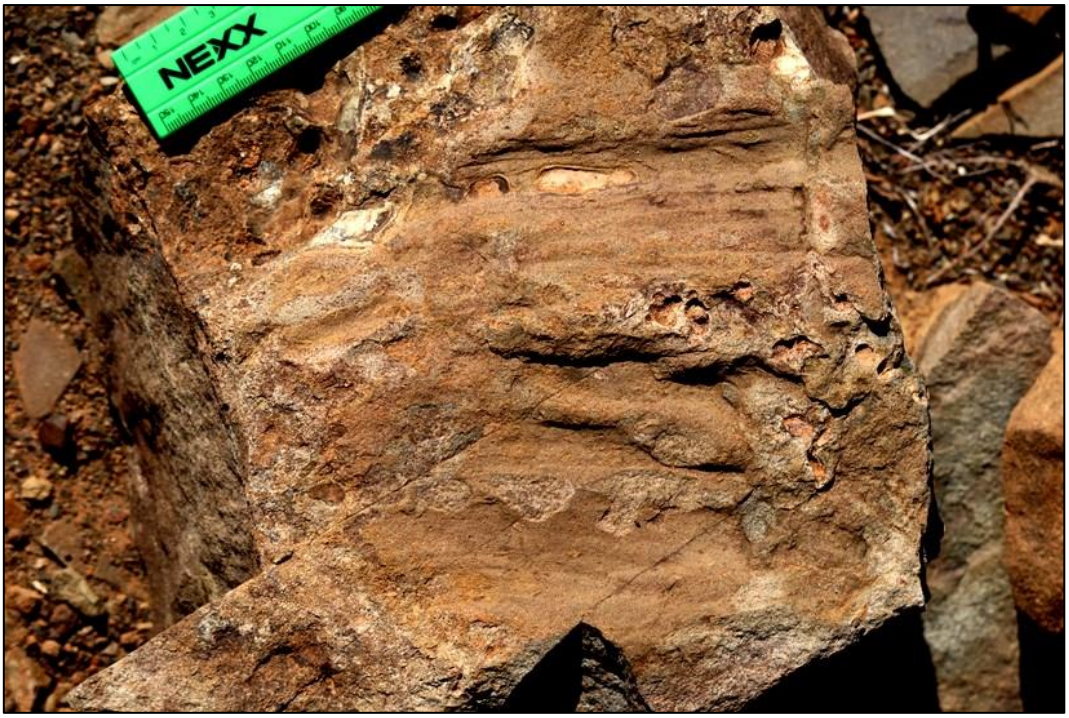


**Figure 5.75: Basal channel breccia of the Poortjie Member with mudflake intraclasts as well as scraps of rolled bone and occasional moulds of woody plant axes, Farm RE/336 (Loc. 323) (scale in cm and mm).**


**Figure 5.76: Isolated, fragmentary limb bone of a large mammal embedded within calcretised older alluvium – possibly Pleistocene in age - of the Sakrivier on Farm Lapfontein 41, grid connection project area (Loc. 310) (scale in cm).**

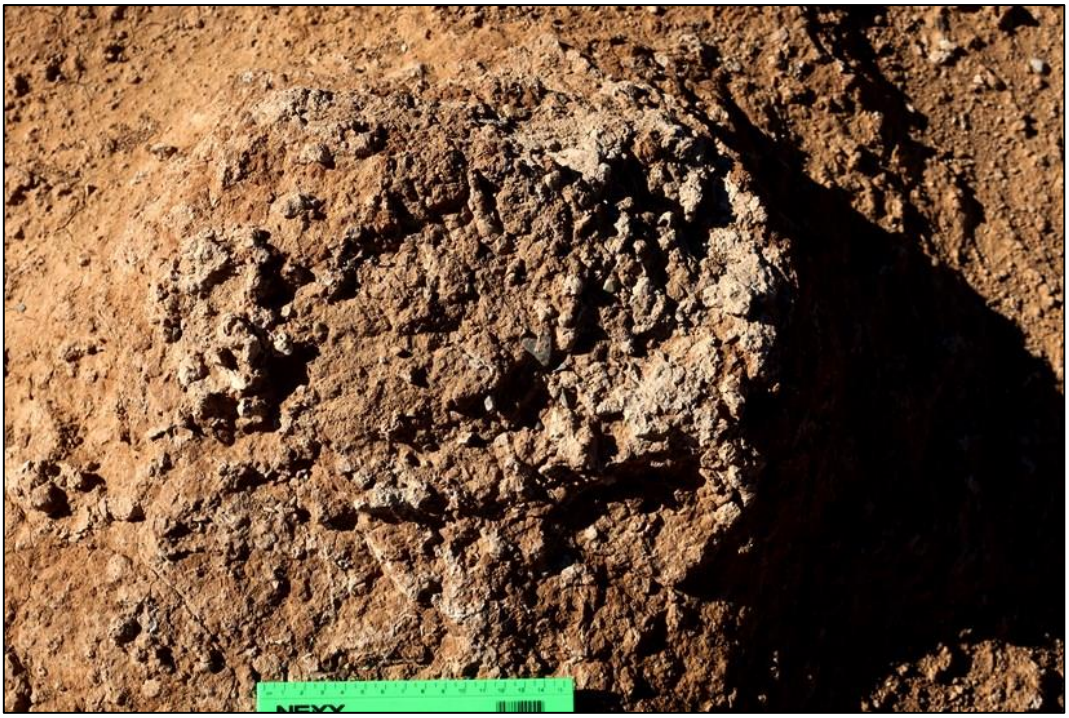

**Figure 5.77: Probable poorly-preserved, calcretised termitarium within calcretised older alluvium of the Sakrivier on Farm Lapfontein 41, grid connection project area (Loc. 314) (scale = 15 cm)**

**Figure 5.78: Hollow, calcretised termite tunnels weathering out of older alluvial deposits on Farm Lapfontein 41, grid connection project area (Loc. 313) (scale = 15 cm).**

**Figure 5.79: Hollow, calcretised termite tunnels weathering out of older alluvial deposits on Farm Lapfontein 41, grid connection project area (Loc. 312) (hammer = 30 cm).**


**Figure 5.80: Shells of modern unionid freshwater bivalves among younger gravels of the Sakrivier drainage system, Farm Lapfontein 41 (Loc. 309) (scale in cm).**

# 6. SENSITIVITY MAPPING

Provisional palaeosensitivity mapping of the combined Hoogland 3 Wind Farm, Hoogland 4 Wind Farm and Hoogland Southern Grid Connection project area based on (1) the SAHRIS palaeosensitivity map as well as (2) the DFFE screening tool suggests that most of the area is of Very High sensitivity, based on the occurrence here of sedimentary bedrocks of the Lower Beaufort Group (See Site Sensitivity Verification Report in Appendix 3). Exceptions recognized include (1) dolerite intrusions (Insensitive) and (2) areas mantled by thick alluvial deposits (Low to Medium Sensitivity). Based on desktop analysis as well as the recent 10-day palaeontological site visit, however, it is concluded that the majority of the project area is, in practice, of Low Palaeosensitivity. This is mainly due to (1) extensive baking of potentially fossiliferous bedrocks by major dolerite intrusions which has compromised fossil preservation; (2) low exposure levels of sedimentary bedrocks due to pervasive cover by low-sensitivity Late Caenozoic superficial sediments (alluvium, colluvium, surface gravels *etc*), (3) the rarity of fossils within the Lower Beaufort Group beds concerned as a consequence of the major global Mass Extinction Event of late Middle Permian age.

The great majority of fossil sites recorded within the project area are (1) of low scientific or conservation value and (2) lie well outside (> 20 m) the project footprint and therefore do not warrant mitigation (See data table in Appendix 2 and satellite map Figure 6**.1** to Figure 6**.3** as well as A2-1 to A2-3). With the minor exceptions of fossil site numbers 335, 209, 210 and 212, all of which can be readily mitigated in the pre-construction phase if necessary, the proposed layouts of the Hoogland 3 Wind Farm and Hoogland 4 Wind Farm do not directly or indirectly threaten any of the known fossil sites here. Three concentrations of fossil sites were identified within the Hoogland Southern Wind Farm Cluster project area during the Screening Phase[1]:

- The **Hoogland Fossil Site 1** on Farm 1/39 (Hoogland 4 Wind Farm project area) contains numerous examples of small tetrapod burrow casts, a few containing poorly-preserved skeletal remains, as well as occasional better preserved isolated skulls and semi-articulated post-cranial material of medium-sized dicynodonts. The great majority of the site lies well outside the project infrastructure footprint and should be protected within the standard riverine ecological buffer zone (Figure 6**.1**). A few sites of fairly low scientific interest (*viz*. sites 209, 210, 212) lie close to the proposed access road footprint (pale blue line on Figure 6**.1**) and should be considered for professional mitigation (recording / sampling) in the pre-construction phase.

- The **Hoogland Fossil Site 2** comprises a high concentration of articulated and semi-articulated skeletal fossils and associated burrow casts of small-bodied tetrapods along the bed and banks of a shallow stream on the northern portion of Farm 4/28 (Hoogland 3 Wind Farm and Hoogland Southern Grid Connection project areas). The site should be protected within the standard riverine ecological buffer zone (Figure 6**.2**). A proposed access road crossing the stream will not directly impact the known fossil sites here and so no specific palaeontological mitigation is recommended for this site.

- The **Hoogland Fossil Site 5** features a concentration of well-preserved invertebrate as well as tetrapod trace fossils on the western margins of Farm RE/336 (Hoogland 3 Wind Farm project area, Figure 6**.3**). This site lies well away from the project infrastructure footprint. It is noted that comparable trace fossil assemblages may well occur more widely in hilly terrain on Farm RE/336; these would be

[1] Note that a total of five High Palaeosensitivity fossil sites were found across all of the Hoogland Project sites during Screening, only three of which within the Southern Cluster.

identified, recorded and, if warranted, mitigated during the proposed pre-construction palaeontological walkdown of selected portions of the project footprint.

It is noted that three of the four small Very High Sensitivity palaeontological research areas identified during the Nuweveld WEF project on Leeu Kloof 43 lie within the Hoogland Southern Grid Connection corridor (red polygons in Figure A2-1). These are to be treated as No-Go areas for both the Nuweveld and Hoogland renewable energy projects. Many of the fossil sites identified elsewhere within the Hoogland Southern Cluster and Southern Grid corridor project areas – including the Hoogland Fossil Site 2 listed above - are located along drainage lines where they should be protected within the specialist ascribed aquatic and ecological buffer zones.

The potential, and largely unpredictable occurrence of further, undocumented palaeontological sites of High to Very High Palaeosensitivity within the Hoogland Southern Cluster project area cannot be completely excluded, however. The final authorised Wind Farm and Grid Connection layouts should therefore be cross-checked against the fossil database and satellite imagery. Limited pre-construction palaeontological surveys of selected, potentially-sensitive, previously unsurveyed sectors of the authorised Wind Farm and Grid Connection footprint by a professional palaeontologist may be required. In the case of the Hoogland Southern Cluster Wind Farms as well as the Hoogland Southern Grid Connection developments, micro-siting adjustments of infrastructure layout (wind turbines, pylons, access roads *etc*) as a consequence of the palaeontological walk-down are considered to be unlikely due to (1) the paucity of high sensitivity fossil sites in the region and (2) the fact that most fossil sites can be adequately mitigated through professional palaeontological pre-construction recording and sampling / collection.

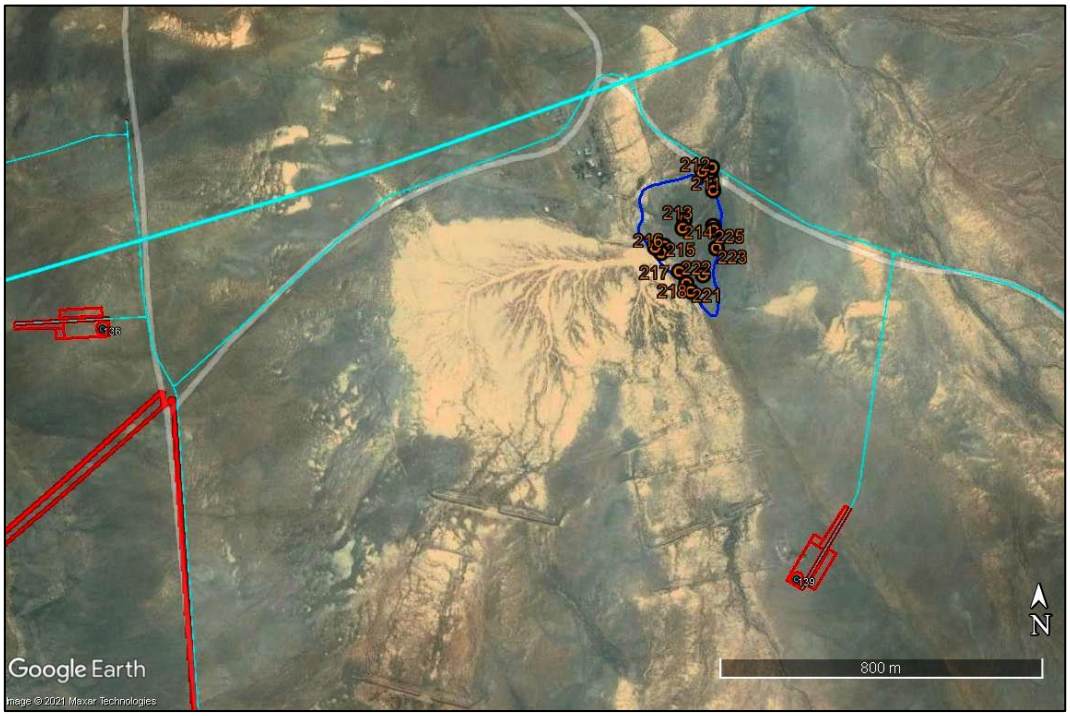


**Figure 6.1: Hoogland Fossil Site 1 (dark blue polygon) on Farm 1/39 (Hoogland 4 Wind Farm project area, just south of the grid corridor boundary, solid pale blue line) includes numerous skeletal remains and burrow casts of small tetrapods in an extensive gullied exposure of Hoedemaker Member mudrocks in a dam overflow area close to Rosary farmstead. The majority of the fossil sites lie >20 from the project infrastructure footprint. A few sites of fairly low scientific interest (209, 210, 212) lie**

**close to the proposed access road footprint (pale blue line) and should be considered for professional mitigation (recording / sampling) in the pre-construction phase.**


**Figure 6.2: Hoogland Fossil Site 2 (dark blue polygon) on the northern portion of Farm 4/28 (Hoogland 3 Wind Farm project area) includes numerous poorly-preserved skulls, skeletons and burrow casts of small-bodied tetrapods within baked mudrocks of the Hoedemaker Member exposed along a shallow stream. The site is therefore of palaeoecological and palaeoethological interest. However, none of the recorded fossils lies < 20 m from the WEF project footprint (proposed road shown as pale blue line) and so no mitigation is required here.**

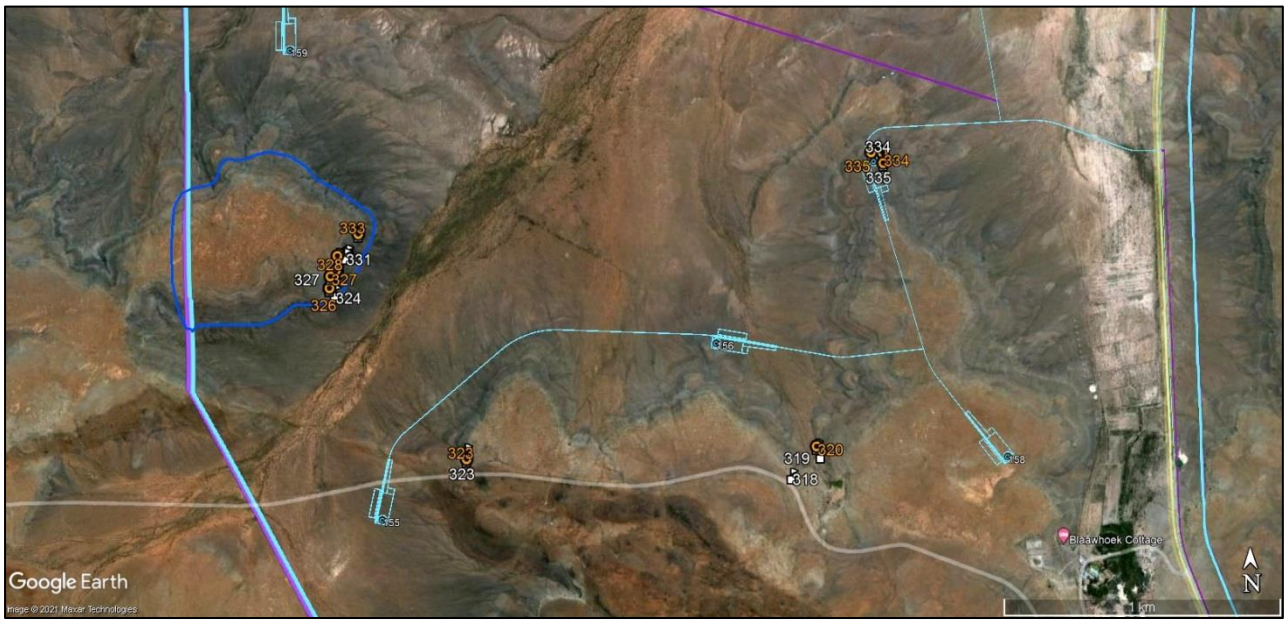

**Figure 6.3: Hoogland Fossil Site 5 (dark blue polygon) on Farm RE/336 (Hoogland 3 Wind Farm project area) features a range of well-preserved invertebrate as well as tetrapod burrows within gullied hillslope exposures of the Poortjie Member. The sensitive area lies well outside the project infrastructure footprint and no mitigation is required here.**

# 7. ASSESSMENT OF IMPACTS TO PALAEONTOLOGICAL HERITAGE

Potential impacts on local palaeontological heritage resources due to the Hoogland 3 Wind Farm, Hoogland 4 Wind Farm and Hoogland Southern Grid Connection are assessed in

Table 7-1 and

Table 7-2 below, using the system developed by SLR.

Given the similar geological (and hence palaeontological) setting for all three developments, the results of their separate impact assessments are also very similar. Fossils of some sort occur widely within almost all sedimentary rocks, but most of them are low scientific or conservation value or are very widely distributed (*e.g.* many microfossils, trace fossils). This assessment therefore focuses on fossil heritage that is of potentially high scientific and / or conservation interest and on the construction phase of the developments where impacts are potentially most damaging.

Given (1) the paucity of high sensitivity fossil sites recorded or anticipated within the project area, which is accordingly judged to be of low overall palaeosensitivity, as well as (2) the fact that almost all the known fossil sites all lie well outside the proposed project infrastructure footprints and (3) the potential for effective mitigation of additional chance fossil finds in the pre-construction or construction phase (Section 8 and Appendix 4), the overall palaeontological heritage impact significance of the construction phase of each of the Hoogland 3 Wind Farm / Hoogland 4 Wind Farm / Hoogland Southern Grid Connection is rated as **Low (-ve)** before mitigation and **Very Low (-ve)** after mitigation. Anticipated cumulative impacts of the Hoogland and Nuweveld renewable energy projects (including grid connections) are assessed as **Medium (-ve)** without mitigation, perhaps falling to **Low (-ve)** with full mitigation (Table 7-3). These potential cumulative impacts fall within acceptable limits.

## 7.1 Impact assessment

Significant impacts on palaeontological heritage are only anticipated for the construction phase of the proposed Hoogland Wind Farms and Grid Connection. These impacts are:

Potential damage, disturbance, destruction or sealing-in of legally-protected and scientifically valuable fossil heritage at or beneath the ground surface within the wind farm / grid connection project area, mainly due to ground clearance and excavations for wind turbine and pylon footings, hard standing areas and access / service roads (The footprints – and hence the impact significance - of the on-site substations, battery storage facilities, O&M buildings, laydown areas and construction areas are small in comparison and are considered collectively with those items mentioned above).

No further significant impacts are expected in the operational and de-commissioning phases of the renewable energy developments.

The palaeontological heritage impact significance of the proposed Hoogland 3 Wind Farm, Hoogland 4 Wind Farm and Hoogland Southern Grid Connection projects, both before and after mitigation, is assessed in

Table 7-1 and below. The destruction, damage or disturbance out of context of legally-protected fossils, preserved at the ground surface or below ground, which may occur during *construction phase* of the Wind Farm / Grid Connection entail *direct negative* impacts to palaeontological heritage resources that are confined to the development footprint (*site*). These impacts can often be effectively mitigated but are *permanent* (*v. high duration*) and cannot be fully rectified (*low reversibility*). All of the sedimentary formations represented within the Hoogland Wind Farm and Grid Connection project area contain fossils of some sort (*e.g*. microfossils, trace fossils, vertebrate fossils, *etc.*). Impacts on fossil heritage at *some* level are definite but, given the low palaeontological sensitivity of large portions of the area, they are likely to be, at most, of *low intensity* overall (Local high intensity impacts on highly-significant fossil remains – such as rare vertebrate fossils – cannot be completely excluded, however). *Without mitigation,* impacts on *scientifically important, well-preserved, unique or rare fossil material* that is worthy of special protection / conservation – the real focus of this assessment exercise - are *probable.*

The overall palaeontological heritage impact significance of the construction phase of the Hoogland 3 Wind Farm / Hoogland 4 Wind Farm / Hoogland Southern Grid Connection, adopting a precautionary approach in view of the potentially significant number of unrecorded fossil sites within the project area as a whole, is rated as **Medium (-ve)** before mitigation. With full implementation of the palaeontological mitigation measures outlined in Section 8, the impact significance may fall to **Very Low (-ve).** This assessment applies to all the Wind Farm / Grid Connection infrastructure listed in the project description (Section 4).

Although palaeontological field surveying within the extensive Wind Farm and Grid Connection project area is necessarily very incomplete (reconnaissance level) at present, confidence levels for this assessment are rated as *medium*. This is because of the availability of fossil data from the scientific literature and previous PIAs in the region (*viz*. the adjacent Nuweveld Wind Farm and Grid Connection projects) as well as from the recent lengthy, field-based reconnaissance study.

***Table 7-1: Assessment of potential palaeontological heritage impacts of each of the proposed Hoogland 3 Wind Farm and Hoogland 4 Wind Farm (Construction Phase)***

| **Issue: Loss or degradation of local palaeontological heritage resources of scientific and / or conservation value** | | |
|---|---|---|
| **Description of Impact** | | |
| **Damage, disturbance, destruction or sealing-in of legally-protected, scientifically valuable fossil heritage at or beneath the ground surface within the wind farm project footprint, mainly due to ground clearance and excavations for wind turbines, hard standing areas, access / service roads, underground cabling and pylon footings.** | | |
| **Type of Impact** | **Direct** | |
| **Nature of Impact** | **Negative** | |
| **Phases** | **Construction** | |
| Criteria | Without Mitigation | With Mitigation |
| **Intensity** | Low | Very Low |
| **Duration** | Permanent | Permanent |
| **Extent** | Site | Site |
| **Consequence** | Low | Low |
| **Probability** | Probable | Possible |
| **Significance** | Low - | Very Low - |
| | | |
| **Degree to which impact can be reversed** | Impacts to palaeontological heritage are generally irreversible. | |
| **Degree to which impact may cause irreplaceable loss of resources** | Low. Most fossils recorded from the project area are of widely occurring forms within the outcrop areas of the formations concerned. | |
| **Degree to which impact can be mitigated** | Moderate. Most recorded fossil sites can be effectively mitigated by a professional palaeontologist in the pre-construction phase (recording / collection). Newly exposed fossils can be mitigated through a Chance Fossil Finds Procedure. However, residual impacts following mitigation may be locally high, given the unavoidable difficulties of identifying and sampling fossils from on-going construction phase excavations and site clearance. | |

***Table 7-2: Assessment of potential palaeontological heritage impacts of the proposed Hoogland Southern Grid Connection (Construction Phase)***

| **Issue: Loss or degradation of local palaeontological heritage resources of scientific and / or conservation value** | | |
|---|---|---|
| **Description of Impact** | | |
| **Damage, disturbance, destruction or sealing-in of legally-protected, scientifically valuable fossil heritage at or beneath the ground surface within grid connection project footprint, mainly due to ground clearance and excavations for access / service roads and pylon footings.** | | |
| **Type of Impact** | **Direct** | |
| **Nature of Impact** | **Negative** | |
| **Phases** | **Construction** | |
| Criteria | Without Mitigation | With Mitigation |
| **Intensity** | Low | Very Low |
| **Duration** | Permanent | Permanent |
| **Extent** | Site | Site |
| **Consequence** | Low | Low |
| **Probability** | Probable | Possible |
| **Significance** | Low - | Very Low - |
| | | |
| **Degree to which impact can be reversed** | Impacts to palaeontological heritage are generally irreversible. | |
| **Degree to which impact may cause irreplaceable loss of resources** | Low. Most fossils recorded from the project area are of widely occurring forms within the outcrop areas of the formations concerned. | |
| **Degree to which impact can be mitigated** | Moderate. Most recorded fossil sites can be effectively mitigated by a professional palaeontologist in the pre-construction phase (recording / collection). Newly exposed fossils can be mitigated through a Chance Fossil Finds Procedure. However, residual impacts following mitigation may be locally high, given the unavoidable difficulties of identifying and sampling fossils from on-going construction phase excavations and site clearance. | |

## 7.2 Alternatives

Due to the comprehensive iterative design process that has been undertaken to inform the respective Wind Farm layouts and associated infrastructure for the Hoogland Wind Farm and Grid Connection Projects, no site or layout alternatives will be assessed.

However, the preferred layouts of the Hoogland Wind Farms, and respective Grid Corridors, will each be assessed against the '**no-go' alternative**. The 'no-go' alternative is the option of not constructing the Project where the status quo of the current farming activities and natural weathering processes on the site would prevail.

The impact significance of the **No-Go Alternative** considers that even without development fossils would still be destroyed by natural weathering and erosion. Other factors such as current farming activities within the project area (*viz.* small stock farming) as well as potential illegal fossil collection are considered to have a negligible effect on local palaeontological resources. In the case of the No-Go Alternative (*i.e.* no Wind Farm / grid development), the likely loss of local heritage resources through construction activities (negative impact) would be avoided while potential improvements in palaeontological understanding through professional mitigation - *i.e.* recording and collection of palaeontological material and data (positive impacts) - would be lost. The slow but relentless destruction of fossils exposed at the surface through natural weathering and erosion would continue, but at the same time new fossils would be revealed and prepared-out for scientific study. On balance, it is concluded that the No-Go alternative would have a *neutral* impact on palaeontological heritage.

## 7.3 Cumulative Impacts

In relation to an activity, cumulative impact "means the past, current and reasonably foreseeable future impact of an activity, considered together with the impact of activities associated with that activity, that in itself may not be significant, but may be significant when added to the existing and reasonably foreseeable impacts eventuating from similar or diverse activities" (NEMA EIA Reg GN R982 of 2014).

Other than the proposed Nuweveld Wind Farms, there are currently no approved renewable energy EA applications within a 30km (or even 50km) radius of the project site (Figure 7.1). The nearest operational wind farm from the site is the Noblesfontein Wind Farm located approximately 65km to the northeast. In addition, the South African Renewable Energy EIA Application Database (REEA) ("REEA_OR_2021_Q3") shows several renewable energy projects (solar) have been authorized close to Beaufort West. Further research confirmed that none of these projects are currently going ahead / have a valid EA (It is noted that the Beaufort West – Aberdeen area has recently been gazetted as a Renewable Energy Development Zone (REDZ) and that several new solar and wind farm projects are currently in the process of being assessed). The cumulative impact assessed here will therefore be the collective impact of the four Hoogland Wind Farms and Grid Connection applications with the three Nuweveld Wind Farm and Gridline applications.

The significance of anticipated impacts on palaeontological heritage for each of the three Nuweveld Wind Farms as well as the associated Grid Connection has been assessed as Moderate Negative in each case (Almond 2020a-c, 2021), while all four proposed Hoogland Wind Farms as well as their Grid Connections have been assigned a Medium Negative impact significance regarding palaeontological heritage (Almond, in prep. 2021).

Anticipated cumulative impacts of the renewable energy projects listed above are assessed as **Medium (-ve)** without mitigation. Overall impact significance may fall to **Low (-ve)** with full mitigation since impacts will then occur at a lower intensity and will be partially offset by valuable new scientific data. The analysis only applies *provided that* all the proposed monitoring and mitigation recommendations made for all these various projects are followed through (*N.B.* This is inherently unpredictable since monitoring of compliance with these recommendations by the regulatory authorities does not generally occur). Unavoidable residual negative impacts may be partially offset by the improved understanding of Karoo palaeontology resulting from appropriate professional mitigation. This is regarded as a *positive* impact for Karoo palaeontological heritage.

It is concluded that the cumulative impacts on local fossil heritage anticipated for the various renewable energy projects in the Upper Karoo region south of Loxton – including the proposed Hoogland and Nuweveld Wind Farms and their associated Grid Connections – fall within acceptable limits, *provided that* all recommended mitigation recommendations for these projects are followed through.

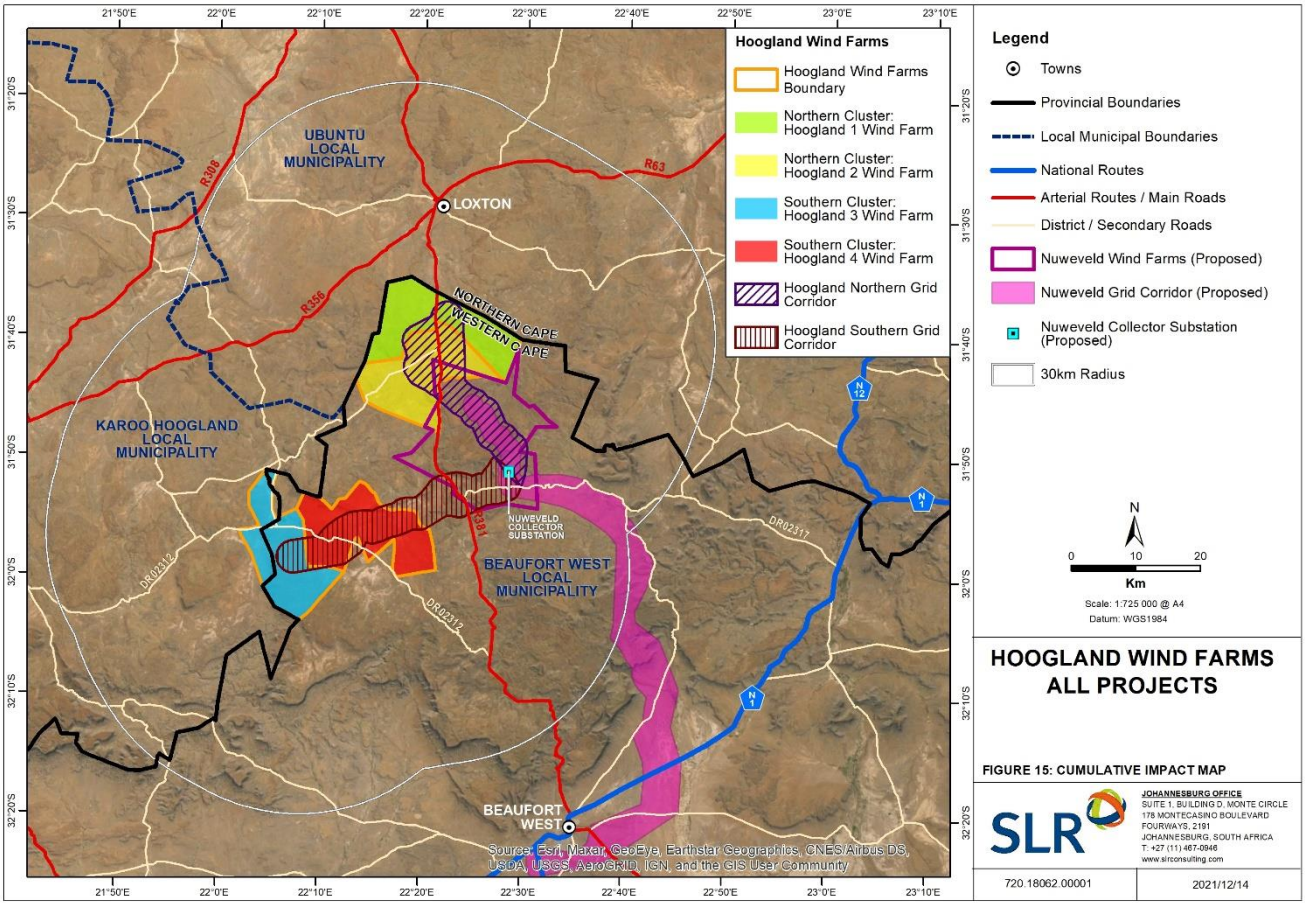


***Figure 7.1: Cumulative Map indicating renewable energy facilities within the 30km buffer of the Hoogland Wind Farms and Grid Connection***

***Table 7-3: Assessment of potential cumulative palaeontological heritage impacts relating to the proposed Hoogland and Nuweveld Wind Farm and associated grid connection projects***

| | | |
|---|---|---|
| **Issue: Loss or degradation of local palaeontological heritage resources of scientific and / or conservation value** | | |
| **Description of Impact** | | |
| **Damage, disturbance, destruction or sealing-in of legally-protected, scientifically valuable fossil heritage at or beneath the ground surface within wind farm / grid connection project footprint, mainly due to ground clearance and excavations.** | | |
| **Type of Impact** | **Direct** | |
| **Nature of Impact** | **Negative** | |
| **Phases** | **Construction** | |
| **Nature of cumulative impacts** | Potential loss of a significant fraction of scientifically important, rare or unique, fossil heritage within the Palaeozoic bedrocks and Late Caenozoic superficial sediments in the Upper Karoo south of Loxton. | |
| **Rating of cumulative impacts** | **Without Mitigation** | **With Mitigation** |
| | Medium - | Low - |

# 8. MITIGATION AND EMPR REQUIREMENTS

Only a handful of the palaeontological sites recorded within the adjoining Hoogland 3 Wind Farm and Hoogland 4 Wind Farm project areas - as tabulated in Appendix 2 - lie within or close to (≤ 20 m) the proposed project footprints (See **Error! Reference source not found.** to **Error! Reference source not found.** and satellite images A2.1-A2.3 in Appendix 2). No palaeontological mitigation is therefore required with regard to almost all the known fossil sites. Those few sites located < 20 m of the project footprint (*viz*. Site numbers 335, 209, 210 and 212) should be considered for possible mitigation during the recommended pre-construction palaeontological specialist walkdown of the final authorized project footprints.

Mitigation measures for the Grid Connection project follow those already outlined by Almond (2021) for the neighbouring Nuweveld Grid Connection project, viz:

1. A pre-construction walkdown of the grid connection alignment and project footprint by a suitably qualified palaeontological specialist, focusing primarily on sectors of inferred high palaeontological sensitivity, with recommendations on micro-siting of the grid connection infrastructure, if required and possible.

2. Avoidance during construction of any very sensitive areas with a high density of *in situ* fossils mapped following the pre-construction walkdown.

3. Professional palaeontological recording and sampling / collection of valuable fossils within the project footprint.

4. If necessary, further pre-construction or construction phase monitoring and mitigation of bedrock excavations by a professional palaeontologist and the ECO, to be specified following the walkdown survey.

5. Application of Chance Fossil Finds Protocol by the ECO and palaeontological specialist during the construction phase (See Appendix 4).

The three small, Very High Sensitivity palaeontological research areas identified during the Nuweveld WEF project on Leeu Kloof 43 that lie within the Hoogland Southern Grid Connection corridor (red polygons in Figure A2-1) are to be treated as No-Go areas for both the Nuweveld and Hoogland renewable energy projects.

The final, authorised layout of the Hoogland Wind Farm and Grid Connection projects should be cross-checked against the available fossil database and other relevant resources (*e.g.* satellite imagery, geological maps) by the palaeontological specialist who should make recommendations for pre-construction phase mitigation, if any proves necessary. This might entail, for example, focussed palaeontological walk-downs of selected, previously unsurveyed and potentially sensitive sectors of the project footprint with judicious sampling or collection of threatened fossil material of scientific and / or conservation value.

Given the potential for the exposure or recognition of additional, scientifically valuable fossil occurrences within the project footprints, a Chance Fossil Finds Protocol, as outlined below and tabulated in Appendix 4, must be included within the Environmental Management Programme (EMPr) and fully implemented throughout the construction phase.

The Environmental Control Officer (ECO) / Environmental Site Officer (ESO) responsible for the development should be made aware of the possibility of important fossil remains (vertebrate bones, teeth, burrows, petrified wood, plant-rich horizons *etc*., such as those illustrated in this report) being found or unearthed during the

construction phase of the development. Monitoring for fossil material of all major surface clearance and deeper (>1m) excavations by the ECO/ESO on an on-going basis during the construction phase is therefore recommended. Significant fossil finds should be safeguarded and reported at the earliest opportunity to the relevant Provincial Heritage Resources Agency – *viz*. Heritage Western Cape for the Western Cape and SAHRA for the Northern Cape - for recording and sampling by a professional palaeontologist (Contact details: Heritage Western Cape. 3rd Floor Protea Assurance Building, 142 Longmarket Street, Green Market Square, Cape Town 8000. Private Bag X9067, Cape Town 8001. Tel: 021 483 5959 E-mail: ceoheritage@westerncape.gov.za. SAHRA, 111 Harrington Street, Cape Town. PO Box 4637, Cape Town 8000, South Africa. Phone: +27 (0)21 462 4502. Fax: +27 (0)21 462 4509. Web: www.sahra.org.za ).

An approved Fossil Collection Permit / Work Plan from SAHRA / Heritage Western Cape respectively will be required by the specialist palaeontologist responsible for mitigation work. Minimum Standards for palaeontological heritage reports and fieldwork have been specified by SAHRA (2013) and Heritage Western Cape (2021).

# 9. SUMMARY & CONCLUSIONS

## 9.1 Summary of Findings

The combined Hoogland 3 Wind Farm, Hoogland 4 Wind Farm and Hoogland Southern Grid Connection project area in the Upper Karoo region near Loxton is underlain by potentially fossiliferous continental (fluvial / lacustrine) sediments of the Lower Beaufort Group (Karoo Supergroup) of Middle to Late Permian age. Few fossil sites have been previously reported from the Teekloof Formation representing the Beaufort Group bedrocks in this area.

During the recent ten-day, reconnaissance-level palaeontological heritage survey of the combined Hoogland 3 Wind Farm, Hoogland 4 Wind Farm and overlapping sectors of the Hoogland Southern Grid Connection project areas by the author and an experienced field assistant a limited number of new fossil sites were recorded (See Appendix 2 for details and satellite mapping). They include several skulls and post-cranial skeletal remains of tetrapods (mainly small-bodied therapsids such as dicynodonts and therocephalians), numerous tetrapod burrow casts, as well as low diversity invertebrate trace fossil assemblages, poorly preserved wood moulds but no other well-preserved plant material.

Based on the new field data as well as desktop research it is concluded that:

1. Well-preserved fossils of scientific and conservation interest are remarkably rare within the project area as a whole. This is attributed to (a) poor levels of bedrock exposure associated with generally low relief and pervasive cover by largely unfossiliferous superficial sediments; (b) extensive dolerite intrusion which has “sterilized” large volumes of potentially fossiliferous bedrocks through thermal metamorphism, leaching and secondary mineralisation, while the large dolerite outcrop areas in the uplands are completely fossil-free; (c) highly impoverished fossil biotas within the Poortjie Member stratigraphic interval that are associated with the catastrophic end Middle Permian Mass Extinction Event of ~260 Ma.

2. The Poortjie Member is generally very fossil poor, with only sparse, fragmentary and highly-baked skeletal remains recorded on Farm 1/28 near Modderpoort se dam. An extensive, laterally-persistent horizon of massive, purple-brown, silty mudrocks cropping out on dissected hillslopes in the Hoogland 3 Wind Farm project area (*e.g.* Farm RE/366) features numerous, cryptic, small tetrapod burrows but no associated skeletal material. This phenomenon is possibly of scientific interest in shedding light on tetrapod survival of challenging

environmental conditions during or shortly after the end Middle Permian Extinction Event through widespread burrowing. Overlying thin-bedded, rippled sandstones contain well-preserved invertebrate trace fossil assemblages associated with a lacustrine setting.

3. The readily-weathering, mudrock-dominated Hoedemaker Member is generally very poorly exposed and extensively intruded or baked and mineralised by major dolerite intrusions within the project area. Dense concentrations of tetrapod skeletal remains and burrows (mainly small, articulated to disarticulated dicynodonts but also rare theriodonts / cynodonts or therocephalians) as well as thin layers of comminuted bone hash have been recorded within baked mudrocks and fine-grained wackes of the Hoedemaker Member in Hoogland 3 Wind Farm and Hoogland 4 Wind Farm project areas (Farms 4/28 and 1/39 respectively) as well as in the nearby Nuweveld North Wind Farm project area (Almond 2020a). However, most of the skeletal material is poorly preserved due to thermal metamorphosis and metasomatism during dolerite intrusion.

4. Fossils within the Late Caenozoic superficial deposits are largely restricted to older, calcretised alluvium (perhaps Pleistocene in age) which contains calcretised rhizoliths (plant root casts) and burrows (*e.g.* termite foraging tunnels and nests) with rare fossilised mammalian bones of Pleistocene age (e.g. Farm Lapfontein 41, Hoogland Southern Grid Connection project area). With the exception of the fossil mammal material, these fossils are of widespread occurrence within the Karoo region and are not, therefore, of high conservation significance.

5. Extensive areas underlain by Karoo dolerite – where a considerable portion of the Wind Farm and Grid Connection infrastructure will be placed - are almost entirely unfossiliferous. Calcretised plant root casts or invertebrate burrows occur in older sandy alluvial deposits overlying dolerite but such fossils are widely occurring and of low heritage significance.

6. Most of the combined Wind Farm and Grid Connection project area has been provisionally rated as of Very High Palaeosensitivity (SAHRIS website, DFFE Screening Tool) due to the rich Permian fossil assemblages recorded from the Lower Beaufort Group in the Main Karoo Basin. This sensitivity rating is *contested* here. The great majority of the fossil sites recorded within the project area are of limited scientific or conservation value (low Heritage Provisional Field Rating) and in practice the majority of the project area is of Low palaeosensitivity. However, the occurrence of sparse, small, and largely unpredictable fossil sites of High Sensitivity cannot be entirely discounted.

7. Hardly any of the known fossil sites within the combined project area lie within or close to (≤ 20m) the proposed project footprints and no palaeontological mitigation is therefore required in their regard. The handful of recorded sites situated within 20 m of the project footprint (*viz*. Sites 335, 209, 210 and 212, shown in satellite map Figures 6.1 to 6.3) as well as most additional, unrecorded fossil sites identified during the pre-construction or construction phase can be readily mitigated, if necessary, through a Chance Fossil Finds Protocol, as outlined in Appendix 4. Three small Very High Sensitivity palaeontological research areas previously identified during the Nuweveld WEF project on Leeu Kloof 43 lie within the Hoogland Southern Grid Connection corridor (red polygons in Figure A2-1). These are to be treated as No-Go areas for both the Nuweveld and Hoogland renewable energy projects.

8. The final, authorised layout of the Hoogland 3 Wind Farm, Hoogland 4 Wind Farm and Hoogland Southern Grid Connection projects submitted for Environmental Authorisation should be cross-checked against the available fossil database and other relevant resources (*e.g.* satellite imagery, geological maps) by the palaeontological specialist who should make recommendations for pre-construction phase mitigation, if any proves necessary. This might entail, for example, focussed palaeontological walk-downs of selected, previously unsurveyed and potentially sensitive sectors of the project footprint with judicious sampling or

collection of threatened fossil material of scientific and / or conservation value. An approved Fossil Collection Permit / Work Plan from SAHRA / Heritage Western Cape respectively will be required by the specialist palaeontologist responsible for mitigation work.

9. In terms of palaeontological heritage the Construction Phase impact significance of each of the proposed Hoogland Wind Farm and Grid Connection projects, including all the component infrastructure listed in the project descriptions, is assessed as **Low (-ve)** without mitigation and **Very Low (-ve)** following mitigation. No significant further impacts are anticipated in the Operational and Decommissioning Phases. The impact significance of the No-Go Alternative would most likely have a *neutral* impact on palaeontological heritage. Anticipated cumulative impacts of the closely spaced Hoogland and Nuweveld renewable energy projects in the Upper Karoo region to the south of Loxton are assessed as **Medium (-ve)** without mitigation, falling to **Low (-ve)** with full mitigation of all projects concerned. These levels of cumulative impact fall within acceptable limits.

10. In terms of palaeontological heritage there are no fatal flaws in the proposed Hoogland 3 Wind Farm, Hoogland 4 Wind Farm and Hoogland Southern Grid Connection renewable energy projects respectively and there are no objections to their authorisation.

11. The palaeontological mitigation measures outlined here in points 7 and 8 above as well as in Appendix 4 should be incorporated into the EMPr for each of the Hoogland renewable energy projects.

## 9.2 Conclusions and Impact Statement

Despite the Very High provisional palaeosensitivity assigned to large parts of the combined project area for the proposed Hoogland 3 Wind Farm, Hoogland 4 Wind Farm and associated Hoogland Southern Grid Connection developments, desktop and field data suggest that, in practice, the area is of low palaeosensitivity overall, with only a sparse, and largely unpredictable, scatter of fossil sites of scientific and / or conservation value. Three small, Very High Sensitivity palaeontological research areas previously identified during the Nuweveld WEF project on Leeu Kloof 43 that lie within the Hoogland Southern Grid Connection corridor are to be treated as No-Go areas.

In terms of palaeontological heritage resources, the proposed Hoogland 3 Wind Farm, Hoogland 4 Wind Farm and associated Hoogland Southern Grid Connection developments are assigned a similar overall impact significance rating (Construction Phase) of Low (-ve) without mitigation and Very Low (-ve) following mitigation. No significant further impacts on fossil heritage resources are anticipated in the planning, operational and decommissioning phases. The No-Go Option will probably have a neutral impact. Anticipated cumulative impacts in the context of several other renewable energy projects in the Upper Karoo region south of Loxton (*viz*: Hoogland 1 and Hoogland 2 Wind Farms, Nuweveld Wind Farms and their associated grid connections) are assessed as Medium (-ve) significance without mitigation and Low (-ve) significance after mitigation.

The proposed Hoogland Wind Farm and Grid Connection developments are not fatally flawed. On condition that the recommended mitigation measures (including Chance Fossil Finds Protocol) are included within the EMPr and implemented in full during the construction phase, there are no objections on palaeontological heritage grounds to their authorisation.

## 10. REFERENCES


ALMOND, J.E. 2020a. Proposed Redcap Nuweveld North Wind Farm, Beaufort West Local Municipality, Central Karoo District Municipality, Western Cape. Palaeontological heritage assessment: desktop and field-based report, 116 pp. Natura Viva cc, Cape Town.

ALMOND, J.E. 2020b. Proposed Redcap Nuweveld West Wind Farm, Beaufort West Local Municipality, Central Karoo District Municipality, Western Cape. Palaeontological heritage assessment: desktop and field-based report, 116 pp. Natura Viva cc, Cape Town.

ALMOND, J.E. 2020c. Proposed Redcap Nuweveld East Wind Farm, Beaufort West Local Municipality, Central Karoo District Municipality, Western Cape. Palaeontological heritage assessment: desktop and field-based report, 115 pp. Natura Viva cc, Cape Town.

ALMOND, J.E. 2021. Grid connection for the proposed Redcap Nuweveld Wind Farms, Beaufort West Local Municipality, Central Karoo District Municipality, Western Cape. Palaeontological heritage assessment: desktop and field-based report, 101 pp. Natura Viva cc, Cape Town.

ALMOND, J.E. & PETHER, J. 2008a. Palaeontological heritage of the Western Cape. Interim SAHRA technical report, 20 pp. Natura Viva cc., Cape Town.

ALMOND, J.E. & PETHER, J. 2008b. Palaeontological heritage of the Northern Cape. Interim SAHRA technical report, 124 pp. Natura Viva cc., Cape Town.

ANDERSON, J.M. & ANDERSON, H.M. 1985. Palaeoflora of southern Africa. Prodromus of South African megafloras, Devonian to Lower Cretaceous, 423 pp. Botanical Research Institute, Pretoria & Balkema, Rotterdam.

BAMFORD, M. 1999. Permo-Triassic fossil woods from the South African Karoo Basin. Palaeontologia africana 35, 25-40.

BENDER, P.A. 2004. Late Permian actinopterygian (palaeoniscid) fishes from the Beaufort Group, South Africa: biostratigraphic and biogeographic implications. Council for Geoscience Bulletin 135, 84 pp.

BENDER, P.A. & BRINK, J.S. 1992. A preliminary report on new large mammal fossil finds from the Cornelia-Uitzoek site. South African Journal of Science 88: 512-515.

BLACKWELL, L., STEININGER, C., NEVELING, J. ABDALA, F., PEREIRA, L., MAYER, E., ROSSOUW, L., DE LA PEÑA P. & BRINK, J. 2017. Holocene large mammal mass death assemblage from South Africa. Quaternary International xxx (2017), p1-15**.**

BOUSMAN, C.B. *et al.* 1988. Palaeoenvironmental implications of Late Pleistocene and Holocene valley fills in Blydefontein Basin, Noupoort, C.P., South Africa. Palaeoecology of Africa 19: 43-67.

BRINK, J.S. & ROSSOUW, L. 2000. New trial excavations at the Cornelia-Uitzoek type locality. Navorsinge van die Nasionale Museum Bloemfontein 16, 141-156.

CHURCHILL, S.E. et al. 2000. Erfkroon: a new Florisian fossil locality from fluvial contexts in the western Free State, South Africa. South African Journal of Science 96: 161-163.

CLUVER, M.A. & KING, G.M. A reassessment of the relationships of Permian Dicynodontia (Reptilia, Therapsida) and a new classification of dicynodonts. Annals of the South African Museum 91, 195-273.

COLE, D.I., NEVELING, J., HATTINGH, J., CHEVALLIER, L.P., REDDERING, J.S.V. & BENDER, P.A. 2004. The geology of the Middelburg area. Explanation to 1: 250 000 geology Sheet 3124 Middelburg, 44 pp. Council for Geoscience, Pretoria.

COLE, D. & SMITH, R. 2008. Fluvial architecture of the Late Permian Beaufort Group deposits, S.W. Karoo Basin: point bars, crevasse splays, palaeosols, vertebrate fossils and uranium. Field Excursion FT02 guidebook, AAPG International Conference, Cape Town October 2008, 110 pp.

COLE, D.I., JOHNSON, M.R. & DAY, M.O. 2016. Lithostratigraphy of the Abrahamskraal Formation (Karoo Supergroup), South Africa. South African Journal of Geology 119.2, 415-424.

DAMIANI R., MODESTO, S., YATES, A. & NEVELING, J. 2003 Earliest evidence of cynodont burrowing. Proceedings of the Royal Society of London B 2003 270, 1747-1751. doi: 10.1098/rspb.2003.2427

DAY 2013a. Middle Permian continental biodiversity changes as reflected in the Beaufort Group of South Africa: a bio- and lithostratigraphic review of the *Eodicynodon*, *Tapinocephalus* and *Pristerognathus* assemblage zones. Unpublished PhD thesis, University of the Watwatersrand, Johannesburg, 387 pp *plus* appendices.

DAY, M. 2013b. Charting the fossils of the Great Karoo: a history of tetrapod biostratigraphy in the Lower Beaufort Group, South Africa. Palaeontologia Africana 48, 41-47.

DAY, M. & RUBIDGE, B. 2010. Middle Permian continental biodiversity changes as reflected in the Beaufort Group of South Africa: An initial review of the *Tapinocephalus* and *Pristerognathus* assemblage zones. Proceedings of the 16th conference of the Palaeontological Society of Southern Africa, Howick, August 5-8, 2010, pp. 22-23.

DAY, M.O., GUVEN, S., ABDALA, F., JIRAH, S., RUBIDGE, B.S. AND ALMOND, J. 2015. Youngest dinocephalian fossils extend the *Tapinocephalus* Zone, Karoo Basin, South Africa. South African Journal of Science 111, 78-82.

DAY, M.O., RAMEZANI, J., BOWRING, S.A., SADLER, P.M., ERWIN, D.H., ABDALA, F. & RUBIDGE, B.S. 2015b. When and how did the terrestrial mid-Permian mass extinction occur? Evidence from the tetrapod record of the Karoo Basin, South Africa. Proc. R. Soc. B 282: 20150834. http://dx.doi.org/10.1098/rspb.2015.0834

DAY, M.O. & RUBIDGE, B.S. 2020. Biostratigraphy of the *Tapinocephalus* Assemblage Zone (Beaufort Group, Karoo Supergroup), South Africa. South African Journal of Geology 123, 149 - 164.

DAY, M.O. & RUBIDGE, B.S. 2021. The Late Capitanian mass extinction of terrestrial vertebrates in the Karoo Basin of South Africa. Frontiers in Earth Science 9, article 631198, 15 pp.

DAY, M.O. & SMITH, R.M.S. 2020. Biostratigraphy of the *Endothiodon* Assemblage Zone (Beaufort Group, Karoo Supergroup), South Africa. South African Journal of Geology 123, 164 - 180.

DE RUITER, D.J., BROPHY, J.K., LEWIS, P.J., KENNEDY, A.M., STIDHAM, T.A., CARLSON, K.B. & HANCOX, P.J. 2010. Preliminary investigation of Matjhabeng, a Pliocene fossil locality in the Free State of South Africa. Palaeontologia Africana 45, 11-22.

DUNCAN & MARSH 2006. The Karoo Igneous Province. In: Johnson, M.R., Anhaeusser, C.R. & Thomas, R.J. (Eds.) The geology of South Africa, pp. 501-520. Geological Society of South Africa, Marshalltown.

FERNANDEZ V, ABDALA F, CARLSON K.J, COOK D.C, RUBIDGE B.S, YATES A & TAFFOREAU P. 2013. Synchrotron Reveals Early Triassic Odd Couple: Injured Amphibian and Aestivating Therapsid Share Burrow. PLoS ONE 8(6): e64978. doi:10.1371/journal.pone.0064978

HERITAGE WESTERN CAPE 2021. Guide for minimum standards for archaeology and palaeontology reports submitted to Heritage Western Cape - June 2021, 6 pp.

JOHNSON, M.R. & KEYSER, A.W. 1979. The geology of the Beaufort West area. Explanation of geological Sheet 3222, 14 pp. Council for Geoscience, Pretoria.

JOHNSON, M.R., VAN VUUREN, C.J., VISSER, J.N.J., COLE, D.I., WICKENS, H. DE V., CHRISTIE, A.D.M., ROBERTS, D.L. & BRANDL, G. 2006. Sedimentary rocks of the Karoo Supergroup. In: Johnson. M.R., Anhaeusser, C.R. & Thomas, R.J. (eds.) The geology of South Africa, pp. 461-499. Geological Society of South Africa, Johannesburg & the Council for Geoscience, Pretoria.

KEYSER, A. W. 1966. Some indications of arid climate during the deposition of the Beaufort Series. Annals of the Geological Survey of South Africa 5,77–79.

KEYSER, A.W. & SMITH, R.M.H. 1977-78. Vertebrate biozonation of the Beaufort Group with special reference to the Western Karoo Basin. Annals of the Geological Survey of South Africa 12: 1-36.

KITCHING, J.W. 1977. The distribution of the Karroo vertebrate fauna, with special reference to certain genera and the bearing of this distribution on the zoning of the Beaufort beds. Memoirs of the Bernard Price Institute for Palaeontological Research, University of the Witwatersrand, No. 1, 133 pp (incl. 15 pls).

KLEIN, R.G. 1984. The large mammals of southern Africa: Late Pliocene to Recent. In: Klein, R.G. (Ed.) Southern African prehistory and paleoenvironments, pp 107-146. Balkema, Rotterdam.

LE ROUX, F.G. & KEYSER, A.W. 1988. Die geologie van die gebied Victoria-Wes. Explanation to 1: 250 000 geology sheet 3122 Victoria West, 31 pp. Council for Geoscience, Pretoria.

MACRAE, C. 1999. Life etched in stone. Fossils of South Africa, 305 pp. The Geological Society of South Africa, Johannesburg.

McCARTHY, T. & RUBIDGE, B. 2005. The story of Earth and life: a southern African perspective on a 4.6-billion-year journey. 334pp. Struik, Cape Town.

McKAY, M.P., WEISLOGEL, A.L., FILDANI, A., BRUNT, R.L., HODGSON, D.M. & FLINT, S.S. 2015.U-PB zircon tuff geochronology from the Karoo Basin, South Africa: implications of zircon recycling on stratigraphic age controls. International Geology Review, 57, 393-410. DOI: 10.1080/00206814.2015.1008592

NICOLAS, M.V. 2007. Tetrapod diversity through the Permo-Triassic Beaufort Group (Karoo Supergroup) of South Africa. Unpublished PhD thesis, University of Witwatersrand, Johannesburg.

PARTRIDGE, T.C. & MAUD, R.R. 1987. Geomorphic evolution of southern Africa since the Mesozoic. South African Journal of Geology 90: 179-208.

PARTRIDGE, T.C., BOTHA, G.A. & HADDON, I.G. 2006. Cenozoic deposits of the interior. In: Johnson, M.R., Anhaeusser, C.R. & Thomas, R.J. (Eds.) The geology of South Africa, pp. 585-604. Geological Society of South Africa, Marshalltown.

PARTRIDGE, T.C. & SCOTT, L. 2000. Lakes and pans. In: Partridge, T.C. & Maud, R.R. (Eds.) The Cenozoic of southern Africa, pp.145-161. Oxford University Press, Oxford.

RETALLACK, G.J., METZGER, C.A., GREAVER, T., HOPE JAHREN, A., SMITH, R.M.H. & SHELDON, N.D. 2006. Middle – Late Permian mass extinction on land. GSA Bulletin 118, 1398-1411.

ROSSOUW, L. 2006. Florisian mammal fossils from erosional gullies along the Modder River at Mitasrust Farm, Central Free State, South Africa. Navorsinge van die Nasionale Museum Bloemfontein 22, 145-162.

RUBIDGE, B.S. (Ed.) 1995. Biostratigraphy of the Beaufort Group (Karoo Supergroup). South African Committee for Biostratigraphy, Biostratigraphic Series No. 1., 46 pp. Council for Geoscience, Pretoria.

RUBIDGE, B.S. 2005. Re-uniting lost continents – fossil reptiles from the ancient Karoo and their wanderlust. 27th Du Toit Memorial Lecture. South African Journal of Geology 108, 135-172.

SAHRA 2013. Minimum standards: palaeontological component of heritage impact assessment reports, 15 pp. South African Heritage Resources Agency, Cape Town.

SKEAD, C.J. 1980. Historical mammal incidence in the Cape Province. Volume 1: The Western and Northern Cape, 903pp. Department of Nature and Environmental Conservation, Cape Town.

SMITH, R.M.H. 1979. The sedimentology and taphonomy of flood-plain deposits of the Lower Beaufort (Adelaide Subgroup) strata near Beaufort West, Cape Province. Annals of the Geological Survey of South Africa 12, 37-68.

SMITH, R.M.H. 1980. The lithology, sedimentology and taphonomy of flood-plain deposits of the Lower Beaufort (Adelaide Subgroup) strata near Beaufort West. Transactions of the Geological Society of South Africa 83, 399-413.

SMITH, R.M.H. 1987. Helical burrow casts of therapsid origin from the Beaufort Group (Permian) of South Africa. Palaeogeography, Palaeoclimatology, Palaeoecology 60, 155-170.

SMITH, R.M.H. 1981. Sedimentology and taphonomy of the Lower Beaufort strata near Beaufort West, Cape province. Unpublished MSc thesis, University of Witwatersrand, Johannesbyrg, 126 pp.

SMITH, R.M.H. 1986. Trace fossils of the ancient Karoo. Sagittarius 1 (3), 4-9.

SMITH, R.M.H. 1987a. Morphological and depositional history of exhumed Permian point bars in the southwestern Karoo, South Africa. Journal of Sedimentary Petrology 57, 19-29.

SMITH, R.M.H. 1987b. Helical burrow casts of therapsid origin from the Beaufort Group (Permian) of South Africa. Palaeogeography, Palaeoclimatology, Palaeoecology 60, 155-170.

SMITH, R.M.H. 1988. Fossils for Africa. An introduction to the fossil wealth of the Nuweveld mountains near Beaufort West. Sagittarius 3, 4-9. SA Museum, Cape Town.

SMITH, R.M.H. 1989a. Fossils in the Karoo – some important questions answered. Custos 17, 48-51.

SMITH, R.M.H. 1989b. Fluvial facies, vertebrate taphonomy and palaeosols of the Teekloof Formation (Permian) near Beaufort West, Cape Province, South Africa. Unpublished Ph.D. Dissertation, University of Cape Town, 230 pp.

SMITH, R.M.H. 1990. Alluvial paleosols and pedofacies sequences in the Permian Lower Beaufort of the southwestern Karoo Basin, South Africa. Journal of Sedimentary Petrology 60, 258-276.

SMITH, R.M.H. 1993a. Sedimentology and ichnology of floodplain paleosurfaces in the Beaufort Group (Late Permian), Karoo Sequence, South Africa. Palaios 8, 339-357.

SMITH, R.M.H. 1993b. Vertebrate taphonomy of Late Permian floodplain deposits in the southwestern Karoo Basin of South Africa. Palaios 8, 45-67.

SMITH, R.M.H. & KEYSER, A.W. 1995a. Biostratigraphy of the *Pristerognathus* Assemblage Zone. Pp. 13-17 *in* Rubidge, B.S. (ed.) Biostratigraphy of the Beaufort Group (Karoo Supergroup). South African Committee for Stratigraphy, Biostratigraphic Series No. 1. Council for Geoscience, Pretoria.

SMITH, R.M.H. & KEYSER, A.W. 1995b. Biostratigraphy of the *Tropidostoma* Assemblage Zone. Pp. 18-22 *in* Rubidge, B.S. (ed.) Biostratigraphy of the Beaufort Group (Karoo Supergroup). South African Committee for Stratigraphy, Biostratigraphic Series No. 1. Council for Geoscience, Pretoria.

SMITH, R.M.H. & ALMOND, J.E. 1998. Late Permian continental trace assemblages from the Lower Beaufort Group (Karoo Supergroup), South Africa. Abstracts, Tercera Reunión Argentina de Icnologia, Mar del Plata, 1998, p. 29.

SMITH, R.M.H, HANCOX, P.J., RUBIDGE, B.S., TURNER, B.R. & CATUNEANU, O. 2002. Mesozoic ecosystems of the Main Karoo Basin: from humid braid plains to arid sand sea. International Symposium on

Mesozoic Terrestrial Ecosystems, Cape Town, South Africa. Post-conference field excursion guidebook, 116 pp.

SMITH, R., RUBIDGE, B. & VAN DER WALT, M. 2012. Therapsid biodiversity patterns and paleoenvironments of the Karoo Basin, South Africa. Chapter 2 pp. 30-62 in Chinsamy-Turan, A. (Ed.) Forerunners of mammals. Radiation, histology, biology. xv + 330 pp. Indiana University Press, Bloomington & Indianapolis.

SMITH, R.M.H., RUBIDGE, B.S., DAY, M.O. & BOTHA, J. 2020. Introduction to the tetrapod biozonation of the Karoo Supergroup. South African Journal of Geology 123, 131-140.

STEAR, W.M. 1978. Sedimentary structures related to fluctuating hydrodynamic conditions in flood plain deposits of the Beaufort Group near Beaufort West, Cape. Transactions of the Geological Society of South Africa 81, 393-399.

STEAR, W.M. 1980. Channel sandstone and bar morphology of the Beaufort Group uranium district near Beaufort West. Transactions of the Geological Society of South Africa 83: 391-398.

VAN DER WALT, J. 2019. Phase 2 Strategic Environmental Assessment for Wind and Solar Photovoltaic Energy Development in South Africa. Appendix A3. Heritage Scoping Assessment Report, 65 pp. CSIR.

VAN DER WALT, M., DAY, M., RUBIDGE, B., COOPER, A.K. & NETTERBERG, I. 2010. A new GIS-based biozone map of the Beaufort Group (Karoo Supergroup), South Africa. Palaeontologia Africana 45, 1-5.

WATKEYS, M.K. 1999. Soils of the arid south-western zone of Africa. In: Dean, W.R.J. & Milton, S.J. (Eds.) The Karoo: ecological patterns and processes, 374 pp. Cambridge University Press.

WILSON, A., FLINT, S., PAYENBERG, T., TOHVER, E. & LANCI, L. 2014. Architectural styles and sedimentology of the fluvial Lower Beaufort Group, Karoo Basin, South Africa. Journal of Sedimentary Research 84, 326-348.

## 11. ACKNOWLEDGEMENTS

I am grateful to Ms Kirsten Jones, Project Manager for Red Cap Energy (Pty) Ltd and all the other members of the Red Cap Hoogland team as well as Ms Liandra Scott-Shaw of SLR Consulting for commissioning this palaeontological heritage study, for providing the necessary project information, for helpful discussions, for painstaking and constructive editorial input and for facilitating the field work. The landowners concerned with the WEF study area are thanked for permission to access their property. Mnr J. Moolman of Dunedin Farm generously shared his extensive knowledge of local Karoo palaeontology. Dr Jayson Orton of ASHA kindly shared valuable additional palaeontological field data. Finally, the companionship in the field, substantial palaeontological contributions as well as outstanding logistical backup kindly provided by Ms Madelon Tusenius are all highly appreciated, as always.

## APPENDIX 1: JOHN ALMOND SHORT CV

Dr John Almond has an Honours Degree in Natural Sciences (Zoology) as well as a PhD in Palaeontology from the University of Cambridge, UK. He has been awarded post-doctoral research fellowships at Cambridge University and the University of Tübingen in Germany, and has carried out palaeontological research in Europe, North America, the Middle East as well as North and South Africa and Madagascar. For eight years he was a scientific officer (palaeontologist) for the Geological Survey / Council for Geoscience in the RSA. His current palaeontological research focuses on fossil record of the Precambrian - Cambrian boundary and the Cape Supergroup of South Africa. He has recently written palaeontological reviews for several 1: 250 000 geological maps published by the Council for Geoscience and has contributed educational material on fossils and evolution for new school textbooks in the RSA.

Since 2002 Dr Almond has also carried out numerous palaeontological impact assessments for developments and conservation areas in the Western, Eastern and Northern Cape, Limpopo, Northwest Province, Mpumalanga, Gauteng, KwaZulu-Natal and the Free State under the aegis of his Cape Town-based company *Natura Viva* cc. He has served as a member of the Archaeology, Palaeontology and Meteorites Committee for Heritage Western Cape (HWC) and an advisor on palaeontological conservation and management issues for the Palaeontological Society of South Africa (PSSA), HWC and SAHRA. He is currently compiling technical reports on the provincial palaeontological heritage of Western, Northern and Eastern Cape for SAHRA and HWC. Dr Almond is an accredited member of PSSA and APHP (Association of Professional Heritage Practitioners – Western Cape).

## APPENDIX 2: HOOGLAND 3 WIND FARM, HOOGLAND 4 WIND FARM & HOOGLAND SOUTHERN GRID CONNECTION PROJECT AREAS NEAR LOXTON - FOSSIL SITE DATA (APRIL – MAY 2021)

All GPS readings were taken in the field using a hand-held Garmin GPSmap 64s instrument. The datum used is WGS 84. Please note that:

- Locality data for South African fossil sites is *not* for public release, due to conservation concerns.
- The table does *not* represent all potential fossil sites within the project area but only those sites recorded during the 10-day field survey. The absence of recorded fossil sites in any area therefore does *not* mean that no fossils are present there.
- Details of fossil sites within sectors of the Grid Connection project area that overlap with the Nuweveld WEF project area have been tabulated elsewhere by Almond (2020a-c, 20201d).
- The detailed stratigraphic data for each site is provisional and has yet to be confirmed.
- **Proposed mitigation** for all sites with a **Proposed Field Rating IIIB or higher** is as follows: IF site lies < 20 m from final, approved footprint, pre-construction fossil recording and sampling by a professional palaeontologist is recommended in the pre-construction phase. Sites located > 20 m from the final, approved footprint do not require mitigation.
- No mitigation is recommended for fossil sites with a **Proposed Field Rating of IIIC**.

| Loc. | GPS data | Comments |
|---|---|---|
| **209** | 31°56'44.20"S 22°18'11.32"E | Farm 1/39. Hoedemaker Member grey-green and purple-brown overbank mudrocks with calcrete concretions. Extensive shallow stream and erosion gulley exposures downstream and NE of dam wall near Rosary Farmstead. Bone fragments of small-bodied tetrapod within calcrete concretion, rounded termination of a tetrapod burrow with silty sandstone infill. Proposed Field Rating IIIB Local Resource. If site lies < 20 m from final approved footprint, pre-construction fossil recording and sampling by a professional palaeontologist is recommended in the pre-construction phase. |
| **210** | 31°56'44.53"S 22°18'11.16"E | Farm 1/39. Hoedemaker Member grey-green and purple-brown overbank mudrocks. Stream bed exposure of mudrocks with sand-infilled mudcracks, concentration of several vertebrate burrow casts up to *c*. 40 cm wide, rounded terminations, smooth floors, infilled with fine, grey-green sandstone within crumbly mudrock. Proposed Field Rating IIIB Local Resource. If site lies < 20 m from final approved footprint, pre-construction fossil recording and sampling by a professional palaeontologist is recommended in the pre-construction phase. |
| **211** | 31°56'46.04"S 22°18'11.45"E | Farm 1/39. Hoedemaker Member. Sandstone tetrapod burrow cast containing partial backbone of a small tetrapod. Proposed Field Rating IIIB Local Resource. |
| **212** | 31°56'44.52"S 22°18'10.40"E | Farm 1/39. Hoedemaker Member. Concentration of weathered-out cranial and post-cranial skeletal remains of medium-sized dicynodont on a gravel bar, including tip of boat-shaped lower jaw. Some bones sun-cracked. Proposed Field Rating IIIB Local Resource. If site lies < 20 m from final approved footprint, pre-construction fossil recording and sampling by a professional palaeontologist is recommended in the pre-construction phase. |
| **213** | 31°56'48.39"S 22°18'8.72"E | Farm 1/39. Hoedemaker Member. Several sandstone tetrapod burrow casts within purple-brown mudrocks with calcrete concretions. Proposed Field Rating IIIB Local Resource. |
| **214** | 31°56'49.07"S 22°18'8.55"E | Farm 1/39. Hoedemaker Member. Skull of small dicynodont, preserved within calcrete concretion, side-upwards. Proposed Field Rating IIIB Local Resource. |
| **215** | 31°56'50.49"S 22°18'6.81"E | Farm 1/39. Hoedemaker Member. Skull of small dicynodont preserved dorsal side upwards with possible post-cranial remains and / or another skull as well as vertebrate burrow casts (some possibly calcretised) in vicinity. Proposed Field Rating IIIB Local Resource. |
| **216** | 31°56'50.61"S 22°18'5.94"E | Farm 1/39. Hoedemaker Member. Vertebrate burrow cast containing the delicate postcrania of a small-bodied tetrapod, including fine ribs and limb bones. Proposed Field Rating IIIB Local Resource. |
| **217** | 31°56'51.04"S 22°18'6.51"E | Farm 1/39. Hoedemaker Member. Poorly-preserved, friable skull with sizeable tusks of medium-sized tetrapod within weathered mudrock. Proposed Field Rating IIIB Local Resource. |
| **218** | 31°56'52.54"S 22°18'8.20"E | Farm 1/39. Hoedemaker Member. Poorly-preserved, partial articulated postcranial skeleton of small-bodied tetrapod within calcrete concretion. Proposed Field Rating IIIB Local Resource. |

| | | |
|---|---|---|
| **220** | 31°56'53.51"S 22°18'8.90"E | Farm 1/39. Hoedemaker Member. Wave-rippled surface of thin crevasse-splay sandstone with small (cm-scale) invertebrate burrows. Proposed Field Rating IIIC Local Resource. |
| **221** | 31°56'54.15"S 22°18'9.31"E | Farm 1/39. Hoedemaker Member. Wave-rippled surface of thin crevasse-splay sandstone elongate to irregular, rounded mud-infilled hollows – possibly mud-infilled tetrapod burrows (equivocal). Proposed Field Rating IIIB Local Resource. |
| **222** | 31°56'54.15"S 22°18'9.31"E | Farm 1/39. Hoedemaker Member. Poorly preserved cranial fragments of small therapsid, including tusks. Proposed Field Rating IIIC Local Resource. |
| **223** | 31°56'50.67"S 22°18'11.72"E | Farm 1/39. Hoedemaker Member. Partially weathered-out skull material, including partial lower jaw, vertebrae of medium-sized dicynodont. Proposed Field Rating IIIB Local Resource. |
| **224** | 31°56'50.68"S 22°18'11.75"E | Farm 1/39. Hoedemaker Member. Partially embedded skull of medium-sized dicynodont exposed ventral side upwards. Proposed Field Rating IIIB Local Resource. |
| **225** | 31°56'49.22"S 22°18'11.47"E | Farm 1/39. Hoedemaker Member. Partially embedded skull of medium-sized dicynodont exposed in oblique dorso-lateral view. Proposed Field Rating IIIB Local Resource. |
| **226** | 31°56'48.90"S 22°18'11.43" | Farm 1/39. Hoedemaker Member. Poorly-preserved, partially embedded cranial remains of medium-sized dicynodont, including lower jaw. Proposed Field Rating IIIB Local Resource. |
| **233** | 31°59'3.21"S 22°20'13.28"E | Farm RE/83. Hoedemaker Member. Small skull preserved within calcrete concretion in float. Proposed Field Rating IIIB Local Resource. |
| **235** | 31°59'1.37"S 22°20'6.09"E | Farm RE/83. Hoedemaker Member within thermal aureole of dolerite dyke. Poorly-preserved small skull within baked wacke. Proposed Field Rating IIIC Local Resource. |
| **237** | 31°58'26.32"S 22°20'40.53"E | Farm RE/83. Hoedemaker Member. Crumbly purple-brown mudrocks with gently inclined tetrapod burrow cast (*c*. 20 cm wide), possibly intersected by second burrow. Proposed Field Rating IIIB Local Resource. |
| **239** | 31°56'0.92"S 22°19'34.59" | Farm 2/39. Hoedemaker Member. Stream bed exposure of purple-brown silsty sandstones with several 3d-preserved sandstone tetrapod burrow casts (15-20 cm across), some bioturbated with small burrows or pustulose floors. Proposed Field Rating IIIC Local Resource. |
| **241** | 31°56'4.44"S 22°19'42.42"E | Farm 2/39. Hoedemaker Member. Good stream gulley exposure of grey-green and purple-brown mudrocks with abundant ferruginous calcrete concretions. Lower jaw of small dicynodont, sun-cracked, within pedocrete concretion. Proposed Field Rating IIIC Local Resource. |
| **242** | 31°56'4.14"S 22°19'44.55"E | Farm 2/39. Hoedemaker Member. As above. Poorly-preserved postcrania of medium-sized tetrapod embedded within purple-brown siltstones. Proposed Field Rating IIIC Local Resource. |
| **243** | 31°56'4.11"S 22°19'44.75"E | Farm 2/39. Hoedemaker Member. As above. Lenticular, calcretised concentration of small bone fragments – possible small channel breccia / carnivore burrow / coprolitic material. Proposed Field Rating IIIB Local Resource. |
| **244** | 31°56'3.90"S 22°19'44.74"E | Farm 2/39. Hoedemaker Member. As above. Small skull with (?) broad intertemporal region emebedded in grey-green siltstone. Proposed Field Rating IIIB Local Resource. |
| **245** | 31°56'3.79"S 22°19'44.91"E | Farm 2/39. Hoedemaker Member. As above. Several small pedocrete concretins containing fossil skeletal material, including skull of small dicynodont with tusks, ventral side upwards. Proposed Field Rating IIIB Local Resource. |
| **246** | 31°56'3.60"S 22°19'45.22"E | Farm 2/39. Hoedemaker Member. As above. Disarticulated postcranial and small dicynodont skull material dispersed within mudrocks. Farm 2/39. Hoedemaker Member. As above. Proposed Field Rating IIIC Local Resource. |
| **265** | 31°52'17.40"S 22°13'57.40"E | Farm RE/37. Hoedemaker Member or perhaps upper Poortjie Member baked purple-brown siltstones and fine-grained purple-brown sandstones, ferruginous carbonate concretions. Several small (15-20 cm wide), green-grey fine sandstone tetrapod burrow casts, gently to steeply inclined, some partially calcretised. Proposed Field Rating IIIB Local Resource. |
| **273** | 31°57'2.44"S 22°12'56.55"E | Farm 2/28. Hoedemaker Member channel sandstone *krans* incised into thin-bedded purple-brown mudrocks. Gullied channel base with lenses of mudflake and calcrete intraclast breccias containing sparse, fragmentary reworked bone material. Sole surfaces of fallen sandstone blocks with rounded, positive hypichnial trace fossils - possibly casts of vertical burrows. Proposed Field Rating IIIC Local Resource. |
| **274** | 31°57'4.45"S 22°12'56.11"E | Farm 2/28. Hoedemaker Member channel breccias with sparse scraps of weathered bone. Proposed Field Rating IIIC Local Resource. |
| **275** | 31°57'6.63"S 22°12'54.86"E | Farm 2/28. Hoedemaker Member. Poorly-preserved bone within purple-brown siltstone. Proposed Field Rating IIIC Local Resource. |
| **276** | 31°56'57.17"S 22°12'56.01"E | Farm 2/28. Hoedemaker Member. Smal skull withi pedocrete concretion, weathered-out in surface float. Proposed Field Rating IIIB Local Resource. |
| **282** | 31°54'54.18"S 22° 7'5.63"E | Farm 1/28. Probable Hoedemaker Member. Vertical, subcylindrical, grey-green sandstone column *c*. 30 cm wide penetrating purple-brown mudrocks beneath a sandstone bed. Possibly a dewatering structure but alternatively may be biogenic in origin (large burrow / tree trunk cast). Proposed Field Rating IIIB Local Resource. |

| | | |
|---|---|---|
| **283** | 31°54'54.17"S 22° 7'2.84"E | Farm 1/28. Probable Hoedemaker Member. Fallen block of mudflake intraclst breccia containing isolated rib of a small-bodied tetrapod. Proposed Field Rating IIIC Local Resource. |
| **286** | 31°53'57.06"S 22° 9'21.32"E | Farm 2/28. Hoedemaker Member. Gulley exposure of baked dark grey siltstone with poorly-preserved, baked postcranial and probably cranial remains of a small-bodied tetrapod. Proposed Field Rating IIIB Local Resource. |
| **289** | 31°56'37.75"S 22°12'38.45"E | Farm 2/28. Hoedemaker Member. Purple-brown mudrock exposures beneath thin channel sandstone. Skeletal material of small tetrapod within pedocrete concretions, including small dicynodont skull (c. 10 cm long). Proposed Field Rating IIIB Local Resource. |
| **292** | 31°57'42.41"S 22° 9'30.89"E | Farm 1/28. Probable Hoedemaker Member. Small streamside exposure of baked dark mudrocks with metamorphosed calcrete concretions, poorly preserved cranial remains, teeth of small tetrapod. Proposed Field Rating IIIB Local Resource. |
| **293** | 31°57'42.71"S 22° 9'31.41"E | Farm 1/28. Probable Hoedemaker Member. As above with disintegrating baked postcranial skeleton of a small to medium-sized tetrapod. Proposed Field Rating IIIB Local Resource. |
| **294** | 31°57'42.48"S 22° 9'31.33"E | Farm 1/28. Probable Hoedemaker Member. As above with baked skull of small-bodied tetrapod. Proposed Field Rating IIIB Local Resource. |
| **299** | 31°54'23.36"S 22°22'34.36"E | Farm 42. Grid connection project area. Hoedemaker Member. Calcrete concretion with narrow elongate fragment of bone or possible plant material. Proposed Field Rating IIIB Local Resource. |
| **300** | 31°54'23.66"S 22°22'33.23"E | Farm 42. Grid connection project area. Hoedemaker Member. Mudflake breccia with several small fragments of rolled bone. Equivocal invertebrate burrows *c*. 2 cm wide. Proposed Field Rating IIIB Local Resource. |
| **304** | 31°55'53.95"S 22°23'31.97"E | Farm 42. Hoedemaker Member. Gulley exposure of mudrocks with remains of several small dicynodonts, including isolated skull preserved on side within mudrock, skull with attached postcrania within pedogenic concretion, snout of small skull with broad skull table, as well as helical burrow cast. Proposed Field Rating IIIB Local Resource. |
| **307** | 31°53'44.11"S 22°19'3.67"E | Farm Lapfontein 41. Thick, pale brown to cream, calcretised older sandy to silty alluvium of Sakrivier system. Dense bioturbation by calcretised termite tunnels and / or plant roots. Shells of unionid bivalves among younger gravels. Proposed Field Rating IIIC Local Resource. |
| **309** | 31°53'44.03"S 22°19'6.29"E | Farm Lapfontein 41. Thick, pale brown to cream, calcretised older sandy, silty to fine gravelly alluvium of Sakrivier system. Dense bioturbation by calcretised termite tunnels and / or plant roots. Shells of unionid bivalves among younger gravels. Proposed Field Rating IIIC Local Resource. |
| **310** | 31°53'44.29"S 22°19'7.60"E | Farm Lapfontein 41. Calcretised older alluvial deposits of Sakrivier containing fractured limb bone of large mammal (*c*. 30 cm long) – possibly Pleistocene in age. Proposed Field Rating IIIB Local Resource. Specimen to be professionally collected if falls within 20 m of project footprint. |
| **312** | 31°53'42.46"S 22°19'33.58"E | Farm Lapfontein 41. Calcretised older alluvial deposits of Sakrivier containing several meter-long calcretised tunnels or tubes, probably constructed by termites. c. 10 cm wide with a central hollow, straight to branching. Proposed Field Rating IIIB Local Resource. |
| **313** | 31°53'43.40"S 22°19'34.49"E | Farm Lapfontein 41. Calcretised older alluvial deposits of Sakrivier containing simple to branching, calcretised termite tunnels. Proposed Field Rating IIIB Local Resource. |
| **314** | 31°53'43.73"S 22°19'34.89"E | Farm Lapfontein 41. Calcretised older alluvial deposits of Sakrivier containing probable poorly-preserved, calcretised termitaria (*c*. 30-40 cm diam.) associated with tunnel systems. Proposed Field Rating IIIB Local Resource. |
| **315** | 31°53'44.49"S 22°19'36.19"E | Farm Lapfontein 41. Calcretised older alluvial deposits of Sakrivier containing hollow to infilled, branching, calcretised termite tunnels. Proposed Field Rating IIIB Local Resource. |
| **320** | 31°54'26.93"S 22° 4'27.66"E | Farm RE/336. Poortjie Member. Stream bed exposure of grey-green siltstones and thin sandstones, latter with wave-rippled palaeosurfaces, narrow horizontal burrows along ripple troughs as well as crossing crests, vague larger (5-8 mm wide) horizontal burrows, probably of the *Scoyenia* Ichnofacies. Proposed Field Rating IIIC Local Resource. |
| **323** | 31°54'27.74"S 22° 3'39.60"E | Farm RE/336. Poortjie Member. Basal channel breccias with mudflake intraclasts as well as scraps of rolled bone, occasional moulds of woody plant axes. Proposed Field Rating IIIB Local Resource. |
| **325** | 31°54'7.65"S 22° 3'21.07"E | Farm RE/336. Poortjie Member. Purple-brown, massive vertebrate-bioturbated mudrocks with several small sandstone tetrapod burrow casts, some with smoothed floors and possible scratch marks. Proposed Field Rating IIIB Local Resource. |
| **326** | 31°54'7.64"S 22° 3'21.07"E | Farm RE/336. Poortjie Member. Purple-brown, massive vertebrate-bioturbated mudrocks with several small sandstone tetrapod burrow casts, some with smoothed floors and possible scratch marks. Proposed Field Rating IIIB Local Resource. |
| **327** | 31°54'6.26"S 22° 3'21.25"E | Farm RE/336. Poortjie Member. Thin purplish, tabular, thin-bedded, mottled and finely bioturbated sandstone with successive horizons of wave ripples, microbial mat textures, horizontal invertebrate burrows, vertical cylindrical casts of reedy plant stems, Vertebrate burrow bioturbated horizon below. Proposed Field Rating IIIB Local Resource. |

| | | |
|---|---|---|
| **328** | 31°54'5.62"S 22° 3'22.00"E | Farm RE/336. Poortjie Member. Well-preserved, inclined tetrapod burrow cast with scratch marks, *c*. 15 cm wide and markedly expanded distally (possible living chamber, extends vertically), bioturbated floors. Proposed Field Rating IIIB Local Resource. |
| **329** | 31°54'5.65"S 22° 3'22.18"E | Farm RE/336. Poortjie Member. Larger (> 20 cm wide) inclined tetrapod burrow cast with comb-like sets of scratch marks dorsally, multi-layered infill. Proposed Field Rating IIIB Local Resource. |
| **330** | 31°54'3.90"S 22° 3'22.26"E | Farm RE/336. Poortjie Member. Mudflake breccias as well as mudflake diamictites. Small fragments of bone / tooth within mudflake breccia lens high up within channel sandstone body. Poorly-preserved moulds of plant axes within sandstone. Proposed Field Rating IIIC Local Resource. |
| **331** | 31°54'3.95"S 22° 3'23.30"E | Farm RE/336. Poortjie Member. Multiple superimposed sandstone tetrapod burrow casts giving teichichnoid-like geometry. Proposed Field Rating IIIB Local Resource. |
| **332** | 31°54'3.54"S 22° 3'23.56"E | Farm RE/336. Poortjie Member. Purple-brown siltstones containing numerous tetrapod burrow casts of various dimensions, *c*. 12 c, up to 30 cm across – possibly a warren / colony. Proposed Field Rating IIIB Local Resource. |
| **333** | 31°54'1.38"S 22° 3'25.13"E | Farm RE/336. Poortjie Member. Purple-brown siltstones containing numerous tetrapod burrow casts of various dimensions. Proposed Field Rating IIIB Local Resource. |
| **334** | 31°53'52.90"S 22° 4'37.42"E | Farm RE/336. Poortjie Member. Extensive hillslope exposures of mudrocks and sandstones. Small (< 5mm wide) invertebrate horizontal burrows within cross-laminated sandstone. Numerous cryptic vertebrate burrow casts (*e.g.* smoothed and bioturbated burrow floors). Proposed Field Rating IIIB Local Resource. |
| **335** | 31°53'54.09"S 22° 4'37.44"E | Farm RE/336. Poortjie Member. Thin, laterally extensive, thin-bedded sandstone package above purple-brown tetrapod burrow zone with wave rippled bed surfaces, microbial mat textures, range of epichnial invertebrate trace fossils including narrow sinuous burrows of possible under-mat miners, pellet-infilled burrows (*c*. 1 cm wide). Proposed Field Rating IIIB Local Resource. If site lies < 20 m from final approved footprint, pre-construction fossil recording and sampling by a professional palaeontologist is recommended in the pre-construction phase. |
| **336** | 31°53'52.81"S 22° 4'35.82"E | Farm RE/336. Poortjie Member. Extension of wave rippled sandstone palaeosurface with a range of epichnial invertebrate trace fossils. Proposed Field Rating IIIB Local Resource. |
| **447** | 31°57'1.66"S 22° 7'54.21"E | Farm 1/28. Poortjie Member (as mapped). Isolated hillslope exposure of baked dark grey mudrocks with pedocrete horizons, thin crumbly sandstones capped by substantial cross-bedded, baked channel sandstone body. Possible altered stellate gypsum roses. Poorly preserved skeletal remains within a baked calcrete concretion. Possible but equivocal sandstone tetrapod burrow casts. Proposed Field Rating IIIC Local Resource. |
| **450** | 31°56'58.89"S 22° 7'58.97"E | Farm 1/28. Poortjie Member (as mapped). Extensive hillslope exposure of dark crumbly mudrocks west of Modderpoort se dam. Several float blocks of pale yellowish baked sandstone containing poorly-preserved postcrania of a small dicynodont, including partial skull. Mud-lined tetrapod burrow (*c*. 20 cm wide). Proposed Field Rating IIIC Local Resource. |
| **451** | 31°56'58.67"S 22° 7'56.33"E | Farm 1/28. Poortjie Member (as mapped). Mottled grey siltstone with poorly-preserved, baked, *in situ* bone material, equivocal tetrapod burrows. Proposed Field Rating IIIC Local Resource. |
| **453** | 31°58'8.81"S 22° 7'25.58"E | Farm 1/28. Stream bed exposure of speckled, baked sandstone with disarticulated baked postcranial bones of small tetrapod. Proposed Field Rating IIIC Local Resource. |
| **455** | 31°58'45.50"S 22° 7'8.66"E | Farm 4/28. Hoedemaker Member. Shallow but extensive streambed and bank exposures of baked grey mudrocks. Scattered ribs and other postcrania. Proposed Field Rating IIIB Local Resource. |
| **456** | 31°58'45.43"S 22° 7'8.82"E | As above. Isolated lower jaw of small dicynodont. Proposed Field Rating IIIB Local Resource. |
| **457** | 31°58'45.43"S 22° 7'8.94"E | As above. Poorly preserved skull and postcrania of small tetrapod. Proposed Field Rating IIIB Local Resource. |
| **458** | 31°58'45.47"S 22° 7'9.03"E | As above. Probable small, poorly-preserved skull. Proposed Field Rating IIIB Local Resource. |
| **459** | 31°58'45.30"S 22° 7'9.13"E | As above. Partially articulated postcrania of small tetrapod. Proposed Field Rating IIIB Local Resource. |
| **460** | 31°58'45.56"S 22° 7'9.10"E | As above. Delicate, curved rib cage of small tetrapod, perhaps curled-up in burrow. Proposed Field Rating IIIB Local Resource. |
| **461** | 31°58'45.60"S 22° 7'9.67"E | As above. Smooth floor of tetrapod burrow. Proposed Field Rating IIIB Local Resource. |
| **462** | 31°58'45.64"S 22° 7'10.53"E | As above. Stretched out postcrania, including rib cage, limb bones, of small tetrapod. Proposed Field Rating IIIB Local Resource. |
| **463** | 31°58'45.68"S 22° 7'10.55"E | As above. Subhorizontal tetrapod burrow cast (baked sandstone). Proposed Field Rating IIIB Local Resource. |
| **464** | 31°58'45.69"S 22° 7'10.64"E | As above. Inclined baked, ferruginised sandstone tetrapod burrow cast preserved in 3d. Proposed Field Rating IIIB Local Resource. |

| | | |
|---|---|---|
| **465** | 31°58'45.79"S 22° 7'10.61"E | As above. Subhorizontal tetrapod burrow cast and probable partial terminal chamber. Proposed Field Rating IIIB Local Resource. |
| **466** | 31°58'45.80"S 22° 7'10.67" E | As above. Disarticulated ribs and other postcranial elements. Proposed Field Rating IIIB Local Resource. |
| **468** | 31°58'45.76"S 22° 7'10.90" E | As above. Baked subhorizontal sandstone tetrapod burrow casts. Proposed Field Rating IIIB Local Resource. |
| **469** | 31°58'46.61"S 22° 7'11.55"E | As above. Shallow riverbank section through baked, crumbly dark grey mudrocks with *in situ* articulated postcrania and separate poorly-preserved skull of small tetrapod. Proposed Field Rating IIIB Local Resource. |
| **470** | 31°58'46.50"S 22° 7'11.85"E | As above. Delicate semi-articulated postcrania of small tetrapod, including rib cage, backbone and limbs. Proposed Field Rating IIIB Local Resource. |
| **471** | 31°58'47.31"S 22° 7'12.19"E | As above. Poorly-preserved bone material. Proposed Field Rating IIIB Local Resource. |
| **472** | 31°58'47.48"S 22° 7'12.06"E | As above. Poorly preserved subhorizontal tetrapod burrow cast. Proposed Field Rating IIIB Local Resource. |
| **473** | 31°58'47.57"S 22° 7'12.10"E | As above. Poorly preserved subhorizontal tetrapod burrow cast. Proposed Field Rating IIIB Local Resource. |
| **474** | 31°58'47.86"S 22° 7'11.94"E | As above. Smooth-floored burrow with delicate, articulated postcranial skeleton (ribs, limbs) plus skull of a small tetrapod inside. Presence of long tail suggests cynodont / therocephalian rather than dicynodont affinities. Proposed Field Rating IIIB Local Resource. |
| **475** | 31°58'47.88"S 22° 7'11.81"E | As above. Jumbled concentration of disarticulated small postcranial bones. Proposed Field Rating IIIB Local Resource. |
| **476** | 31°58'47.71"S 22° 7'11.70" E | As above. Semi-articulated concentration of small postcranial bones. Proposed Field Rating IIIB Local Resource. |
| **477** | 31°58'47.95"S 22° 7'11.59" E | As above. Poorly-preserved delicate postcrania (ribs, vertebrae) of small tetrapod within burrow cast. Proposed Field Rating IIIB Local Resource. |
| **478** | 31°58'48.12"S 22° 7'11.79"E | As above. Smooth-floored tetrapod burrow cast. Proposed Field Rating IIIB Local Resource. |
| **479** | 31°58'48.52"S 22° 7'10.80"E | As above. Articulated ribs, vertebrae of small tetrapod. Proposed Field Rating IIIB Local Resource. |
| **480** | 31°58'46.86"S 22° 7'12.94"E | As above. Indeterminate baked bone. Proposed Field Rating IIIB Local Resource. Proposed Field Rating IIIB Local Resource. |
| **481** | 31°58'46.86"S 22° 7'13.02"E | As above. Possible small pear-shaped skull (with snout?) – perhaps a theriodont. Proposed Field Rating IIIB Local Resource. |
| **482** | 31°58'46.76"S 22° 7'13.68"E | As above. Probable large, gently inclined tetrapod burrow cast, partially ferruginised, expanding from 30 cm wide tunnel to c. 45 cm wide terminal chamber and descending through c. 1 m of sediment. Terminated just above dolerite sill. Proposed Field Rating IIIB Local Resource. |
| **483** | 31°58'47.27"S 22° 7'12.08"E | As above. Poorly preserved postcrania. Proposed Field Rating IIIB Local Resource. |
| **484** | 31°58'45.65"S 22° 7'4.04"E | As above. Poorly preserved postcrania. Proposed Field Rating IIIB Local Resource. |
| **485** | 31°58'45.80"S 22° 7'4.06"E | As above. Pale patches comprising a thin layer of finely-comminuted bone hash overlying grey-green baked wacke. Teeth not observed but might be present. Proposed Field Rating IIIB Local Resource. |
| **486** | 31°58'45.70"S 22° 7'3.98"E | As above. Small (*c*. 6 cm long) poorly-preserved skull. *Possibly* with teeth. Proposed Field Rating IIIB Local Resource. |
| **487** | 31°58'45.71"S 22° 7'3.99"E | As above. Isolated small lower jaw. Proposed Field Rating IIIB Local Resource. |
| **488** | 31°58'45.66"S 22° 7'2.74"E | As above. Probable small skull (*c*. 6 cm long). Proposed Field Rating IIIB Local Resource. |
| **489** | 31°58'45.62"S 22° 7'2.88"E | As above. Probable small skull (*c*. 6 cm long). Proposed Field Rating IIIB Local Resource. |
| **490** | 31°58'45.84"S 22° 7'3.06"E | As above. Probable small skull (*c*. 6 cm long). Proposed Field Rating IIIB Local Resource. |
| **491** | 31°58'45.65"S 22° 7'2.36"E | As above. Possible juvenile dicynodont skull (*c*. 4 cm long). Occasional tetrapod burrow in vicinity. Proposed Field Rating IIIB Local Resource. |
| **492** | 31°58'45.84"S 22° 7'1.76" | As above. Possible small partial skull. Proposed Field Rating IIIB Local Resource. |
| **493** | 31°58'45.79"S 22° 7'1.50"E | As above. Probable small skull (*c*. 4 cm long). Possible juvenile. Proposed Field Rating IIIB Local Resource. |
| **494** | 31°58'46.15"S 22° 7'1.22"E | As above. Probable small skull (*c*. 4 cm long). Possible juvenile. Proposed Field Rating IIIB Local Resource. |
| **495** | 31°59'21.74"S 22° 6'51.18"E | Farm 4/28. Streambed exposure of grey-green baked mudrocks with scrappy skeletal remains, including possible skull material. Proposed Field Rating IIIB Local Resource. |

| | | |
|---|---|---|
| **501** | 31°58'55.70"S 22° 5'8.67"E | Farm 4/28. Hoedemaker Member. Escarpment gulley exposures of prey-green and purple-brown mudrocks, wackes, with sparse gypsum pseudomorphs. Float block of sandstone tetrapod burrow cast with scratch marks. Proposed Field Rating IIIC Local Resource. |
| **502** | 31°58'55.80"S 22° 5'9.36"E | Farm 4/28. Hoedemaker Member. Isolated, fragmentary, sun-cracked rib or limb bone of medium-sized tetrapod in float. Proposed Field Rating IIIB Local Resource. |
| **503** | 31°58'55.11"S 22° 5'9.68"E | Farm 4/28. Hoedemaker Member. Baked skull of small dicynodont within grey siltstone matrix. Partial postcrania in vicinity. Proposed Field Rating IIIB Local Resource. |
| **505** | 31°59'22.87"S 22° 6'49.72"E | Farm 4/28. Hoedemaker member. Exstrensive stream gulley exposure of baked grey-green mudrock with only a few bone scraps, occasional narrow (c. 2cm), mud-lined horizontal invertebrate burrow. Proposed Field Rating IIIB Local Resource. |

Fossil sites recorded during the palaeontological site visit for the Hoogland Southern Wind Farm Cluster (orange numbered dots, tabulated above) as well as those recorded during previous site visits to the Nuweveld Wind Farm project area (yellow, pale orange and green numbered dots, tabulated in Almond 2020a-c, 2021) are mapped on Google Earth© satellite images in Figures A2.1 to A2.4 below.

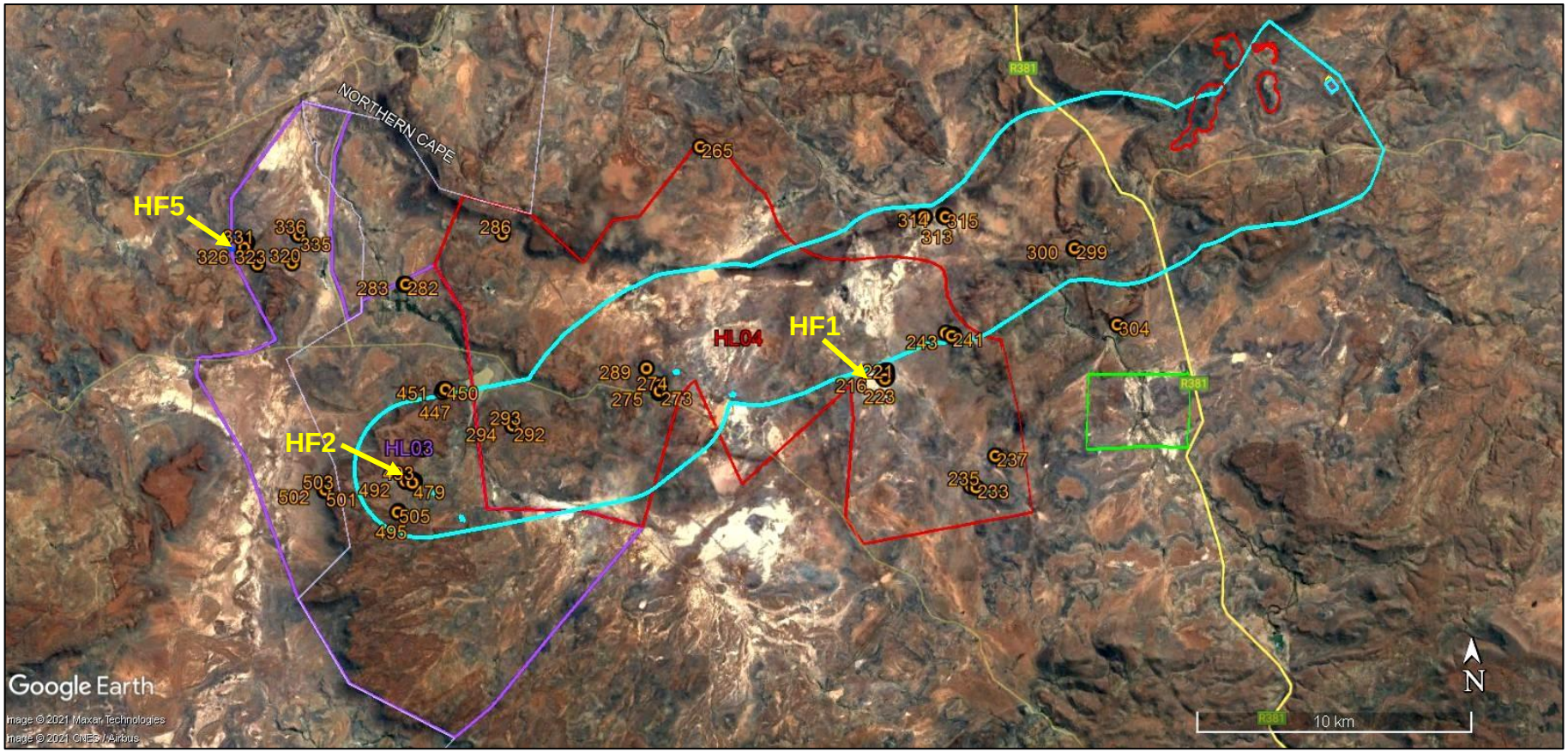


**Figure A2.1: Google Earth© satellite image of the Hoogland Southern Cluster project area (Hooglad 3 WEF project area – purple; Hoogland 4 WF project area – red; Southern Grid Connection Corridor – pale blue) showing the location of recently recorded fossil sites, numbered in orange. Small red areas in the NE are Very High Paleosensitivity areas previously mapped within the Nuweveld Wind Farm project area (See Figure A2.4 for additional fossil sites in the vicinity). The green rectangle is the recently designated Type Area for the *Tropidostoma – Gorgonops* Subzone on the Farm Dunedin. Detailed satellite maps of the Hoogland Fossil Site 1, Hoogland Fossil Site 2 and Hoogland Fossil Site 5 (HF1, HF2 and HF5 respectively), where high concentrations of fossils of scientific and conservation interest have been recorded, are provided in Section 6 of the PIA report.**

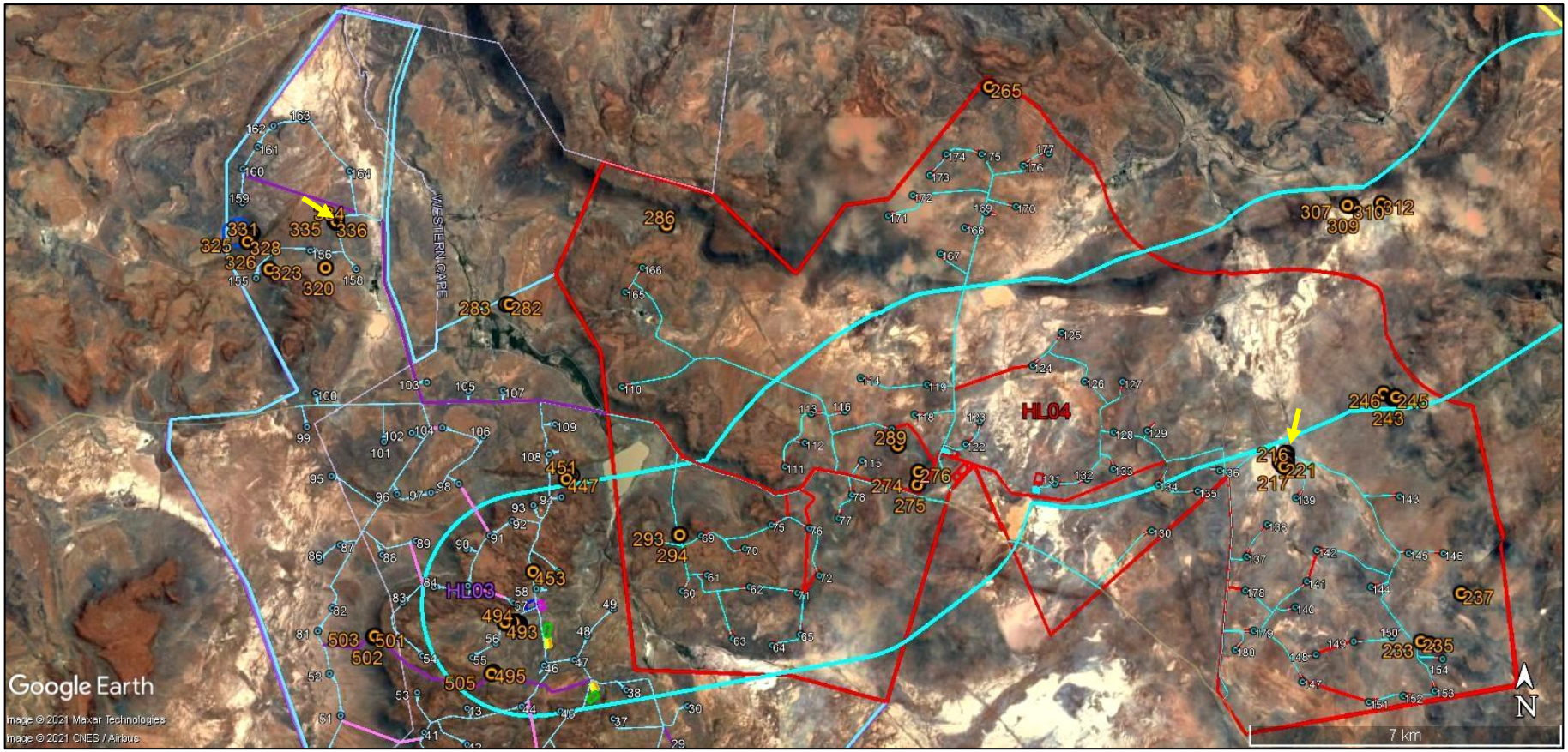


**Figure A2.2: Google Earth© satellite image of the Hoogland 4 Wind Farm project area (red polygon) and adjoining northern sector of the Hoogland 3 Wind Farm project area (pale blue polygon) and Hoogland Southern Grid Connection project area (elongate pale blue shape) showing the location of new fossil sites (orange numbered dots). Also shown are *selected* key elements of the wind farm infrastructure layout including: wind turbine positions (small numbered blue dots), access roads (thin blue lines), on-site substations and BESS (small yellow and green rectangles), site camp and batching plant (purple rectangle) and laydown area (blue rectangle). With the exception of fossil sites 209-212 and 335 (arrowed; see also satellite maps in main text of the report, Figures 6.1 to 6.3), none of the recorded sites lies within or close to (≤ 20 m) the footprint of the proposed WEF layout and therefore no mitigation of these sites is necessary.**

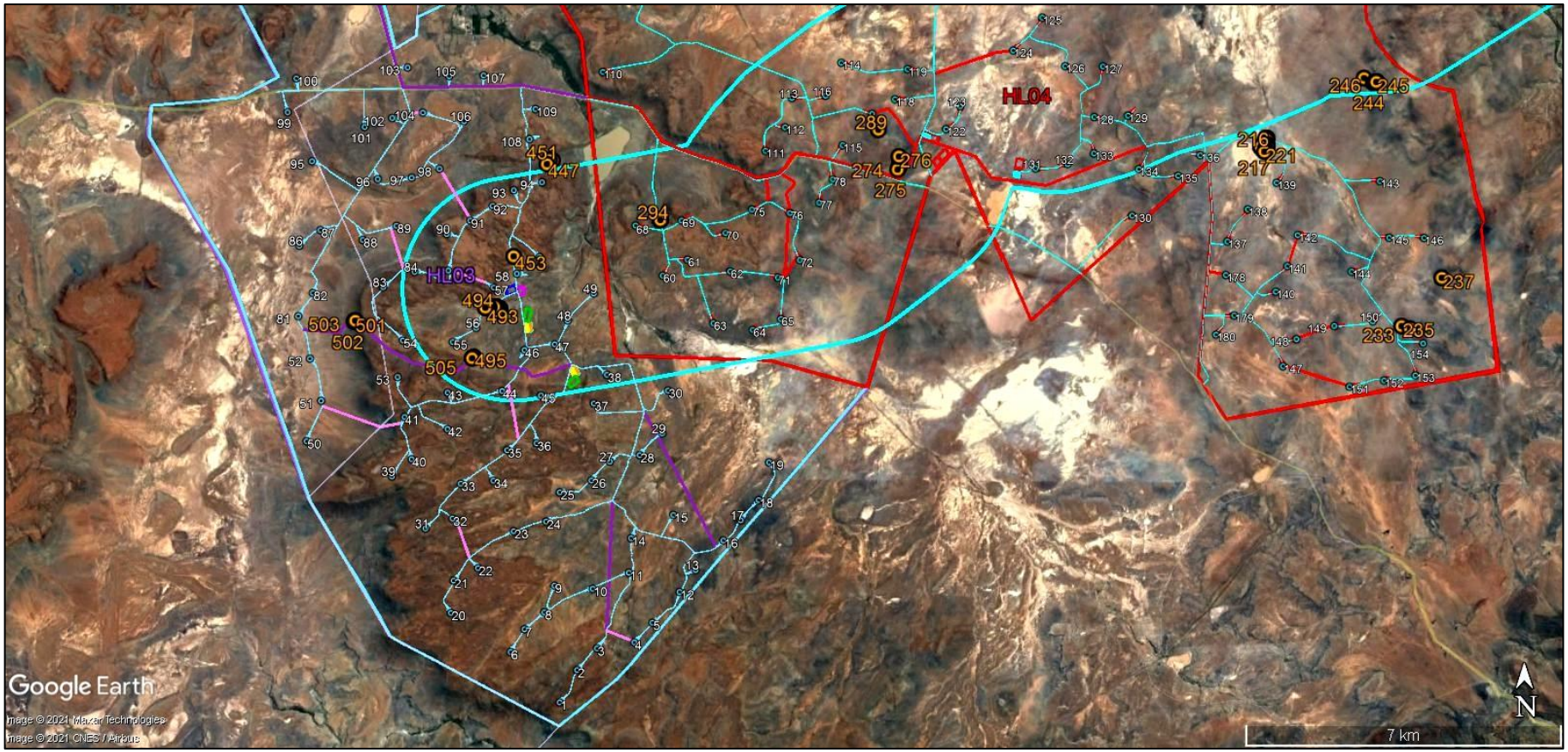


**Figure A2.3: Google Earth© satellite image of the southern portions of the adjoining Hoogland 3 Wind Farm project area (pale blue polygon) and the Hoogland 4 Wind Farm project area (red polygon) and the Hoogland Southern Grid Connection project area (elongated pale blue shape) showing the location of new fossil sites (orange numbered dots). Also shown are *selected* key elements of the wind farm infrastructure layout including: wind turbine poitions (small numbered blue dots), access roads (thin blue lines), on-site substations and BESS (small yellow and green rectangles), site camp and batching plant (purple rectangle) and laydown area (blue rectangle). Only a hardful of the recorded sites lies within or close to (≤ 20 m) the footprint of the proposed WEF layout and therefore no mitigation of these sites is necessary.**

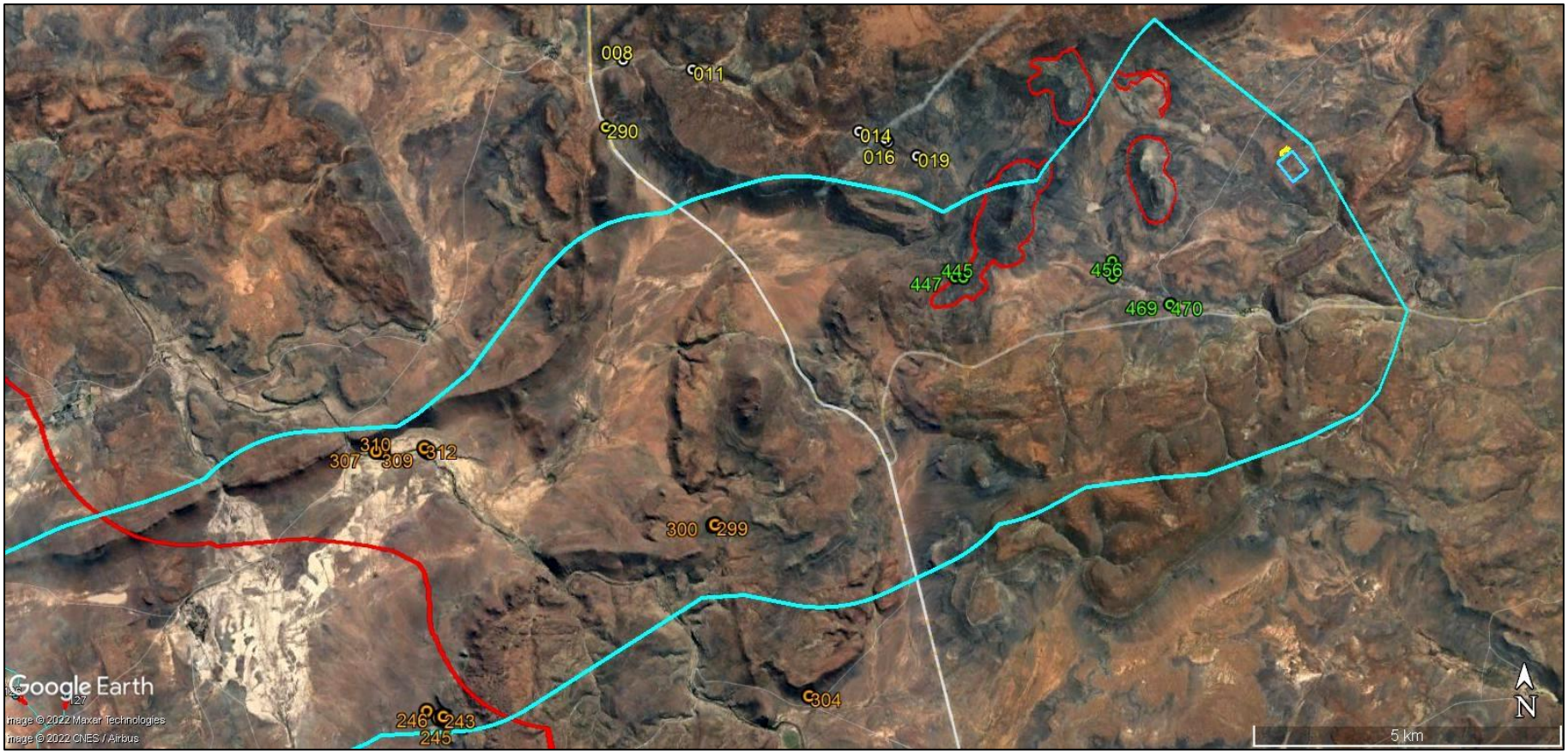


**Figure A2.4: Google Earth© satellite image of the eastern sector of the Hoogland Southern Grid Connection project area (elongated pale blue shape) showing additional fossil sites previously recorded within the overlapping sector of the Nuweveld East Wind Farm (pale yellow and green numbered dots). Palaeontological mitigation for these sites, as well for the four small Very High Palaeosensitivity areas outlined here in red, has been treated in the relevant PIA report for the Nuweveld East Wind Farm by Almond (2020c).**

## APPENDIX 3: PALAEONTOLOGICAL HERITAGE SITE SENSITIVITY VERIFICATION: HOOGLAND 3 WIND FARM, HOOGLAND 4 WIND FARM & HOOGLAND SOUTHERN GRID CONNECTION, WESTERN CAPE

### SUMMARY

The Low to Very High Palaeosensitivity provisionally proposed by the DFFE screening tool for the combined project area for the Hoogland Southern Cluster of wind farms and associated Southern Grid Connection is *contested* here. Based on desktop analysis as well as a ten-day site visit to the project area, it is concluded that this is largely of Low Palaeosensitivity with sparse, small and largely unpredictable sites of High to Very High Palaeosensitivity.

### INTRODUCTION

Red Cap Energy (Pty) Ltd ('Red Cap') is proposing to develop four wind farms and associated grid connections (together known as the Hoogland Projects) in an area located between Loxton and Beaufort West in the Northern and Western Cape Provinces (
Figure A3.**1: Locality** and Figure A3.2**: Map showing** ). Each wind farm would have a targeted nameplate capacity of up to a maximum of 420 MW and would involve the construction of no more than 60 turbines each.

The Hoogland 3 Wind Farm and Hoogland 4 Wind Farm project areas are located to the south, closer to Beaufort West, and form the Southern Cluster of wind farms which will share a grid connection, named the Hoogland Southern Grid Connection. The Grid Connection will comprise a 132 kV overhead power line which will connect the Hoogland Wind Farms to the Nuweveld Collector Substation on Red Cap's adjacent Nuweveld Wind Farms Project. Power will then be fed into the Eskom Droërivier Substation located near Beaufort West *via* the proposed Nuweveld Gridline.

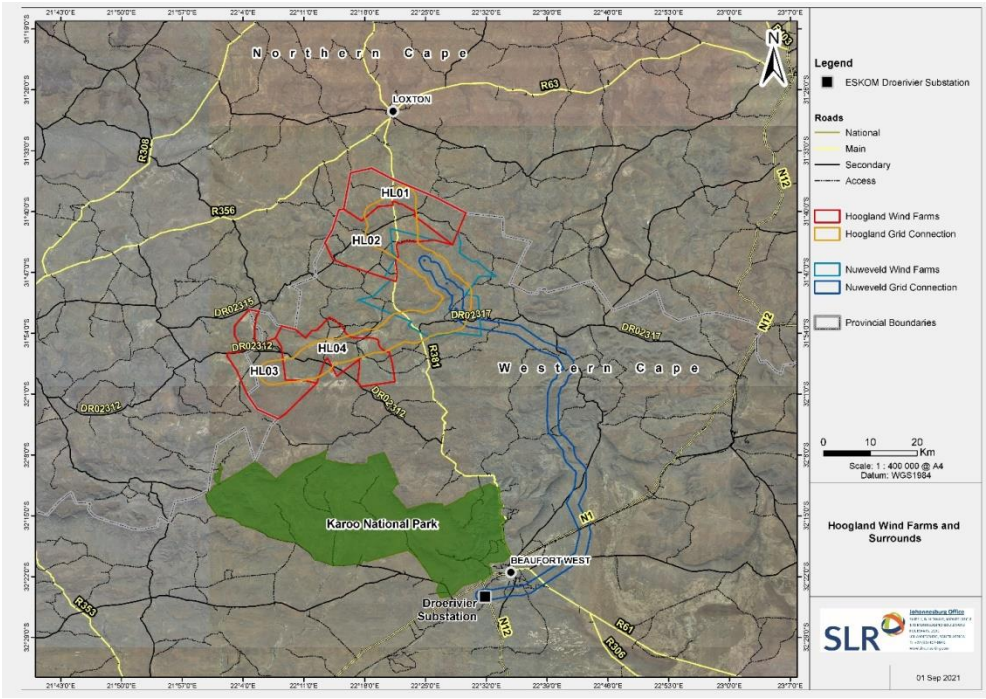


**Figure A3.1: Locality Map of the Proposed Hoogland Wind Farms and associated Grid Corridor showing the adjacent Nuweveld Wind Farms and Grid Connection (part of six separate application processes).**

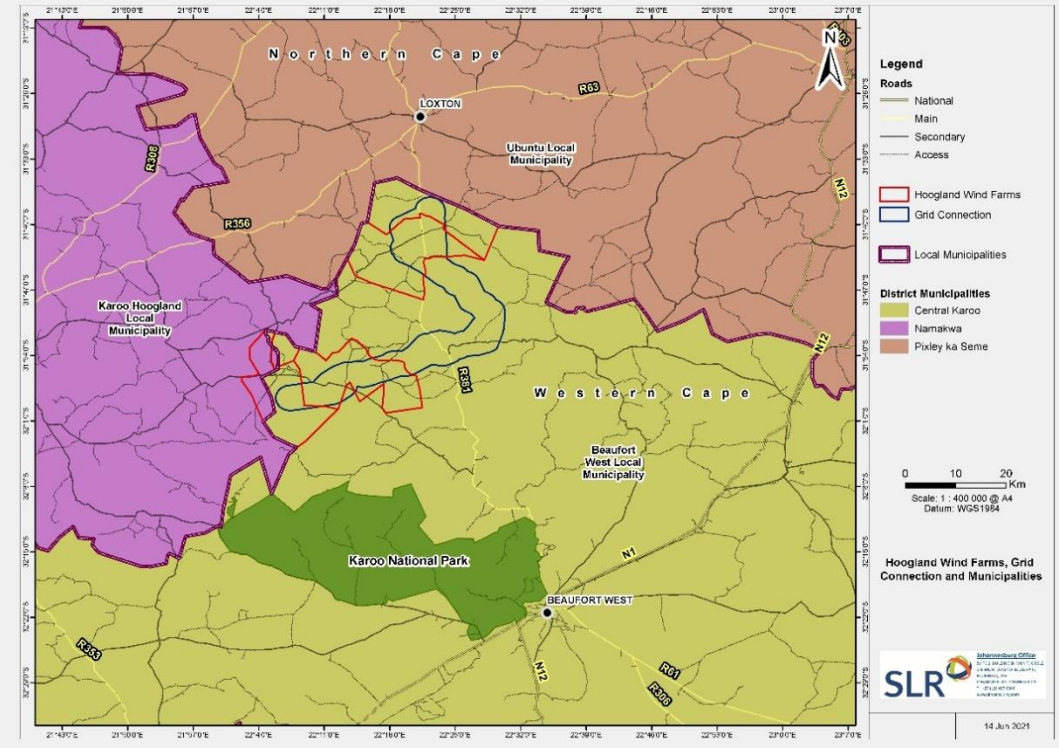


**Figure A3.2: Map showing the location of the proposed Hoogland Wind Farms and associated Grid Connection Corridor (part of 6 separate application processes). The Hoogland 3 Wind Farm, Hoogland 4 Wind Farm and associated Hoogland Southern Grid Connection lie within the Central Karoo District Municipality of the Western Cape Province as well as the Namaqua District Municipality of the Northern Cape Province.**

In terms of the National Environmental Management Act (Act 107 of 1998, as amended) (NEMA) Environmental Impact Assessment (EIA) Regulations (4 December 2014, Government Notice (GN) R982, R983, R984 and R985, as amended), various aspects of the proposed development may have an impact on the environment and are considered to be listed activities. These activities require authorisation from the National Competent Authority (CA), namely the Department of Forestry, Fisheries and the Environment (DFFE), prior to the commencement thereof.

In accordance with GN 320 and GN 1150 (20 March 2020)[2] of the NEMA EIA Regulations of 2014, prior to commencing with a specialist assessment, a site sensitivity verification must be undertaken to confirm the current land use and environmental sensitivity of the proposed project area as identified by the National Web-Based Environmental Screening Tool (Screening Tool). Dr John Almond (*Natura Viva* cc) has been commissioned to verify the palaeontological heritage sensitivity of the Hoogland Wind Farm and Grid Connection project sites under these specialist protocols.

The scope of this report is the Hoogland 3 Wind Farm and Hoogland 4 Wind Farm (the Southern Wind Farm Cluster) as well as the Hoogland Southern Grid Connection applications. Even though these are three separate applications they will be considered in the same specialist site sensitivity verification report, given their very similar geological and palaeontological heritage character.

[2] [2] GN 320 (20 March 2020): Procedures for The Assessment and Minimum Criteria for Reporting on Identified Environmental Themes in terms of Sections 24(5)(A) and (H) and 44 of the National Environmental Management Act, 1998, when applying for Environmental Authorisation

## 1. SITE SENSITIVITY VERIFICATION METHODOLOGY

The present palaeontological site sensitivity verification is based on:

(1) A desktop review of relevant 1:50 000 scale topographic maps, Google Earth© satellite imagery, published geological and palaeontological literature, including 1:250 000 geological maps (3122 Victoria West) and the relevant sheet explanations (Le Roux & Keyser 1988) as well as recent palaeontological heritage assessments (PIAs) in the Upper Karoo region near Loxton by the author (*viz*: Nuweveld Wind Farm projects, Hoogland 1 Wind Farm and Hoogland 2 Wind Farm);

(2) The author's field experience with the formations concerned and their palaeontological heritage; and

(3) A ten-day field assessment of the combined Hoogland 3 Wind Farm, Hoogland 4 Wind Farm project areas during the period 11 to 18 May as well as 24 to 26 May 2021. This study also makes reference to field data for sectors of the Southern Grid Connection corridor that overlap the project area of the Nuweveld Wind Farm cluster and that were previously assessed by Almond (2020a-c, 2021).

## OUTCOME OF SITE SENSITIVITY VERIFICATION

Provisional palaeosensitivity mapping using the DFFE Screening Tool suggests that the majority of the combined Hoogland 3 Wind Farm, Hoogland 4 Wind Farm and Hoogland Southern Grid Connection project area is of Very High palaeosensitivity based on the widespread occurrence here of Permian age sedimentary bedrocks of the Lower Beaufort Group (Karoo Supergroup) (Figs. A3.3 to A3.5). Areas underlain by thick Late Caenozoic alluvium are assigned a Low to Medium palaeosensitivity while dolerite intrusions (igneous rocks) are not sensitive at all.

The ten-day palaeontological site visit indicated that, in practice, well-preserved fossils of scientific and conservation interest are remarkably rare within the Lower Beaufort Group bedrocks within Hoogland project area as a whole. This is attributed to (a) poor levels of bedrock exposure associated with generally low relief and pervasive cover by largely unfossiliferous superficial sediments; (b) extensive dolerite intrusion which has "sterilized" large volumes of potentially fossiliferous bedrocks through thermal metamorphism, leaching and secondary mineralisation, while the large dolerite outcrop areas in the uplands are completely fossil-free; (c) highly impoverished fossil biotas within the upper Abrahamskraal – Poortjie Member stratigraphic interval that are associated with the catastrophic end Middle Permian Mass Extinction Event of ~260 Ma. Only three limited areas of High Sensitivity, featuring concentrations of small vertebrate skeletal remains and tetrapod burrows, have been identified here so far. The pervasive Late Caenozoic cover sediments, including alluvium, are also largely unfossiliferous, mainly yielding low diversity trace fossils of widespread occurrence and limited scientific or conservation value.

Based on this recent field data as well as desktop analysis, it is concluded that the combined Hoogland 3 Wind Farm, Hoogland 4 Wind Farm and Hoogland Southern Grid Connection project areas is effectively of Low Palaeosensitivity overall. The presence of additional small, hitherto unrecorded pockets of High to Very High palaeosensitivity cannot be discounted, however. The provisional DFFE site sensitivity mapping is accordingly *contested* here.

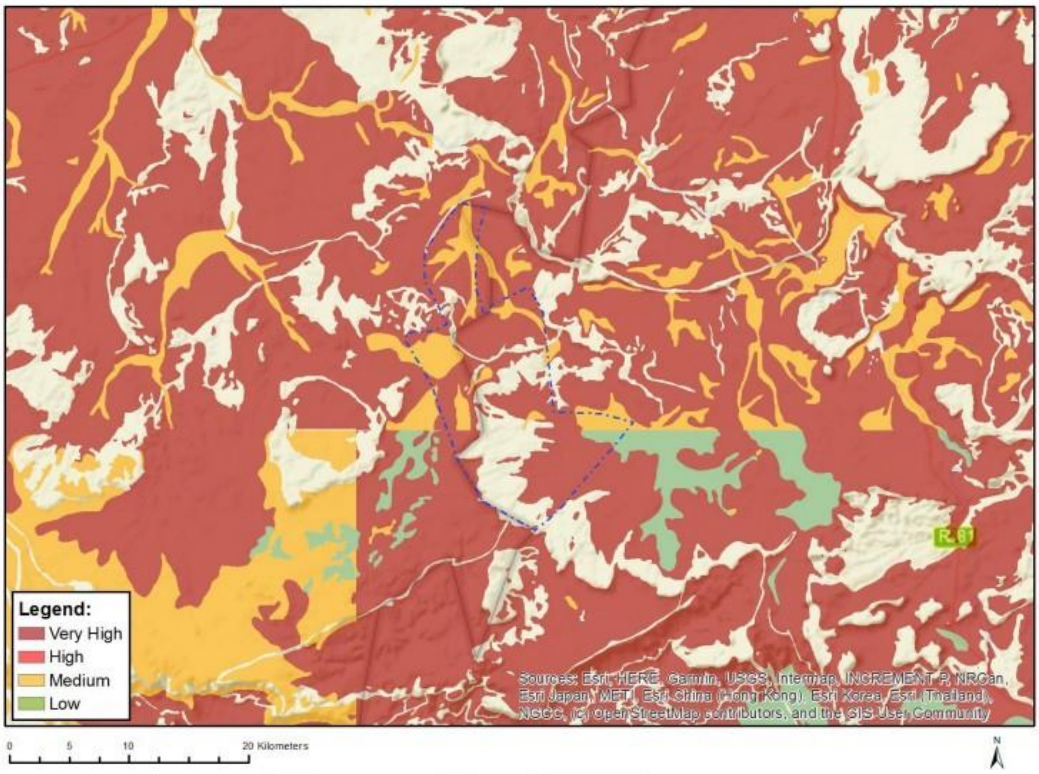


**Figure A3.3: Palaeosensitivity of the Hoogland 3 Wind Farm project area (blue polygon) based on the DFFE Screening Tool (Abstracted from screening report provided by SLR Consulting).**

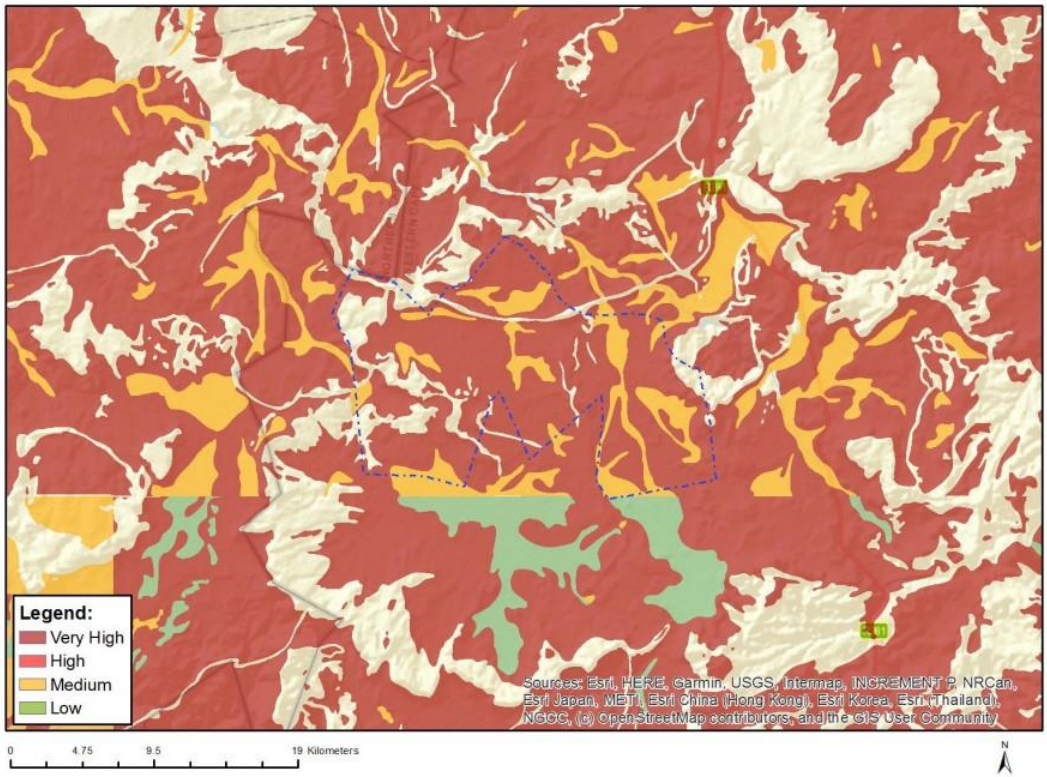


**Figure A3.4: Palaeosensitivity of the Hoogland 4 Wind Farm project area (blue polygon) based on the DFFE Screening Tool (Abstracted from screening report provided by SLR Consulting).**

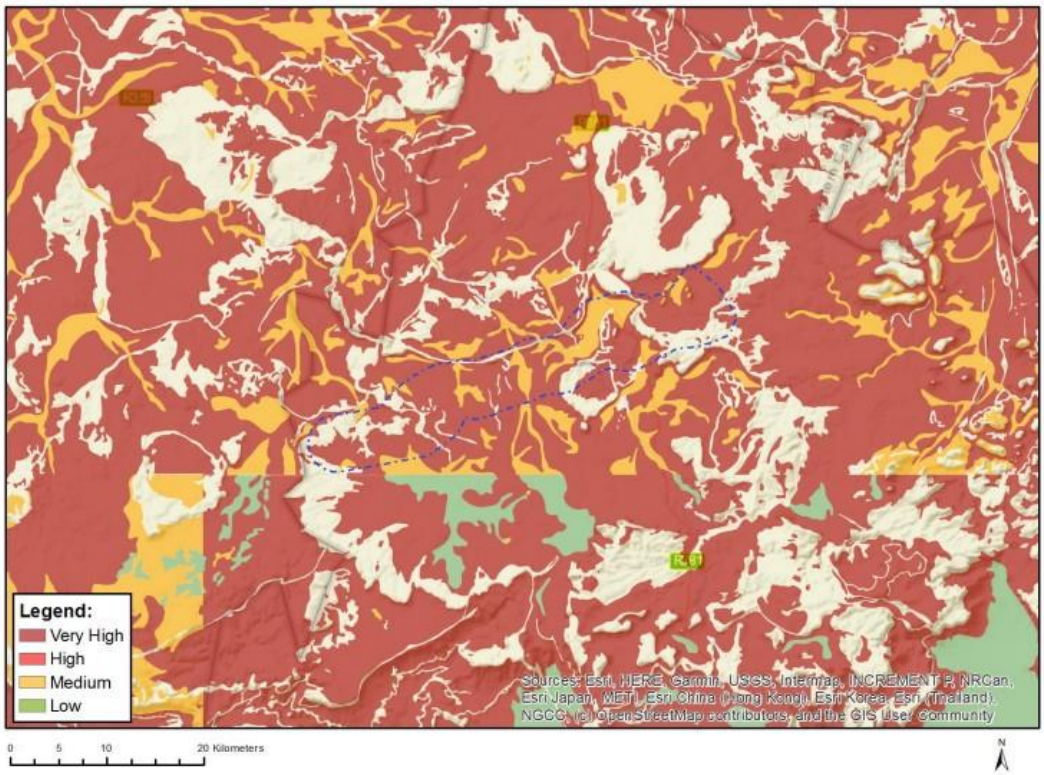


**Figure A3.5: Palaeosensitivity of the Hoogland Southern Grid Connection project area (blue polygon) based on the DFFE Screening Tool (Abstracted from screening report provided by SLR Consulting).**

## APPENDIX 4: CHANCE FOSSIL FINDS PROTOCOL

<table>
<tr><td colspan="3">HOOGLAND SOUTHERN WIND FARM CLUSTER and GRID CONNECTION south of Loxton, Western Cape</td></tr>
<tr><td>Province & region:</td><td colspan="2">Western Cape (Central Karoo District): Beaufort West Local Municipality; Northern Cape (Namaqua District): Karoo Hoogland Local Municipality</td></tr>
<tr><td>Responsible Heritage Resources Agency</td><td colspan="2">Western Cape: Heritage Western Cape (Contact details: Heritage Western Cape. 3rd Floor Protea Assurance Building, 142 Longmarket Street, Green Market Square, Cape Town 8000. Private Bag X9067, Cape Town 8001. Tel: 021 483 5959 Email: ceoheritage@westerncape.gov.za)<br>Northern Cape: SAHRA, 111 Harrington Street, Cape Town. PO Box 4637, Cape Town 8000, South Africa. Phone: +27 (0)21 462 4502. Fax: +27 (0)21 462 4509. Web: www.sahra.org.za</td></tr>
<tr><td>Rock unit(s)</td><td colspan="2">Teekloof Formation (Lower Beaufort Group), Late Caenozoic alluvium</td></tr>
<tr><td>Potential fossils</td><td colspan="2">Fossil vertebrate bones, teeth, trace fossils including burrows, trackways, petrified wood, plant-rich beds in the Lower Beaufort Group bedrocks.<br>Fossil mammal bones, teeth, horn cores, freshwater molluscs, plant material in Late Caenozoic alluvium.</td></tr>
<tr><td rowspan="5">ECO/ESO protocol</td><td colspan="2">1. Once alerted to fossil occurrence(s): alert site foreman, stop work in area immediately (N.B. safety first!), safeguard site with security tape / fence / sand bags if necessary.</td></tr>
<tr><td colspan="2">2. Record key data while fossil remains are still in situ:<br>• Accurate geographic location – describe and mark on site map / 1: 50 000 map / satellite image / aerial photo<br>• Context – describe position of fossils within stratigraphy (rock layering), depth below surface<br>• Photograph fossil(s) in situ with scale, from different angles, including images showing context (e.g. rock layering)</td></tr>
<tr><td>3. If feasible to leave fossils in situ:<br>• Alert Heritage Resources Agency and project palaeontologist (if any) who will advise on any necessary mitigation<br>• Ensure fossil site remains safeguarded until clearance is given by the Heritage Resources Agency for work to resume</td><td>3. If not feasible to leave fossils in situ (emergency procedure only):<br>• Carefully remove fossils, as far as possible still enclosed within the original sedimentary matrix (e.g. entire block of fossiliferous rock)<br>• Photograph fossils against a plain, level background, with scale<br>• Carefully wrap fossils in several layers of newspaper / tissue paper / plastic bags<br>• Safeguard fossils together with locality and collection data (including collector and date) in a box in a safe place for examination by a palaeontologist<br>• Alert Heritage Resources Agency and project palaeontologist (if any) who will advise on any necessary mitigation</td></tr>
<tr><td colspan="2">4. If required by Heritage Resources Agency, ensure that a suitably-qualified specialist palaeontologist is appointed as soon as possible by the developer.</td></tr>
<tr><td colspan="2">5. Implement any further mitigation measures proposed by the palaeontologist and Heritage Resources Agency</td></tr>
<tr><td>Specialist palaeontologist</td><td colspan="2">Record, describe and judiciously sample fossil remains together with relevant contextual data (stratigraphy / sedimentology / taphonomy). Ensure that fossils are curated in an approved repository (e.g. museum / university / Council for Geoscience collection) together with full collection data. Submit Palaeontological Mitigation report to Heritage Resources Agency. Adhere to best international practice for palaeontological fieldwork and Heritage Resources Agency minimum standards.</td></tr>
</table>